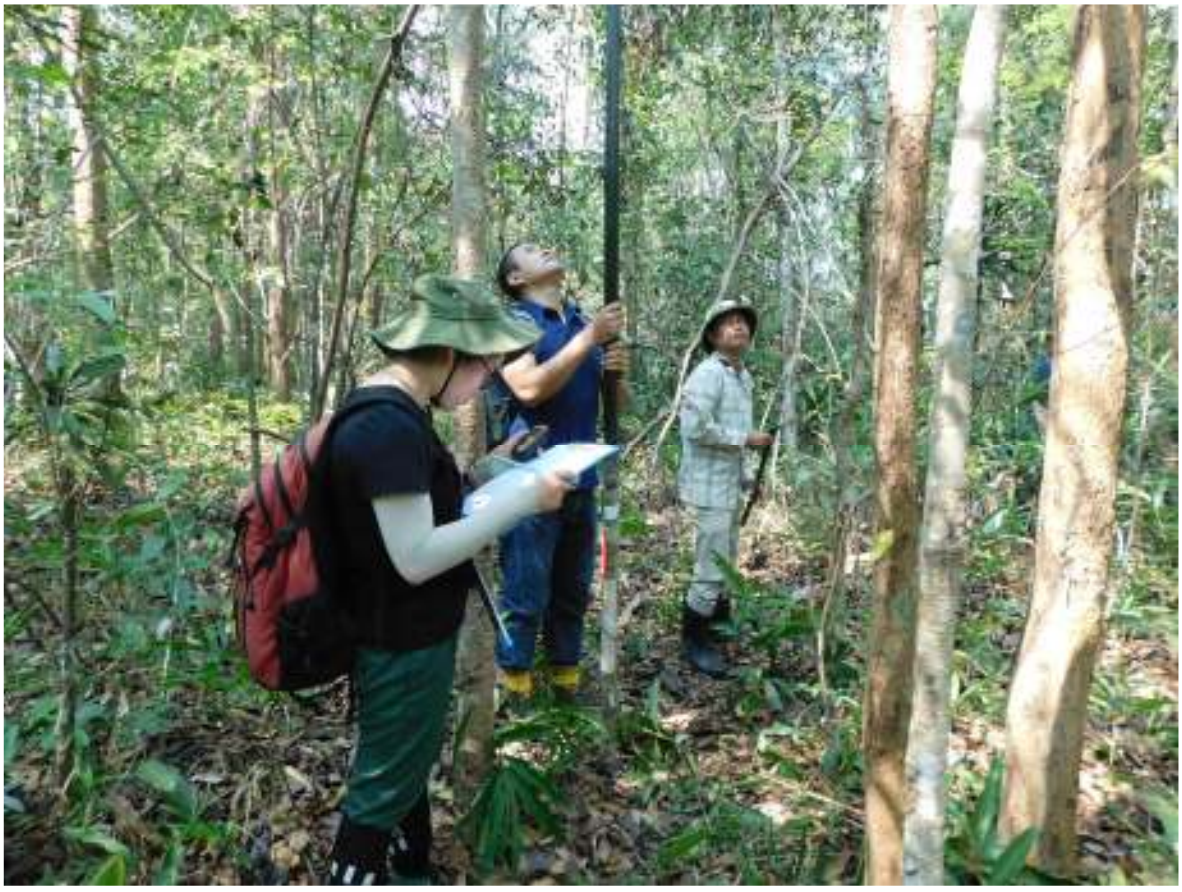
REPORT ON THE SYSTEMATIC FIELD SURVEY OF THE POPULATION DISTRIBUTION, ABUNDANCE AND STOCKING OF *DALBERGIA COCHINCHINENSIS* AND *DALBERGIA OLIVERI* IN FOUR KEY PROTECTED AREAS OF THE DAK UY SPECIAL-USE FOREST, THE BU GIA MAP, THE CAT TIEN AND THE YOK DON NATIONAL PARKS IN VIETNAM

Dinh Thi Kim Van[1], La Quang Trung[2], Ta Quoc Truong[3], Hoang Thanh Son[4] & Nguyen Manh Ha[5]



[1, 2, 3] Center for Nature Conservation and Development, No. 5, Alley 56/119, Tu Lien Street, Tay Ho district, Ha Noi, Vietnam. E-mail: van.dinh@ccd.org.vn

[4] Silviculture Research Institute of the Vietnam Academy of Forest Sciences, Duc Thang ward, Bac Tu Liem district, Hanoi, Vietnam. E-mail: hoangsonfsiv@gmail.com.

[5] CITES Management Authority of Vietnam, MARD, No. 2 Ngoc Ha Street, Ha Noi, Vietnam. E-mail: ha.nguyenba@gmail.com.

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENTS

The “Report on the systematic field survey of the population distribution, abundance and stocking of *D. cochinchinensis* and *D. oliveri* in four key protected areas of the Dak Uy Special-Use Forest, the Bu Gia Map, the Cat Tien and the Yok Don National Parks in Vietnam” was prepared based on the requirements of CITES Management Authority of Vietnam and the Center for Nature Conservation and Development through the project “Strengthening the management and conservation of *Dalbergia cochinchinensis* and *Dalbergia oliveri* in Vietnam”. This work was funded by the European Union through the CITES Tree Species Programme.

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On behalf of the project team.

Nguyen Manh Ha – Team Leader.

ACRONYMS AND ABBREVIATIONS

a.s.l	above sea level
cm	centimeter
CPC	Center for Plant Conservation
CCD	Center for Nature Conservation and Development
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
$D_{1.3}$	Diameter at 1.3 m from the ground level and equal to DBH
DBH	Diameter at Breast Height
D.	*Dalbergia*
Effective regenerants	Effective regenerants or effective seedlings/coppices are promising regenerating plants that have the potential to grow into trees. In contrast, ineffective regenerants or ineffective seedlings/coppices are unpromising regenerating plants that do not the potential to grow into trees.
EN	Endangered
FPD	Forest Protection Department
GPS	Global Positioning System
H	Tree height
ha	hectare
IUCN	International Union for Conservation of Nature
IV%	Important value is an index showing the importance level of a species in the forest structure and is expressed in %. The higher the IV%, the more dominant the species in the forest structure. Only species with IV% ≥ 5% are ecologically significant.
km	kilometer
MARD	Ministry of Agriculture and Rural Development
MOST	Ministry of Science and Technology
m	meter
m^2	square meter
m^3	cubic meter
mm	millimeter
ND-CP	Decree of the government
N-DBH distribution	Distribution of tree number by DBH class or Diameter distribution
N-H distribution	Distribution of tree number by tree height (H) class
NP	National Park
PA	Protected area
SUF	Special-Use Forests, known as Protected Areas, are mainly used to conserve natural forest ecosystems and genetic resources of forest organisms, carry out scientific research, preserve historical - cultural relics, beliefs and places of scenic beauty associated with ecotourism; and provide forest environmental services. SUFs include national parks; nature reserves; species and habitat conservation areas; landscape protection areas; and scientific research or experiment forests
TTg	Prime Minister
VAST	Vietnam Academy of Science and Technology
VUSTA	Vietnam Union of Science and Technology Associations

1. INTRODUCTION

Dalbergia cochinchinensis and *Dalbergia oliveri* are included in the rosewood group that has been used in Vietnam, China and other Southeast Asia countries for a long time. Their timber is well-known for durability, corrosion resistance, and termite resistance and has been used in making highly valuable furniture and handicrafts for a century (Nguyen et al., 2019b, 2019a). A study showed that the value of these species in international trade was up to US$ 6,000/m^3 (EIA, 2012). The market price of *D. cochinchinensis* was as high as US$ 20,000/m^3 (Wenbin & Xiufang, 2013). Recently, the price of *D. cochinchinensis* was even recorded much higher of up to US$ 93,000/m^3 and *D. oliveri* was at US$ 9,200 per cubic meter[1]. For this reason, *D. cochinchinensis* and *D. oliveri* have been the most heavily exploited and traded species not only in Vietnam but also in many countries in the world. In Vietnam, wild populations of *D. cochinchinensis* and *D. oliveri* were severely declined and these species were listed as endangered (EN) in the 2007 Vietnam Red Data Book (MOST & VAST, 2007). Unfortunately, for many years there were few protection and management measures and conservation and restoration efforts undertaken for these species. Furthermore, in recent times, there were no field surveys to assess the distribution, density and stocking of the remaining wild populations of these two species. Most studies were focused on the biological and ecological characteristics and ability of propagation (Pham et al., 2013, 2011), forest structure (Bui et al., 2018), genetic diversity and physiological responses (Hien & Phong, 2012; Hung et al., 2020). The remaining populations are likely small and fragmented in the wild.

In the latest review, *D. cochinchinensis* was thought to be sparsely distributed in Da Nang, Quang Nam (Hien and Phuoc Son districts), Kon Tum (Dak To, Dak Uy and Sa Thay districts), Gia Lai (Krong Pa district and Cheo Reo commune of Ayun Pa district), Dak Lak, Lam Dong (Blao/Bao Loc district), Binh Thuan (Ham Thuan Bac district), Binh Duong (Ben Cat), Dong Nai (Nam Cat Tien), Binh Phuoc, Ba Ria-Vung Tau (Dinh mountain), Ho Chi Minh City, Tay Ninh, and Kien Giang (Phu Quoc district) (Nguyen et al., 2019a). *Dalbergia oliveri* is likely to be distributed in Da Nang (Son Tra district), Quang Tri (Huong Hoa district), Kom Tum (Chu Mom Ray national park in Sa Thay and Dak To districts), Gia Lai (Krong Pa, La Grai, Duc Co and Chu Prong districts), Dak Lak (Ea Kar, Krong Nang and Lak districts, and Yok Don national park), Dak Nong (Dak Mil and Cu Jut districts), Lam Dong (Lang Biang and Di Linh districts), Dong Nai (Cat Tien national park and Dong Nai cultural nature reserve), Phu Yen, Khanh Hoa, Ninh Thuan (Ca Na commune of Thuan Nam district and Song Pha commune of Ninh Son district), Binh Thuan (Ham Thuan Bac district), Binh Phuoc (Bu Gia Map district), and in the Tay Ninh and Ba Ria-Vung Tau provinces (Xuyen Moc district) (Nguyen et al., 2019b). However, details on status, distribution, viable populations, abundance, stocking and regeneration ability of *D. cochinchinensis* and *D. oliveri* were unknown. It was believed that four protected areas in the Dak Uy Special-Use Forest, the Yok Don, Bu Gia Map and Cat Tien national parks, with a total area of about 211,000 hectares (ha) of natural forest may be the key sites for the existence, restoration and thriving populations of *D. cochinchinensis* and *D. oliveri*.

The project conducted field surveys in the Dak Uy Special-Use Forests (SUF), the Yok Don, Bu Gia Map and the Cat Tien national parks to collect data on *D. cochinchinensis* and *D. oliveri* to fill the gaps stated above. This report will present the findings of the surveys on the distribution, abundance, stocking and regeneration ability of *D. cochinchinensis* and *D. oliveri*. Results of the surveys will provide important inputs for the assessment and preparation of a non-detriment findings report.

[1] https://www.unodc.org/documents/wwcr/Rosewood.pdf

2. STUDY SITES

The four protected areas are located in six provinces in the central highland and south of Vietnam, where *D. cochinchinensis* and *D. oliveri* are naturally found (Nguyen et al., 2019a, 2019b). The total area of these protected areas is more than 211,000 ha (**Table 1**).

Table 1. Locations and area of four protected areas

No.	Protected Area	Location	Area (ha)
1	Dak Uy Special Use Forest	Kon Tum province	546.24
2	Yok Don National Park	Dak Lak and Dak Nong provinces	113,853
3	Cat Tien National Park	Dong Nai, Lam Dong and Binh Phuoc provinces	71,920
4	Bu Gia Map National Park	Binh Phuoc province	25,601.18
	Total		**211,920.42**

2.1. Cat Tien National Park

The Cat Tien national park was established in 1992 with a total area of 71,920 ha, including the south Cat Tien area of 44,070 ha and the Cat Loc area or north Cat Tien of 27,850 ha (**Figure 1**). The park is located on latitudes $11^0$20'50" – $11^0$50'20" north and longitudes $107^0$09'05" – $107^0$35'20" east in five districts of three provinces including the Cat Tien and Bao Lam districts of the Lam Dong province (known as the Cat Loc area), the Tan Phu and Vinh Cuu districts of the Dong Nai province (known as the south Cat Tien area) and the Bu Dang district of the Binh Phuoc province.

The Cat Tien national park lies in the transitional topography from the southern central highlands to the southern delta. Thus, the Cat Tien national park has typical geological features of the ending Truong Son mountain range and the southwestern region of Vietnam and has five main terrain types. First, the high mountain with steep slopes terrain located mainly in the north of the Cat Tien national park. The average altitude is about 200 m a.s.l., and the slope is 15^0 – 20^0 with some places of up to 30^0. The terrain is steep on both sides of the mountain. This is the starting point of small streams flowing into the Dong Nai river. Second, the medium-high mountain also with steep slope terrain located in the southwest of the Cat Tien national park with the altitude ranging from 200 m – 300 m, and a slope of about 15^0 – 20^0. Large streams such as the Dac Lua and Da Tapok are formed by this hilly midland region and flow into the Dong Nai River. Third, the low and flat hilly terrain located in the southeast of the NP with an altitude of 130 m – 150 m, and slope of 5^0 – 7^0 with little fragmentation. Fourth, the hilly terrain adjacent to lakes that is located in the southwest of the NP with an average altitude of about 130 m. Fifth, the streams, lakes and lagoons that include small streams, scattered wetlands, rivers and lakes in the tributaries of the Dac Lua stream and the center area of the northern national park. These areas often lack water in the dry season but are flooded in the rainy season. In the dry season, water only exists in large lagoons such as the Bau Sau, Bau Chim, and Bau Ca. The elevation of these areas is less than 130 m.

The Cat Tien NP is located between two changing bio-geographical regions from the Truong Son Plateau to the Southern Delta, so there is a convergence of abundant flora and fauna. In terms of flora composition, the Cat Tien NP has 1,610 species belonging to 724 genera, 162 families, and 75 orders of higher vascular plants with the dominant species of the *Dipterocarpaceae*, *Fabaceae*, and *Lythraceae*. Of the total plant species, 38 species of 13 families are listed in the Vietnam Red Data Book including *Afzelia xylocarpa, Pterocarpus macrocarpus, Sindora siamensis, Diospyros maritima*, and *Dalbergia* species. The Cat Tien NP has five main types of forests. First, the evergreen broadleaf forest with dominant tree species such as Chestnut, *Scaphium macropodium*, *Michelia mediocris*, *Sandoricum indicum*, and *Xerospermum noronhianum*. Second, the semi-deciduous evergreen broadleaf forest that includes deciduous species in the dry season such as Bang Lang, Tung and species of the Dau family Third, the wood and bamboo mixed forests which is a secondary forest type. Evergreen and semi-deciduous evergreen forests are affected by forest fires, toxic chemicals, open canopy and interspersed with bamboo. The common species are *Lagerstroemia calyculata, Mesua ferrea,* and *Bambusa procera*. Fourth, the pure bamboo habitat which used to be forest but cleared for agricultural activities and then left abandoned and colonized by bamboo species. Fifth, the wetland habitat including many swamps named after the animals living there such as Bau Sau (Crocodile swamp), Bau Chim (Bird swamp), and Bau Ca (Fish swamp). In the rainy season, the river water floods an area of about 2,500 ha. The dominant plant species consists of *Barringtonia acutangular*, *Saccharum spontaneum,* etc. In terms of fauna, the most dominant animals are species in the even-toed ungulates such as the Sambar deer, Gaur, Banteng, Indian muntjac, Java mouse-deer, and wild boar. The Cat Tien NP has 1,529 animal

species belonging to 222 families and 55 orders (113 mammal species, 351 bird species, 109 reptile species, 41 amphibian species, 756 insect species and 159 fish species).

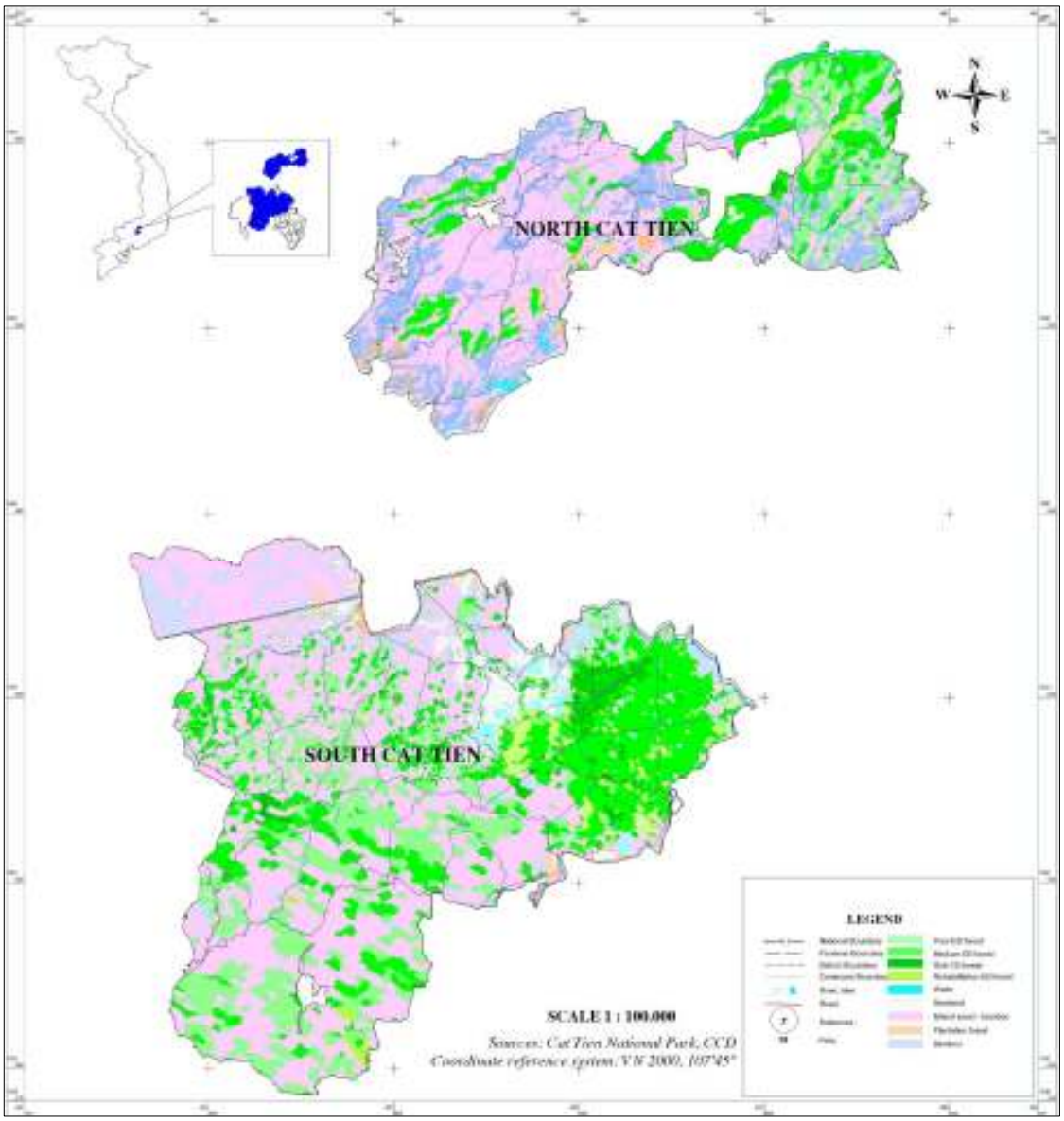

Figure 1. Map of the Cat Tien NP.

2.2. Yok Don National Park

According to Decision 39/2002/QD-TTg of the Prime Minister dated 18 March 2002, the total area of the Yok Don national park (NP) is 115,545 ha, including 80,947 ha of strictly protected zone, 30,426 ha of rehabilitation zone and 4,172 ha of administration zone (**Figure 2**). The coordinates of the Yok Don national park are from latitudes $12^0$45' – $13^0$10' north and longitudes $107^0$29' – $107^0$48' east. The park is located in the Ea Bung and Cu M'Lan communes of the Ea Sup district, Dak Lak province; Ea Huar, Ea Wer and Krong Na communes of the Buon Don district, Dak Lak province; and the Ea Po commune of the Cu Jut district, Dak Nong province. The topography is quite flat with rolling hills and average elevation ranges from 200 m – 300 m. The highest place is the Cu M'lan mountain at an altitude of 502 m. The terrain slopes gradually from the east (elevation is from 400 m – 500 m) to the west (elevation is about 140 m), where the Srepok River flows into Cambodia.

In terms of geology and pedology, the source rock that makes up the geology of the Yok Don national park is siltstone. Hot and humidity temperature is the decisive factor affecting the formation and development of the soil layers in this park. The soil-forming processes in the Yok Don national park include ferasol, accumulation and leaching. Soils in the Yok Don national park consist of six

groups of grey soil (Acrisols), brown soil in semi-arid areas (Lixisols), black soil (Luvisols), newly transformed soil (Cambisols), eroded soil with gravel exposure, and tight clay layer soil.

In terms of hydrology, the Srepok river, formed by two tributaries of the Krong Kno and Krong Ana rivers, runs through the park with a length of 60 kilometers (km). In the rainy season, the river water level reaches about 5 m – 10 m, and the flow is very fast. On the contrary, the water level reaches about 2 m – 3 m in the dry season. Even in some places, wading across the river is possible. The Yok Don national park has many streams and brooks such as the Dak Nor, Dak Na, Dak Kin, Dak Nan, and Dak Rue. These streams are quite steep (between 9 – 20%) and the beds of streams are narrow. As a result, they are shallow in the dry season.

