BIODIVERSITAS
Volume 24, Number 6, June 2023
Pages: 3245-3257

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d240619

The diversity and regional conservation status of wild edible fruit species in Sumatra, Indonesia

ADI BEJO SUWARDI[1,3], SYAMSUARDI[2,♥], ERIZAL MUKHTAR[2], NURAINAS[2]

[1]Doctoral Program, Department of Biology, Faculty of Mathematics and Sciences, Universitas Andalas. Jl. Universitas Andalas, Kampus Limau Manis, Padang 25163, West Sumatra, Indonesia

[2]Department of Biology, Faculty of Mathematics and Sciences, Universitas Andalas. Jl. Universitas Andalas, Kampus Limau Manis, Padang 25163, West Sumatra, Indonesia. Tel.: +62-751-777427, ♥email: syamsuardi@sci.unand.ac.id

[3]Department of Biology Education, Faculty of Teacher Training and Education, Universitas Samudra. Jl. Prof. Syarief Thayeb, Meurandeh, Langsa 24416, Aceh, Indonesia

Manuscript received: 29 April 2023. Revision accepted: 15 June 2023.

Abstract. *Suwardi AB, Syamsuardi, Mukhtar E, Nurainas. 2023. The diversity and regional conservation status of wild edible fruit species in Sumatra, Indonesia. Biodiversitas 24: 3245-3257.* Sumatra Island is recognized as the distribution center of tropical fruit species in Indonesia. However, increased human activity threatens the existence of edible wild fruit plants in nature. The study aims to assess the diversity and regional conservation status of wild edible fruit plant species in Sumatra, Indonesia. The study was conducted in four provinces: West Sumatra, Riau, Jambi, and Bengkulu. For the sampling, a modified line transect method was used. A total of 331 wild edible fruit plant species at four studied sites in Sumatra consisted of 73 families. The highest number of fruit plant species was recorded in West Sumatra Province, i.e., 176 species, followed by Jambi (172 species), Riau (121 species), and Bengkulu (76 species). The diversity of wild edible fruit plant species was higher in West Sumatra Province (3.85) but lower in Riau Province (3.25). *Artocarpus integer* (Thunb.) Merr., *Baccaurea lanceolata* (Miq.) Müll.Arg., *Baccaurea macrocarpa* (Miq.) Müll.Arg., *Baccaurea polyneura* Hook.f., *Garcinia atroviridis* Griff. ex T.Anderson, *Garcinia xanthochymus* Hook.fil. ex J.Anderson, *Mangifera foetida* Lour., *Mangifera laurina* Blume, *Mangifera odorata* Griff., and *Pometia pinnata* J.R.Forst. & G.Forst. were the most frequently recorded wild fruit plant species in all of the study area. However, 74 wild edible fruit plant species were recorded only in West Sumatra, 45 in Riau, 79 in Jambi, and 9 in Bengkulu. Among the 331 wild edible fruit species in the present study, 1 taxon was classified as endangered (0.30%), 9 taxa (2.72%) as vulnerable, 11 taxa (3.32%) as near threatened, and 139 taxa (41.99%) as least concern, and 171 taxa (51.67%) as Data Deficient.

Keywords: Biodiversity, IUCN red list, Sumatra, tropical fruit

INTRODUCTION

Indonesia, the largest tropical rainforest in Southeast Asia, is considered a mega biodiversity country (Von Rintelen et al. 2017) and one of the world's centers of plant genetic diversity (Uji 2007). More than half the world's estimated 10 million plant, animal, and insect species live in tropical forests (Myers et al. 2000). This forest is critical for regulating nutrient cycling and soil formation (Šamonil et al. 2010), flood mitigation (Calder and Aylward 2006), water and air purification (Song et al. 2016), and the provision of food (Navia et al. 2022a; Suwardi and Navia 2022) and medicinal plants (Begossi et al. 2002; Navia et al. 2021). According to the Global Forest Resources Assessment report in 2020, approximately 1.6 billion people worldwide depend on forests for their livelihoods (FAO 2020).

Wild edible fruit plants, one of the forest resources, are widely used by people in their daily lives. These non-cultivated species exist naturally in their natural habitats and are harvested for human consumption (Mahapatra and Panda 2012; Ramaidani and Navia 2022). Wild edible fruit plants play an important role in the human diet as sources of vitamins, minerals, and dietary fiber (Mahapatra and Panda 2012). It has been reported that several wild fruits are more nutritious than cultivated fruits (Nazarudeen 2010; Suwardi et al. 2022a). Wild edible fruits have also improved household food security under normal conditions (Broegaard et al. 2017) and during crop insufficiency (Erskine et al. 2015). Moreover, the wild edible fruit plants have multiple uses, such as cosmetics (Gebauer et al. 2016), medicine (Dreher 2018; Adnan et al. 2022; Navia et al. 2022b), spices and condiments (Sutrisno et al. 2021; Syamsuardi et al. 2022a), crafts (Hazarika and Singh 2018), fiber (Karun et al. 2014), and fuel (Klimas et al. 2012).

