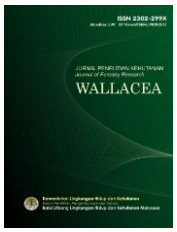

Jurnal Penelitian Kehutanan Wallacea (2022) **11**(1), 1-11

Jurnal Penelitian Kehutanan Wallacea

Akreditasi Kemendikbudristek: 158/E/KPT/2021

eISSN 2407-7860
pISSN 2302-299X

JPK WALLACEA
www.jurnal.balithutmakassar.org

Ecological aspects of meranti kunyit (*Shorea macroptera* Dyer) in Rantau Bertuah Forest, Siak Regency, Riau Province and the implication for forest management and conservation

*(Aspek ekologi meranti kunyit (*Shorea macroptera *Dyer) di Kelompok Hutan Rantau Bertuah, Kabupaten Siak, Provinsi Riau, dan implikasi terhadap manajemen dan konservasi hutan)*

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Article Info

Article History:
Received 07 December 2020; Accepted 22 October 2021; Published online 31 March 2022

Keywords:
Dominace, population structure, regeneration, Riau, vegetation

Kata Kunci:
Dominansi, struktur populasi, regenerasi, Riau, vegetasi

How to cite this article:
Fambayun, R. A., Heriyanto, N.M. & Wardani, M. (2022). Ecological Aspects of Meranti Kunyit (*Shorea macroptera* Dyer) in Rantau Bertuah Forest, Siak Regency, Riau Province and the Implication for Forest Management and Conservation. *Jurnal Penelitian Kehutanan Wallacea, 11*(1), 1-11. doi: http://dx.doi.org/10.18330/jwallacea.2022.vol11iss1pp1-11

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Abstract

Sumatra's lowland tropical rainforest is in the third place after Kalimantan and Papua in terms of Indonesia's plant species diversity. *Shorea macroptera* is one of the species from the Dipterocarpaceae family, known as an important commercial timber tree species. In September 2019, the study was conducted in Rantau Bertuah Forest, Siak Regency, Riau Province, Sumatra, with a total sample plot area of 1 ha. The data were analyzed to show the vegetation quantitative structure and composition on the study site using the Important Value Index, and the association of *S. macroptera* using the Ochiai index. The results recorded 55 plant species belong to 33 families on this study site. Dipterocarpaceae, Euphorbiaceae, and Fabaceae have the most abundant species, encompassed 51 species ≥10 cm in diameter with a total of 624 individuals. The result showed that the top three dominant species in this area, namely *Callophyllum macrocarpum* Hook.f. (IVI = 27.88%), *Shorea parvifolia* Dyer (IVI = 21.98%) and *Gironniera nervosa* Planch. (IVI = 19.99%). *C. macrocarpum* dominated all the regeneration levels: tree, sapling and seedling with IVI of 27.88%, 49.57% and 86.31%, respectively. *S. macroptera* has the strongest association with *C. macrocarpum* (Ochiai index of 0.73), followed by the *S. parvifolia* (Ochiai index of 0.61) and *G. nervosa* species (Ochiai index of 0.51). *S. macroptera* is widely used for industrial timber purposes and has limited distribution. Therefore, it is necessary to increase the efforts to manage it sustainably, especially in production forests.

Abstrak

Di Indonesia, hutan hujan tropis dataran rendah Sumatra menempati urutan ketiga setelah Kalimantan dan Papua dalam hal keanekaragaman spesies tumbuhan. Shorea macroptera merupakan salah satu spesies dari famili Dipterocarpaceae yang dikenal sebagai spesies pohon penghasil kayu komersial yang penting. Penelitian ini dilakukan pada bulan September 2019 di Hutan Rantau Bertuah, Kabupaten Siak, Provinsi Riau, Sumatra dengan luas plot 1 ha. Analisis data dilakukan untuk mengetahui keanekaragaman spesies menggunakan Indeks Nilai Penting, dan asosiasi Shorea macroptera dengan spesies lain menggunakan indeks Ochiai. Dari hasil penelitian ini, tercatat sedikitnya 55 spesies tumbuhan yang termasuk dalam 33 famili dijumpai di areal tersebut. Famili Dipterocarpaceae, Euphorbiaceae, dan Fabaceae adalah famili dengan jumlah spesies paling melimpah, meliputi 51 spesies berdiameter ≥10 cm dengan jumlah total 624 individu. Hasil penelitian menunjukkan tiga spesies dominan teratas di lokasi penelitian ini, yaitu Callophyllum macrocarpum Hook.f. (INP = 27,88%), Shorea parvifolia Dyer (INP = 21,98%), dan Gironniera nervosa Planch. (INP = 19,99%). C. macrocarpum mendominasi semua tingkat permudaan: pohon, pancang, dan semai dengan INP masing-masing 27,88%, 49,57%, dan 86,31%. S. macroptera memiliki asosiasi terkuat dengan C. macrocarpum (indeks Ochiai 0,73), diikuti oleh S. parvifolia (indeks Ochiai 0,61), dan spesies G. nervosa (indeks Ochiai 0,51). Kayu S. macroptera banyak ditebang untuk keperluan industri, namun jenis ini memiliki persebaran terbatas. Oleh karena itu, perlu ditingkatkan upaya pengelolaan secara lestari, khususnya di hutan produksi.