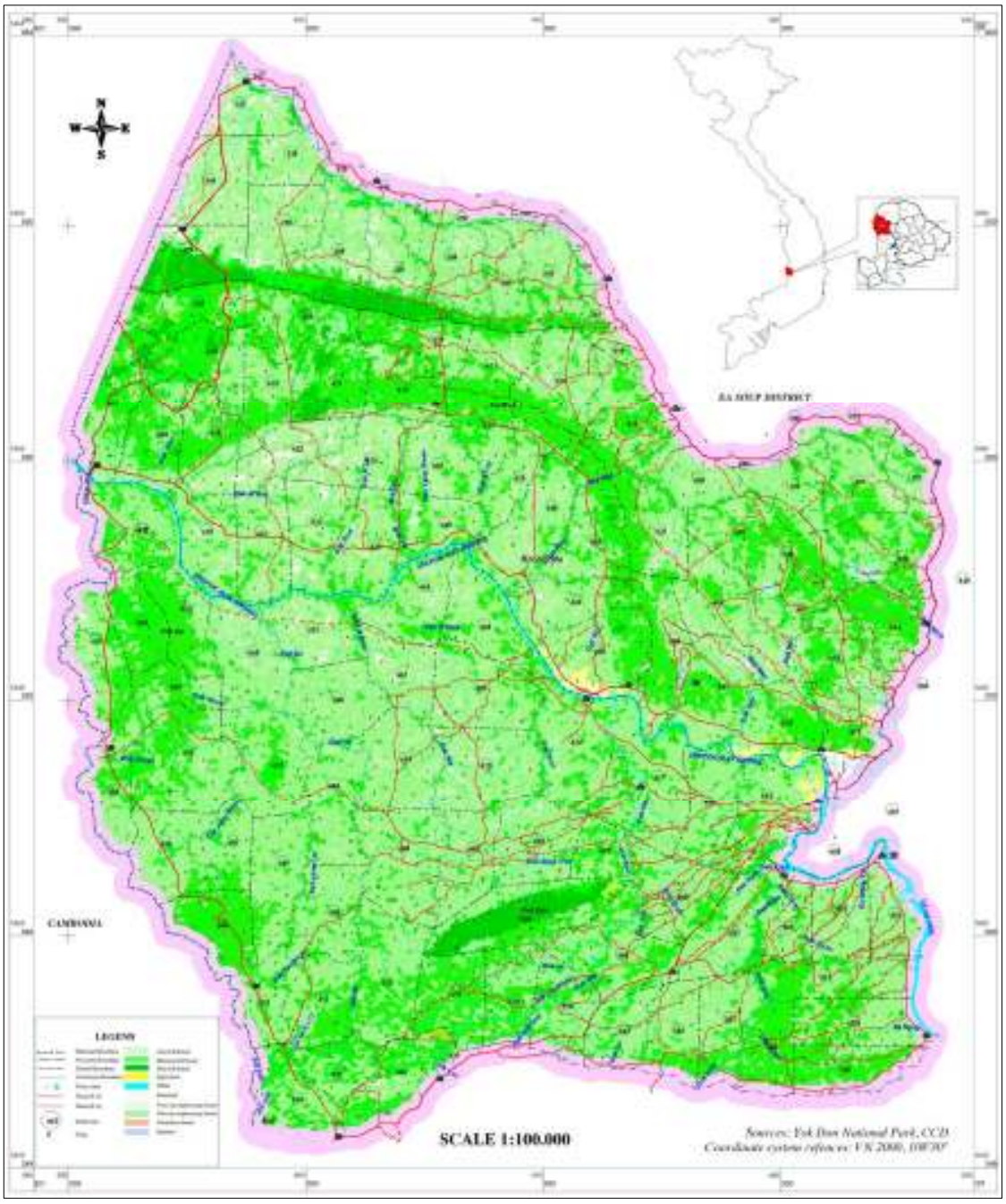

Figure 2. Map of the Yok Don NP.

The Yok Don NP is located in the hot and dry natural condition region that has created the flora with the structure of the seasonal deciduous broadleaf forest, dominated by dipterocarp species. There are three main types of habitats, namely, (i) evergreen or semi-deciduous broadleaf forest that

accounts for nearly 9%; (ii) deciduous broadleaf forest of nearly 90%; and (iii) mixed wood-bamboo forest of 1%.

2.3. Dak Uy Special Use Forest

The Dak Uy Special-Use Forest (SUF) is 25 km from Kon Tum City to the north and is located in the Dak Mar commune of the Dak Ha District in the Kon Tum province. The Dak Uy SUF is quite small with a total area of 546.24 ha, of which, the strictly protected zone accounts for 54.24% (**Figure 3**).

The topography of the Dak Uy SUF slopes from north to south and from the east to the west. The highest place is at 650 m a.s.l. The average slope is less than 15^0.

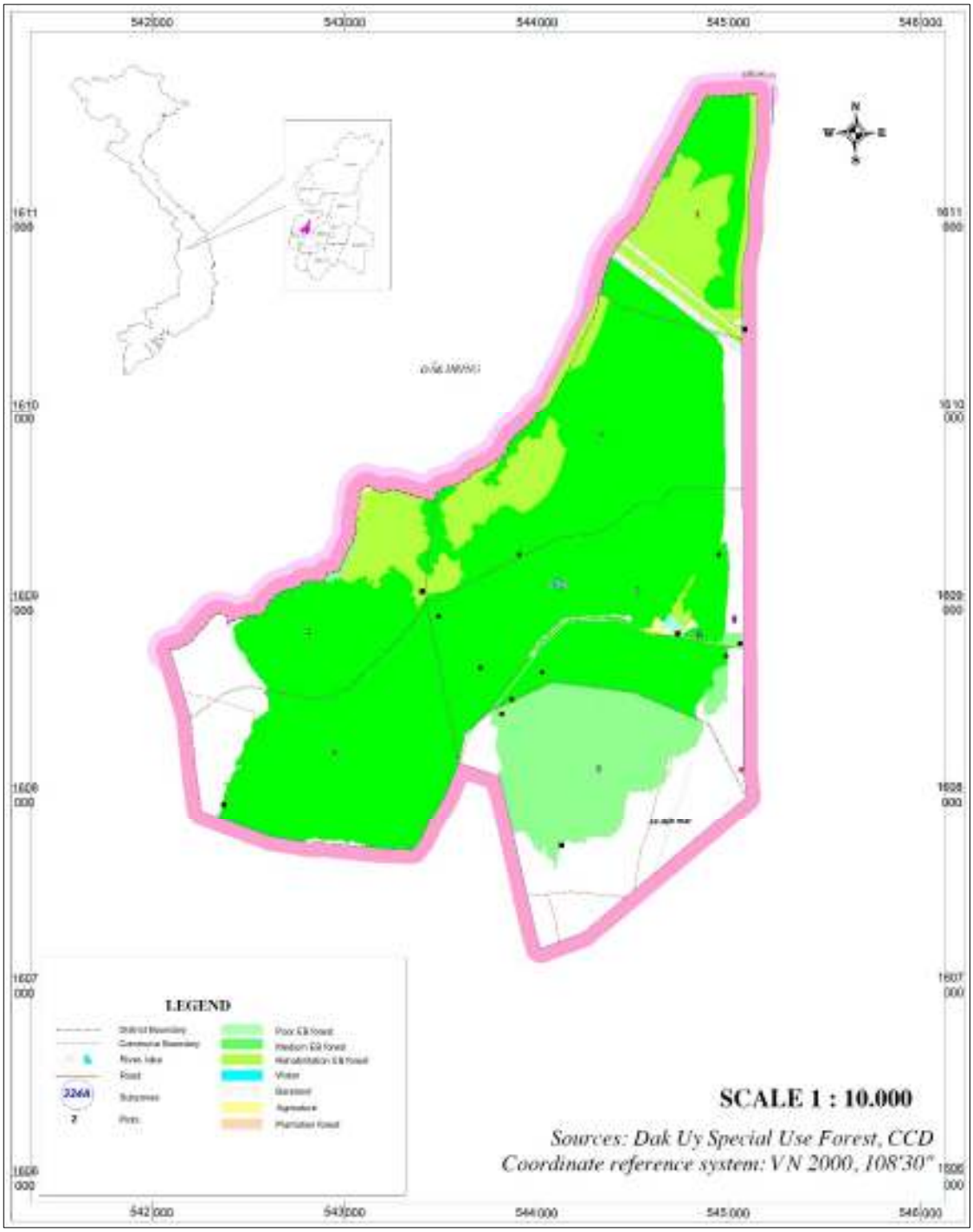

Figure 3. Map of the Dak Uy SUF.

The soil includes three main groups. First, the ferralsols (red-yellow soil) are found in the rolling terrain. The soil horizon is medium and soil texture is from medium to sandy loam. Second, the

humic acrisols (mountainous yellow-red humic soil) are found in the south of the protected area (PA). This soil is formed on alkaline and neutral igneous rocks. The soil horizon and litter layer are thick, porous and rich in nutrients. Soil texture is from medium to heavy. Third, the fluvisols and dystric gleysols are found in the drainage basins of low-laying terrain.

The Dak Uy SUF is located in the tropical monsoon climate of the highlands, which is divided into two distinct seasons, namely, the rainy season from May to October with the rainfall accounting for 80-90% of the total annual rainfall, and the dry season from November to April the following year, when the whole region often suffers from prolonged severe drought. The average annual temperature is 24.9^0 C and the rainfall is 1,600 mm.

The main vegetation of the Dak Uy SUF is evergreen broadleaf forests. The Dak Uy SUF contains a naturally viable population of *D. cochinchinensis*, which is highly valuable for scientific research and the conservation of genetic resources to contribute to population restoration in historical distribution areas.

2.4. Bu Gia Map National Park

The total area of the Bu Gia Map NP is 25,601 ha, of which the natural forests are 25,545.3 ha (4,134 ha of rich forests, 1,310 ha of medium forests, 169 ha of poor forests, 304.8 ha of rehabilitation forests, 17,851 ha of mixed forests, and 1,776.5 ha of bamboo forests) (**Figure 4**).

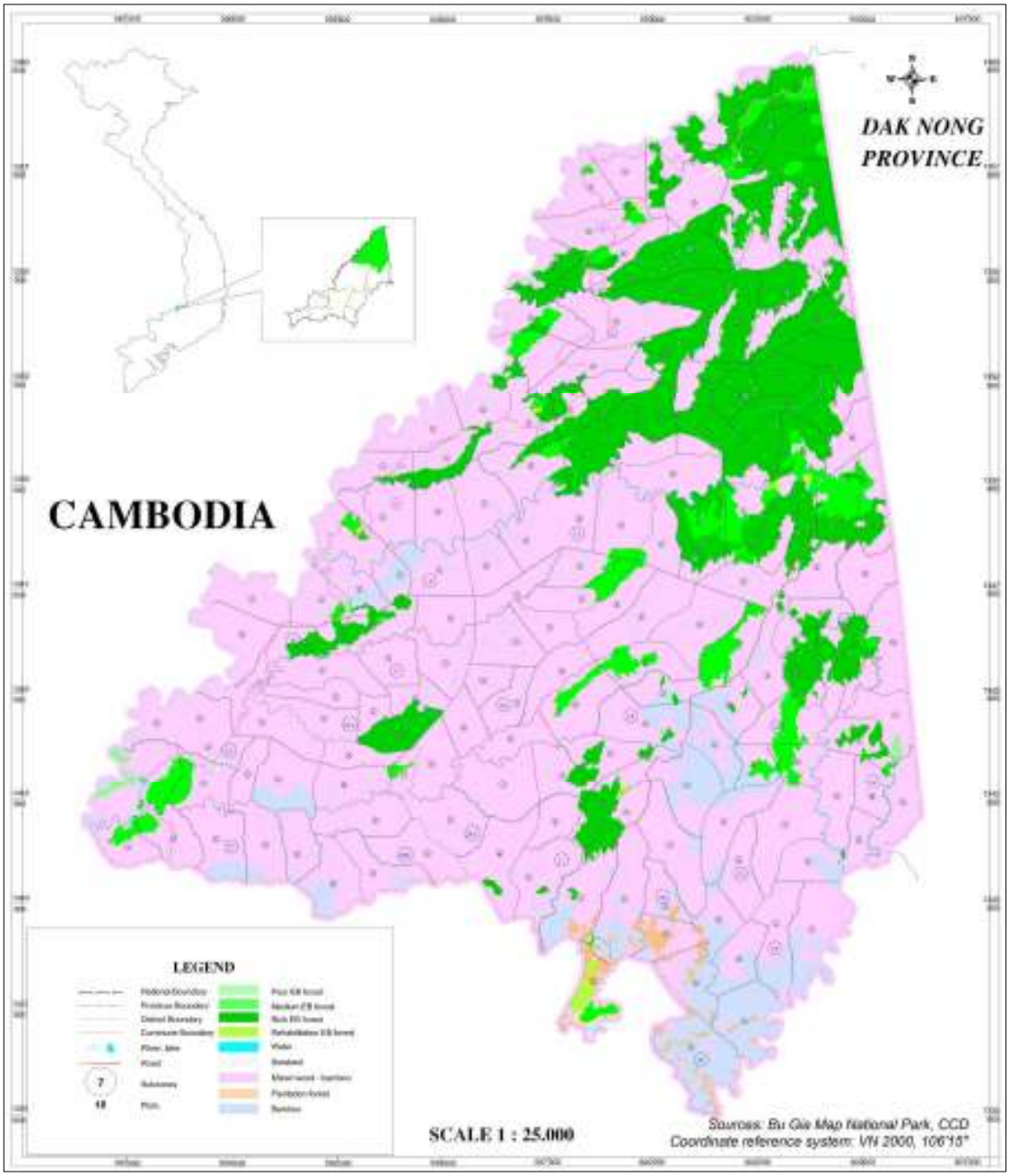

Figure 4. Map of Bu Gia Map NP.

The Bu Gia Map NP is adjacent to the natural forests of Cambodia, thus creating a biodiversity corridor for the movement of wild animals. The Bu Gia Map NP is a transitional area from the Central Highlands to the Southern Delta, so it has distinct features of mountainous terrain, rivers, and streams with the altitude of the mountains decreasing from west to east and from north to south causing strong fragmentation of the topography. The elevation of the highest mountain is 738 m a.s.l.

The Bu Gia Map national park contains two main types of forest, including closed evergreen tropical rain forests and closed semi-evergreen tropical moist forests. The evergreen forest ecosystem covers more than 90% of the total area making the Bu Gia Map national park important in water regulation and watershed protection for hydropower dams and irrigation systems downstream of the Be River. The flora includes 1,117 vascular plants of 128 families and 59 orders, while the. fauna has 104 mammal species, 246 bird species, 63 reptile and amphibian species, 273 insect species and 39 freshwater fish species.

3. OBJECTIVES AND SCOPES

3.1. Objectives

The purpose of this activity is to provide inputs for the preparation of a non-detrimental findings report to support better management and enforcement for *D. cochinchinensis* and *D. oliveri* in Vietnam.

The specific objectives are:

- To determine the population distribution of *D. cochinchinensis* and *D. oliveri* in four key protected areas.
- To assess the abundance of *D. cochinchinensis* and *D. oliveri* in four key protected areas.
- To calculate the stocking of *D. cochinchinensis* and *D. oliveri* in four key protected areas.

3.2. Survey time

- March to April 2020: Dak Uy SUF and Bu Gia Map NP.
- May to June 2020: Cat Tien NP and Yok Don NP.

3.3. Scope of work

The surveys were implemented for:

- Populations of *Dalbergia cochinchinesis* and *Dalbergia oliveri* distributed in the wild.
- Four key protected areas, namely the Dak Uy SUF in the Dak Ha district of the Kon Tum province, the Yok Don national park of the Dak Lak province, the South Cat Tien national park of the Dong Nai province, and the Bu Gia Map national park of the Binh Phuoc province.

4. METHODS

4.1. Literature review

All documents related to *D. cochinchinesis* and *D. oliveri* and maps of the four protected areas were collected for the review. These included:

- Books and papers relating to the morphology, ecology and distribution of *D. cochinchinesis* and *D. oliveri*.
- Technical reports of the study areas.
- Previous studies on *D. cochinchinesis* and *D. oliveri* in these four protected areas.
- Review on the taxonomy, biology, ecology, and the status, trend and population structure and dynamics of *D. cochinchinensis* and *D. oliveri* in Vietnam (Nguyen et al., 2019a; Nguyen et al., 2019b).
- Forest status maps, inventory maps, soil maps and other relevant maps (if available).

The review of these documents had provided important insights into the natural conditions of the study area and some initial data on plant species composition.

4.2. Interview

A quick interview was conducted with the technical staff of the four protected areas during the first visit in 2019 to understand the provisional distribution and abundance of *D. cochinchinesis* and *D. oliveri* in their PAs.

In the 2020 surveys, the survey team conducted a thorough discussion with the technical staff and forest rangers who have many years of working experience in the Yok Don, Cat Tien and Bu Gia Map national parks to map the distribution areas of *D. cochinchinesis* and *D. oliveri*. In the Bu Gia Map national park, the interviews were also conducted with the community-based forest protection groups. This was an important step to narrow down the areas for field surveys because these areas, especially the Yok Don and Cat Tien national parks, are large. Furthermore, according to the Cat Tien NP's staff, they had never seen *D. cochinchinesis* distributed in the southern part of the NP. Both *D. cochinchinesis* and *D. oliveri* are flagship species in these PAs and the PAs' staff are well aware of them. The Cat Tien and Bu Gia Map NPs even assigned their forest rangers based at their

stations in the forests to locate and mark trees of *D. cochinchinesis* and *D. oliveri* that have diameters at breast height (DBH) of 20 cm and above during forest patrols.

4.3. Field survey

In each protected area, the survey team was divided into two sub-teams using the common survey methods consisting of transects and plot surveys (Nguyen, 2007; Thai, 1978). Species identification followed those as advocated by Pham (1999).

4.3.1. Sampling designs

Rare plant populations tend to distribute in clusters in a certain area or region. Thus, the (adaptive) cluster sampling is designed to increase survey efforts to collect information on targeted rare species from clustered and scattered populations (Acharya et al., 2000; Nolau et al., 2022; Philippi, 2005; Wulfsohn D, 2010). The areas of the Yok Don, Cat Tien and Bu Gia Map NPs were large; therefore, adaptive cluster sampling was selected for surveying *D. cochinchinensis* and *D. oliveri*.

In contrast, as the area of the Dak Uy SUF was quite small (slightly more than 500 ha), random sampling was selected for surveying the *D. cochinchinensis* and *D. oliveri* in this area.

4.3.2. Transect survey

Transects were designed to identify distribution areas of *D. cochinchinensis* and *D. oliveri* in the protected areas. The transects were created to run through as many forest types as possible. The number of transects would depend on the forest types, terrain types, and changes in the elevation of the survey area. On the transects, the surveyors observed a perpendicular distance of 10 m on both sides but 5 m for the Dak Uy SUF to record information on the individuals *D. cochinchinensis* and/or *D. oliveri* encountered. Collected data included DBH from 6 cm and above, the total tree height, regeneration sources (shoot or seed regeneration) and quality of seedlings, and GPS coordinates. In addition, the type of forest, terrain and soil were also recorded in the datasheet.

In total, 10 transects with a total length of 10 km (average of 1 km/transect), 18 transects with a total length of 62.792 km (average of 3.5 km/transect), 16 transects with a total length of 51.5 km (average of 3.2 km/transect), and 25 transects with a total length of 71.86 km (average of 2.87 km/transect) were surveyed in the Dak Uy SUF, the Cat Tien NP, the Bu Gia Map NP and the Yok Don NP respectively.

4.3.3. Plot survey

On the transects, the survey teams had set up random plots or typical plots depending on the survey areas. The plot size was 1,000 m^2 (20 m × 50 m). All tree species with the DBH of 6 cm and above in the plots were counted. Measurement indicators included:

- $D_{1.3}$ or DBH.
- Tree height.
- GPS coordinates.
- Phenology characteristics such as flowers, fruits and seeds of *D. cochinchinensis* and *D. oliveri*.

4.3.4. Measurements of timber trees

All trees with a DBH at the height of 1.3 m above the ground that is equal to or greater than 6 cm were measured and recorded on the datasheet. At each site of the four key PAs, different technical staff was assigned to measure the tree diameter at the different sites. To ensure that the DBH measurement is consistent at 1.3 m tall, a pole with a length of 1.3 m was used to place on the ground and close to the trunk during the survey. The measurement of DBH followed those as advocated by Bhishma et al. (2010) and illustrated in **Figure 5**.

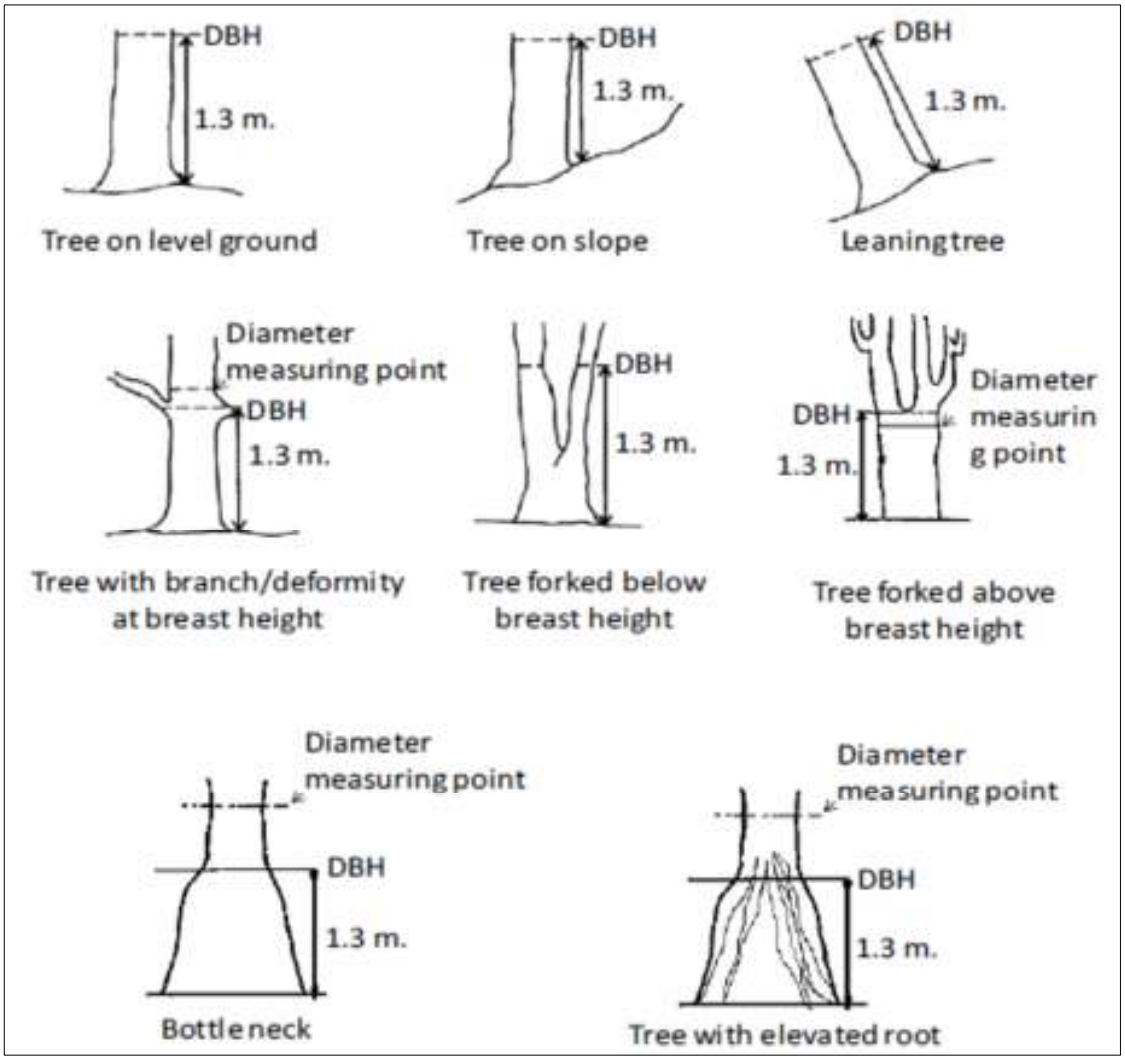

Figure 5. Measuring diameter at breast height (Bhishma et al., 2010)

4.3.5. Survey of regeneration plants

In the large plot of 1,000 m^2 (20 m x 50 m), the survey team set up five sub-plots of 25 m^2 (5 m × 5 m) each at the four conners and one at the center of the rectangle plot. All *D. cochinchinensis* and *D. oliveri* plants were counted, and their height, origin, quality and GPS coordinates were recorded.