Sumatra is the world's sixth-largest island and the second-largest in the Malay Archipelago after Borneo, and it is recognized as the tropical fruit distribution center in Indonesia. A total of 226 fruit tree species have been identified in Indonesia, with 148 (65%) found in Sumatra and more than 70% growing wild in Sumatra's tropical forests (Uji 2007). Furthermore, Harianja et al. (2021) recorded 29 species of wild fruit plants in the North Tapanuli forest in North Sumatra Province, 67 species in Bukit Rimbang-Bukit Baling, Riau Province (Syamsuardi et al. 2022b), and 73 species in Bengkulu Province (Suwardi et al. 2023a), and 129 species in Aceh Province

(Suwardi et al. 2022b). This condition suggests that intensive exploration activities may increase the number of wild fruit plant species recorded. However, our knowledge of the world's total biodiversity is severely limited. Many regions of the world continue to be considerably under-collected for many taxa (Whittaker et al. 2005). Consequently, data gaps or shortfalls in species' distribution, identification, evolution, and dynamics should be considered. The incorrect identification of ecological and evolutionary processes, as well as inadequate use of limited conservation investment, could be caused by data gaps or bias (Hortal et al. 2015). Furthermore, seven data gaps or shortfalls in biodiversity have been identified, including the Linnean shortfall for species taxonomy, Wallacean shortfall for distributions, the Prestonian shortfall for abundance, the Darwinian shortfall for evolutionary patterns, the Hutchinsonian shortfall for abiotic tolerances of species, Eltonian shortfall for biotic interactions and Raunkiaeran shortfall relating to limited knowledge of species traits (Hortal et al. 2015; Shaltout and Bedair 2022). The seven biodiversity data gaps or shortfalls may assist in determining more effective study targets and conservation efforts. In addition, floristic and biogeography studies could be useful for filling fundamental data gaps or biases in biodiversity conservation (Lomolino 2004; Whittaker et al. 2005) relating to plant distribution, fragmentation, fluctuations, and conservation status (Shaltout and Bedair 2022).

Anthropogenic activities, particularly land use change, lead to forest degradation and endanger various biological resources, including wild edible fruit plants. BPS (2021a) reported that more than 66,995 ha of Indonesia's forests were deforested in 2019-2020, with Sumatra areas accounting for 14,196 ha. In addition to infrastructure development, settlements, and mining, the conversion of forest land into agricultural land is considered to be the primary driver of the increasing rate of forest deforestation in various regions of Indonesia (Wahyuni and Suranto 2021; Suwardi and Navia 2022), including those in Sumatra. As a result, most wild fruits have become vulnerable to extinction. According to IUCN (2020), the current global loss of species approaches a rate of 1:10 times that of the past. This situation necessitates long-term conservation efforts for threatened species, including wild edible fruit species.

The first list of threatened wild edible fruit species included 129 species assigned by Suwardi et al. (2022b) in Aceh Province, Indonesia. Since no definitive evaluation study has included all wild edible fruit species in Sumatra, exploration and conservation status assessments of wild edible fruit species are critical. The IUCN Red List Categories and Criteria are widely regarded as the most reliable and authoritative method for determining the global risk of species extinction (Vié et al. 2009). One of the IUCN Red List's primary goals is to highlight species at high risk of extinction on a global scale (Shaltout and Bedair 2022). Species diversity assessments have the potential to determine species protection priorities and develop species conservation strategies by providing information on the risks of extinction (Zhang et al. 2011). The study aims to assess the diversity and regional conservation status of wild edible fruit plant species in Sumatra, Indonesia.

MATERIALS AND METHODS

The study area

Sumatra Island is Indonesia's second-largest island and is recognized for its diverse biodiversity. The western part of Sumatra is dominated by hills which comprise a ridge of the Bukit Barisan mountains, with an average elevation of 2,000-2,500 masl and many emerging volcanoes reaching 3,800 meters. On the other hand, lowland areas with sloping to hilly topography dominate the eastern part. Sumatra has a tropical climate with annual rainfall exceeding 2,000 mm and means monthly temperatures ranging from 25 to 27°C (Laumonier et al. 2010). Sumatra Island is divided into ten provinces, namely Aceh, Sumatera Utara, West Sumatra, Riau, Riau Islands, Jambi, Bengkulu, Sumatera Selatan, Bangka Belitung, and Lampung, with a total population of 58,557,211 people (BPS 2021b). The study was conducted in four provinces: West Sumatra, Jambi, Riau, and Bengkulu (Figure 1).

Data collection

Wild edible fruit plant species were collected from June to October 2022. Four study sites were chosen based on geographic location and forest availability (Table 1). Therefore, a modified line transect method collected wild edible fruit plants (Buckland et al. 2007). A 1,000-meter-long line transect was laid from the forest's edge into the forest at each study site. Wild edible fruit species discovered along the transect were collected, and each plant's local name was recorded. The botanical name of the species was identified at the Herbarium Andalas, Universitas Andalas, West Sumatra, Indonesia. The botanical names have been updated online using The Plants of the World (http://www.plantsoftheworldonline.org).

Major threats to each taxon were observed in the field. The IUCN Classification Scheme (http://www.iucnredlist.org/technical-documents/classification-schemes/threats-classification-scheme) assessed major threats to wild edible fruit species in Sumatra)

Table 1. List of study area in Sumatra, Indonesia

Study area	Type	Coordinate
West Sumatra	Lowland dipterocarp	0°56'15.3"S, 100°21'36.5"E
Riau	Lowland dipterocarp	0°31'03.8"N, 101°26'45.1"E
Jambi	Lowland dipterocarp	1°36'11.8"S, 103°35'01.3"E
Bengkulu	Lowland dipterocarp	3°49'15.5"S, 102°17'02.6"E