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I. Introduction

The lowland tropical rainforest in Sumatra is in third place after Kalimantan and Papua in terms of plant diversity (Kusmana & Hikmat, 2015). The ecosystems in this area are dominated by Dipterocarpaceae species, which form a stable ecosystem. The change of forest ecosystem such as biodiversity loss and degradation are caused by various disturbances, such as overexploitaton, pollution, climate change, fire, land use change, etc. (United Nations Environment Programme, 2021). Conventional illegal logging could bring residual stands damaging from 38.10% to 50% or around 135 individuals/ha (Muhdi *et al*., 2012). Medjibe & Putz (2012) stated that wood extraction using selective logging causes forest degradation, especially destruction on the remaining stand in the tropical forest.

Dipterocarpaceae is an emergent tree that dominates primary lowland forest, production forest, or logged-over forest in Kalimantan, both in the number of trees and basal areas. However, there is a significant difference between 5-year and 10-year logged-over forests and primary forests regarding the number of trees and the basal areas (Dharmawan & Samsoedin, 2012). The decline in the number of Dipterocarpaceae trees in logged-over forests also affects the quality of habitats and populations of arboreal animals, especially endemic primate species (Bismark *et al*., 2008). In this case, the Dipterocarpaceae tree is one of the resting places for primates and birds. Hence, the species from the Dipterocarpaceae family have an important role in the tropical forest ecosystems.

Meranti (*Shorea*), one of the genera of the Dipterocarpaceae family, which dominates the tropical rain forests, is known has high valued for economic, ecological and environmental benefits. The timber and non-timber forest product of *Shorea* are very promising in the forestry industry. The *meranti* wood commercially is categorized as the first quality timber, and its timber industry is still supplied from natural forests (Subiakto *et al*., 2016; Djarwanto *et al*., 2017). Furthermore, *meranti* or *Shorea* has the highest number of species compared to the other genera of the Dipterocarpaceae family. It consists of more than 190 species which the distribution was not documented well enough. Hence, the effort to conserve this species existence is urgently needed (Pulan & Buot, 2014).

Meranti kunyit (*Shorea macroptera* Dyer) is included in the Red *Meranti* groups in the timber industry. *S. macroptera* is a species from the genus *Shorea* that is widely and illegally extracted but has limited distribution. However, the study regarding the ecological aspect of this species is still limited. There is no current information on this species available yet. Therefore, this study is expected to give more ecological information of the species to fill its lack of data and information. As the demand for this species is relatively high, followed by the high rate of exploitation, the conservation effort must also be considered. This study aimed to investigate the structure-composition of vegetation, population structure, diameter classes distribution, the morphology and phenology, the species associate with *Meranti Kunyit* (*S. macroptera*) in the Rantau Bertuah Forest, Siak Regency, Riau Province. This study could support the action that all stakeholders should take regarding the management and conservation of this species to keep the number of population stable amidst the continuous threats to the forest ecosystem.

II. Methods

A. Study Site

The study was conducted in Rantau Bertuah Forest, Siak Regency, Riau Province, in September 2019. Administratively, this location belongs to Rantau Bertuah Village, Minas District, Siak Regency, Riau Province. Geographycally, it is located at 0°44'31,85'' S and 101°22'03,09'' E (Figure 1). This study site is part of Sumatra's tropical lowland rainforest with an altitude of ± 60 m above sea level. The topography condition is generally flat, with slopes range between 0-10%. Red-yellow podzolic soil dominates the study site; with pH 4-6 indicates a low fertility rate (Pusat Penelitian Tanah dan Agroklimat, 1993). The soil parent material consists of sedimentary rock, sandstone and sand deposit. Solum soil is thick, red to yellow with consistent texture, acid, low nutrient content with low to medium permeability, and is very easy to erode (Soewandita & Sudianan, 2011).