4.3.6. Equipment

- Diameter measurement tools: used both 5 m Forestry Suppliers English Fabric Diameter Tape and a Haglöf Mantax calliper.
- Tree height measurement tool: used Blume Leiss and a pole.
- Position collection: used GPS Garmin eTrex 20x with coordinate system VN2000.
- Datasheet, maps, 20 m tape, ropes to set up the plots.

4.4. Data treatment and computation

The data collected from the field surveys were checked and processed by the software of Excel and SPSS Statistic 16.

- Tabulation:

DBH and H data were tabulated into DBH classes and H classes using the following formulae:

$$m = 5 \lg N$$

$$k = (x_{max} - x_{min})/m$$

of which: N: Total number of trees

x_{max}: maximum DBH or maximum H

x_{min}: minimum DBH or minimum H

k: interval between two classes and was reached to even number

- Basal area:

G = (D1.3)/2)^2 × π ÷ 10,000

of which: G: Basal area (m^2)

$D_{1,3}$: Diameter at Breast Height (cm).

- Stem volume of each tree:

V = G × H × f

of which: V: Stem volume (m^3)

G: Basal area (m^2)

H: Total tree height (m)

f: Stem form factor, f = 0.5 for natural forest

- Forest stand volume

$M = \sum_{n}^{1} V \times \frac{10000}{S}$

of which: M: Forest stand volume (m^3/ha)

$\sum_{n}^{1} V$: Total stem volume in sample plot (m^3)

S: Sample plot size (m^2)

- Forest structure:

$IV\% = (N\% + G\%)/2$

of which: IV%: The important value of a species in a plot

N%: Percentage according to number of trees of each species

G%: Percentage according to the basal area of each species

- Density:

$D = \frac{N}{S}$

of which: D: Number of trees per hectare

N: Number of recorded trees

S: Total surveyed area (ha)

- Regeneration rate:

$N\% = (n \times 100)/N$

of which: N%: Percentage of regenerating plants

n: number of regenerating plants

N: Total number of recorded regenerating plants.

- Stocking:

$S_t = D \times A_d$

of which: S_t: Total number of trees in a protected area

D: Density (trees/ha)

A_d: Area of distribution

5. RESULTS AND DISCUSSIONS

5.1. Distribution of *D. cochinchinensis* and *D. oliveri*

The distribution of tree number by diameter class (N-DBH) and tree height class (N-H) is usually presented for a forest stand. According to Vu & Pham (1997), a forest stand is a forest area that has the same internal structure and is distinctly different from the surrounding area. Under this definition, such a stand exists only in a small area and has no practical value (Vu & Pham, 1997). To apply a stand in the context of the forests of Vietnam, it was suggested to use a plot (Vu & Pham, 1997). The Circular No. 31/2018/TT-BNNPTNT of the Ministry of Agriculture and Rural Development of Vietnam dated 16 November 2018 defines "a plot is an area of approximately 10 ha with relatively consistent state of forest or forestry land and is located within one commune". This would be very difficult and would also take a lot of time for the survey teams to identify a plot in the field under the definition above. To make it easier and more realistic for the computation and presentation of the collected data, one hectare was used instead of a stand or a plot. Therefore, N-DBH distribution and N-H distribution in this report were the distribution of tree number per one hectare or density by DBH and H, and not the frequency or the total number of trees recorded from the sampling surveys in a protected area.

5.1.1. Cat Tien National Park

5.1.1.1. Distribution of D. cochinchinensis

The survey in the southern part of the Cat Tien NP did not record the existence of *D. cochinchinensis.* This finding was compatible with the information provided by the technical staff and forest rangers of the Cat Tien NP.

5.1.1.2. Distribution of D. oliveri

a) Distribution by forest types

The broadleaf evergreen forest: This type of forest is located in the southeastern part of the Cat Tien, where it is dominated by *Fagaceae* species, *Aglaia* species*, Pterocarpus macrocarpus, Afzelia xylocarpa* and *Dalbergia oliveri.* The density of *D. oliveri* in this area was 11.1 trees/ha, higher than the average density of the entire area. *D. oliveri* trees with DBH greater than 20 cm accounted for 55%. The density of seedlings was 12.3 seedlings/ha.

The semi-deciduous forest: This forest type is characterized by deciduous trees in the dry season that include *Lagerstroemia calyculata* and *Tetrameles nudiflora*. The density of *D. oliveri* trees is 9.9 trees/ha, relatively high compared to the average density of the entire area. *D. oliveri* trees with DBH greater than 20 cm accounted 67.5%. The density of seedlings was 7.5 seedlings/ha.

The mixed bamboo-wood tree forest: *D. oliveri* was sparsely distributed in the area where the density of trees and seedlings were 4 trees/ha and 16.1 seedling/ha respectively. *D. oliveri* seedlings prefer light at an early age, therefore the mixed-bamboo-wood tree forest with the canopy cover of about 20 – 40% is ideal for growth of the seedlings. However, the composition of this forest type is mainly native bamboos and *Bambusa balcooa* which tend to have low spreading branches that suppress the growth of *D. oliveri* seedlings. As a result, seedlings were often seen as topless (their tops were broken) or curved stem and were considered as ineffective regenerants or unpromising plants because they were difficult to grow to mature trees.

b) Distribution by geography

The field surveys in the southern part of the Cat Tien NP had shown that *D. oliveri* was distributed mainly in the southeast of the NP (**Figure 6**). This area is characterized by low and flat hills with the elevation from 120 m – 160 m, rarely reach to 190 m a.s.l and belongs to the management of the Da Mi, Ben Cu, Da Lak and Da Co forest ranger stations. The slope is approximately between 5 – 7 degrees*. D. oliveri* was commonly recorded at the elevation of 120 m – 175 m a.s.l.

D. oliveri was also found in the southwestern part of the Cat Tien NP with moderate-high mountain at an average elevation from 200 m – 300 m a.s.l. that sometimes reaches up to 350 m; and the mountain slope is between 15 – 20 degrees. In this area, *D. oliveri* was distributed at the elevation of 210 m – 320 m a.s.l in the management areas of the Dat Do and the Sa Mach forest ranger stations.

c) Distribution of regenerating plants

The density of *D. oliveri* regenerants in the Cat Tien NP was 12.3 plants/ha. Regenerating plants were unevenly distributed amongst forest types and forest management areas with the highest density of 79.2 plants/ha and the lowest density of 0.8 plants/ha.

Most of the regenerating plants were from seeds, accounting for 88.34% while the coppices accounted for 11.66%. This showed that the Cat Tien NP has great potential for the regeneration and recovery of *D. oliveri* and is a source for quality mother trees. Of the total regenerating plants, effective seedlings were 39.3% and 60.7% remaining seedlings were ineffective seedlings.

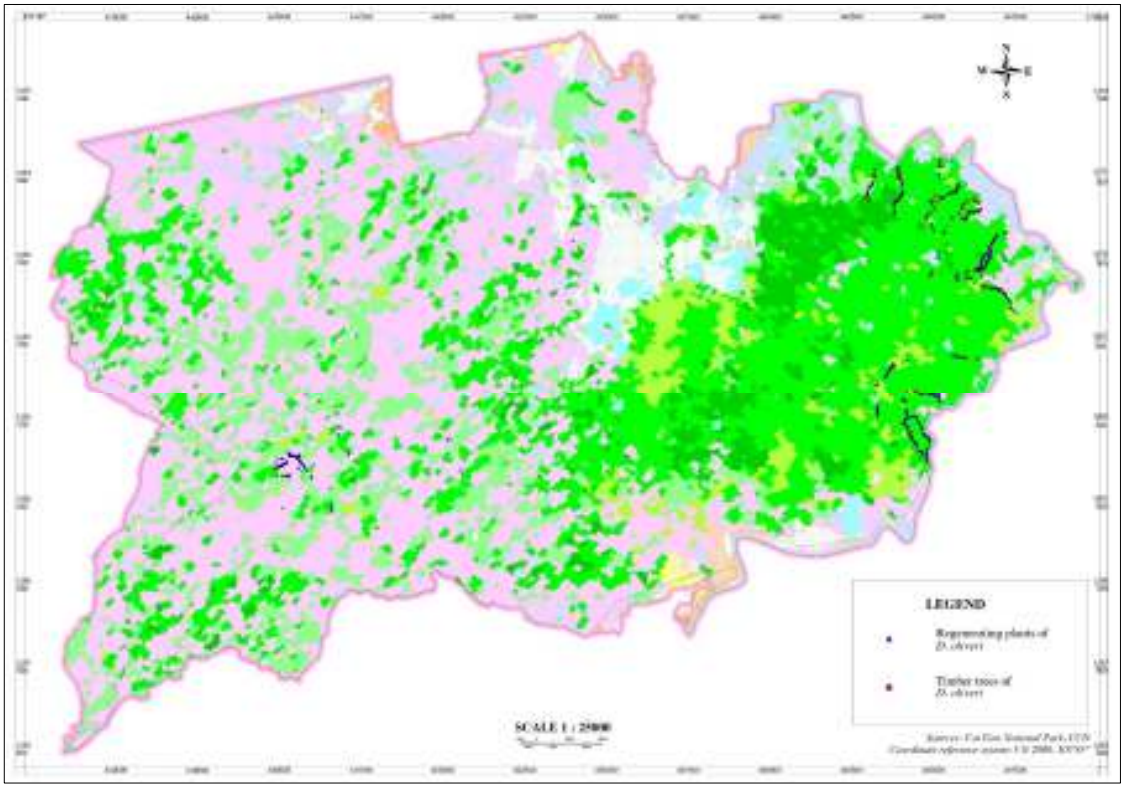

Figure 6. Distribution of *D. oliveri* in the south Cat Tien NP.

d) N-DBH distribution of D. oliveri in the Cat Tien NP

The N-DBH distribution of *D. oliveri* in the southern part of the Cat Tien NP showed a decline with increasing DBH size. The highest number of trees was observed in DBH mid-classes of 9 cm to 21 cm, accounting for 57.6% (**Table 2**). The lowest number of trees observed in DBH mid-classes of 75 cm to 87 cm accounted for 1.5% (**Table 2**).

Table 2. Distribution of *D. oliveri* tree number by DBH classes in the Cat Tien NP.

DBH class (cm)	DBH mid-class (cm)	Frequency (tree)	Density (trees/ha)	Percent (%)	Cumulative Percent (%)
6-12	9	194	1.54	22.80	22.80
12-18	15	151	1.20	17.70	40.50
18-24	21	146	1.16	17.10	57.60
24-30	27	85	0.67	10.00	67.60
30-36	33	56	0.44	6.60	74.20
36-42	39	66	0.52	7.70	81.90
42-48	45	43	0.34	5.00	87.00
48-54	51	39	0.31	4.60	91.50
54-60	57	23	0.18	2.70	94.20
60-66	63	20	0.16	2.30	96.60
66-72	69	16	0.13	1.90	98.50
72-78	75	7	0.06	0.80	99.30
78-84	81	4	0.03	0.50	99.80
84-90	87	2	0.02	0.20	100.00
Total		852	6.76	100.00	

The N-DBH distribution of *D. oliveri* trees in the southern part of the Cat Tien NP showed a declining trend with several serrated peaks (DHB classes = 9, 21, 39 and 51 cm) and a major peak starting from the lowest DBH class (9 cm) and the number of trees gradually decreased with the increase in DBH size (**Figure 7**). This is a typical distribution pattern of mixed-species natural stands of different ages. Species with distribution patterns similar to those of the stand are dominant (Vu & Pham, 1997). Hence, *D. oliveri* in the southern part of the Cat Tien NP was the dominant species in the forest structure.

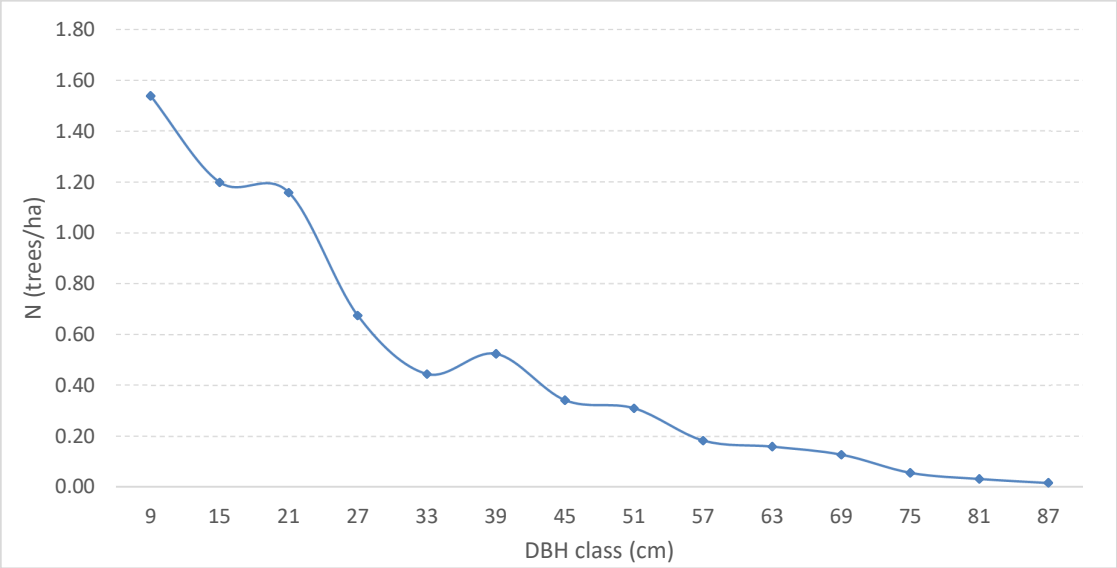

Figure 7. N-DBH distribution of *D. oliveri* trees in the Cat Tien NP.

e) N-H distribution of D. oliveri in the Cat Tien NP

The highest number of trees was at H mid-classes of 15 m to 17 m, accounting for nearly 25% while the lowest number of trees was at H mid-classes of 5 m and 31 m to 35 m (**Table 3**).

Table 3. Distribution of *D. oliveri* tree number by H classes in the Cat Tien NP.

H class (m)	H mid-class (m)	Frequency (tree)	Density (trees/ha)	Percent (%)	Cumulative Percent (%)
4-6	5	8	0.06	0.94	0.94
6-8	7	54	0.43	6.34	7.28
8-10	9	82	0.65	9.62	16.90
10-12	11	51	0.40	5.99	22.89
12-14	13	89	0.71	10.45	33.33
14-16	15	103	0.82	12.09	45.42
16-18	17	107	0.85	12.56	57.98
18-20	19	91	0.72	10.68	68.66
20-22	21	71	0.56	8.33	77.00
22-24	23	77	0.61	9.04	86.03
24-26	25	51	0.40	5.99	92.02
26-28	27	46	0.37	5.40	97.42
28-30	29	16	0.13	1.88	99.30
30-32	31	3	0.02	0.35	99.65
32-34	33	2	0.02	0.23	99.88
34-36	35	1	0.01	0.12	100.00
Total		852	6.76	100.00	

The N-H distribution of *D. oliveri* trees in the southern part of the Cat Tien NP had several peaks. The highest peak was at the H mid-class of 17 m; the two lower peaks on the two sides were observed at the H mid-classes of 9 m and 23 m (**Figure 8**). The number of trees decreased on the two sides of the peaks. This means that the number of trees gradually decreased with the decrease in H classes to the left and with the increase in H classes to the right (**Figure 8**).

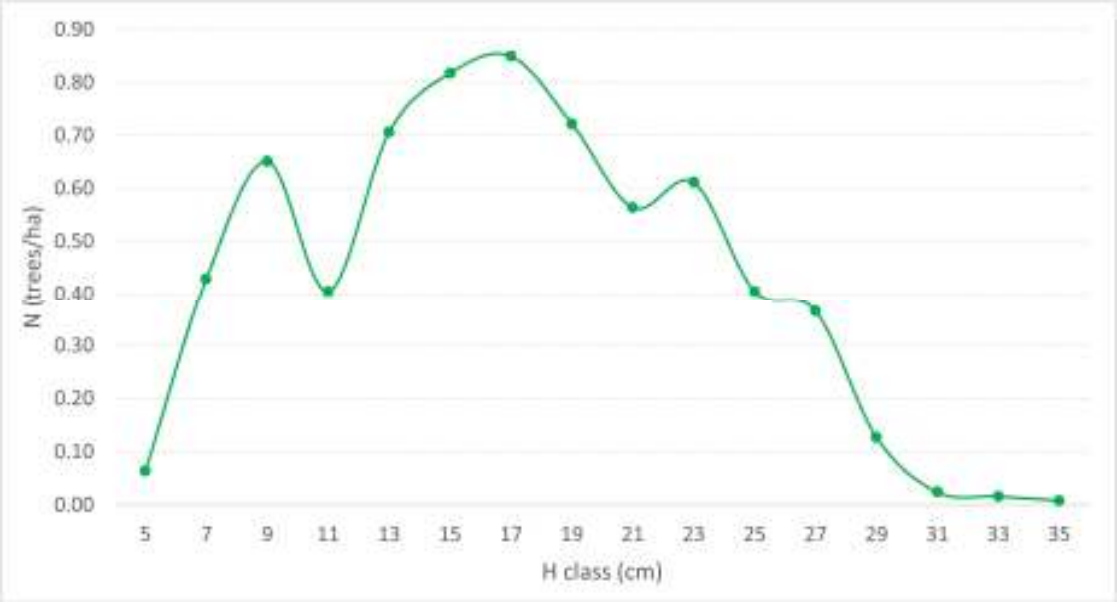

Figure 8. N-H distribution of *D. oliveri* in the Cat Tien NP.

f) N-DBH and N-H distribution of D. oliveri in the Cat Tien NP

To understand the distribution of tree numbers by DBH and H, it needs to develop a table of correlation between H and DBH classes to calculate the mean H class (H_m) to establish a correlation chart. The highest number of trees was associated with H mid-classes of 17 m to 19 m and DBH classes of 9 m to 21 cm (**Table 4**).

Table 4. Correlations between H and DBH of *D. oliveri* in the Cat Tien NP.

H mid-class (m)	DBH class (cm)														Total (tree)
	9	15	21	27	33	39	45	51	57	63	69	75	81	87	
5	6	2	0	0	0	0	0	0	0	0	0	0	0	0	8
7	50	0	3	0	0	0	0	0	0	1	0	0	0	0	54
9	71	6	2	1	2	0	0	0	0	0	0	0	0	0	82
11	30	15	5	0	0	0	1	0	0	0	0	0	0	0	51
13	22	48	16	1	1	1	0	0	0	0	0	0	0	0	89
15	13	45	27	10	2	3	1	0	1	0	1	0	0	0	103
17	1	24	51	18	8	4	0	1	0	0	0	0	0	0	107
19	0	10	33	26	10	7	3	1	1	0	0	0	0	0	91
21	1	1	5	11	16	18	8	4	1	4	0	0	1	1	71
23	0	0	2	9	12	19	14	13	5	1	0	2	0	0	77
25	0	0	2	6	3	9	7	9	4	4	3	2	1	1	51
27	0	0	0	3	2	5	6	8	7	6	6	1	2	0	46
29	0	0	0	0	0	0	3	3	3	3	4	0	0	0	16
31	0	0	0	0	0	0	0	0	1	1	1	0	0	0	3
33	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2
35	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Total (tree)	194	151	146	85	56	66	43	39	23	20	16	7	4	2	852
H_m (m)	9.6	14.2	16.5	19.3	20.1	21.7	23.2	24.3	25.1	24.7	27.0	27.3	25.0	23.0	

According to **Figure 9**, the larger the diameter, the higher the tree height. The tree height reached a peak at H_m of 27 m and the DBH classes of 69 cm to 75 cm. Then, the tree height slightly declined with increasing DBH sizes.

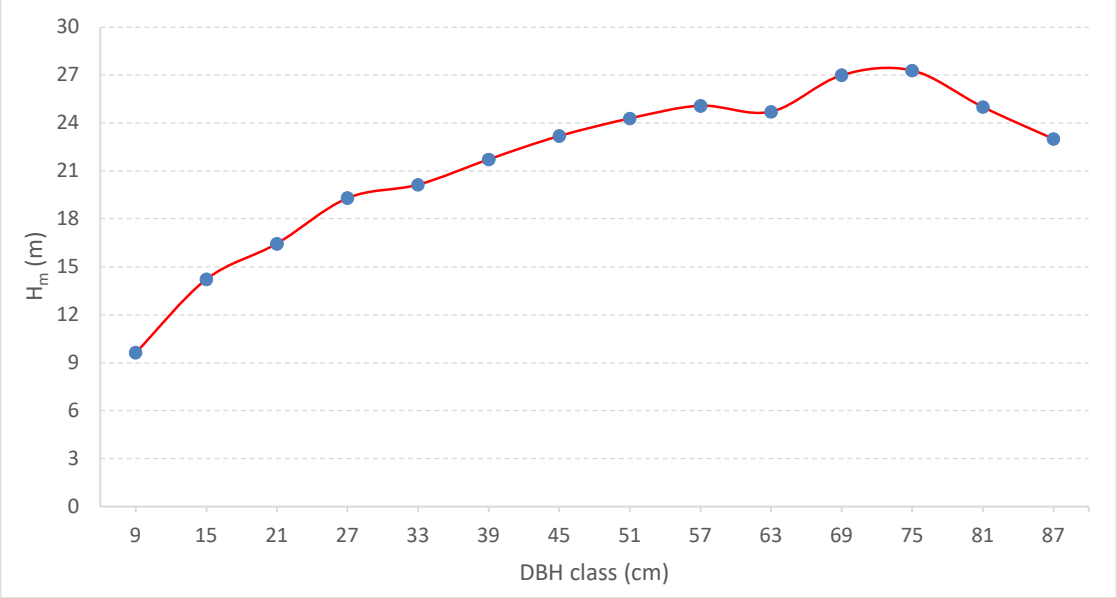

Figure 9. Correlations between *D. oliveri* tree number and DBH and H classes.