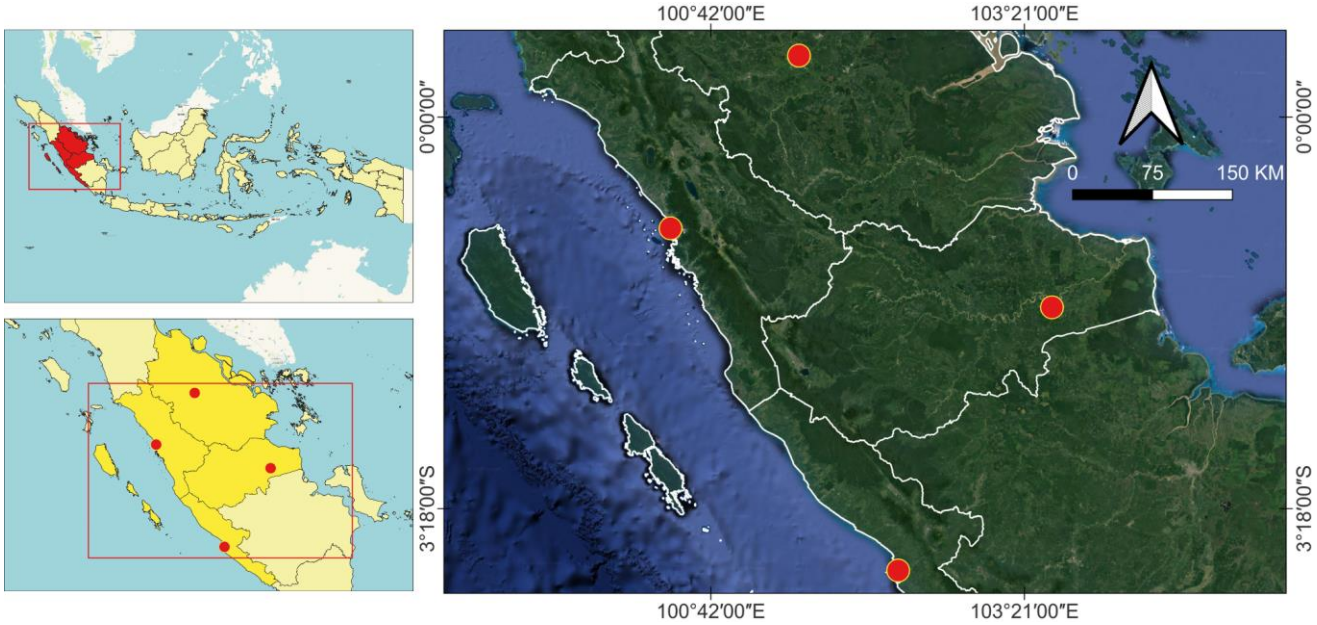

Figure 1. Map of the study area in Sumatra Island, Indonesia

Data analysis

Diversity index

Wild edible fruit plant species diversity in the study area was determined using the Shannon-Wiener Index (H') calculated using the following formula (Ludwig and Reynolds 1988).

$$H' = \sum_{i=1}^{s} \left[\left(\frac{n_i}{n}\right) \ln\left(\frac{n_i}{n}\right)\right] \quad \ldots\ldots (1)$$

Where:
H' : Shannon-Wiener Diversity index
s : the number of species
n_i : the number of individuals belonging to the i^{th}
n : the total number of individuals in the sample
The diversity index criteria are as follows:
H'≤1 : low diversity
1 < H'< 3 : moderate diversity
H'≥3 : high diversity

Evenness index

The evenness index (E) is calculated using the following formula (Magurran 2004).

$$E = \frac{H'}{H_{max}} = \frac{H'}{Ln\, S} \quad \ldots\ldots (2)$$

Where:
E : Evenness,
H' : Shannon-Wiener Diversity Index
S : Total number of species in the sample
Ln : Natural logarithm
The evenness index is categorized as follows:
0 < E ≤ 0.5 : Depressed community
0.5 < E ≤ 0.75: Unstable community
0.75 < E ≤1.0 : Stable community

Dominance index

A high uniformity index and low diversity indicate a species' dominance over others. The dominance index formula is as follows (Odum 1996).

$$C = \sum_{i=1}^{s} Pi^2 \quad \ldots\ldots (3)$$

Where:
C : Dominance Index,
Pi : The proportion of individuals in wild edible fruit species
i : 1, 2…, n
Index values range from 0-1 by the following categories:
0 < C < 0.5 : Low dominance
0.5< C ≤0.75 : Moderate dominance
0.75< C ≤ 1.0 : High dominance

Similarity index

Therefore, to assess the similarities in plant species among the study areas, the Jaccard similarity coefficient (CJ) was employed using the following Cabrera-Meléndez et al. (2022):

$$CJ = \frac{c}{a+b+c} \quad \ldots\ldots (4)$$

Where:
a : The number of species present only at site A
b : The number of species present only at site B
c : The number of species present at sites A and B

RESULTS AND DISCUSSION

Wild edible fruit plant species diversity

Moreover, a total of 331 wild edible fruit plants were recorded from the four study areas, consisting of 73 families. The highest number of fruit plant species was recorded in West Sumatra Province, i.e., 176 species, followed by Jambi (172 species), Riau (121 species), and Bengkulu (76 species) (Figure 2).

Phyllantaceae is the most represented plant family with 34 species each, followed by Moraceae (31 species), Euphorbiaceae and Fagaceae (18 species each), Myrtaceae (16 species), Anacardiaceae (14 species), Fabaceae and Sapindaceae (13 species each) and Malvaceae with 12 species. The other 64 families possess one to 10 representative species each. *Artocarpus integer* (Thunb.) Merr., *Baccaurea lanceolata* (Miq.) Müll.Arg., *Baccaurea macrocarpa* (Miq.) Müll.Arg, *Baccaurea polyneura* Hook.f., *Garcinia atroviridis* Griff. ex T.Anderson, *Garcinia xanthochymus* Hook.fil. ex J.Anderson, *Mangifera foetida* Lour., *Mangifera laurina* Blume, *Mangifera odorata* Griff., and *Pometia pinnata* J.R.Forst. & G.Forst were the most frequently recorded wild fruit plant species in all of the study area. On the other hand, 74 wild edible fruit plant species were recorded only in West Sumatra, 45 in Riau, 79 in Jambi, and 9 in Bengkulu (Table 2).