The climate condition is categorized as type A according to the classification of Schmidt & Fergusson (1951). The annual rainfall is 2,598.7 mm/year and the minimum rainfall of around

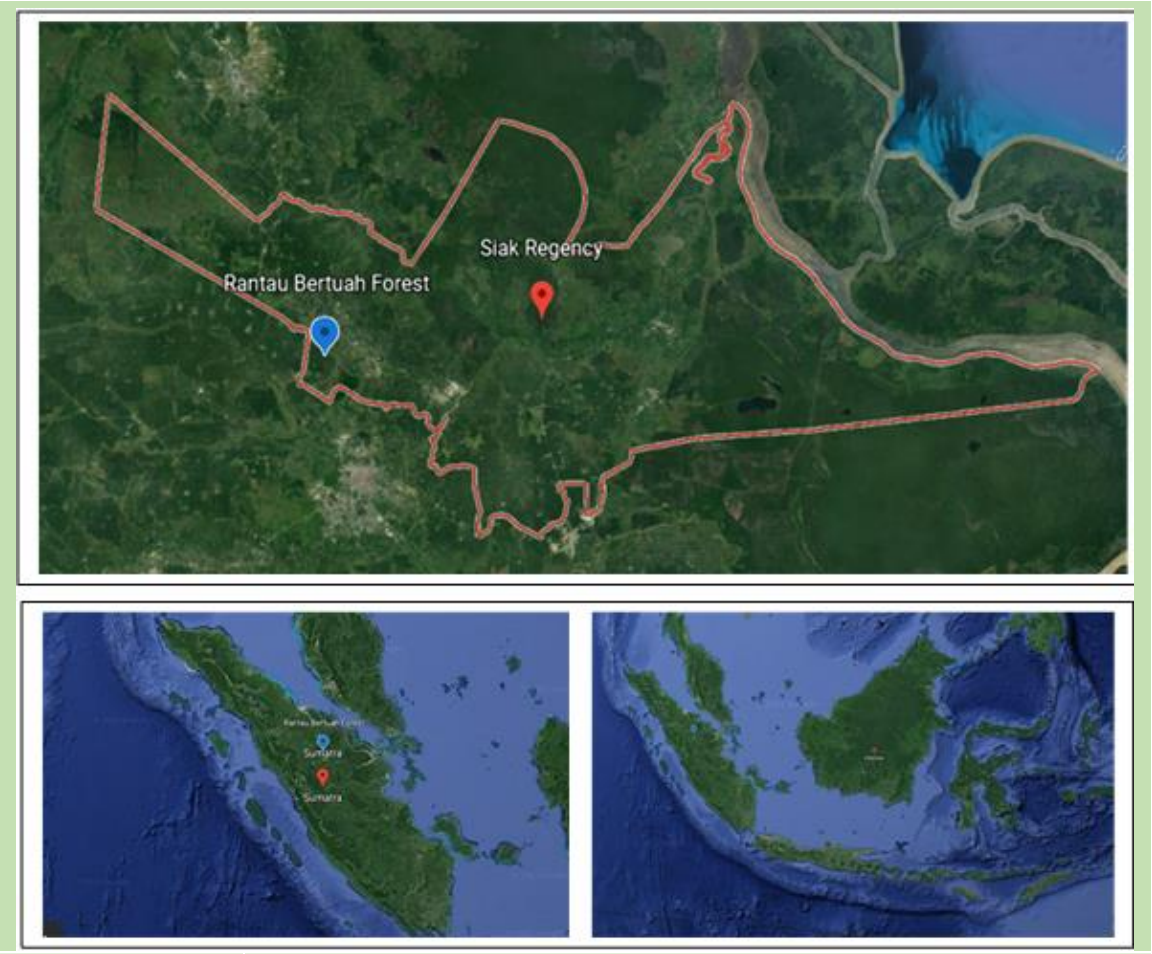

Figure 1.	Map of the study site, Rantau Bertuah Forest, Siak Regency. The location is indicated by a blue pin.
Gambar 1.	*Peta dari lokasi penelitian, Hutan Rantau Bertuah, Kabupaten Siak. Lokasi tepatnya ditunjukkan dengan pin berwarna biru.*

66.7 mm/month in January with 12 rainy days. The maximum precipitation occurs in November, around 439.5 mm/month, with 27 days of rain. The lowest average temperature in this area occurred in September, 26ºC, and the highest in June, which was around 28.1ºC. Air humidity ranged from 69%-83%.

The Rantau Bertuah Forest in Siak Regency is a former forest concession. Now, its status is a protected forest or protected area surrounded by the village or settlement of local people and transmigrants. Moreover, according to the local information, this forest is a wildlife habitat such as Sumatran tigers, elephants, sambar deer and bears.

B. Species Studied

Shorea macroptera is the main target of this study and belongs to the Dipterocarpaceae family. In Sumatra, this species distributes limited in eastern part, namely Riau, Singkep Island and Lingga Island (Ashton, 1982). In the IUCN Red List of Threatened Species (Newman *et al*., 2017), *S. macroptera* is indicated to grow in the Riau forest area and is included in the Least Concern ver 3.1 (LC/unnoticed) category. *S. macroptera* has a straight, cylindrical bole that can reach 150 cm in diameter with buttresses up to 2.5 meters high. Growing in well-drained mixed dipterocarp forest, especially in hills, with clay soils and sandy clays, at elevations up to 900 meters. It can grow up to 40-50 meters tall (National Parks Board, 2016). The leaf shape is elliptic-oblong, ca 13 cm long by 5 cm wide. *S. macroptera*'s flowers are small, only about 2 cm across when it blooms. The flower color is white in the center and pinkish on the base. Similar to other Dipterocarpaceae species, *S. macroptera* has winged-like structures with three large outer wings around 12 cm long, very broad,

lobed at the base and two smaller inner wings, narrow in shape, approximately 6 cm in length (Symington *et al,* 2004).