5.1.2 Yok Don National Park

5.1.2.1. Distribution of D. cochinchinensis

a) Distribution by forest types

D. cochinchinensis were found to locate in three main types of forest as follows:

Evergreen forest: This type of forest is located in the Don mountain. Two transects went through this habitat with a total length of 8.9 km, equivalent to a survey area of 17.9 ha. There were five saplings with a height of 4-5 m, regenerated from sprouts. The average density of *D. cochinchinensis* was low at 0.3 sapling/ha.

Semi-evergreen forest: This type of forest is close to Cambodia. Most of the timber trees recorded were from 6 cm to 15 cm in diameter, except for one tree of 15.9 cm in DBH. The average density of *D. cochinchinensis* trees was 2.1 trees per hectare and the regenerant density was 10.6 plants per hectare. In this area, *D. oliveri* was found to grow together with *D. cochinchinensis* in a plot.

Dry deciduous forest: This is a typical forest type and occupies most of the area of the Yok Don National Park. *D. cochinchinensis* was sparsely distributed in this forest. The densities of trees and regenerants were low with 0.2 tree/ha and 1.7 coppices/ha respectively. Most of the coppices were regenerated from root remnants or stumps of burnt trees.

b) Distribution by geography

D. cochinchinensis population was found in the north of the Yok Don NP and part of the Don mountain with an average density of 3.2 trees/ha, in which the density of trees (D1.3 ≥ 6cm) was 0.4 trees/ha and the density of regenerants was 2.8 trees/ha (**Figure 10**).

D. cochinchinensis was recorded mainly growing on the slopes near the top and the tops of hills that have rocky foundations, elevations in the range of 190 m – 300 m, and slopes of between 18^0 - 20^0.

In all the surveyed forests that have altitudes of above 300 m, *D. cochinchinensis* was not found at these altitudes except for a few regenerating saplings found in the Don mountain at an altitude of between 380 m – 390 m.

c) Distribution of regenerating plants

The density of *D. cochinchinensis* regenerants was 2.8 plants/ha of which coppices were 90.39% and seedlings were 9.61%. The percentage of effective and ineffective regenerating plants was 41.63% and 58.37% respectively.

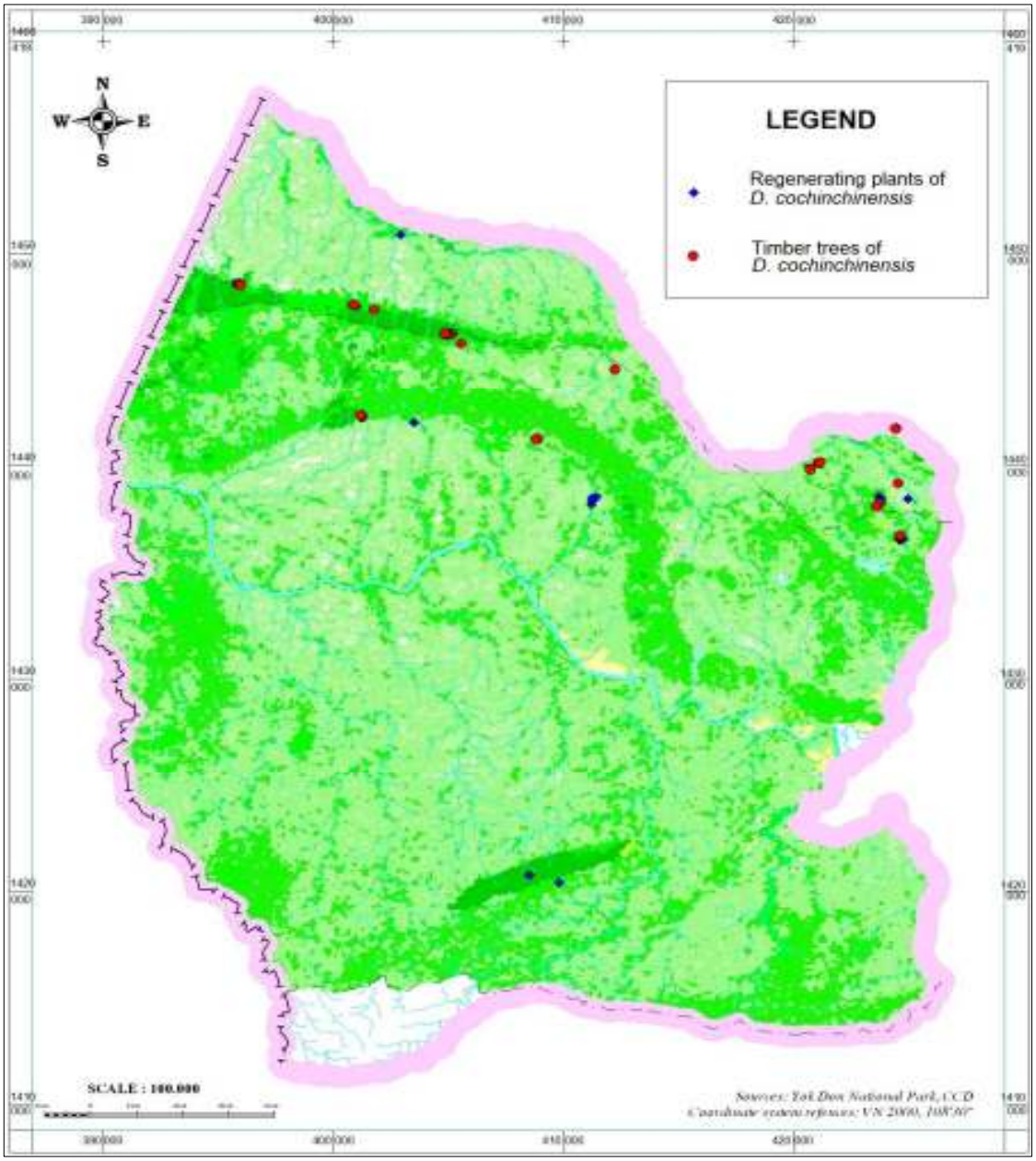

Figure 10. Distribution of *D. cochinchinensis* in the Yok Don NP.

d) N-DBH distribution of D. cochinchinensis in the Yok Don NP

The highest number of trees was observed in DBH mid-classes of 7 cm to 9 cm, accounting for 66.2%. The lowest number of trees observed in DBH classes of 17 cm to 19 cm accounted for 3.2% (**Table 5**). This showed that the *D. cochinchinensis* population in the Yok Don NP was very young.

Table 5. Distribution of *D. cochinchinensis* tree number by DBH classes in the Yok Don NP.

DBH class (cm)	DBH mid-class (cm)	Frequency (tree)	Density (tree/ha)	Percent (%)	Cumulative Percent (%)
6-8	7	20	0.24	32.3	32.3
8-10	9	21	0.25	33.9	66.1
10-12	11	9	0.11	14.5	80.6
12-14	13	5	0.06	8.1	88.7
14-16	15	3	0.04	4.8	93.5
16-18	17	1	0.01	1.6	95.2

DBH class (cm)	DBH mid-class (cm)	Frequency (tree)	Density (tree/ha)	Percent (%)	Cumulative Percent (%)
18-20	19	1	0.01	1.6	96.8
20-22	21	2	0.02	3.2	100
	Total	62	0.74	100	

The N-DBH distribution of *D. cochinchinensis* in the Yok Don NP showed a decline with increasing DBH size (**Figure 11**).

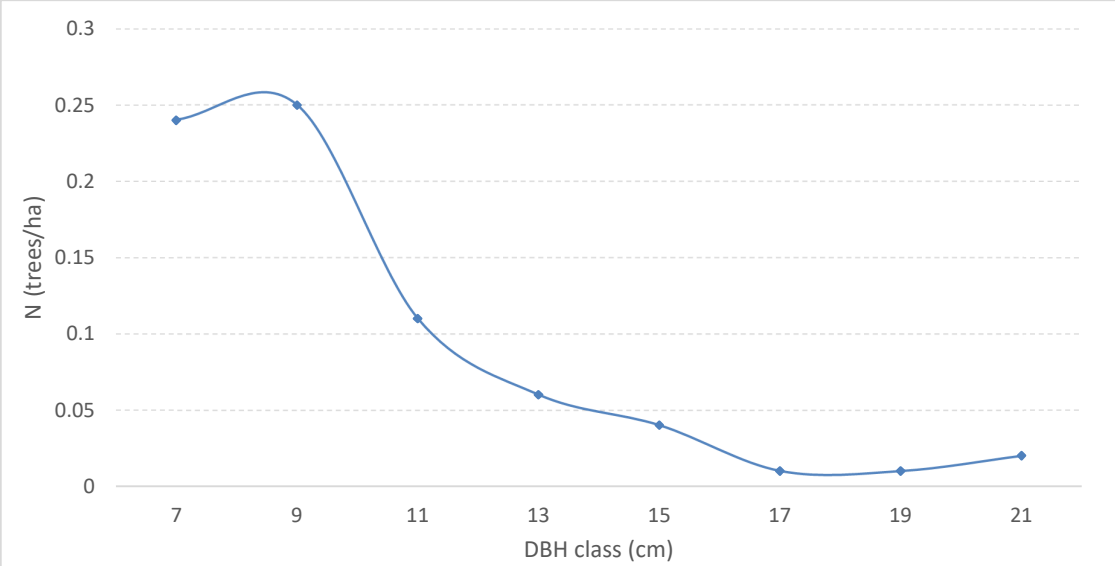

Figure 11. N-DBH distribution of *D. cochinchinensis* trees in the Yok Don NP.

e) N-H distribution of D. cochinchinensis in the Yok Don NP

The N-H distribution of *D. cochinchinensis* trees in the Yok Don NP followed a gradual decline. The N-H distribution reduced rapidly in the H mid-classes of 15 m to 17 m. The highest number of trees distributed in the H mid-classes of 7 m to 9 m accounted for 48.4% (**Table 6** and **Figure 12**).

Table 6. Distribution of *D. cochinchinensis* tree number by H classes in the Yok Don NP.

H class (m)	H mid-class (m)	Frequency (tree)	Density (tree/ha)	Percent (%)	Cumulative Percent (%)
6-8	7	16	0.19	25.8	25.8
8-10	9	14	0.17	22.6	48.4
10-12	11	10	0.12	16.1	64.5
12-14	13	10	0.12	16.1	80.6
14-16	15	10	0.12	16.1	96.8
16-18	17	2	0.02	3.2	100
	Total	62	0.74	100	

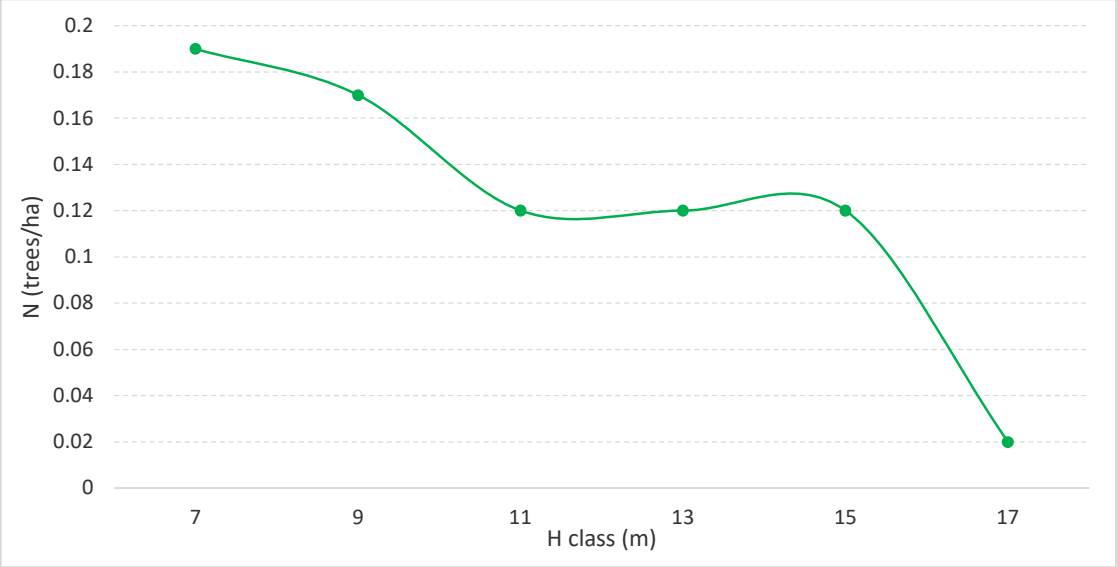

Figure 12. N-H distribution of *D. cochinchinensis* in the Yok Don NP.

f) N-DBH and N-H distribution of D. cochinchinensis in the Yok Don NP

The highest number of trees was at H_m of 8.3 – 10.43 m and DBH classes of 7 – 9 cm. The number of trees reduced when the DBH and H increased (**Table 7**). The percentage of trees that had DBH from 15 cm and H mid-class from15 m was about 11.3%.

Table 7. Correlations between H and DBH of *D. cochinchinensis* in the Yok Don NP.

H mid-class (m)	DBH (cm)								Total (tree)
	7	9	11	13	15	17	19	21	
7	12	3	1	0	0	0	0	0	16
9	4	7	3	0	0	0	0	0	14
11	3	5	2	0	0	0	0	0	10
13	1	5	1	1	1	0	0	1	10
15	0	1	2	4	1	1	1	0	10
17	0	0	0	0	1	0	0	1	2
Total (tree)	20	21	9	5	3	1	1	2	62
H_m (m)	8.30	10.43	11.00	14.60	15.00	15.00	15.00	15.00	

The N-DBH and N-H distribution of *D. cochinchinensis* in the Yok Don NP was proportional to each other at the earlier stage as the increase of DBH corresponds to the increase of H. However, the distribution curve changed to linear at H_m 15 m though the DBH increased from 15 cm to 21 cm **(Figure 13**). Hence, the height of *D. cochinchinensis* trees in the Yok Don NP was stable at the DBH of 15 cm to 21 cm.

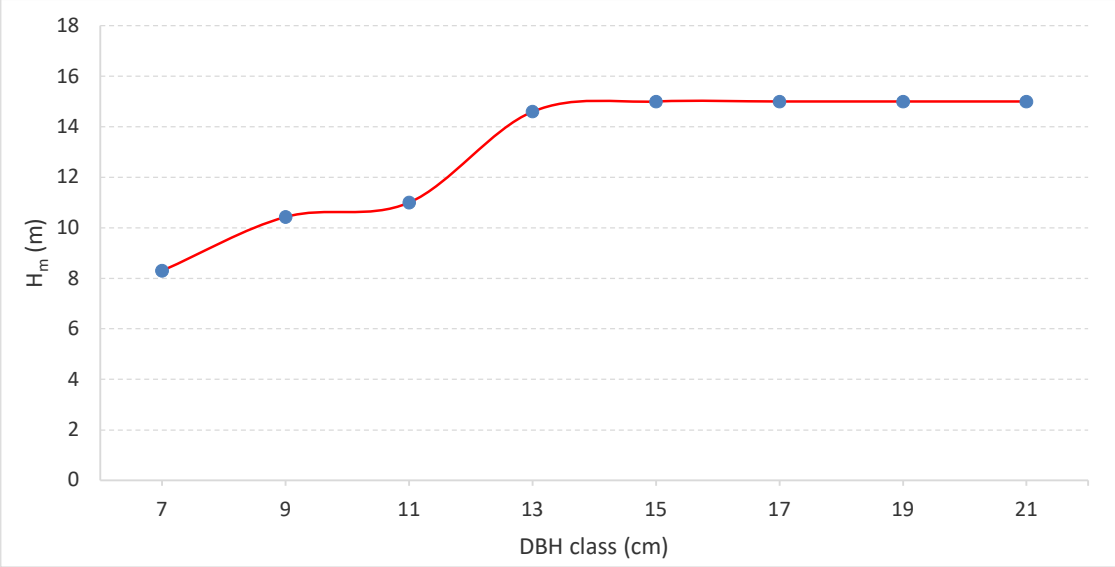

Figure 13. Correlations between *D. cochinchinensis* tree number and DBH and H in Yok Don NP.

5.1.2.2. Distribution of D. oliveri

a) Distribution by forest types

D. oliveri was distributed in all forest types surveyed of the Yok Don NP, including:

Mountain evergreen forest: In this type of forest, small timber trees and coppices of *D. oliveri* were recorded in the transitional zones between the evergreen and the dry deciduous forests at the bottom of the Don mountain. The density of timber trees was about 1.2 trees/ha while the density of regenerants was about 15,5 plants/ha.

Semi-evergreen forest: *D. oliveri* were sparsely distributed in this forest type with the densities of timber trees at 1.7 trees/ha and the regenerants at 7.4 plants/ha respectively.

Dry deciduous forest and semi-evergreen forest close to brooks and streams: The distribution of *D. oliveri* was scattered in the dry deciduous forest but widely distributed in the semi-evergreen forest strips along the two sides of the brooks and/or streams. This indicated that *D. oliveri* is a moisture-preferred species. The densities of timber trees and the regenerants were 3.4 trees/ha and 24.9 plants/ha respectively.

b) Distribution by geography

D. oliveri was distributed at altitudes of 156 m – 298 m in the northern part of the Yok Don NP. At the Don mountain which is located at the south of the Yok Don NP, *D. oliveri* was found at altitudes up to 421 m (**Figure 14**). Most of them were distributed at altitudes from 180 m to less than 260 m.

c) Distribution of regenerating plants

The density of *D. oliveri* regenerants was 21.2 plants/ha, of which, coppices were 91.3% and seedlings were 8.7%. Though the regenerating density was very high, the majority were ineffective regenerants (87.09%). The percentage of effective regenerating plants was 12.91%.

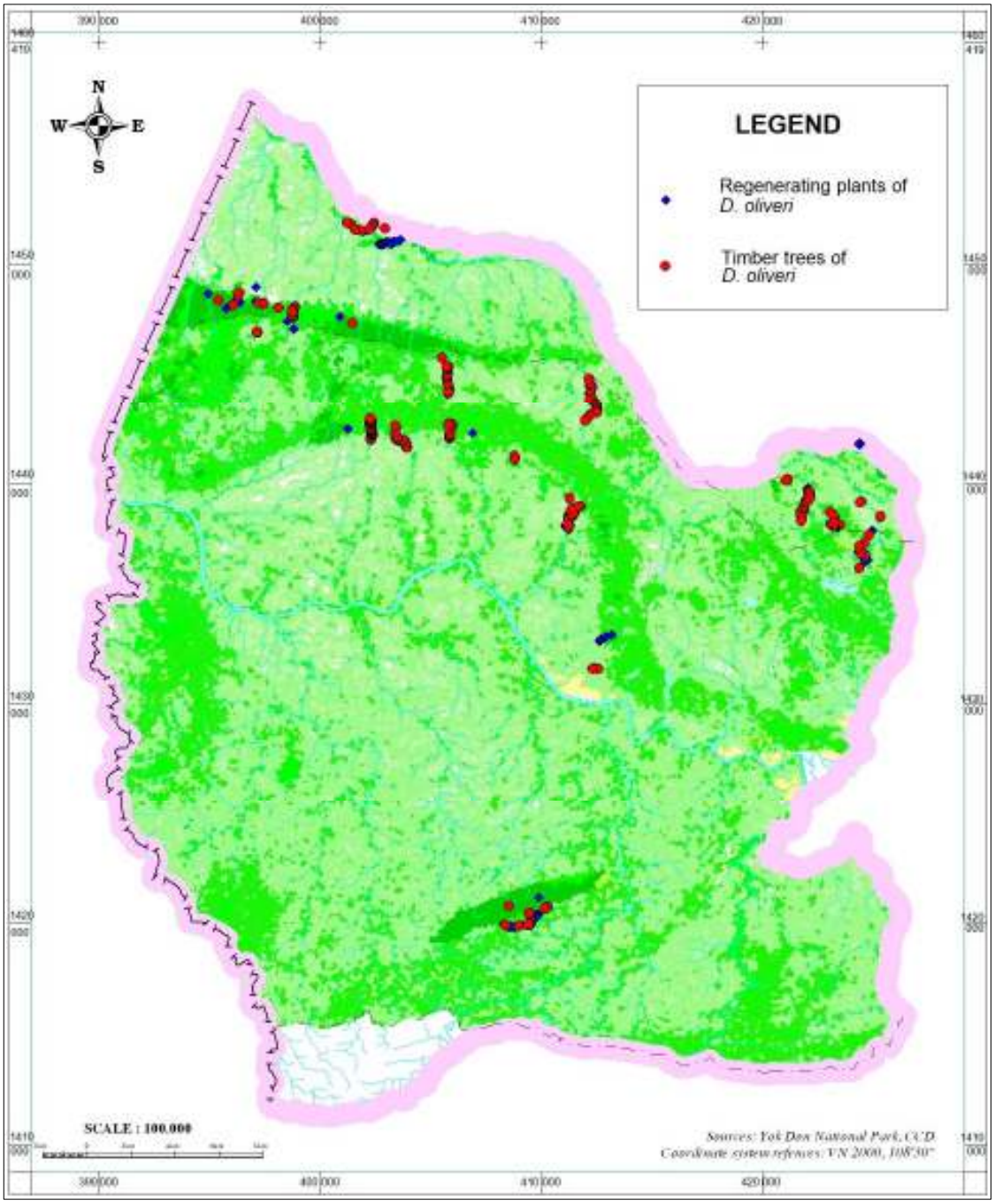

Figure 14. Distribution of *D. oliveri* in the Yok Don NP.

d) N-DBH distribution of D. oliveri in the Yok Don NP

The highest number of trees was at the average DBH of less than 15 cm accounting for more than 40%. The percentage of trees under the DBH mid-classes of 15 cm to 27 cm was 52.2%. The percentage of big trees with DBH greater than 27 cm (from 33 cm to 39 cm) was only about 7% (**Table 8**). These indicators showed that the *D. oliveri* population in the Yok Don NP was still young.

Table 8. Distribution of *D. oliveri* tree number by DBH classes in the Yok Don NP.

DBH class (cm)	DBH mid-class (cm)	Frequency (tree)	Density (tree/ha)	Percent (%)	Cumulative Percent (%)
6-12	9	166	1.15	40.9	40.9
12-18	15	99	0.69	24.4	65.3
18-24	21	58	0.4	14.3	79.6

DBH class (cm)	DBH mid-class (cm)	Frequency (tree)	Density (tree/ha)	Percent (%)	Cumulative Percent (%)
24-30	27	55	0.38	13.5	93.1
30-36	33	19	0.13	4.7	97.8
36-42	39	9	0.06	2.2	100
	Total	406	2.81	100	

N-DBH distribution of *D. oliveri* in the Yok Don NP was observed to follow a declining distribution with increasing DBH size. The number of trees gradually decreased with the increase in DBH size (**Figure 15**).