The number of species recorded in this study (331 species) was higher than the 86 wild fruit plant species reported in Kerala, India (George and Cristopher 2019), 52 species in Thanh Hoa Province, Northern Vietnam (Nguyen et al. 2021), 30 species in Nias, West Sumatra, Indonesia (Ziraluo and Duha 2020), and 36 species in the Benguet, Philippines (Chua-Barcelo 2014). However, the number of species in the study area was lower than the 520 wild edible fruit species in Malaysia (Milow et al. 2014). This variation in the diversity of wild edible fruit plant species was influenced by the culture and traditional knowledge of the local community that used the plants. Traditional ecological knowledge of local communities is critical for biodiversity conservation in a given area (Hanazaki et al. 2018).

The findings of the species diversity analysis in the studied area revealed that the value of the species diversity index (H') ranged between 3.25 and 3.85 (Table 3). That indicated the study area's fruit-plant species diversity index was high. The diversity of wild edible fruit plant species was higher in West Sumatra Province (3.85) but lower in Riau Province (3.25). The high diversity index in West Sumatra (3.85) was caused by the number of species and population in this site being greater than in other study sites. This finding is comparable to those reported by Solikin (2019), who noticed that the number of species and populations positively correlates with the diversity index value. The dominance of wild edible fruit plant species in the study area ranged from 0.03 to 0.05, indicating a low level of dominance, and the population of each plant species was more evenly distributed. This is supported by a high evenness index value of more than 0.90, indicating that the community in the entire study area is more stable (Odum 1996).

Comparison of species diversity among study areas

The Jaccard Similarity Index expresses species similarity among all study areas compared. A comparison of species diversity in all study areas is shown in Table 4

Similarity Index (CJ) values ranged from 0.23 to 0.33 (Table 4). The similarity is very low, with a coefficient lower than 50%, with the highest similarity coefficient for sites West Sumatra–Bengkulu (33%). This is predicted because these areas' forest habitat was comparable to topography and forest structure. Topographical factors (e.g., altitude, aspect, and slope) and edaphic factors (soil type, soil fertility, and texture) influence vegetation growth (Ramos et al. 2020) and play an important role in plant species distribution (Bhat et al. 2020; Suwardi et al. 2023b), which leads to species diversification (Bhardwaj et al. 2021) and could guide forest composition at one altitude (Kumar et al. 2021). The lowest similarities were detected at sites West Sumatra–Riau and Jambi–Bengkulu (23% each).

Threaten status of wild edible fruit species.

Land-use changes (e.g., conversion to agriculture, changes in agricultural practices, and infrastructure development), habitat destruction (due to timber harvesting, fuelwood collection, grazing, and forest fires), and overharvesting are all threats to wild edible fruit plants. We use the IUCN Classification Scheme to determine the threatened status of 331 wild edible fruit species. Among the 331 wild edible fruit species in the present study, 1 taxon was classified as endangered (0.30%), 9 taxa (2.72%) as vulnerable, 11 taxa (3.32%) as near threatened, and 139 taxa (41.99%) as least concern. For 171 taxa (51.67%), there is no adequate information about their occurrence or population status; therefore, they are evaluated as data deficient (Figure 3).

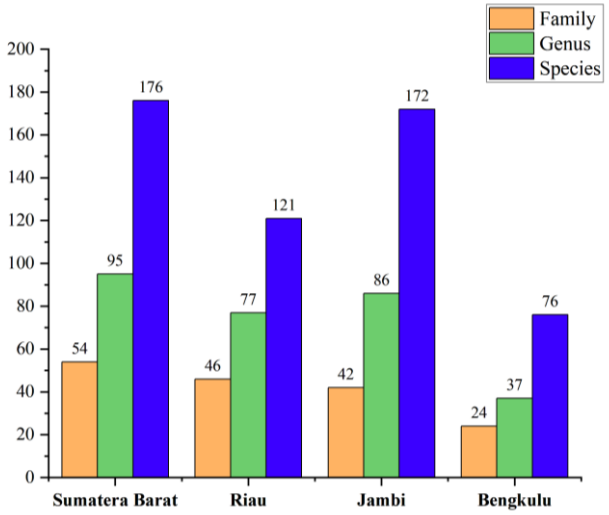

Figure 2. Species composition of wild fruit plants in the study areas

Table 2. List of wild edible fruit plant species found at each of the study areas