C. Sampling Design and Data Collection

The data collected in this research were using plot method with size of one hectare, 100 m x 100 m. The study plot was established using random sampling, which was expected to represent the stand's condition. Inside the square plot, a total of 25 subplots of 20 m x 20 m were set up (Figure 2).

The field the data of species names, diameters and total height are recorded for all trees and saplings found in the sampling plot. Herbarium specimens of all trees or saplings, which were observed within the sampling plot were collected for identification at the Forest Botanical Herbarium Laboratory, Forest Research and Development Center (*Herbarium Botani Hutan, Pusat Penelitian dan Pengembangan Hutan*) in Bogor. The specimens were identified using the comparative method through the comparison process between herbarium samples obtained from the field with the specimen collections in herbarium to determine the accuracy of each species name. The identification process was carried out at the Forest Botanical Herbarium Laboratory, Forest Research and Development Center, Bogor.

The species name was updated according to The Plant List at the website of http://www.theplantlist.org/ (2013). For the tree height data collection; we used a digital Hagloff meter with an automatic distance and a sensitivity level of 10 cm. For the morphological and phenological aspects, we observed the real condition of *S. macroptera* in the field and combine it with the references.

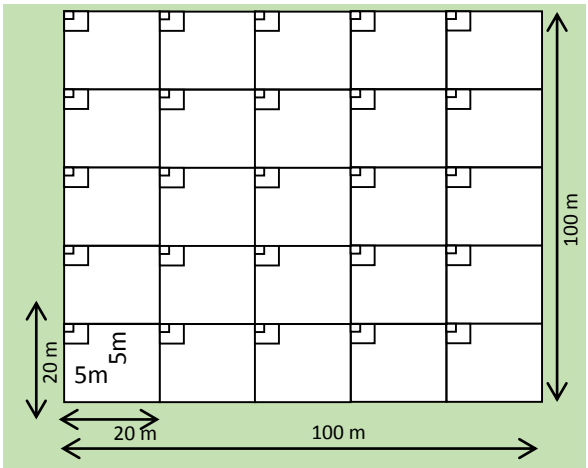

Figure 2. Sampling plot
Gambar 2. *Plot sampling*

The tree, sapling and seedling categories on this study are based on Kartawinata (2013) and Wardani, *et al*. (2017) as follows:

1. The tree is an individual plant with a dbh >10 cm; if there is a tree with a buttress, the dbh is measured 20 cm above the buttresses. The trees are investigated at the plot size of 20 m x 20 m.
2. The sapling is the regeneration of trees with a height of >1.5 m and young trees with a diameter of <10 cm. The saplings are investigated at the plot size of 5 m x 5 m.
3. Seedlings are described as tree seedlings ranging from sprouts to height <1.5 m. The seedlings are investigated at plot size 2 m x 2 m.

D. Data Analysis

The data were analyzed to determine the potency, dominant species and trees associated with *S. macroptera* species. The formulas are adapted from Mueller-Dombois & Ellenberg (1974), Dharmawan & Samsoedin (2012) and Magurran (2004).

$$\text{Density} = \frac{\text{number of a species}}{\text{total area sampled}} \quad (1)$$

$$\text{Relative density} = \frac{\text{density of a species}}{\text{total density of all sepcies}} x\ 100\% \quad (2)$$

$$\text{Dominance} = \frac{\text{total basal area of a species}}{\text{total area sampled}} \quad (3)$$

$$\text{Relative dominance} = \frac{\text{dominance of a species}}{\text{total dominance of all species}} x\ 100\% \quad (4)$$

$$\text{Frequency} = \frac{\text{the number of plots where the species found}}{\text{the total number of plots}} \quad (5)$$

$$\text{Relative frequency} = \frac{\text{frequency of a species}}{\text{total frequency of all species}} x\ 100\% \quad (6)$$

Dominant species were calculated using the Importance Value Index (%) as the sum of relative density, relative dominance and relative frequency of each species in the sampling plot. The association index was calculated to determine the association between *S. macroptera* with other plants. The Ochiai index was used to calculate the association index (Ludwig & Reynolds, 1988; Subiandono *et al*., 2013).

Ochiai Index:

$$\text{Oi} = \frac{a}{(\sqrt{a}+b)(\sqrt{a}+c} \quad (7)$$

Remarks:
a = Number of plots which both species A and B are found
b = Number of plots which only species A is found
c = Number of plots which only species B is found
Association occurs at an interval of 0-1.