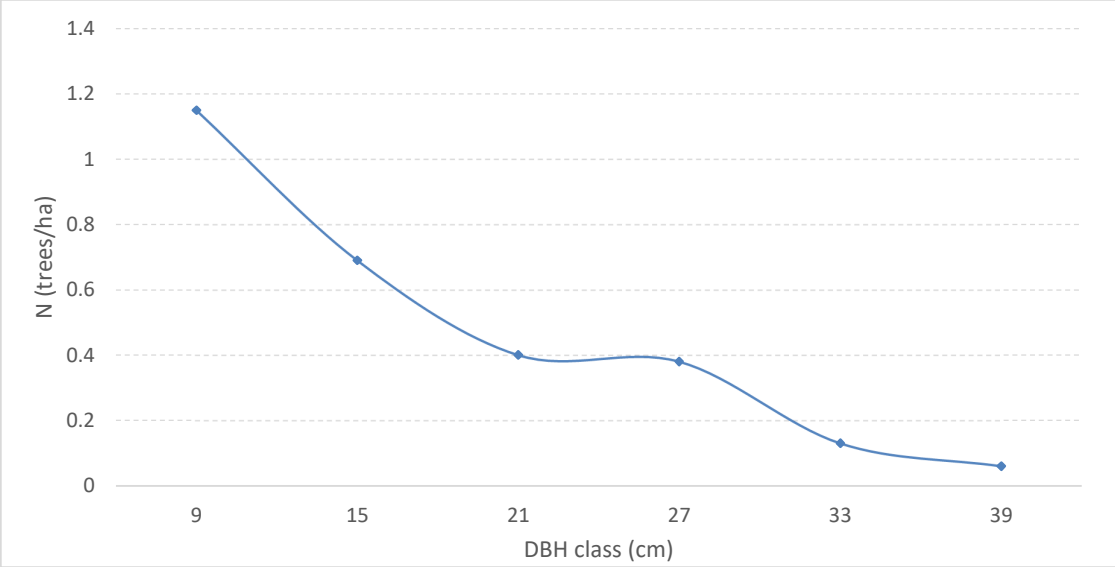

Figure 15. N-DBH distribution of *D. oliveri* trees in the Yok Don NP.

e) N-H distribution of D. oliveri in the Yok Don NP

The highest number of trees was observed at the H mid-classes of 7 m to 9 m, accounting for 67.7% (**Table 9**). As the H mid-classes increased, the number of trees decreased and reached the lowest at 0.7% when the H mid-class was 25 m.

Table 9. Distribution of *D. oliveri* tree number by H classes in the Yok Don NP.

H class (m)	H mid-class (m)	Frequency (tree)	Density (tree/ha)	Percent (%)	Cumulative Percent (%)
4-6	5	26	0.18	6.4	6.4
6-8	7	76	0.53	18.7	25.1
8-10	9	71	0.49	17.5	42.6
10-12	11	33	0.23	8.1	50.7
12-14	13	61	0.42	15	65.8
14-16	15	48	0.33	11.8	77.6
16-18	17	43	0.3	10.6	88.2
18-20	19	24	0.17	5.9	94.1
20-22	21	15	0.1	3.7	97.8
22-24	23	6	0.04	1.5	99.3
24-26	25	3	0.02	0.7	100
	Total	406	2.81	100	

The N-H distribution of *D. oliveri* trees in the Yok Don NP followed a declining trend with several peaks. The lowest peak was observed at the H class of 13 m (**Figure 16**). The number of trees gradually decreased from the lower peak with the increase in the H classes of 13 m to 25 m (**Figure 16**).

Figure 16. N-H distribution of *D. oliveri* in the Yok Don NP.

f) N-DBH and N-H distribution of D. oliveri in the Yok Don NP

To understand the distribution of tree number by DBH and H, a table of correlations between H and the DBH classes was established to calculate the mean of H class (H_m) to create a correlation chart. The highest number of trees was associated with the DBH class of 9 cm and H_m of 7.94 m (**Table 10**).

Table 10. Correlations between H and DBH of *D. oliveri* in the Yok Don NP.

H mid-class (m)	DBH class (cm)						Total (tree)
	9	15	21	27	33	39	
5	24	0	2	0	0	0	26
7	71	5	0	0	0	0	76
9	51	19	0	0	1	0	71
11	13	15	4	1	0	0	33
13	5	39	12	5	0	0	61
15	1	17	21	7	0	2	48
17	0	3	14	17	5	4	43
19	1	1	4	11	6	1	24
21	0	0	1	9	4	1	15
23	0	0	0	2	3	1	6
25	0	0	0	3	0	0	3
Total (tree)	166	99	58	55	19	9	406
H_m (m)	7.94	12.15	14.83	17.98	19.00	17.89	

The N-DBH and N-H distribution of *D. oliveri* in the Yok Don NP showed an increased curve with the increase of DBH proportional to the increase of H. The distribution curve reached a peak at the H_m of 19 m and the DBH of 39 cm. Then, the tree height declined with the increase in DBH sizes (**Figure 17**).

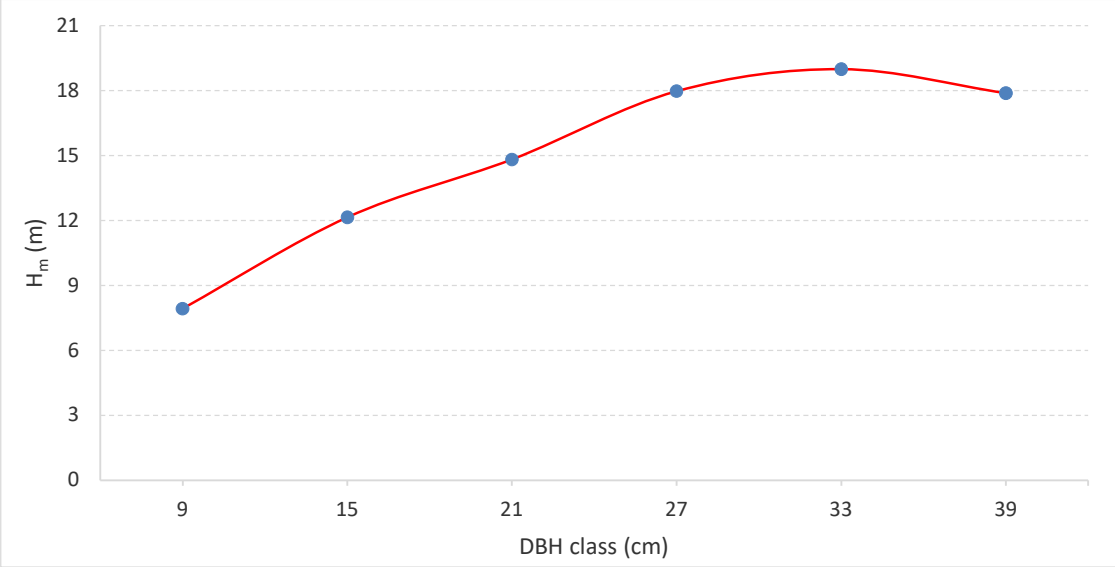

Figure 17. Correlations between the number of *D. oliveri* trees and DBH and H in the Yok Don NP.

5.1.3 Dak Uy Special-Use Forest

5.1.3.1. Distribution of D. cochinchinensis

a) Distribution by forest types

The findings of the surveys indicated that the density of *D. cochinchinensis* trees was 14.9 trees/ha which was distributed widely in the Dak Uy SUF in the three main types of forests as follows:

Restored evergreen broad-leaved forest without reserves: This type of forest surrounds the SUF in the northern and western areas and under sub-compartments 1, 2, and 4 of the SUF (**Figure 18**). The habitat mainly consists of reed and bamboo mixed with some small non-valuable timber trees. One transect cut through this habitat without any timber trees of *D. cochinchinensis* detected but some coppices were sparsely found. However, at the end of the transect, there was an area, close to the botanic garden of the SUF, that had many effective seedlings.

Poor broadleaf evergreen forest: This type of forest belongs to the sub-compartment 5. Two transects with the length of 3.5 km went through this habitat. The density of *D. cochinchinensis* was 4 trees/ha. Soil texture is medium.

Medium broadleaf evergreen forest: This type of forest belongs to the sub-compartment 4 and 6 where one transect with the length of 1.4 km cut through. Only one *D. cochinchinensis* tree with DBH of 51.9 cm was recorded on this transect. Two individuals of *D. cochinchinensis* seedlings were also recorded on the transect. The records indicated that the distribution of *D. cochinchinensis* in this area was rare. This was understandable because the areas close to the edge of the Dak Uy SUF had suffered from extensive illegal logging. According to the Dak Uy SUF management board, 26 cases of illegal timber logging and 2 cases of timber transportation *D. cochinchinensis* with the loss of 4.4 cubic meter were detected in 2017 and 7 cases of digging the tree roots from previous logging were detected in 2018. Some deep holes resulted from digging the *D. cochinchinensis* roots were seen in the area.

b) Distribution by geography

D. cochinchinensis usually grows in the mixed evergreen broadleaf–deciduous forests on lowland with the elevation of 50 m – 60 m to 500 m a.s.l. or in the tropical monsoon evergreen moist broadleaf forest on lowland, preferring sandy loam and limestone soils. Natural conditions include lower topography, tropical monsoon climate, soil horizon and texture of the Dak Uy SUF as mentioned in section 2.3 earlier are suitable for the ecological distribution of *D. cochinchinensis*.

c) Distribution of regenerating plants

The density of *D. cochinchinensis* regenerants was 35 plants/ha of which coppices were 56% and seedlings were 44%. The percentage of effective and ineffective regenerating plants was 76% and 24% respectively. The Dak Uy SUF has a high potential for the thriving *D. cochinchinensis*.

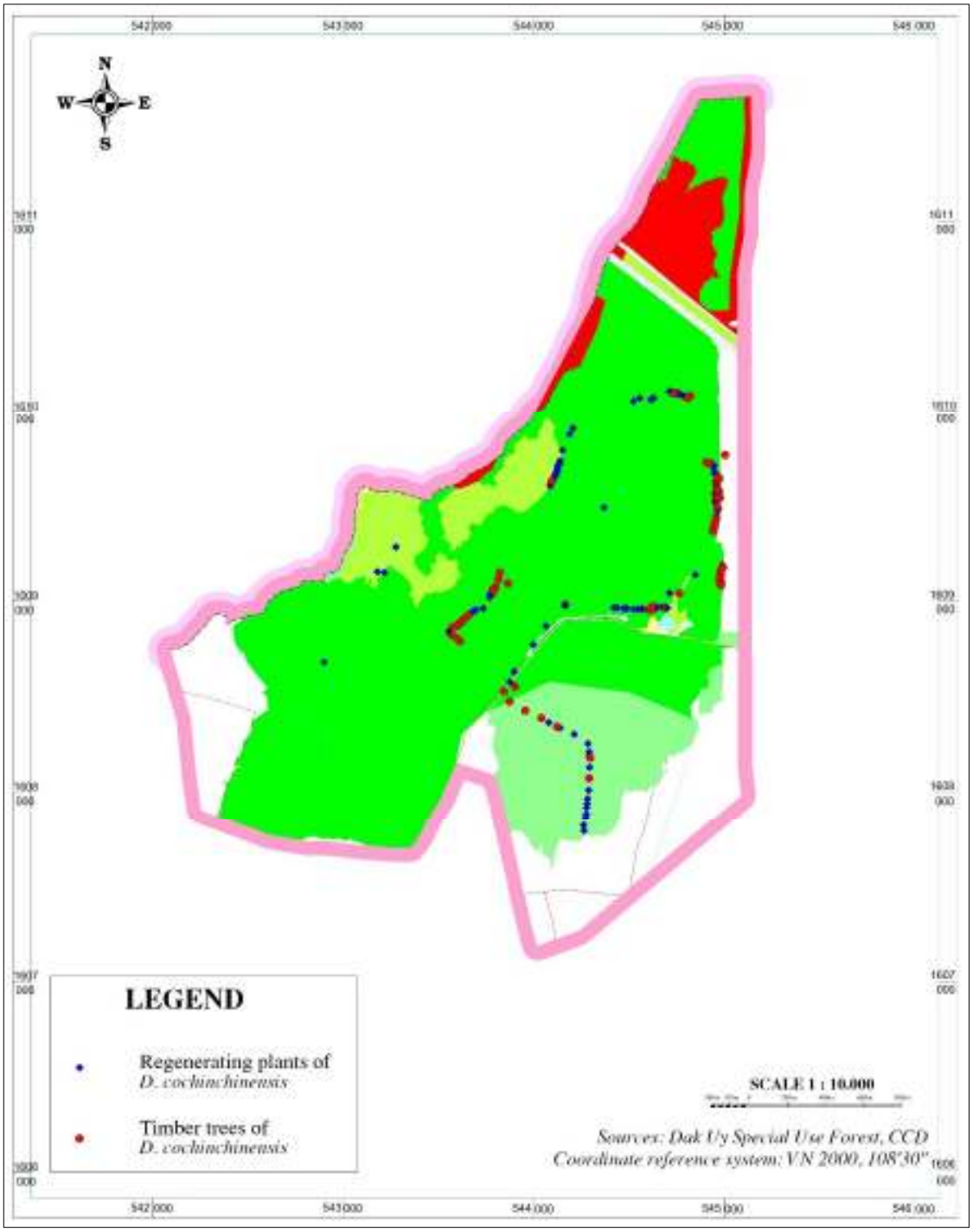

Figure 18. Distribution of *D. cochinchinensis* in the Dak Uy SUF.

d) N-DBH distribution of D. cochinchinensis in the Dak Uy SUF

The highest number of trees was observed in the DBH mid-classes of 9 cm to 15 cm, accounting for 87.9% (**Table 11**). The lowest number of trees was observed in the DBH mid-classes of 51 cm to 75 cm which accounted for 2.8%.

Table 11. Distribution of *D. cochinchinensis* tree number by DBH classes in the Dak Uy SUF.

DBH class (cm)	DBH mid-class (cm)	Frequency (tree)	Density (tree/ha)	Percent (%)	Cumulative Percent (%)
6-12	9	89	8.90	59.7	59.7
12-18	15	42	4.20	28.2	87.9

DBH class (cm)	DBH mid-class (cm)	Frequency (tree)	Density (tree/ha)	Percent (%)	Cumulative Percent (%)
18-24	21	7	0.70	4.7	92.6
24-30	27	2	0.20	1.3	94
30-36	33	3	0.30	2	96
36-42	39	2	0.20	1.3	97.3
48-54	51	1	0.10	0.7	98
60-66	63	1	0.10	0.7	98.7
66-72	69	1	0.10	0.7	99.3
72-78	75	1	0.10	0.7	100
	Total	149	14.90	100	

The N-DBH distribution curve of *D. cochinchinensis* in the Dak Uy SUF showed a decline with increasing DBH size. However, the greatest decrease was observed at DBH classes of 9 cm to 21 cm (**Figure 19**).

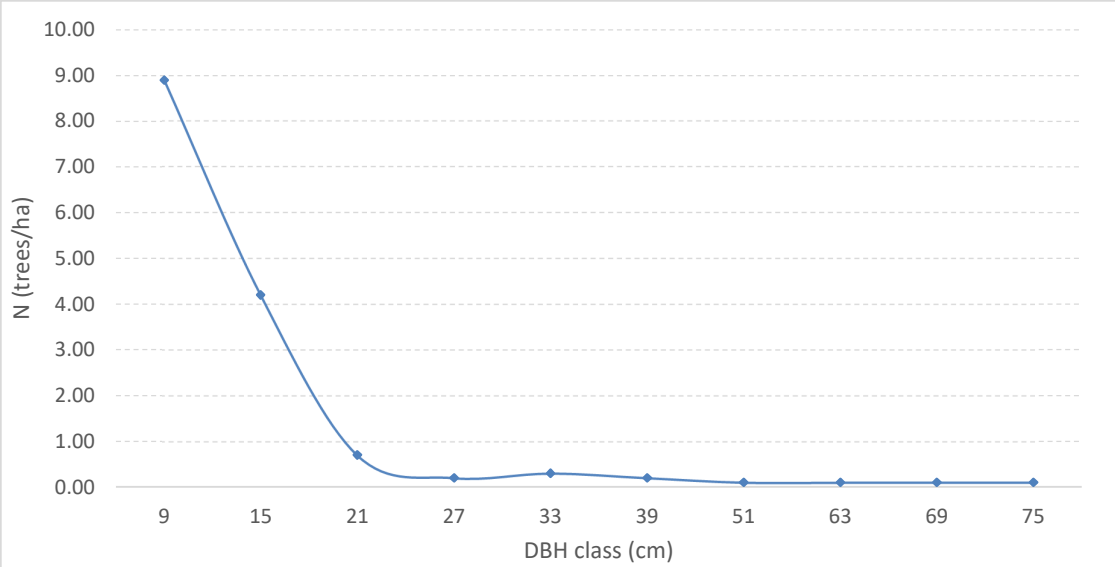

Figure 19. Distribution of *D. cochinchinensis* in the Dak Uy SUF.

e) N-H distribution of D. cochinchinensis in the Dak Uy SUF

The highest number of trees was found in the H class of 6 m to 10 m, accounting for 51% (**Table 12**). The number of trees gradually decreased with the increase in the H classes from 10 m to 24 m.

Table 12. Distribution of *D. cochinchinensis* tree number by H classes in the Dak Uy SUF.

H class (m)	H mid-class (m)	Frequency (tree)	Density (tree/ha)	Percent (%)	Cumulative Percent (%)
5-7	6	23	2.3	15.4	15.4
7-9	8	34	3.4	22.8	38.3
9-11	10	19	1.9	12.8	51
11-13	12	17	1.7	11.4	62.4
13-15	14	18	1.8	12.1	74.5
15-17	16	16	1.6	10.7	85.2
17-19	18	7	0.7	4.7	89.9
19-21	20	7	0.7	4.7	94.6
21-23	22	7	0.7	4.7	99.3
23-35	24	1	0.1	0.7	100
	Total	149	14.9	100	

The N-H distribution of *D. cochinchinensis* trees in the Dak Uy SUF was skewed to the left with a peak at the DBH mid-class of 8 cm (**Figure 20**).

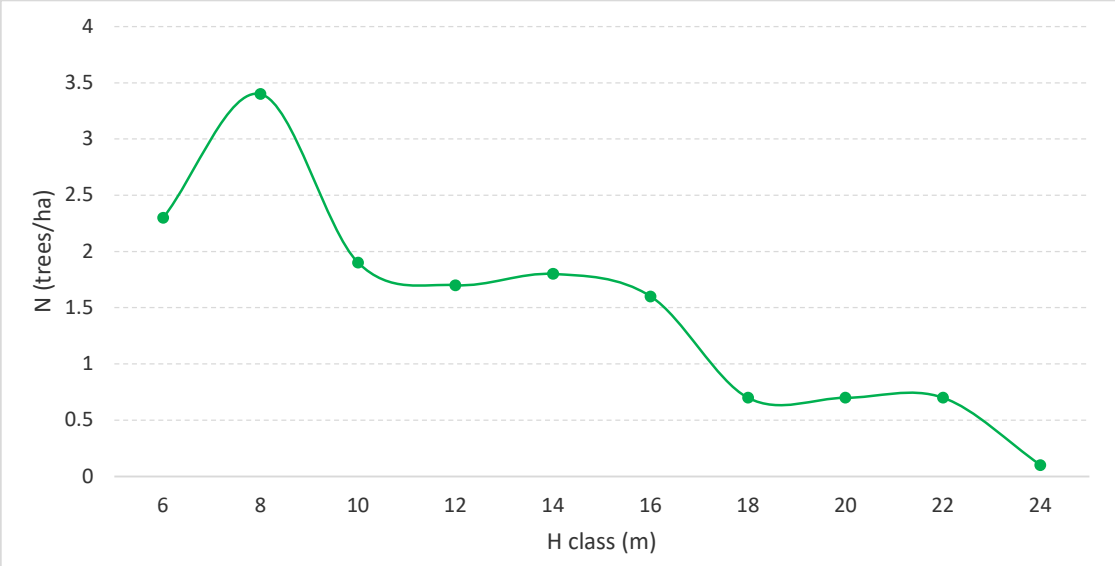

Figure 20. N-H distribution of *D. cochinchinensis* in the Dak Uy SUF.

f) N-DBH and N-H distribution of D. cochinchinensis in the Dak Uy SUF

The highest number of trees was seen at the DBH classes of 9 cm to 15 cm and H_m of 9.19 – 14.19, accounting for 87.92%. The lowest number of trees was observed at the DBH classes of 51 cm to 75 cm corresponding to the H_m from 22 m to 24 m (**Table 13**).

Table 13. Correlations between H and DBH of *D. cochinchinensis* in the Dak Uy SUF.

H mid-class (m)	DBH class (cm)										Total (tree)
	9	15	21	27	33	39	51	63	69	75	
6	23	0	0	0	0	0	0	0	0	0	23
8	29	4	1	0	0	0	0	0	0	0	34
10	16	2	1	0	0	0	0	0	0	0	19
12	9	8	0	0	0	0	0	0	0	0	17
14	7	9	0	1	1	0	0	0	0	0	18
16	4	12	0	0	0	0	0	0	0	0	16
18	1	5	0	0	0	0	0	1	0	0	7
20	0	2	3	1	1	0	0	0	0	0	7
22	0	0	2	0	1	2	1	0	1	0	7
24	0	0	0	0	0	0	0	0	0	1	1
Total (tree)	89	42	7	2	3	2	1	1	1	1	149
Hm	9.19	14.19	17.43	17.00	18.67	22.00	22.00	22.00	22.00	24.00	

The N-DBH and N-H distribution of *D. cochinchinensis* in the Dak Uy SUF was proportional to each other as the increase of DBH corresponds to an increase of H as presented in the incremental curve (**Figure 21**).

Figure 21. Correlations between *D. cochinchinensis* tree number and DBH and H in Dak Uy SUF.

5.1.3.2. Distribution of D. oliveri

The surveys undertaken in the Dak Uy SUF did not record the existence of *D. oliveri* though the report provided by the Dak Uy SUF management board mentioned it.

5.1.4. Bu Gia Map National Park

5.1.4.1. Distribution of D. cochinchinensis

During the field surveys in the Bu Gia Map NP, no *D. cochinchinensis* was recorded.