Family	Botanical name	Study area				Conservation Status (IUCN)
		SB	RI	JA	BK	
Achariaceae	*Pangium edule* Reinw.	+	+	+	-	LC
Actinidiaceae	*Saurauia bracteosa* DC.	+	-	-	-	VU
	Saurauia javanica (Blume ex Nees) Hoogland	+	-	-	-	DD
Anacardiaceae	*Bouea macrophylla* Griff.	+	-	-	-	DD
	Dracontomelon dao (Blanco) Merr. & Rolfe	-	-	+	-	LC
	Gluta wallichii (Hook.f.) Ding Hou	-	+	+	-	LC
	Mangifera caesia Jack	-	+	+	+	NT
	Mangifera decandra Ding Hou	-	-	+	-	DD
	Mangifera foetida Lour	+	+	+	+	LC
	Mangifera griffithii Hook.f.	-	-	+	-	DD
	Mangifera laurina Blume	+	+	+	-	DD
	Mangifera odorata Griff.	+	+	+	+	DD
	Mangifera parvifolia Boerl. & Koord.-Schum.	-	-	+	-	LC
	Mangifera quadrifida Jack	-	-	+	-	LC
	Mangifera similis Blume	+	+	-	-	VU
	Mauria heterophylla Kunth	+	-	-	-	LC
	Solenocarpus philippinensis (Elmer) Kosterm.	-	+	-	-	LC
Anisophylleaceae	*Anisophyllea disticha* (Jack) Baill.	-	+	+	-	LC
Annonaceae	*Artabotrys suaveolens* (Blume) Blume	-	+	-	-	DD
	Drepananthus deltoideus (Airy Shaw) Survesw. & R.M.K.Saunders	-	-	+	-	DD
	Goniothalamus macrophyllus (Blume) Zoll.	-	-	+	-	DD
	Huberantha rumphii (Blume ex Hensch.)	-	+	-	-	DD
	Polyalthia cauliflora Hook.f. & Thomson	-	-	+	-	DD
	Xylopia malayana Hook.f. & Thomson	-	-	+	-	LC
Apocynaceae	*Dyera costulata* (Miq.) Hook.f.	+	-	+	-	LC
	Voacanga foetida (Blume) Rolfe	-	+	+	-	DD
	Willughbeia coriacea Wall.	+	-	+	-	DD
	Willughbeia edulis Roxb.	+	-	-	-	DD
Araliaceae	*Brassaiopsis glomerulata* (Blume) Regel	+	-	-	+	LC
	Heptapleurum ellipticum (Blume) Seem.	+	-	-	-	LC
	Polyscias diversifolia (Blume) Lowry & G.M.Plunkett	-	+	-	-	LC
	Schefflera rigida (Blume) Harms	-	-	+	-	DD
	Trevesia palmata (Roxb. ex Lindl.) Vis.	+	-	-	-	LC
Arecaceae	*Eleiodoxa conferta* (Griff.) Burret	-	+	-	-	DD
	Licuala ferruginea Becc.	-	-	+	-	DD
	Salacca affinis Griff.	-	+	+	-	DD
	Salacca wallichiana Mast.	-	+	-	-	DD
Aristolochiaceae	*Thottea piperiformis* (Griff.) Mabb.	+	-	-	-	DD
Asparagaceae	*Dracaena elliptica* Thunb. & Dalm.	-	+	-	-	DD
Burseraceae	*Canarium caudatum* King	-	-	+	-	DD
	Canarium hirsutum Willd.	-	-	+	-	LC
	Canarium patentinervium Miq.	-	-	+	-	LC
	Dacryodes rostrata (Blume) H.J.Lam	-	+	+	-	LC
	Dacryodes rugosa (Blume) H.J.Lam	-	-	+	-	LC
	Santiria apiculata A.W.Benn.	-	+	-	-	LC
	Santiria laevigata Blume	+	-	+	-	LC
	Santiria oblongifolia Blume	-	+	-	-	DD
	Santiria rubiginosa Blume	-	-	+	-	DD
	Triomma malaccensis Hook.f.	-	+	-	-	DD
Cannabaceae	*Trema orientalis* (L.) Blume	-	+	-	-	LC
Celastracaceae	*Celastrus monospermoides* Loes.	-	-	+	-	DD
Centroplacaceae	*Bhesa paniculata* Arn.	+	-	-	-	LC
Chloranthaceae	*Chloranthus elatior* Link	+	-	-	-	DD
Clusiaceae	*Garcinia atroviridis* Griff. ex T.Anderson	+	+	-	+	DD
	Garcinia celebica L.	+	-	-	-	DD
	Garcinia cowa Roxb. ex Choisy	+	+	+	+	LC
	Garcinia griffithii T.Anderson	+	+	+	-	DD
	Garcinia nervosa (Miq.) Miq.	+	-	+	-	DD
	Garcinia parvifolia (Miq.) Miq.	+	-	+	+	DD
	Garcinia rigida Miq.	-	-	+	-	DD
	Garcinia xanthochymus Hook.f. ex T. Anderson	+	+	-	+	LC
Combretaceae	*Terminalia catappa* L.	-	-	-	+	LC
	Terminalia foetidissima Griff.	-	-	-	+	LC