III. Result and Discussion

A. Important Value Index and Status of Regeneration

Based on the results of plant species and family identification, 55 plant species were found, which belong to 33 families. Dipterocarpaceae, Euphorbiaceae and Fabaceae were the most species rich families. This result was in accordance with the study of Senbeta *et al*. (2014) and Maua *et al*. (2020) who found that those families were on the top ten most dominant families in the tropical rain forest. This is possibly due to the fact that Euphorbiaceae is one of the main components of the understorey layer (Maua *et al*., 2020). While Fabaceae is commonly known as fast growing and pioneer plants, and the family with the highest number of species worldwide (Beech, 2017). The number of families in this study site was slightly lower compare to the number of families in Bukit Barisan Selatan National Park, 38 familes (Erly *et al*., 2019), in Bukit Duabelas National Park, 38 families (Rahmah *et al.,* 2016), and in Foja Mountains, 59 families (Sadili *et al.,* 2018). However, that was slightly higher compare to the number of families in Protection Forest Area in West Lampung Regency, 19 families (Heriyanto *et al.,* 2019a).

In this study, there were 51 species of trees with a diameter of ≥10 cm; in total, there were 642 stems/ha in 25 sub-plots of 20 m x 20 m. From 51 species of trees ≥10 cm in diameter, there were ten dominant tree species with IVI >10%. The density and IVI value of dominant species were presented in Table 1. This result was slightly higher compare to the result from the Area Permanent Pample Plots (PSPs) PT. Kawedar Wood Industry in Kapuas Hulu Regency with 48 species (Andewi & Dewantara, 2015).

The IVI indicates the importance or ecological significance of species in a specified ecosystem (Abunie & Dalle, 2018). Hence, the species with high IVI values are considered more important than those species with low values. At the tree stage, the population was dominated by mentangur (*C. macrocarpum*) IVI = 27.88%, followed by *meranti* floating (*S. parvifolia*) IVI = 21.98% and medang (*G. nervosa*) IVI = 19.99%., the sapling stage will eventually replacing the current stands. The top three dominant species on the sapling stage, namely mentangur (*C. macrocarpum*) IVI = 49.57%, *meranti kunyit* (*S. macroptera*) IVI = 27.13%, and teratai (*D. excelsum*) IVI = 22.88%. These species will also dominate this area combined with the current tree-dominant species in Tabel 1. The sapling of *S. macroptera* will still dominate this area in the near future. Hence, the proper management effort of this species needs to be planned carefully in the midst of pressure on the forest area.

Table 1. The top ten most dominant tree species of ≥10 cm in diameter with IVI >10% at the study site

Tabel 1. *Sepuluh besar spesies paling dominan pada tingkat pohon dengan diameter ≥10 cm dan INP >10% di lokasi penelitian*

No.	Species (*Spesies*)	Density N/ha (*Kerapatan N/ha*)	Important Value Index (%) (*Indeks Nilai Penting (%)*)
1	*Calophyllum macrocarpum* Hook.f.	74	27.88
2	*Shorea parvifolia* Dyer	40	21.98
3	*Gironniera nervosa* Planch.	50	19.99
4	*Lithocarpus gracilis* (Korth.) Soepadmo	35	17.63
5	*Palaquium sumatranum* Burck	39	16.73
6	*Shorea macroptera* Dyer	41	16.70
7	*Dysoxylum excelsum* Blume	33	13.69
8	*Xylopia caudata* Hook.f. & Thomson	28	11.87
9	*Nephelium lappaceum* L.	26	11.51
10	*Endospermum diadenum* (Miq.) Airy Shaw	16	10.01

The natural regeneration process in the forest occurs as the effect of disturbances in the forest development. The continuous regeneration depends on the favourable site conditions (Tinya *et al.*, 2020). The complete regeneration stages (in each stratum: trees, saplings and seedlings) were recorded from 12 species shown in Table 2. *C. macrocarpum* was the species which dominated all the regeneration stage.

B. Population Structure of *Shorea macroptera*

Forest stand structure or population structure is the distribution of individuals within the canopy layer. It can be interpreted as the distribution of trees per unit area in various diameter classes (Heriyanto *et al.*, 2019b). The population structure overall in the study site is presented in Figure 3. It showed the distribution of all trees in diameter classes 10-19 cm, 20-29 cm, 30-39 cm and >40 cm at the study site. Each tree is known to have different abilities and capacities of competition in using nutrients, minerals, water and solar energy. Such conditions caused the different structures of forest stands. The different conditions, sometimes, were also influenced by human approach in terms of forest management (Duncker *et al.*, 2012).