5.1.4.2. Distribution of D. oliveri

a) Distribution by forest types

The field surveys recorded *D. oliveri* in six types of forests including evergreen closed forest, semi-evergreen closed forest, lower montane evergreen forest, lower montane semi-evergreen forest, mixed bamboo and wood forest, and bamboo forest. The density of timber trees of *D. oliveri* was 7.49 trees/ha (**Figure 22**).

b) Distribution by geography

D. oliveri individuals were observed in moist areas or areas close to water sources such as rivers and streams in the Bu Gia Map NP. On steep slopes, ridges or peaks of the mountains, the observed *D. oliveri* were relatively low. *D. oliveri* were distributed at the altitudes of 350 m – 500 m a.s.l.

c) *Distribution of regenerating plants*

The density of *D. oliveri* regenerants was quite low with 5.63 plants/ha, of which, coppices were 56% and seedlings were 44%. The percentage of effective and ineffective regenerating plants was 49% and 51% respectively (**Figure 22**).

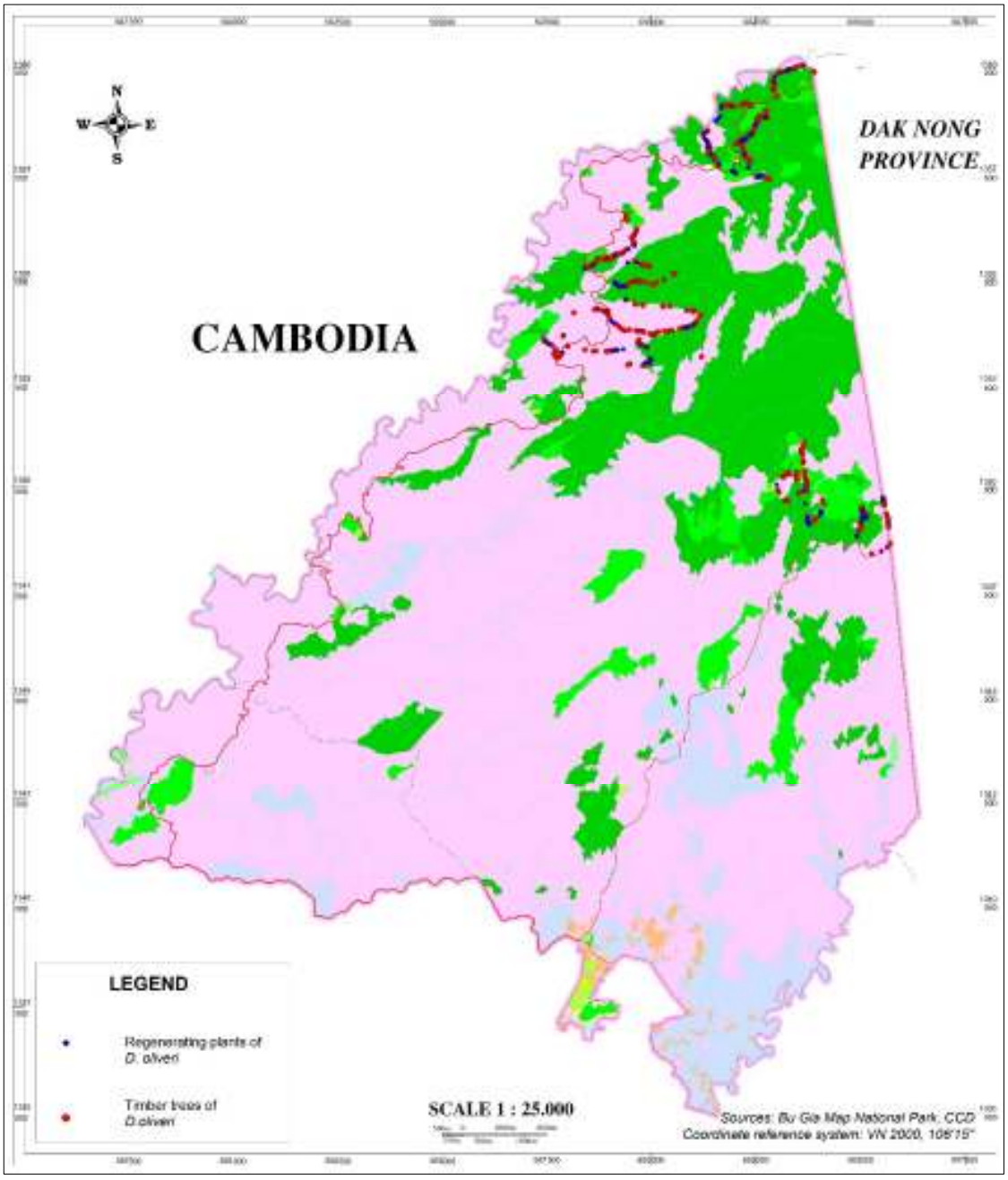

Figure 22. Distribution of *D. oliveri* in Bu Gia Map NP.

d) N-DBH distribution

The highest number of *D. oliveri* trees was observed at the DBH mid-classes of 9 cm to 33 cm, accounting for more than 86.4%. The lowest number of trees was observed in DBH mid-classes of 51 cm to 93 cm, accounting for 2.0% (**Table 14**Error! Reference source not found.).

Table 14. Distribution of *D. oliveri* tree number by DBH classes in Bu Gia Map NP.

DBH class (cm)	DBH mid-class (cm)	Frequency (tree)	Density (tree/ha)	Percent (%)	Cumulative Percent (%)
6-12	9	178	1.73	23.1	23.1
12-18	15	162	1.57	21	44.1
18-24	21	116	1.13	15	59.1
24-30	27	106	1.03	13.7	72.9

30-36	33	104	1.01	13.5	86.4
36-42	39	62	0.6	8	94.4
42-48	45	27	0.26	3.5	97.9
48-54	51	6	0.06	0.8	98.7
54-60	57	4	0.04	0.5	99.2
60-66	63	5	0.05	0.6	99.9
90-96	93	1	0.01	0.1	100
	Total	771	7.49	100	

The N-DBH distribution of *D. oliveri* in the Bu Gia Map NP showed a gradually declining curve with increasing DBH size. Two periods that the distribution curve was horizontal were at the DBH classes of 21 cm to 33 cm and 51 cm to 63 cm (**Figure 23**).

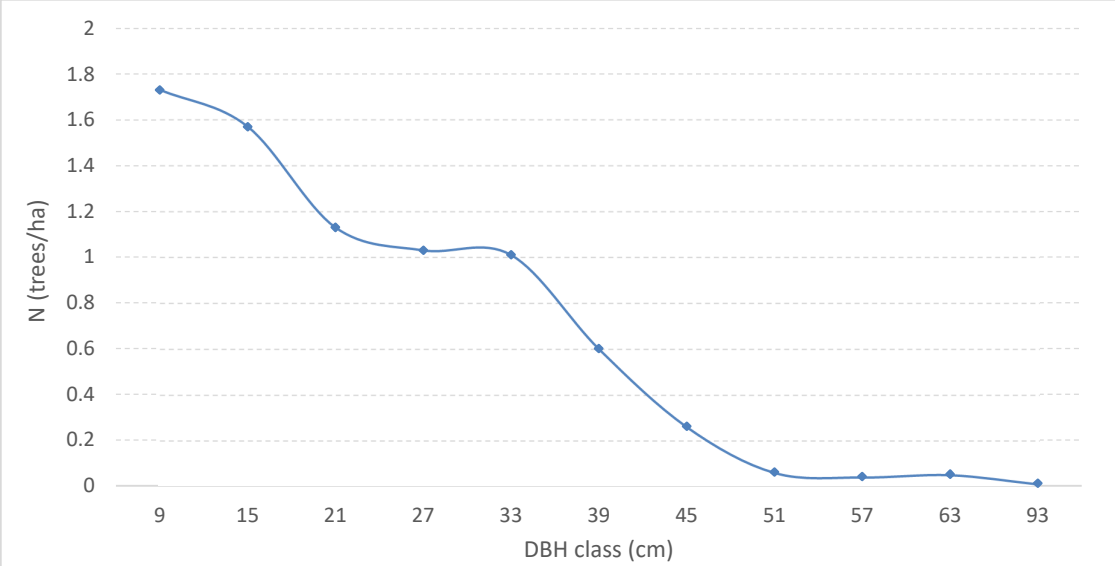

Figure 23. N-DBH distribution of *D. oliveri* trees in the Bu Gia Map NP.

e) *N-H distribution*

The highest number of trees was observed at the H mid-classes of 15 m and 17 m, accounting for 28.3%. The lowest number of trees was observed at the H mid-classes of 27 cm to 29 m (**Table 15**).

Table 15. Distribution of *D. oliveri* tree number by DBH classes in the Bu Gia Map NP.

H class (m)	H mid-class (m)	Frequency (tree)	Density (tree/ha)	Percent (%)	Cumulative Percent (%)
4-6	5	22	0.21	2.9	2.9
6-8	7	83	0.81	10.8	13.6
8-10	9	95	0.92	12.3	25.9
10-12	11	47	0.46	6.1	32
12-14	13	92	0.89	11.9	44
14-16	15	103	1	13.4	57.3
16-18	17	115	1.12	14.9	72.2
18-20	19	91	0.88	11.8	84
20-22	21	52	0.5	6.7	90.8
22-24	23	50	0.49	6.5	97.3
24-26	25	16	0.16	2.1	99.4
26-28	27	4	0.04	0.5	99.9
28-30	29	1	0.01	0.1	100
	Total	771	7.49	100	

The N-H distribution of *D. oliveri* trees in the Bu Gia Map NP reached several peaks. The highest peak was in the middle at the H class of 17 m and a lower peak was on the left at the H class of 9 m.

The number of trees decreased on the two sides of the peaks. This means that the number of trees gradually decreased with the decrease in H classes to the left and with the increase in H classes to the right (**Figure 24**).

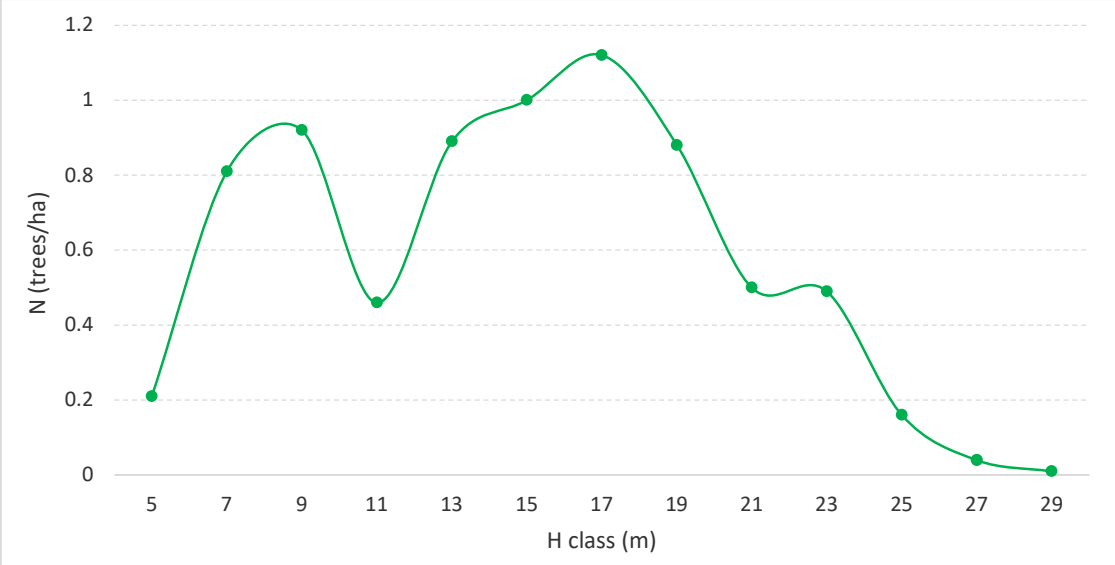

Figure 24. N-H distribution of *D. oliveri* in the Bu Gia Map NP.

f) N-DBH and N-H distribution of D. oliveri in the Bu Gia Map NP

A table of correlation between H and DBH classes and the number of trees was created to calculate the mean of H class (H_m) to understand the distribution of tree numbers by DBH and H. The highest number of *D. oliveri* trees was observed at the DBH classes of 9 cm to 33 cm and the H_m classes of 8.3 m to 18.96 m. The lowest number of trees was seen at the DBH classes of 51 cm to 93 cm and H_m classes of 21.33 m to 24 m (**Table 16**).

Table 16. Correlations between H and DBH of *D. oliveri* in the Bu Gia Map NP.

H mid-class (m)	DBH class (cm)											Total (tree)
	9	15	21	27	33	39	45	51	57	63	93	
5	21	1	0	0	0	0	0	0	0	0	0	22
7	72	8	3	0	0	0	0	0	0	0	0	83
9	52	38	2	1	2	0	0	0	0	0	0	95
11	17	19	7	2	1	1	0	0	0	0	0	47
13	13	51	18	7	2	1	0	0	0	0	0	92
15	3	33	32	23	7	3	2	0	0	0	0	103
17	0	9	39	29	28	10	0	0	0	0	0	115
19	0	2	11	27	26	17	4	3	0	1	0	91
21	0	1	4	13	20	8	5	0	1	0	0	52
23	0	0	0	3	15	16	10	2	1	2	1	50
25	0	0	0	1	2	4	5	1	1	2	0	16
27	0	0	0	0	1	2	0	0	1	0	0	4
29	0	0	0	0	0	0	1	0	0	0	0	1
Total (tree)	178	162	116	106	104	62	27	6	4	5	1	771
H_m (m)	8.3	12.23	15.4	17.36	18.96	20.19	22.04	21.33	24	23	23	

The N-DBH and N-H distribution of *D. oliveri* in the Yok Don NP showed a gradually increasing curve with increasing DBH class, corresponding to the increase of H. The distribution curve reached a peak at the H_m of 24 m and the DBH of 57 cm, then declined with increasing DBH sizes (**Figure 25**).

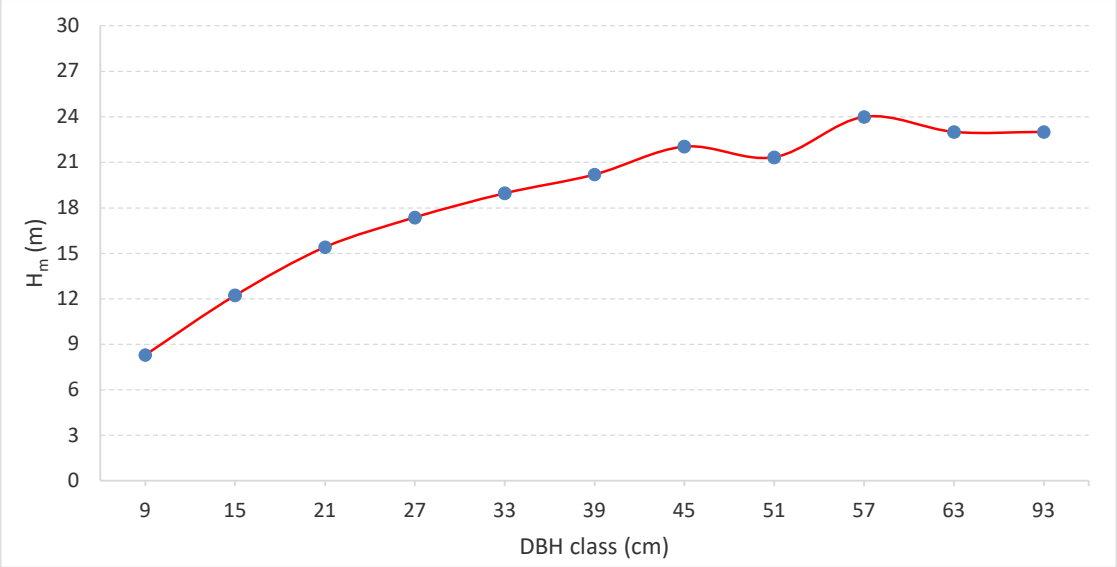

Figure 25. Correlations between *D. oliveri* tree number and DBH and H in the Bu Gia Map NP.

5.2. Abundance of *D. cochinchinensis* and *D. oliveri*

5.2.1. Abundance of D. cochinchinensis between the Dak Uy SUF and the Yok Don NP

It was found that the *D. cochinchinensis* in the Dak Uy SUF was more abundant than in the Yok Don NP because the number of trees per hectare in the Dak Uy SUF was higher than in the Yok Don NP in all DBH classes (**Table 17**Error! Reference source not found.).

Table 17. Comparison of *D. cochinchinensis* density between the Dak Uy SUF and the Yok Don NP.

DHB class (cm)	6 ≤ D1.3 ≤ 15	15 < D1.3 ≤ 30	30 < D1.3 ≤ 50	D1.3 > 50	Density
Density in the Dak Uy SUF (tree).	12.00	2.00	0.50	0.40	14.90
Density in the Yok Don NP (tree).	0.67	0.07	0.00	0.00	0.74

5.2.2. Abundance of D. oliveri amongst the Yok Don, Cat Tien and Bu Gia Map NPs.

The Bu Gia Map NP had the highest density of *D. oliveri* indicating that the abundance of the species was higher than compared to the Cat Tien and Yok Don NPs. The Yok Don NP had the lowest density of *D. oliveri* and was only 38% and 42% as compared to the Bu Gia Map and the Cat Tien NPs respectively; therefore, the abundance of *D. oliveri* in the Yok Don NP was lowest (**Table 18**). In terms of DBH class, the number of *D. oliveri* trees in the DBH class greater than 30 cm and smaller than 50 cm in the Yok Don NP was only 10% and 14% of the Bu Gia Map and Cat Tien NPs respectively, especially the Yok Don NP did not have any *D. oliveri* trees that had DBH greater than 50 cm.

The number of *D. oliveri* trees in DBH from 6 cm to 50 cm in the Cat Tien NP was lower than those in the Bu Gia Map NP, however, the number of *D. oliveri* trees having DBH greater than 50 cm in the Cat Tien NP was much higher than compared to those in the Bu Gia Map NP.

Table 18. Comparison of *D. oliveri* density amongst the Dak Uy SUF, Cat Tien and Yok Don NPs

DBH class (cm)	6 ≤ D1.3 ≤ 15	15 < D1.3 ≤ 30	30 < D1.3 ≤ 50	D1.3 > 50	Density
Density in the Yok Don NP (tree).	1.45	1.17	0.19	0.00	2.81
Density in the Bu Gia Map NP (tree).	2.78	2.71	1.88	0.12	7.49
Density in the Cat Tien NP (tree).	2.35	2.28	1.38	0.75	6.76

The abundance of *D. cochinchinensis* and *D. oliveri* in terms of species composition in each protected area is elaborated below.

5.2.3. Cat Tien National Park

In terms of species composition in the forest structure, amongst the 36 species recorded, *D. oliveri* was one of the four dominated species by the percentage of trees (N%) and one of the three dominated species by the important value (IV%). It is noted that only species with N% and IV% equal or greater than 5% were considered dominant. Details of the calculation are found in **Appendix 1**. Appendix 1. N% and IV% of all species in the Cat Tien NP.Hence, the abundance of *D. oliveri* in the Cat Tien NP was quite high and only ranked after the two species of *Diospyros sylvatica* and *Lagerstroemia calyculata*. Below is the species composition by N% and IV%:

Species composition by N%:

20.82 Dios + 16.73 Lagc + 9.80 Dol + 8.57 Stei + 44.08 others

Note: Dios = *Diospyros sylvatica*; Lagc = *Lagerstroemia calyculata*;

Dol = *Dalbergia oliveri*; Stei = *Streblus ilicifolius*

Species composition by IV%:

37.48 Lagc + 12.43 Dios + 10.23 Dol + 39.88 others

Note: Lagc = *Lagerstroemia calyculata*; Dios = *Diospyros sylvatica*; Dol = *Dalbergia oliveri*

5.2.4. Yok Don National Park

5.2.4.1. The abundance of D. cochinchinensis

Species composition by N% for *D. cochinchinensis*:

10.70 Shoo + 9.77 Shos + 8.84 Crf + 7.44 Can1 7.44 Dipo + 7.44 **Dco** + 48.37 others.

Note: Shoo = *Shorea obtuse*; Shos = *Shorea siamensis*; Crf = *Cratoxylum formosum*;

Can1 = *Canarium sp1*; Dipo = *Dipterocarpus obtusifolius*; Dco = *Dalbergia cochinchinensis*

Species composition by IV% for *D. cochinchinensis*:

12.54 Shoo + 9.19 Crf + 8.06 Can1 + 8 Dipo + 7.41 Shos + 5.7 Lagc + 49.11 others.

Note: Shoo = *Shorea obtuse*; Crf = *Cratoxylum formosum*; Can1 = *Canarium sp1*;

Dipo = *Dipterocarpus obtusifolius*; Shos = *Shorea siamensis*;

Lagc = *Lagerstroemia calyculata*

In the species composition by percentage of number of trees, *D. cochinchinensis* contributed 7.44% amongst the 40 recorded species. This showed that *D. cochinchinensis* was one of the dominant species in the forest structure. However, *D. cochinchinensis* did not appear in the IV% species composition, meaning that *D. cochinchinensis* was not an important species amongst the dominant species. Details of the calculation are in **Appendix 2**.

5.2.4.2. The abundance of D. oliveri

As the survey team had focused its efforts on finding the existence and surveying *D. cochinchinensis*, it did not have the time to survey *D. oliveri* in the established plots. Therefore, the species composition by N% and IV% for *D. oliveri* was not able to be established to assess its abundance. However, the abundance level between *D. oliveri* and *D. cochinchinensis* were comparable as evident from the comparison of their population density (**Table 19**) . The density of *D. cochinchinensis* trees ranged from 6 cm to 30 cm in DBH size while the density of *D. oliveri* ranged from 6 cm to 50 cm in DBH size. Specifically, the density of young trees (bigger than 6 cm but smaller than 15 cm) of *D. cochinchinensis* was two times lower than that of *D. oliveri*, while the density of *D. oliveri* at the DBH class from 15 cm to 30 cm was almost 10 times higher. In general, the population density of *D. oliveri* (2.81 trees/ha) was four times higher than that of *D. cochinchinensis* (0.74 trees/ha) in the Yok Don NP, that is, the abundance of *D. oliveri* was much higher than that of *D. cochinchinensis*.

Table 19. Comparison of density between *D. cochinchinensis* and *D. oliveri* in the Yok Don NP.

DBH class (cm)	6 ≤ D1.3 ≤ 15	15 < D1.3 ≤ 30	30 < D1.3 ≤ 50	D1.3 > 50	Density
Density of *D. cochinchinensis* in the Yok Don NP (tree)	0.67	0.07	0.00	0.00	0.74

Density of *D. oliveri* in the Yok Don NP (tree)	1.45	1.17	0.19	0.00	2.81

5.2.5. Dak Uy Special-Use Forest

The species composition by the percentage of tree number (N%) and by important value (IV%) is elaborated below. Only species with N% and IV% greater than 5% were considered dominant.