Commelinaceae	*Amischotolype marginata* (Blume) Hassk.	+	-	-	-	DD
	Amischotolype mollissima (Blume) Hassk.	-	+	-	-	DD
Connaraceae	*Agelaea trinervis* (Llanos) Merr.	+	-	-	-	DD
Cornaceae	*Alangium ridleyi* King	-	-	+	-	DD
	Alangium uniloculare (Griff.) King	-	-	+	-	DD
Costaceae	*Hellenia speciosa* (J.Koenig) S.R.Dutta	+	+	-	-	LC
Ctenolophonaceae	*Ctenolophon parvifolius* Oliv.	-	-	+	-	VU
Cucurbitaceae	*Zehneria repanda* (Blume) C.M.Simmons	-	-	-	+	DD
Cyclanthaceae	*Evodianthus funifer* (Poit.) Lindm.	+	-	-	-	DD
Daphniphyllaceae	*Daphniphyllum griffithianum* (Wight) Noltie	+	-	-	-	DD
Dilleniaceae	*Dillenia excelsa* (Jack) Gilg	+	-	+	-	DD
	Dillenia indica L.	+	-	-	-	LC
	Dillenia reticulata King	+	-	-	-	LC
	Tetracera scandens (L.) Merr.	+	-	-	-	DD
Ebenaceae	*Diospyros buxifolia* (Blume) Hiern	-	+	-	-	DD
Elaeocarpaceae	*Elaeocarpus floribundus* Blume	+	+	-	+	DD
	Elaeocarpus serratus L.	-	-	+	-	DD
	Elateriospermum tapos Blume	-	-	+	-	DD
	Sloanea sigun (Blume) K.Schum.	-	+	-	-	DD
Euphorbiaceae	*Antidesma cuspidatum* Müll.Arg.	-	+	+	-	DD
	Antidesma montanum var. montanum Blume	-	-	+	-	LC
	Cephalomappa malloticarpa J.J.Sm.	+	-	-	-	DD
	Endospermum diadenum (Miq.) Airy Shaw	-	-	+	-	LC
	Glochidion obscurum (Roxb. ex Willd.) Blume	-	+	-	-	DD
	Homalanthus populneus Pax	+	-	+	+	LC
	Koilodepas longifolium Hook.f.	-	-	+	-	DD
	Macaranga conifera (Rchb.f. & Zoll.) Müll.Arg.	-	-	+	-	DD
	Macaranga gigantea (Rchb.f. & Zoll.) Müll.Arg.	-	-	+	-	DD
	Macaranga pruinosa (Miq.) Müll.Arg.	-	-	+	-	DD
	Macaranga tanarius (L.) Müll.Arg.	-	+	-	-	LC
	Mallotus floribundus (Bl.) M.A.	-	-	+	-	LC
	Mallotus macrostachyus Müll.Arg.	-	+	+	-	DD
	Mallotus miquelianus (Scheff.) Boerl.	+	-	-	+	LC
	Mallotus paniculatus (Lam.) Müll.Arg.	+	-	+	-	LC
	Mallotus peltatus (Geiseler) Müll.Arg.	+	-	-	+	LC
	Mallotus philippensis (Lam.) Müll.Arg.	-	+	-	-	LC
	Triadica cochinchinensis Lour.	+	-	-	-	LC
Fabacaeae	*Dialium platysepalum* Baker	-	+	+	-	DD
	Adenanthera pavonina L.	-	-	+	-	LC
	Archidendron bubalinum (Jack) I.C.Nielsen	+	+	+	+	DD
	Archidendron clypearia (Jack) I.C.Nielsen	-	-	+	-	LC
	Archidendron cockburnii I.C.Nielsen	+	-	-	-	DD
	Archidendron ellipticum (Blume) I.C.Nielsen	-	-	+	-	LC
	Archidendron microcarpum (Benth.) I.C.Nielsen	-	-	+	-	DD
	Dialium indum L.	-	+	+	-	DD
	Falcataria falcata (L.) Greuter & R.Rankin	-	-	+	-	LC
	Guilandina bonduc L.	+	-	-	-	LC
	Parkia singularis Miq.	-	-	-	+	DD
	Parkia timoriana (DC.) Merr.	-	-	+	-	LC
	Whitfordiodendron nieuwenhuisii (J.J.Sm.) Dunn	+	-	-	-	DD
Fagaceae	*Castanopsis acuminatissima* (Blume) A.DC.	-	+	-	-	LC
	Castanopsis argentea (Blume) A.DC.	+	+	+	+	EN
	Castanopsis clemensii Soepadmo	-	-	-	+	LC
	Castanopsis costata (Blume) A.DC.	+	+	-	-	DD
	Castanopsis inermis (Lindl.) Benth. & Hook.f.	+	-	-	-	DD
	Castanopsis javanica (Blume) A.DC.	+	-	-	-	LC
	Castanopsis malaccensis Gamble	-	-	-	+	DD
	Castanopsis schefferiana Hance	-	-	+	-	DD
	Castanopsis scortechinii Gamble	+	-	-	-	VU
	Lithocarpus bancanus (Scheff.) Rehder	-	-	+	+	DD
	Lithocarpus daphnoideus (Blume) A.Camus	+	-	-	-	LC
	Lithocarpus elegans (Blume) Hatus. ex Soepadmo	+	-	+	+	DD
	Lithocarpus encleisacarpus (Korth.) A.Camus	+	-	-	-	DD
	Lithocarpus gracilis (Korth.) Soepadmo	-	-	+	-	LC
	Lithocarpus hystrix (Korth.) Rehder	+	+	+	+	DD
	Lithocarpus lucidus (Roxb.) Rehder	+	+	+	+	DD
	Lithocarpus reinwardtii (Korth.) A.Camus	-	-	-	+	DD
	Lithocarpus sundaicus (Blume) Rehd	+	-	+	+	DD