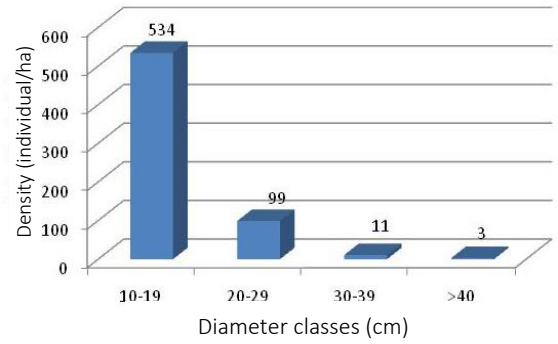

Figure 3. Population structure in Rantau Bertuah Forest, Siak Regency, Riau Province

Gambar 3. *Struktur populasi yang ada pada Hutan Ratau Bertuah, Kabupaten Siak, Provinsi Riau*

The population structure at the study site showed the inverse J-curve (Figure 3). The curve showed the domination of small individuals, followed by the reduction of the mature individual with a large diameter class. That type of population structur was also found in Bukit Barisan Selatan National Park (Wardani and Heriyanto, 2015). That type of population structure shows a healthy forest with an active regeneration and many recruitments of new individuals (Jew *et al.*, 2016) which the smaller diameter class is more dominant than the larger diameter class. Furthermore, this condition also indicated some disturbances in the forest.

Table 2. The list of plant species in Rantau Bertuah Forest which have the complete regeneration stages

Tabel 2. *Daftar jenis tumbuhan yang memiliki tahapan regenerasi lengkap di Hutan Rantau Bertuah, Provinsi Riau*

No.	Botanical name (*Nama ilmiah*)	Family (*Famili*)	IVI (%) *INP (%)*		
			Seedling (*Anakan*)	Sapling (*Pancang*)	Tree (*Pohon*)
1.	*Calophyllum macrocarpum* Hook.f.	Clusiaceae	86.31	49.57	27.88
2.	*Dialium indum* L.	Fabaceae	5.35	19.65	9.07
3.	*Dillenia excelsa* (Jack) Martelli ex Gilg.	Dilleniaceae	2.68	1.99	0.49
4.	*Dysoxylum excelsum* Blume	Meliaceae	12.93	22.88	13.69
5.	*Gironniera nervosa* Planch.	Cannabaceae	9.01	22.20	19.99
6.	*Hopea pachycarpa* (F. Heim.) Symington	Dipterocarpaceae	3.66	1.99	5.97
7.	*Hopea sangal* Korth.	Dipterocarpaceae	2.68	15.86	7.76
8.	*Hydnocarpus kunstleri* (King) Warb.	Achariaceae	38.70	4.07	7.56
9.	*Ilex cymosa* Blume	Aquifoliaceae	2.68	6.92	1.05
10.	*Shorea macroptera* Dyer	Dipterocarpaceae	22.65	27.13	16.70
11.	*Shorea parvifolia* Dyer	Dipterocarpaceae	2.68	2.55	21.98
12.	*Xylopia caudata* Hook.f. & Thomson	Annonaceae	2.68	2.22	11.87

Anthropogenic activities such as overexploitation could be the reason of large-sized individual removal and its low densities. Human acivities are causing extensive degradation of global ecosystem and threatening the ecosystem services where all human-being depends (Harfoot *et al.,* 2014).

C. The Diameter Classes Distribution of *Meranti Kunyit* (*Shorea macroptera*)

The *S. macroptera* distribution of the diameter ≥ 10 cm at the study site is presented in Figure 4. It showed the most dominant diameter class of *S. macroptera* is on the 10-19 cm diameter class. The number of trees with a small diameter is higher than the number of trees with a large diameter. It is typically oocured in an uneven-age stand (Clatterbuck *et al*., 2011). In a diameter class ≥ of 40 cm, it was only counted one stem/ha. It is suspected that the people near the forest exploited the large-diameter trees for their needs as building materials (Arbainsyah *et al.,* 2014).

D. Morphology and Phenology of *Meranti Kunyit* (*Shorea macroptera*)

Shorea macroptera is a medium to large tree, with a total height up to 50 m; straight, rounded, cylindrical, buttressed stem, with a stem diameter reach 140 cm; it has resin which colour in brown to whitish brown. Stipula is falling easily, oval shape, +10 mm in length, +3.5 mm in width. The petiole is 1-1.5 cm long. The leaf is oblong to reverse of an oval, 8-14 cm in length, 3.5-5.5 cm in width, rigid leaf and creamy scale on the bottom surface, glossy on the top surface, blunt or taper on the leaf base. Leaf tips of taper reach 8 mm in length, secondary leaf veins are 10-18 pairs, tertiary leaf veins are in the stairs form, sometimes domatia are found in the secondary leaf veins armpit (Figure 5).

It has small flowers, a yellowish-white flower crown with a pink base, stamens amounting to 15. Fruit wrapped in fruit pods with lobes of fruit petals amounted to 5 and growing in the form of wings consisting of three longer wings 12-14 cm x 2-3 cm and two shorter wings 6 x 0.6 cm; ovate seeds with a tapered end 1.8 x 0.2 cm (Ashton, 2004). The flowering season occurs every 2-3 years and simultaneously in various places and gives off a pungent aroma (Soerianegara & Lemmens, 2002).