Species composition by N%:

17.00 Cra1 + 12.83 Crp + 11.33 Dco + 58.84 others

Note: Cra1 = *Cratoxylon sp1*; Crp = *Crypteronia paniculata*; Dco = *Dalbergia cochinchinensis*

Species composition by IV%:

14.73 Crp + 13.42 Dco + 13.41 Cra1 + 5.14 Paa + 53.32 others

Note: Crp = *Crypteronia paniculata*; Dco = *Dalbergia cochinchinensis;*

Cra1 = *Cratoxylon sp1*; Paa = *Parinari annamensis.*

Amongst the 52 species recorded, *D. cochinchinensis* was one of three dominant species with high N%, accounting for 11.33% after *Cratoxylon sp1* (17%) and *Crypteronia paniculate* (12.83%). The 49 remaining species accounted for 58.84%. *D. cochinchinensis* was the second most important valued species contributing to the main canopy of the forest with the percentage of tree number at 13.42%. As a result, *D. cochinchinensis* was very abundant in the Dak Uy SUF. Details of the calculation are in **Appendix 3.**

5.2.6. Bu Gia Map National Park

The species composition by the percentage of tree number (N%) and by important value (IV%) is elaborated below. Only species with N% and IV% greater than 5% were considered dominant.

Species composition by N%:

6.78 Dol + 5.81 Dia + 5.53 Hoo + 5.12 Syc + 76.76 others.

Note: Dol = *Dalbergia oliveri*; Dia = *Dipterocarpus alatus*;

Hoo = *Hopea odorata*; Syc = *Syzygium chanlos*

Species composition by IV%:

12.48 Hoo + 12.20 Dia + 6 Dol + 69.32 others.

Note: Hoo = *Hopea odorata*; Dia = *Dipterocarpus alatus*; Dol = *Dalbergia oliveri*.

The Bu Gia Map NP was abundant in species composition. Amongst the 97 species recorded, *D. oliveri* recorded the highest N% with 6.78%, followed by *Dipterocarpus alatus* (5.81%), *Hopea odorata* (5.53%), and *Syzygium chanlos* (5.12%). This means that *D. oliveri* in the Bu Gia Map NP was very abundant.

Considering the IV%, *D. oliveri* was one of the three dominant species and contributed 6% to the IV% species composition, after *Hopea odorata* (12.48%) and *Dipterocarpus alatus* (12.20%). This proved that *D. oliveri* plays an important role in the crown canopy of the forest. Details of calculation are in **Appendix 4**.

5.3. Stocking of *D. cochinchinensis* and *D. oliveri*

5.3.1. Cat Tien National Park

Through detailed discussions with the technical staff and forest rangers of the Cat Tien NP, it was revealed that *D. oliveri* was distributed unevenly in the southern part of the Cat Tien NP. *D. oliveri* was distributed mainly in the southeastern Cat Tien NP and sparsely distributed in the southwestern Cat Tien NP (Error! Reference source not found.). Putting the results of the discussions and field surveys on the map, the distribution area of *D. oliveri* in the southeastern and southwestern Cat Tien NP was 10,005 ha and 14,281 ha respectively (Error! Reference source not found.). The densities of *D. oliveri* in the southeastern and southwestern Cat Tien NP were 11 trees/ha and 2.11 trees/ha respectively. Thus, the stocks of *D. oliveri* in the southeastern and southwestern Cat Tien NP were:

$$S_{southeastern} = 11 \times 10{,}005 = 110{,}055 \text{ trees}$$

$$S_{southwestern} = 2.11 \times 14{,}281 = 30{,}133 \text{ trees}$$

The stock of *D. oliveri* in the southern Cat Tien NP was:

S = 110,055 + 30,133 = 140,188 trees.

If the population density of *D. oliveri* in the southern Cat Tien NP was 6.76 trees per ha as computed in **Table 2** of section 5.1.1.1 above, the stock of *D. oliveri* in the southern part of the Cat Tien NP was:

S = 6.76 x 24,286 = 164,173 trees.

Thus, the wild population of *D. oliveri* in the Cat Tien NP was estimated to be between 140,000 – 160,000 trees with the DBH above 6 cm.

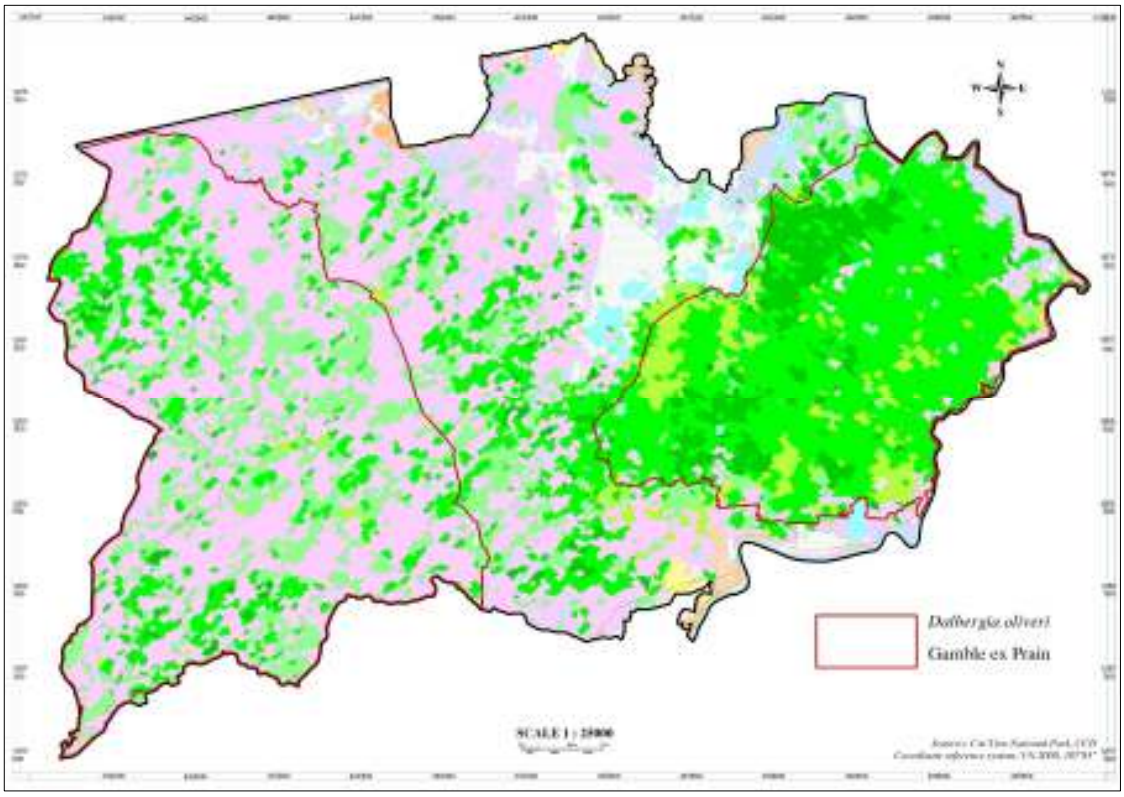

Figure 26. Estimated distribution area of *D. oliveri* in the southern Cat Tien NP.

5.3.2. Yok Don National Park

5.3.2.1. Stock of D. cochinchinensis

Through detailed discussions with the technical staff and forest rangers of the Yok Don NP, it was revealed that *D. cochinchinensis* was distributed in some small areas, mainly in the north and east of the Yok Don NP. Putting the results of the discussions and field surveys on the map, the distribution area of *D. cochinchinensis* in the Yok Don NP was estimated to be 12,272 ha (**Figure 27**). The density of *D. cochinchinensis* in the Yok Don NP was 0.74 trees/ha. The stock of *D. cochinchinensis* in the Yok Don NP was:

S = 0.74 x 12,272 = 9,081 trees.

Thus, the wild population of *D. cochinchinensis* in the Yok Don NP was estimated to be between 8,000 – 10,000 trees with the DBH above 6 cm.

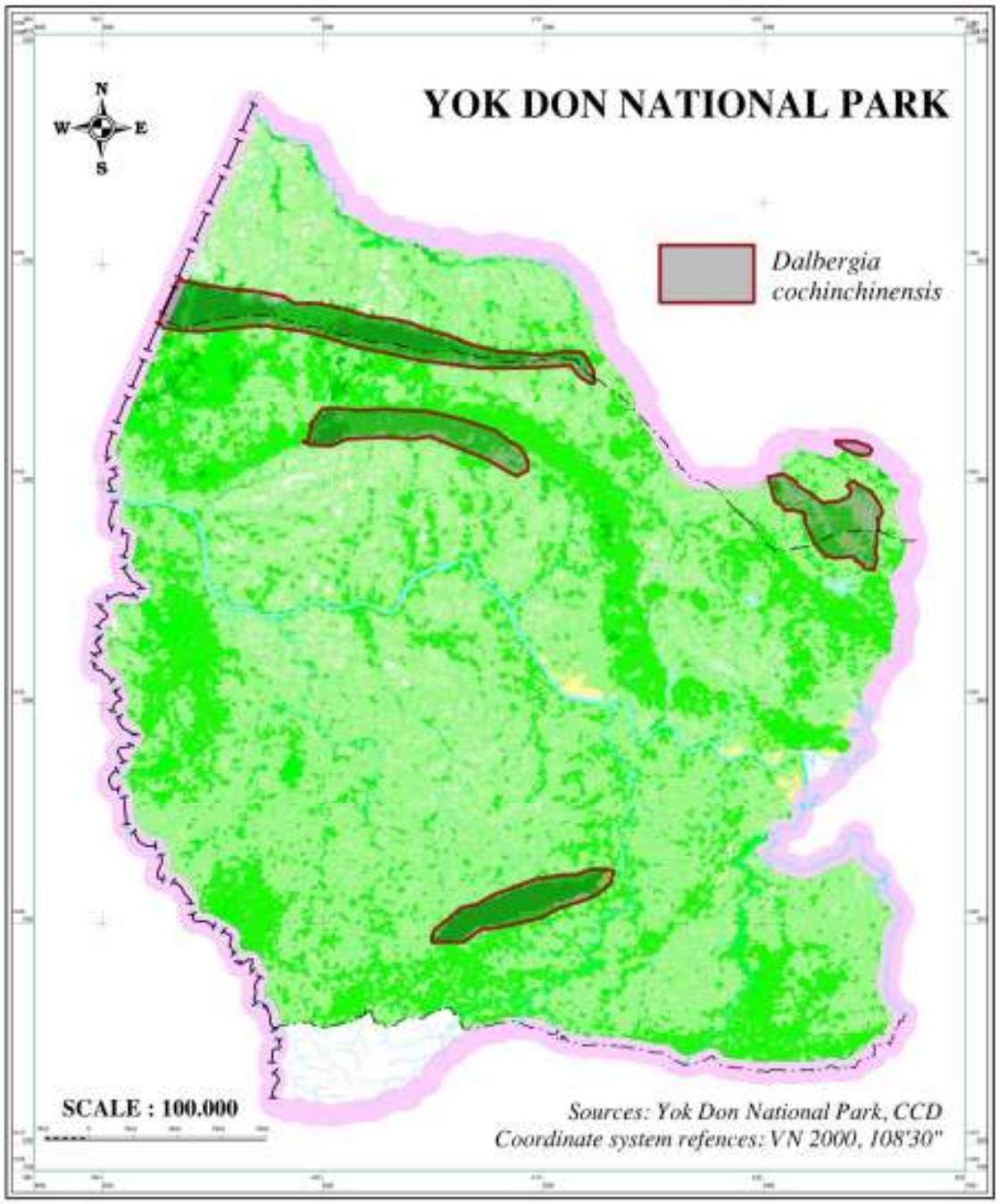

Figure 27. Estimated distribution area of *D. cochinchinensis* in the Yok Don NP.

5.3.2.2. Stock of D. oliveri

Through detailed discussions with the technical staff and forest rangers of the Yok Don NP, it was revealed that *D. oliveri* was distributed around the Yok Don NP. Putting the results of the discussions and field surveys on the map, the distribution area of *D. oliveri* in the Yok Don NP was estimated to be 20,520 ha (**Figure 28**). The density of *D. oliveri* in the Yok Don NP was 2.81 trees/ha. The stock of *D. oliveri* in the Yok Don NP was:

$$S = 2.81 \times 20{,}520 = 57{,}661 \text{ trees.}$$

Thus, the wild population of *D. oliveri* in the Yok Don NP was estimated to be between 50,000 – 60,000 trees with the DBH above 6 cm.

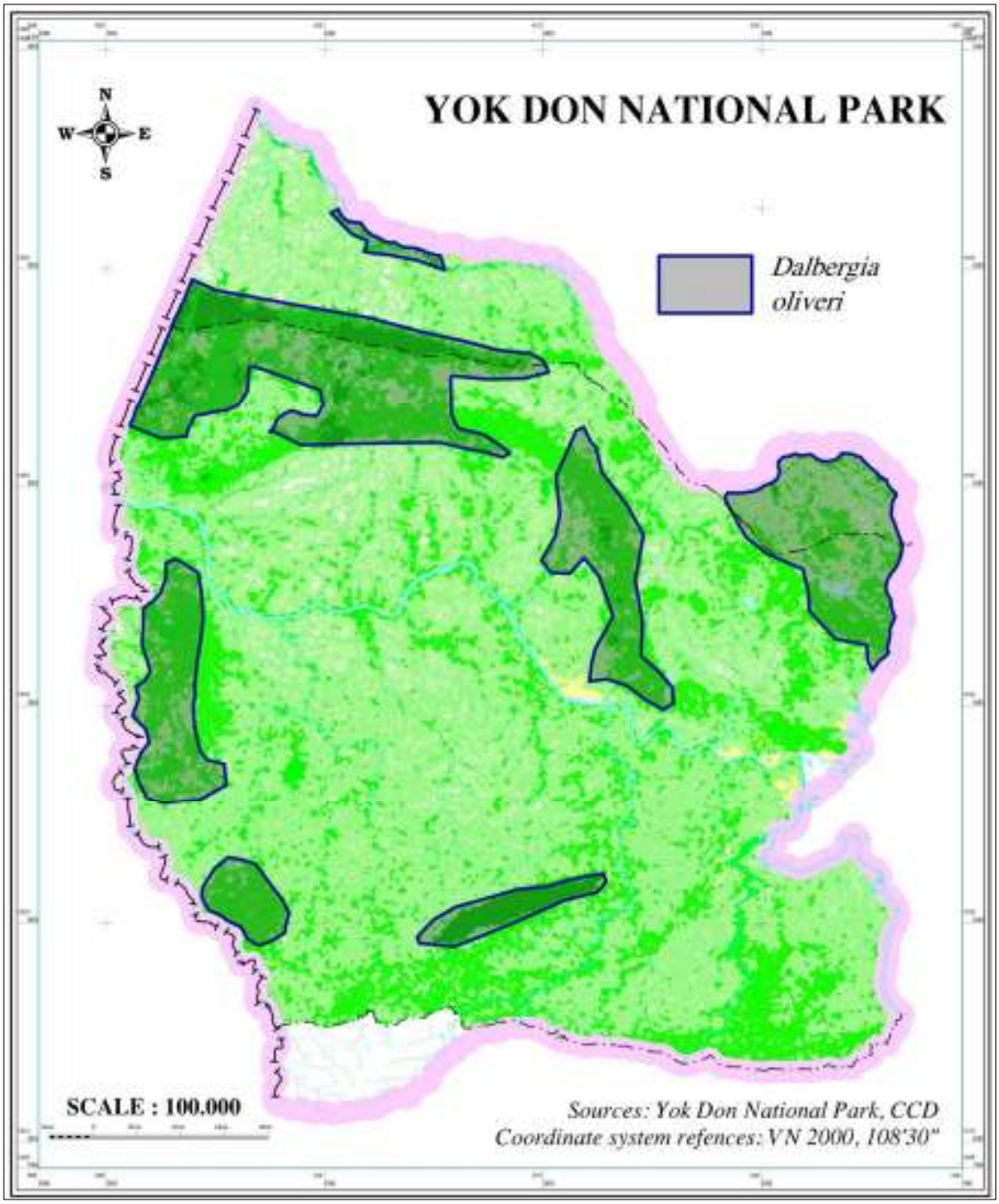

Figure 28. Estimated distribution area of *D. oliveri* in the Yok Don NP.

5.3.3. Dak Uy Special Use Forest

In the Dak Uy SUF, *D. cochinchinensis* was widely distributed in the entire protected area. The population density of *D. cochinchinensis* in the Dak Uy SUF was very high with 14.9 trees per hectare (Error! Reference source not found. in section 5.1.3.1 above) while the distribution area (540 ha) was also the area of the Dak Uy SUF. The stock of *D. cochinchinensis* in the Dak Uy SUF was:

S = 14.9 x 540 = 8.046 trees

This finding matched with the data of about 8,000 trees having DBH above 6 cm as was reported by the Dak Uy management board.

5.3.4. Bu Gia Map National Park

Through detailed discussions with the technical staff of the Bu Gia Map NP and interviews with the community-based forest protection groups, it was revealed d that *D. oliveri* was not evenly

distributed in the entire national park. It was mainly distributed in the north of the Bu Gia Map NP. Mapping the results of these discussions, interviews and field surveys, it was revealed that the distribution area of *D. oliveri* in the Bu Gia Map NP was about 9,589 ha (**Figure 29**). The density *D. oliveri* in Bu Gia Map NP was 7.49 trees per ha. The stock of *D. oliveri* was:

S = 7.49 x 9,589 = 71,822 trees.

Thus, the wild population of D. oliveri in the Bu Gia Map NP was estimated to be between 70,000 – 80,000 trees with the DBH above 6 cm.

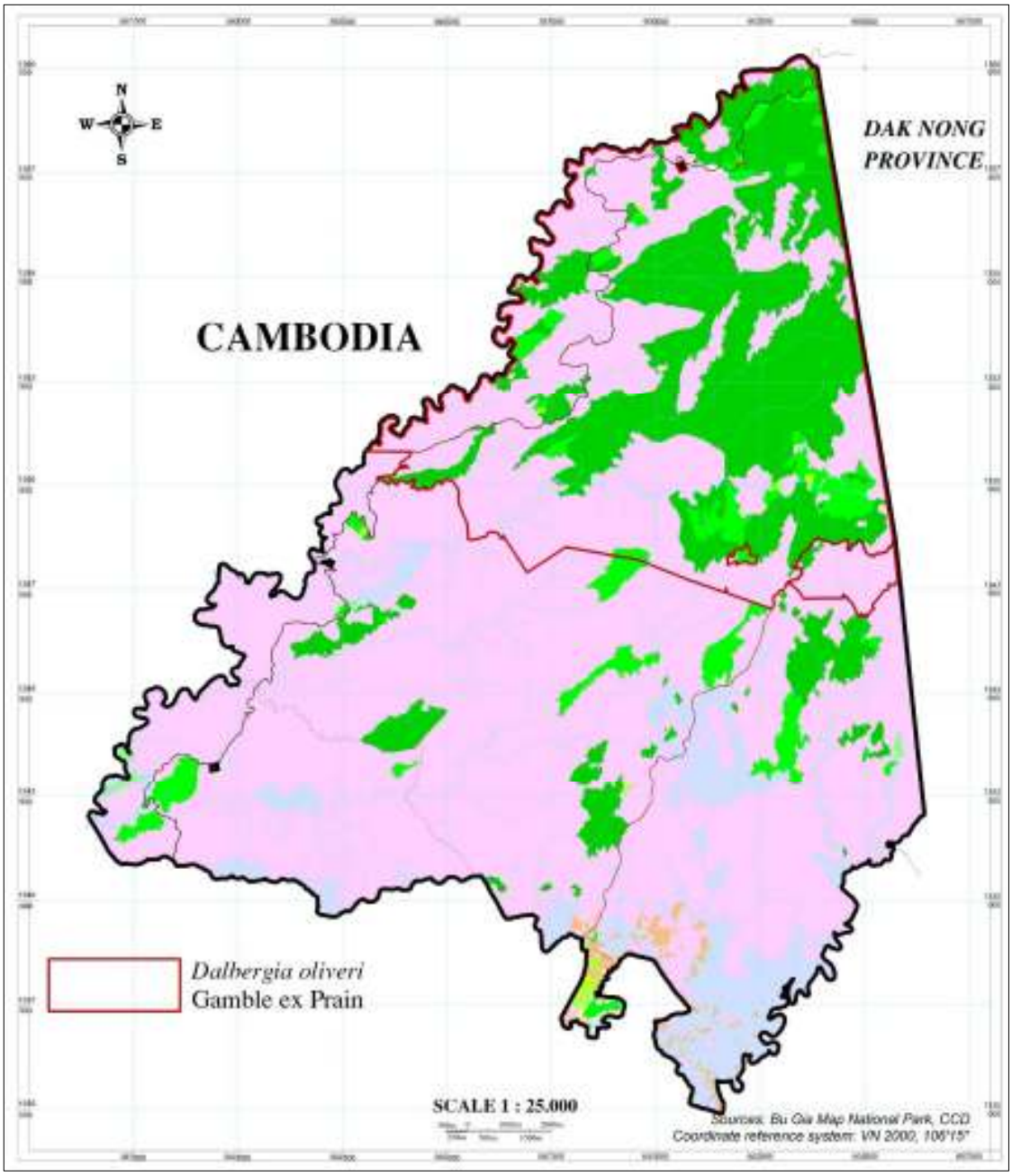

Figure 29. Estimated distribution area of *D. oliveri* in the Bu Gia Map NP.

6. LIMITATIONS

The field surveys were conducted during the COVID-19 outbreaks, so it was difficult to be granted permits from the management authorities of the Dak Uy SUF, the Bu Gia Map, Cat Tien and the Yok Dok NP to work at their sites. Even with a survey permit, the movement between forest rangers and communes to reach the designated survey area was difficult and strictly controlled by the local COVID-19 prevention groups.

The northern part of the Cat Tien NP was not surveyed though the Cat Tien NP's staff reported that *D. oliveri* was sparsely distributed in the area. This area could also have the distribution of *D. cochinchinensis*.

Some parameters such as soil profile and forest vegetation were not studied to have enough data for assessment and to draw concrete conclusions of the reasons why *D. cochinchinensis* was not found in the southern Cat Tien NP and the Bu Gia Map NP? Why *D. cochinchinensis* was found in restricted range of the Yok Dok NP? Why *D. oliveri* was not found in the Dak Uy SUF?