Gnetaceae	*Gnetum cuspidatum* Blume	+	-	-	-	LC
	Gnetum macrostachyum Hook.f.	+	-	-	-	LC
Hypericaceae	*Cratoxylum formosum* (Jack) Benth. & Hook.f. ex Dyer	+	-	-	-	LC
	Cratoxylum sumatranum (Jack) Blume	-	-	+	-	LC
Hypoxidaceae	*Curculigo capitulata* (Lour.) Kuntze	+	+	+	+	DD
Irvingiaceae	*Irvingia malayana* Oliv. ex A.W.Benn.	-	-	+	-	LC
Lamiaceae	*Callicarpa pentandra* Roxb.	-	-	+	-	LC
	Vitex pinnata L.	+	+	+	-	LC
	Gmelina elliptica Sm.	+	-	-	-	LC
Lauraceae	*Cinnamomum iners* (Reinw. ex Nees & T.Nees) Blume	+	-	-	-	LC
	Litsea cubeba (Lour.) Pers.	-	-	+	-	LC
	Litsea insignis (Blume) Boerl.	-	-	+	-	LC
	Litsea noronhae Blume	-	+	-	-	LC
	Litsea umbellata (Lour.) Merr.	-	+	+	-	LC
	Nothaphoebe umbelliflora (Blume) Blume	-	-	+	-	LC
	Phoebe grandis (Nees) Merr.	+	-	+	-	LC
Lecythidaceae	*Barringtonia acutangula subsp. spicata* (Blume) Payens	-	+	-	-	LC
	Barringtonia macrostachya (Jack) Kurz	+	-	-	-	DD
	Barringtonia pendula (Griff.) Kurz	+	+	+	-	DD
	Barringtonia sarcostachys (Blume) Miq.	+	-	-	-	DD
	Planchonia valida (Blume) Blume	-	+	-	-	DD
Loganiaceae	*Strychnos ignatii* P.J.Bergius	+	-	-	-	DD
Malvaceae	*Boschia griffithii* Mast.	-	+	-	-	DD
	Durio carinatus Mast.	-	-	+	-	NT
	Durio graveolens Becc.	+	-	-	-	VU
	Durio lowianus Scort. ex King	+	+	+	+	VU
	Durio oxleyanus Griff.	+	-	+	+	NT
	Leptonychia caudata (Wall. ex G.Don) Burret	-	-	+	-	DD
	Microcos tomentosa Sm.	+	-	-	-	LC
	Scaphium macropodum (Miq.) Beumée ex K.Heyne	-	-	+	-	LC
	Sterculia chrysodasys Miq.	-	-	+	-	DD
	Sterculia foetida L.	+	-	-	+	DD
	Sterculia macrophylla Vent.	+	-	-	-	DD
	Sterculia stipulata Korth.	+	-	-	-	DD
Melastomataceae	*Bellucia pentamera* Naudin	+	+	+	+	LC
	Clidemia hirta D.Don	-	+	+	-	DD
	Diplectria divaricata (Willd.) Kuntze	-	+	-	-	DD
	Melastoma malabathricum L.	+	+	+	+	DD
	Memecylon excelsum Blume	-	-	+	-	DD
	Miconia crenata (Vahl) Michelang.	+	+	-	+	DD
	Pternandra azurea (DC.) Burkill	-	-	+	-	DD
Meliaceae	*Aglaia edulis* (Roxb.) Wall.	-	-	+	-	NT
	Aglaia tomentosa Teijsm. & Binn.	-	+	-	-	LC
	Aidia racemosa (Cav.) Tirveng.	-	+	-	-	LC
	Dysoxylum alliaceum (Blume) Blume ex A.Juss	-	+	-	-	LC
	Epicharis parasitica (Osbeck) Mabb.	+	+	-	+	DD
	Sandoricum koetjape (Burm.f.) Merr.	+	-	-	-	LC
	Aglaia angustifolia (Miq.) Miq.	+	-	+	-	VU
	Aglaia crassinervia Kurz ex Hiern	+	-	+	+	NT
	Aglaia silvestris (M.Roem.) Merr.	+	-	+	+	NT
Moraceae	*Artocarpus anisophyllus* Miq.	-	+	+	-	VU
	Artocarpus elasticus Reinw. ex Blume	+	+	+	+	LC
	Artocarpus integer (Thunb.) Merr.	+	+	+	+	DD
	Artocarpus kemando Miq.	+	-	+	-	DD
	Artocarpus lacucha Buch.-Ham.	-	+	-	+	DD
	Artocarpus odoratissimus Blanco	+	-	+	+	NT
	Artocarpus rigidus Blume	+	+	+	+	DD
	Ficus altissima Blume	-	+	-	-	LC
	Ficus annulata Blume	+	+	+	-	DD
	Ficus aurata (Miq.) Miq.	-	-	+	-	DD
	Ficus benjamina L.	-	-	+	-	LC
	Ficus cotinifolia Kunth	-	-	+	-	LC
	Ficus fistulosa Reinw. ex Blume	+	+	+	+	LC
	Ficus fulva Reinw. ex Blume	+	-	-	+	LC
	Ficus glandulifera (Miq.) Wall. ex King	+	-	+	+	DD
	Ficus globosa Blume	-	+	-	-	LC
	Ficus grossularioides Burm.f.	-	+	+	-	LC

	Ficus hispida L.f.	+	+	-	+	LC
	Ficus lepicarpa Blume	+	+	+	-	LC
	Ficus obscura Blume	+	-	+	-	LC
	Ficus padana Burm.f.	+	-	+	-	LC
	Ficus parietalis Blume	+	+	-	-	LC
	Ficus racemosa L.	+	+	-	+	LC
	Ficus ribes Reinw. ex Blume	+	-	+	+	DD
	Ficus rosulata C.C.Berg	+	-	-	-	DD
	Ficus sagittata Vahl	+	-	-	+	LC
	Ficus sumatrana (Miq.) Miq.	-	-	+	-	LC
	Ficus variegata Blume	+	+	+	+	LC
	Ficus virens Aiton	+	+	-	+	LC
	Prainea limpato (Miq.) Beumée ex K.Heyne	+	-	-	-	DD
	Sloetia elongata (Miq.) Koord.	-	+	-	-	DD
Musaceae	*Musa acuminata* Colla	+	+	+	-	LC
Myristicaceae	*Horsfieldia polyspherula* (Hook.f.) J.Sinclair	+	+	+	-	VU
	Knema cinerea (Poir.) Warb.	-	-	+	-	DD
	Knema conferta (King) Warb.	+	-	+	-	LC
	Knema furfuracea (Hook.f. & Thomson) Warb.	+	+	-	+	LC
	Knema latericia Elmer	-	+	-	-	LC
	Knema laurina (Blume) Warb.	-	-	+	-	LC
	Myristica elliptica Wall. ex Hook.f. & Thomson	+	+	+	+	LC
Myrsinaceae	*Embelia amentacea* C.B.Clarke	-	+	-	-	DD
Myrtaceae	*Litsea angulata* Blume	+	-	-	+	DD
	Litsea elliptica Blume	+	-	-	+	LC
	*Rhodomyrtus tomentosa (*Aiton) Hassk	+	-	-	-	LC
	Syzygium acuminatissimum (Blume) DC.	-	-	+	-	LC
	Syzygium antisepticum (Blume) Merr. & L.M.Perry	+	-	+	+	DD
	Syzygium attenuatum (Miq.) Merr. & Perry	-	-	+	-	DD
	Syzygium cerasiforme (Blume) Merr. & L.M.Perry	-	-	+	-	DD
	Syzygium creaghii (Ridl.) Merr. & L.M.Perry	+	-	-	-	DD
	Syzygium cumini (L.) Skeels	-	+	-	-	LC
	Syzygium grande (Wight) Walp.	-	-	+	-	DD
	Syzygium littorale (Blume) Amshoff	-	-	+	-	DD
	Syzygium palawanense (C.B.Rob.) Merr. & L.M.Perry	-	+	-	-	DD
	Syzygium polyanthum (Wight) Walp.	-	+	+	+	DD
	Syzygium pycnanthum Merr. & L.M.Perry	+	+	+	+	DD
	Syzygium racemosum (Blume) DC.	-	-	+	-	DD
	Syzygium zeylanicum (L.) DC.	+	-	-	-	DD
Olacaceae	*Ochanostachys amentacea* Mast.	-	+	+	-	DD
	Scorodocarpus borneensis (Baill.) Becc.	-	+	+	-	DD
Passifloraceae	*Passiflora foetida* L.	+	+	+	+	DD
Pentaphylacaceae	*Adinandra dumosa* Jack	+	-	-	-	LC
	Eurya acuminata DC.	+	-	-	-	DD
	Eurya nitida Korth.	-	-	-	+	LC
	Eurya trichocarpa Korth.	+	-	-	-	LC
Phyllanthaceae	*Antidesma nigricans* Tul.	+	-	-	-	DD
	Antidesma roxburghii Wall. ex Tul.	-	-	+	-	DD
	Aporosa benthamiana Hook.f.	-	-	+	-	DD
	Aporosa falcifera Hook.f.	+	+	-	-	DD
	Aporosa granularis Airy Shaw	+	-	-	-	DD
	Aporosa lucida (Miq.) Airy Shaw	-	+	+	-	DD
	Aporosa maingayi Hook.f.	-	-	+	-	DD
	Aporosa nervosa Hook.f.	-	+	-	-	DD
	Aporosa octandra (Buch.-Ham. ex D.Don) Vickery	+	-	+	-	LC
	Aporosa stellifera Hook.f.	+	-	-	-	DD
	Aporosa subcaudata Merr.	+	-	+	-	DD
	Aporosa yunnanensis (Pax & K.Hoffm.) F.P.Metcalf	+	-	-	-	DD
	Baccaurea angulata Merr.	+	-	-	-	DD
	Baccaurea bracteata Mull.Arg.	-	-	+	-	DD
	Baccaurea brevipes Hook.f.	-	+	-	-	DD
	Baccaurea deflexa Müll.Arg.	+	+	+	+	DD
	Baccaurea dulcis (Jack) Müll.Arg.	+	-	+	-	LC
	Baccaurea edulis Merr.	+	-	+	-	DD
	Baccaurea javanica M.A.	-	-	+	-	LC
	Baccaurea lanceolata (Miq.) Müll.Arg.	+	+	+	+	DD
	Baccaurea macrocarpa (Miq.) Müll.Arg.	+	+	+	+	DD