E. Association of *Meranti Kunyit* (*Shorea macroptera*) with Other Trees Species

The association aspect is used to determine the relationship between *S. macroptera* trees and other surrounding plants. The tree association will show the similarity of habitat or environment requirements of a species and other species. Species interactions create the

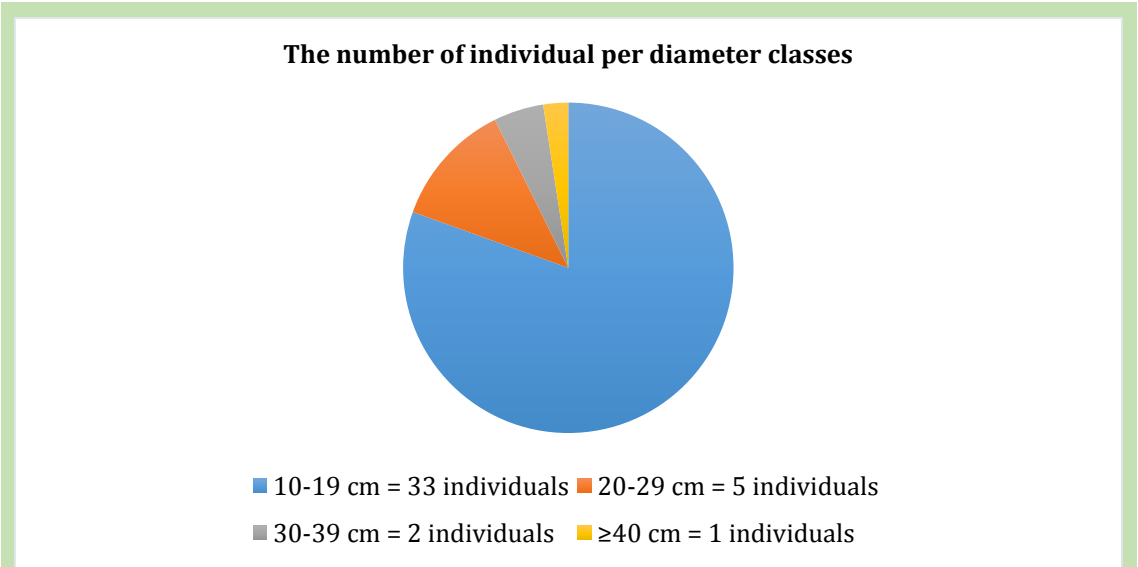

Figure 4.	The diameter class distribution of *S. macroptera* is based on diameter class in Rantau Bertuah Forest, Siak Regency, Riau Province
Gambar 4.	*Distribusi kelas diameter dari* S. macroptera *berdasarkan kelas diameter di Hutan Ratau Bertuah, Kabupaten Siak, Provinsi Riau*

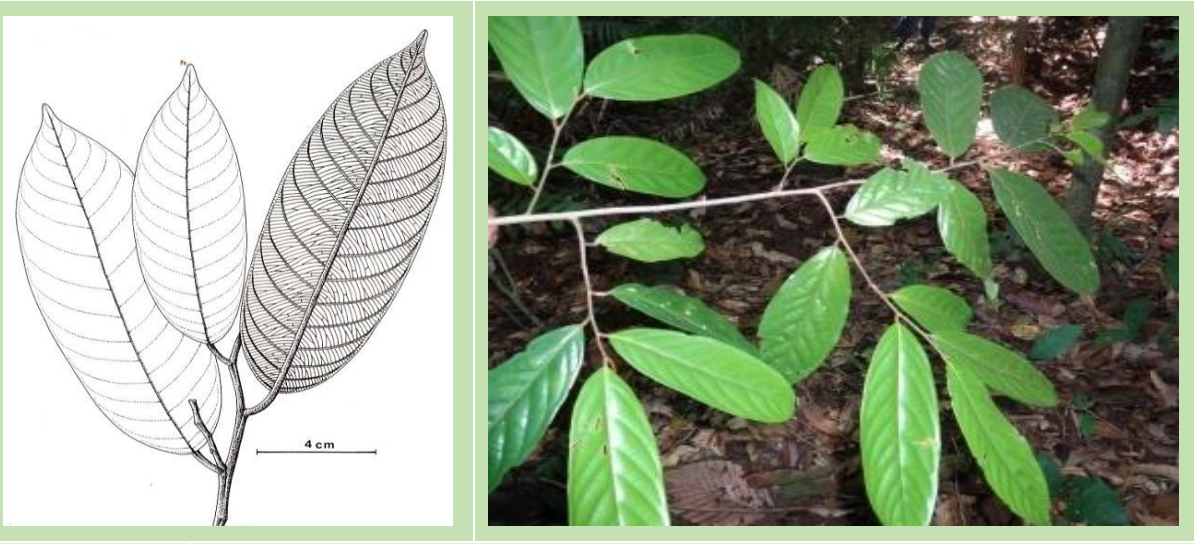

Figure 5. Leaf morphology of meranti kunyit or *Shorea macroptera* (Wardani, 2017)

Gambar 5. *Morfologi daun meranti kunyit atau* Shorea macroptera *(Wardani, 2017)*

basis for many ecosystem properties and processes, for example nutrient cycling and food webs (Lang & Benbow, 2013). In this study, the index association of *S. macroptera* with other vegetation for tree stage is presented in Table 3.