7. CONCLUSION

The field surveys had confirmed the distribution of *D. cochinchinensis* in the Dak Uy SUF and the Yok Don NP; and *D. oliveri* in the Yok Don, Cat Tien and Bu Gia Map NPs.

The surveys had also assessed the different types of distribution of *D. cochinchinensis* and *D. oliveri* in the four PAs to better understand their growth and the role they play in the forest structure.

The surveys had found the abundance of *D. cochinchinensis* and *D. oliveri* in these key PAs through species composition by the percentage of tree number (N%) and by the important value (IV%).

The surveys had also found densities of timber trees and regenerating plants of *D. cochinchinensis* and *D. oliveri* in the four key PAs of the Dak Uy SUF, the Yok Don, Cat Tien and the Bu Gia Map NPs.

The studies had identified the estimated distribution areas of *D. cochinchinensis* and *D. oliveri* for three large protected areas of the Yok Don, Cat Tien and the Bu Gia Map NPs.

In this regard, the stocking of *D. cochinchinensis* was estimated to be 8,000 trees in the Dak Uy SUF and between 8,000 – 10,000 trees in the Yok Don NP. The stocking of of *D. oliveri* was estimated to be 50,000 – 60,000 trees in the Yok Don NP, 70,000 – 80,000 trees in the Bu Gia Map NP, and 140,000 – 160,000 trees in the Cat Tien NP. These data were used as input in the preparation of a non-detriment findings report.

Soil profiles in the areas where *D. oliveri* and *D. cochinchinensis* were found and surveyed should be further analyzed to ascertain the factors contributing to the presence of both *D. oliveri* and *D. cochinchinensis* in the Yok Don national park and the absence of *D. cochinchinensis* in the southern part of the Cat Tien and the Bu Gia Map national parks, as well as the absence of *D. oliveri* in the Dak Uy Special-Use-Forest.

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APPENDICES

Appendix 1. N% and IV% of all species in the Cat Tien NP.

No.	Scientific name	Abbreviation	N	N%	G	G%	IV%
1	*Lagerstroemia calyculata*	Lagc	41	16.73	10.74	58.22	37.48
2	*Diospyros silvatica*	Dios	51	20.82	0.74	4.03	12.43
3	***Dalbergia oliveri***	**Dol**	**24**	**9.80**	**1.97**	**10.65**	**10.23**
4	*Streblus ilicifolius*	Stei	21	8.57	0.08	0.45	4.51
5	*Hopea odorata*	Hoo	1	0.41	1.27	6.87	3.64
6	*Xerospermum noronhianum*	Xer	9	3.67	0.35	1.92	2.80
7	*Ochrocarpos siamensis*	Och	10	4.08	0.22	1.17	2.63
8	*Polyalthia sp2.*	Poly2	11	4.49	0.09	0.46	2.48
9	*Cleistanthus indochinensis*	Cli	10	4.08	0.13	0.70	2.39
10	*Syzygium levinei*	Syle	7	2.86	0.31	1.69	2.28
11	*Afzelia xylocarpa*	Afx	3	1.22	0.59	3.21	2.22
12	*Syzygium chanlos*	Syc	7	2.86	0.19	1.02	1.94
13	*Terminalia nigrovenulosa*	Tern	7	2.86	0.09	0.51	1.69
14	*Orophea sp.*	Oro1	6	2.45	0.13	0.68	1.57
15	*Garcinia basacensis*	Gab	1	0.41	0.32	1.71	1.06
16	*Vitex trifolia*	Vitt	4	1.63	0.08	0.43	1.03
17	*Careya arborea*	Caa	1	0.41	0.30	1.64	1.03
18	*Tetrameles nudiflora*	Tet	3	1.22	0.13	0.69	0.96
19	*Pterospermum sp.*	Pte1	3	1.22	0.08	0.46	0.84
20	*Randia wallichii*	Raw	3	1.22	0.02	0.09	0.66
21	*Flacourtia jangomas*	Fla	2	0.81	0.08	0.42	0.62
22	*Aglaia sp1.*	Agl1	2	0.81	0.07	0.39	0.60
23	*Amoora gigantea*	Amg	2	0.81	0.06	0.31	0.56
24	*Albizia lucidior*	All	2	0.82	0.05	0.29	0.56
25	*Stereospermum neuranthum*	Sten	2	0.82	0.04	0.23	0.53
26	*Vitex glabrata*	Vig	1	0.41	0.10	0.53	0.47
27	*Dalbergia sp.*	Dal1	2	0.82	0.02	0.09	0.46
28	*Albizia sp.*	Alb1	1	0.41	0.07	0.37	0.39
29	*Endospermum chinense*	Enc	1	0.41	0.07	0.37	0.39
30	*Knema globularia*	Keg	1	0.41	0.02	0.13	0.27
31	*Cryptocarya sp.*	Cry	1	0.41	0.02	0.08	0.25
32	*Garcinia delpyana*	Gad	1	0.41	0.01	0.07	0.24
33	*Xantolis dongnaiensis*	Xan	1	0.41	0.01	0.04	0.23
34	*Antidesma sp1*	Ant1	1	0.41	0.01	0.03	0.22
35	*Polyalthia luensis*	Polu	1	0.41	0.00	0.03	0.22
36	*Syzygium zeylanicum*	Syze	1	0.41	0.00	0.02	0.22
Total			245	100.00	18.45	100.00	100.00

Appendix 2. N% and IV% of all species in the Yok Don NP.

No.	Scientificname	Abbreviation	N	N%	G	G%	IV%
1	*Shoreaobtusa*	Shoo	23	10.70	0.88	14.38	12.54
2	*Cratoxylumformosum*	Crf	19	8.84	0.58	9.54	9.19
3	*Canariumsp1*	Can1	16	7.44	0.53	8.67	8.06
4	*Dipterocarpusobtusifolius*	Dipo	16	7.44	0.52	8.56	8.00
5	*Shoreasiamensis*	Shos	21	9.77	0.31	5.05	7.41
6	*Lagerstroemiacalyculata*	Lagc	6	2.79	0.53	8.61	5.70
7	*Terminaliacorticosa*	Terc	8	3.72	0.36	5.97	4.85
8	***Dalbergiacochinchinensis***	**Dco**	**16**	**7.44**	**0.12**	**2.00**	**4.72**
9	*Syzygiumlanceolatum*	Syla	3	1.40	0.45	7.33	4.37
10	*Grewiatomentosa*	Grt	9	4.19	0.15	2.45	3.32
11	*Sindorasiamensis*	Sin	4	1.86	0.24	4.00	2.93
12	*Shorearoxburghii*	Shox	5	2.33	0.21	3.44	2.89
13	*Xyliaxylocarpa*	Xyl	9	4.19	0.08	1.23	2.71
14	*Aporosasp3*	Apo3	9	4.19	0.05	0.83	2.51
15	*Vitextrifolia*	Vitt	6	2.79	0.12	1.98	2.39
16	*Xylopiavielana*	Xyv	4	1.86	0.13	2.07	1.97
17	*Polyalthiajucunda*	Poju	6	2.79	0.05	0.79	1.79
18	*Polyalthiasp3*	Poly3	3	1.40	0.07	1.19	1.30
19	***Dalbergiaoliveri***	**Dol**	**3**	**1.40**	**0.07**	**1.17**	**1.29**
20	*Dipterocarpustuberculatus*	Dtu	3	1.40	0.07	1.08	1.24
21	*Irvingiamalayana*	Irm	2	0.93	0.09	1.43	1.18
22	*Syzygiumlevinei*	Syle	2	0.93	0.07	1.09	1.01
23	*Melanorrohealaccifera*	Mel	2	0.93	0.05	0.74	0.84
24	*Artocarpusgomezianus*	Arg	2	0.93	0.04	0.72	0.83
25	*Millettiasp1*	Mil1	2	0.93	0.04	0.61	0.77
26	*Careyaarborea*	Caa	1	0.47	0.06	0.98	0.73
27	*Bombaxinsigne*	Boi	1	0.46	0.06	0.94	0.70
28	*Morindaumbellata*	Mou	2	0.93	0.01	0.24	0.59
29	*Vaticasp1*	Vat1	1	0.47	0.04	0.64	0.56
30	*Neonaucleasessilifolia*	Neos	1	0.46	0.03	0.52	0.49
31	*Stereospermumneuranthum*	Sten	1	0.47	0.02	0.35	0.41
32	*Pterocarpusmacrocarpus*	Ptm	1	0.46	0.02	0.30	0.38
33	*Terminaliachebula*	Ter	1	0.46	0.01	0.24	0.35
34	*Semecarpussp1*	Sem1	1	0.46	0.01	0.19	0.33
35	*Dilleniasp2*	Dil2	1	0.46	0.01	0.15	0.31
36	*Antidesmasp3*	Ant3	1	0.46	0.01	0.14	0.30
37	*Brideliabalansea*	Brb	1	0.46	0.01	0.13	0.30
38	*Haldinacordifolia*	Hal	1	0.46	0.01	0.12	0.29
39	*Holarrhenapubescens*	Hop	1	0.47	0.00	0.06	0.27
40	*Lanneacoromandelica*	Lanc	1	0.46	0.00	0.07	0.27
Total			215	100.00	6.11	100.00	100.00

Appendix 3. N% and IV% of all tree species in the Dak Uy SUF.

No.	Tên Latinh	Abbreviation	N	N%	G	G%	IV%
1	*Crypteronia paniculata*	Crp	77	12.83	2.93	16.62	14.73
2	***Dalbergia cochinchinensis***	**Dco**	**68**	**11.33**	**2.73**	**15.50**	**13.42**
3	*Cratoxylon sp1*	Cra1	102	7.00	1.73	9.82	13.41
4	*Parinari annamensis*	Paa	18	3.00	1.28	7.27	5.14
5	*Schima crenata*	Sch	18	3.00	1.04	5.91	4.46
6	*Scaphium macropodium*	Sca	22	3.67	0.74	4.19	3.93
7	*Macclurodendron oligophlebia*	Mao	23	3.83	0.60	3.42	3.63
8	*Ilex sp.*	Ile1	27	4.50	0.38	2.13	3.32
9	*Machilus sp.*	Mac1	23	3.83	0.46	2.61	3.22
10	*Syzygium chanlos*	Syc	19	3.17	0.44	2.48	2.83
11	*Irvingia malayana*	Irm	7	1.17	0.77	4.34	2.76
12	*Lithocarpus sp1*	Lit1	23	3.83	0.29	1.67	2.75
13	*sp5*		10	1.67	0.37	2.11	1.89
19	*Elaeocarpus tectorius*	Elat	7	1.17	0.44	2.48	1.83
14	*Glochidion sp.*	Glo1	7	1.17	0.44	2.47	1.82
15	*Hopea odorata*	Hoo	13	2.17	0.25	1.41	1.79
16	*Ixonanthes chinensis*	Ixo	8	1.33	0.38	2.16	1.75
17	*Pterospermum sp.*	Pte1	12	2.00	0.25	1.39	1.70
23	*Vitex trifolia*	Vitt	9	1.50	0.21	1.22	1.36
18	*Xylopia vielana*	Xyv	9	1.50	0.18	1.04	1.27
20	*Styrax agrestis*	Sty	10	1.67	0.11	0.65	1.16
21	*Grewia tomentosa*	Grt	10	1.67	0.08	0.48	1.08
22	*Dillenia sp.*	Dil1	8	1.33	0.13	0.71	1.02
24	*Lithocarpus stenopus*	Lits	5	0.83	0.18	1.00	0.92
25	*Prunus arborea*	Pru	5	0.83	0.15	0.85	0.84
27	*Xylopia pierrei*	Xyp	6	1.00	0.10	0.59	0.80
26	*Aporosa sp1*	Apo1	6	1.00	0.07	0.39	0.70
29	*Litsea verticillata*	Lver	5	0.83	0.04	0.23	0.53
36	*Dipterocarpus sp.*	Dip	4	0.66	0.06	0.33	0.50
30	*Lithocarpus sp2*	Lit2	3	0.50	0.08	0.43	0.47
31	*Careya arborea*	Caa	2	0.33	0.11	0.60	0.47
32	*Grewia sp.*	Gre1	4	0.66	0.04	0.24	0.45
33	*Syzygium zeylanicum*	Syze	3	0.50	0.06	0.35	0.43
28	*Dipterocarpus intricatus*	Dii	2	0.33	0.09	0.52	0.43
34	*Vatica sp1*	Vat1	3	0.50	0.04	0.23	0.37
35	*Chaetocarpus castanocarpus*	Cha	2	0.33	0.03	0.19	0.26
38	*Horsfieldia longiflora*	Hol	1	0.17	0.06	0.33	0.25
37	*Litsea rotundifolia*	Lrot	2	0.33	0.03	0.16	0.25
39	*Vatica helferi*	Vath	2	0.33	0.03	0.16	0.25
40	*Pyrenaria jonquieriana*	Pyre	2	0.33	0.02	0.14	0.24
41	*Ailanthus triphysa*	Ait	1	0.17	0.05	0.27	0.22
42	*Fagraea fragrans*	Faf	2	0.33	0.01	0.08	0.21
43	*Tarrietia javanica*	Tar	1	0.17	0.03	0.17	0.17
44	*Breynia fruticosa*	Brf	1	0.17	0.02	0.14	0.16
45	*Castanopsis sp.*	Cast1	1	0.17	0.02	0.13	0.15
46	*Syzygium sp3*	Syz3	1	0.17	0.02	0.09	0.13
47	*Xylia xylocarpa*	Xyl	1	0.17	0.02	0.09	0.13
48	*Engelhardtia spicata var. integra*	Esi	1	0.17	0.01	0.06	0.12
49	*Archidendron sp.*	Arc1	1	0.17	0.01	0.05	0.11
50	*Albizia lucidior*	All	1	0.17	0.01	0.04	0.11
51	*Ficus sp.*	Fic1	1	0.17	0.01	0.04	0.11
52	*Illigera sp.*	Ill1	1	0.17	0.00	0.02	0.10
Total			600	100.00	17.63	100.00	100.00

Appendix 4. N% and IV% of all tree species in the Bu Gia Map NP.

No.	Scientific name	Abbreviation	N	N%	G	G%	IV%
1	*Hopea odorata*	Hoo	40	5.53	6.90	19.43	12.48
2	*Dipterocarpus alatus*	Dia	42	5.81	6.60	18.59	12.20
3	***Dalbergia oliveri***	**Dol**	**49**	**6.78**	**1.85**	**5.22**	**6.00**
4	*Irvingia malayana*	Irm	22	3.04	2.42	6.81	4.93
5	*Anisoptera costata*	Anc	10	1.38	2.26	6.37	3.88
6	*Syzygium chanlos*	Syc	37	5.12	0.50	1.40	3.26
7	*Lagerstroemia calyculata*	Lagc	18	2.49	1.20	3.37	2.93
8	*Vitex trifolia*	Vitt	28	3.87	0.68	1.90	2.89
9	*Lithocarpus pyriformis*	Litp	18	2.49	0.89	2.50	2.50
10	*Machilus macrophylla*	Mam	24	3.32	0.47	1.33	2.33
11	*Diospyros silvatica*	Dios	24	3.32	0.39	1.10	2.21
12	*Ormosia sp1*	Orm1	20	2.77	0.56	1.58	2.18
13	*Metadina trichotoma*	Mett	17	2.35	0.51	1.44	1.90
14	*Cratoxylon sp2*	Cra2	17	2.35	0.46	1.29	1.82
15	*Diospyros apiculata*	Dio	19	2.63	0.17	0.47	1.55
16	*Syzygium sp1*	Syz1	16	2.21	0.27	0.76	1.49
17	*Terminalia nigrovenulosa*	Tern	9	1.24	0.60	1.69	1.47
18	*Syzygium zeylanicum*	Syze	9	1.24	0.55	1.55	1.40
19	*Gardenia philastrei*	Gap	11	1.52	0.44	1.25	1.39
20	*Gonocaryum lobbianum*	Gol	17	2.35	0.11	0.32	1.34
21	*Syzygium sp2*	Syz2	11	1.52	0.35	0.98	1.25
22	*Litsea sp1*	Lits1	14	1.94	0.14	0.38	1.16
23	*Streblus ilicifolius*	Stei	15	2.07	0.08	0.23	1.15
24	*Crypteronia paniculata*	Crp	9	1.24	0.35	0.97	1.11
25	*Parinari annamensis*	Paa	6	0.83	0.48	1.35	1.09
26	*Helicia formosana*	Hef	9	1.24	0.31	0.87	1.06
27	*Peltophorum pterocarpus*	Pep	7	0.97	0.37	1.05	1.01
28	*Garcinia sp2*	Gar2	10	1.38	0.17	0.47	0.93
29	*Dillenia sp.*	Dil1	9	1.24	0.21	0.58	0.91
30	*Afzelia xylocarpa*	Afx	4	0.55	0.36	1.00	0.78
31	*Bombax ceiba*	Boc	2	0.28	0.45	1.26	0.77
32	*Barringtonia acutangula*	Baa	8	1.11	0.14	0.41	0.76
33	*Polyalthia sp1*	Poly1	8	1.11	0.10	0.29	0.70
34	*Calophyllum soulattri*	Cas	6	0.83	0.19	0.54	0.69
35	*Garcinia sp3*	Gar3	7	0.97	0.14	0.39	0.68
36	*Aidia pycnantha*	Aip	6	0.83	0.18	0.51	0.67
37	*Baccaurea ramiflora*	Bar	7	0.97	0.06	0.17	0.57
38	*Dipterocarpus sp1*	Dip1	3	0.41	0.25	0.72	0.57
39	*Camellia sp1*	Cam1	7	0.97	0.04	0.12	0.55
40	*Chaetocarpus castanocarpus*	Cha	6	0.83	0.08	0.21	0.52
41	*Prunus arborea*	Pru	5	0.69	0.12	0.33	0.51
42	*Pterocarpus macrocarpus*	Ptm	2	0.28	0.26	0.72	0.50
43	*Careya arborea*	Caa	4	0.55	0.16	0.44	0.50
44	*Mangifera sp1*	Mag1	4	0.55	0.14	0.41	0.48
45	*Flacourtia jangomas*	Fla	4	0.55	0.12	0.35	0.45
46	*Castanopsis annamensis*	Cast	3	0.41	0.17	0.49	0.45
47	*Garcinia sp1*	Gar1	5	0.69	0.06	0.17	0.43
48	*Knema conferta*	Kne	4	0.55	0.10	0.29	0.42
49	*Amoora gigantea*	Amg	4	0.55	0.10	0.28	0.42
50	*Hopea recopei*	Hor	4	0.55	0.09	0.26	0.41

No.	Scientific name	Abbreviation	N	N%	G	G%	IV%
51	*Stereospermum neuranthum*	Sten	3	0.42	0.13	0.36	0.39
52	*Vitex sp1*	Vit1	3	0.41	0.12	0.34	0.38
53	*Engelhardtia spicata var. integra*	Esi	3	0.41	0.12	0.34	0.38
54	*Syzygium sp4*	Syz4	3	0.42	0.11	0.31	0.37
55	*Sageraea elliptica*	Sae	2	0.28	0.16	0.44	0.36
56	*Michelia sp1*	Mic1	4	0.55	0.06	0.16	0.36
57	*Turpinia montana*	Tur	2	0.28	0.15	0.42	0.35
58	*Colona thorelii*	Cot	3	0.41	0.08	0.22	0.32
59	*Pterospermum grewiaefolium*	Ptg	3	0.41	0.08	0.22	0.32
60	*Shorea sp1*	Shor1	3	0.42	0.07	0.19	0.31
61	*Dipterocarpus costatus*	Dipc	3	0.41	0.06	0.16	0.29
62	*Dipterocarpus dyeri*	Did	3	0.41	0.05	0.14	0.28
63	*Aporosa sp2*	Apo2	3	0.41	0.03	0.09	0.25
64	*Semecarpus sp1*	Sem1	3	0.42	0.03	0.07	0.25
65	*Stemonurus sp1*	Stem1	3	0.41	0.03	0.07	0.24
66	*Albizia lucidior*	All	1	0.14	0.11	0.32	0.23
67	*Calophyllum sp1*	Cal1	2	0.28	0.04	0.11	0.20
68	*Ficus sp2*	Fic2	1	0.14	0.09	0.24	0.19
69	*Aglaia sp2*	Agl2	2	0.28	0.03	0.08	0.18
70	*Knema lenta*	Knel	2	0.28	0.02	0.06	0.17
71	*Elaeocarpus sp1*	Ela1	2	0.28	0.02	0.05	0.17
72	*Clausena lansium*	Cla	2	0.28	0.02	0.05	0.17
73	*Cinnamomum parthenoxylon*	Cip	2	0.28	0.01	0.03	0.16
74	*Streblus asper*	Stas	2	0.28	0.01	0.02	0.15
75	*Dysoxylum loureirii*	Dyl	1	0.14	0.05	0.13	0.14
76	*Hydnocarpus anthelmintica*	Hya	1	0.14	0.04	0.11	0.13
77	*sp?*		1	0.14	0.03	0.10	0.12
78	*Lagerstroemia speciosa*	Lags	1	0.14	0.02	0.06	0.10
79	*Spondias lakonensis*	Spo	1	0.14	0.02	0.06	0.10
80	*Garugu pierrei*	Gpi	1	0.14	0.02	0.05	0.10
81	*Rothmannia eucodon*	Roe	1	0.14	0.02	0.05	0.10
82	*Atalantia citroides*	Atc	1	0.14	0.01	0.04	0.09
83	*Symplocos sp1*	Sym1	1	0.14	0.02	0.04	0.09
84	*sp2?*		1	0.14	0.01	0.03	0.09
85	*Sp3?*		1	0.14	0.01	0.03	0.09
86	*Sterculia lanceolata*	Ster	1	0.14	0.01	0.03	0.09
87	*Cryptocarya sp1*	Cry1	1	0.14	0.01	0.02	0.08
88	*Tarrietia javanica*	Tar	1	0.14	0.01	0.02	0.08
89	*Gironniera subaequalis*	Gis	1	0.14	0.01	0.02	0.08
90	*Polyalthia luensis*	Polu	1	0.14	0.01	0.02	0.08
91	*sp4?*		1	0.14	0.01	0.02	0.08
92	*Dialium cochinchinensis*	Dic	1	0.14	0.01	0.02	0.08
93	*Litsea lancifolia*	Llan	1	0.14	0.01	0.01	0.08
94	*Antidesma sp2*	Ant2	1	0.14	0.00	0.01	0.08
95	*Lithocarpus dahuoaiensis*	Litd	1	0.14	0.00	0.01	0.08
96	*Xylopia vielana*	Xyv	1	0.14	0.00	0.01	0.08
97	*Horsfieldia longiflora*	Hol	1	0.14	0.01	0.01	0.08
Total			723	100.00	35.50	100.00	100.00