The association of *S. macroptera* with other tree species is indicated by the Ochiai index and the values ranging from 0.22 to 0.73. The value is closer to 1 means the stronger the relationship between the two species and vice versa (Ludwig & Reynolds, 1988). Based on the data in Table 3, it can be seen that *C. macrocarpum* has the strongest association with *S. macroptera*. This was indicated by 0.73 of the Ochiai index, followed by *S. parvifolia* (Ochiai index 0.61) and *G. nervosa* (Ochiai index 0.51).

Table 3. Trees index association of *S. macroptera* with nine other trees in Rantau Bertuah Forest, Siak Regency, Riau Province

Tabel 3. *Indeks asosiasi pohon S. macroptera dengan sembilan pohon lain di Hutan Rantau Bertuah, Kabupaten Siak, Provinsi Riau*

No.	Botanical name *(Nama ilmiah)*	*S. macroptera* Ochiai index *(Indeks Ochiai)*
1.	*Calophyllum macrocarpum*	0.73
2.	*Shorea parvifolia*	0.61
3.	*Gironniera nervosa*	0.51
4.	*Lithocarpus gracilis*	0.40
5.	*Palaquium sumatranum*	0.35
6.	*Dysoxylum excelsum*	0.32
7.	*Xylopia caudata*	0.27
8.	*Nephelium lappaceum*	0.25
9.	*Endospermum diadenum*	0.22

Mueller-Dombois & Ellenberg (2016) states the association exists on the even habitat conditions. However, it does not show the habitat similarity yet, but at least, there is a view of the common environmental condition similarity.

F. The Implication for Forest Management and Conservation

Shorea macroptera belongs to Dipterocarpaceae family and the genus of *Shorea* consting of more than 190 species with poor distribution documentation (Pulan & Buot, 2014). This species is commercially important as a timber trade species. The wood of this species is categorized as fancy wood with high-quality timber. However, most of its industrial demand is still supplied from the natural forest (Subiakto *et al*., 2016; Djarwanto *et al*., 2017). Hence, this species is still allowed to be exploited for industrial timber purposes. The effort to maintain the regeneration of this species is highly required since logging both conventional and selective causes damages to the remaining stand (Medjibe & Putz, 2012; Muhdi *et al*., 2012). The initial information through this study will be useful to estimate the number of this species in Sumatra; however, we also need further information from the other populations to know the exact population of *S. macroptera*. In this study, we also try to find the species associated with *S. macroptera* as we want to give the information about the species that possibly suitable to be mix planted with

S. macroptera and where it should be planted in terms of an ex-situ conservation strategy.

The species conservation status indicates the number of *S. macroptera* in nature is still on the adequate number, which does not need an urge conservation effort. However, currently, the human population is continuing to rise, and the human needs will also linearly increase, and the possibility of this species to be over-exploited will be higher. Today, we need to mitigate the destruction before the possible species extinction happens as many Dipterocarp species are on the threatened status. The cause of those extinctions could be our lesson to prevent the endangered status of *S. macroptera*. This study also emphasizes the importance of management and conservation action to all species, possibly suffering greater exploitation. Those actions could be classified as a mitigation action since we are commonly focus on the adaptation action which could be said as an excuse action.

IV. Conclusion and Recommendation

A. Conclusion

Meranti kunyit (*S. macroptera*) has complete regeneration stages, and the number of small individuals is high which indicate an active regeneration in the study site. The population structure of *S. macroptera* also shows relatively small number of big diameter trees which may indicate the possibility of disturbances in this area. *S. macroptera* include in the top ten dominant species in the Rantau Bertuah Forest and it is highly associated with *C. macrocarpum* and *S. parvifolia.*

B. Recommendation

Since *meranti kunyit* (*S. macroptera*) has good regeneration and is quite dominant in the Rantau Bertuah Forest, it is important to manage it sustainably amid the increasing human population and high threats to it its population. As it is found in the production forests, the effort is needed to keep the population stable and prevent it from being overexploited.

Acknowledgements

The authors would like to thank Forest Research and Development Center, the Ministry of Environment and Forestry for facilitating budget funding during the data collection.

Declarations

Author contribution

RAF, NMH, and MW are the main contributors who developed the study plan, collected the data, analyzed and interpreted the data, wrote and edited the manuscript.

Conflict of interest

All the authors have neither financial nor personal relationships which might influence them in writing this manuscript.

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