	Baccaurea macrophylla (Müll.Arg.) Müll.Arg.	-	+	-	-	DD
	Baccaurea parviflora (Müll.Arg.) Müll.Arg.	+	-	+	+	DD
	Baccaurea polyneura Hook.f.	+	-	+	+	DD
	Baccaurea pubera (Miq.) Mull.Arg.	+	-	+	-	DD
	Baccaurea pyriformis Gage	+	-	-	-	LC
	Baccaurea racemosa (Reinw.) Müll.Arg.	+	-	-	+	DD
	Baccaurea ramiflora Lour.	+	+	+	+	LC
	Baccaurea sumatrana (Miq.) Müll.Arg.	+	+	+	+	DD
	Baccaurea tetrandra (Baill.) Mull.Arg.	-	-	+	-	LC
	Bischofia javanica Blume	+	-	+	-	LC
	Breynia vitis-idaea (Burm.f.) C.E.C.Fisch.	+	-	-	-	LC
	Bridelia glauca Blume	+	-	-	-	LC
	Bridelia tomentosa Blume	+	-	-	-	LC
Piperaceae	*Piper aduncum* L.	-	-	+	-	LC
Primulaceae	*Ardisia crenata* Sims	+	-	-	-	DD
	Ardisia elliptica Thunb.	+	-	-	-	DD
	Ardisia forbesii S.Moore	+	-	-	-	LC
	Ardisia pterocaulis Miq.	+	-	-	-	DD
Proteaceae	*Helicia robusta* (Roxb.) R.Br. ex Blume	-	+	-	-	LC
Putranjivaceae	*Drypetes polyneura* Airy Shaw	+	-	-	-	LC
Rhizoporaceae	*Carallia borneensis* Oliv.	-	+	-	-	DD
Rosaceae	*Nauclea orientalis* (L.) L.	-	-	-	+	LC
	Rubus moluccanus L.	+	+	+	+	DD
Rubiaceae	*Coffea canephora* Pierre ex A.Froehner	+	-	-	-	LC
	Gardenia jasminoides J.Ellis	-	-	+	-	DD
	Nauclea subdita (Korth.) Steud.	+	-	-	-	LC
	Neolamarckia cadamba (Roxb.) Bosser	-	+	-	-	DD
	Porterandia anisophylla (Jack ex Roxb.) Ridl.	-	+	-	-	DD
	Psychotria limonensis K.Krause	+	-	-	-	DD
Rutaceae	*Citrus swinglei* Burkill ex Harms	+	-	+	-	DD
	Clausena excavata Burm.f.	+	-	-	-	DD
	Micromelum minutum (G.Forst.) Wight & Arn.	-	+	-	-	LC
Sabiaceae	*Meliosma sumatrana* (Jack) Walp.	+	+	-	-	LC
Salicaceae	*Flacourtia inermis* Roxb.	+	-	+	+	DD
	Flacourtia rukam Zoll. & Moritzi	+	-	+	+	DD
Sapindaceae	*Dimocarpus fumatus* (Blume) Leenh.	-	-	+	-	LC
	Dimocarpus longan subsp. malesianus Leenh.	-	-	+	-	DD
	Harpullia cupanioides Roxb.	+	-	-	-	LC
	Lepisanthes rubiginosa (Roxb.) Leenh.	-	-	+	-	LC
	Mischocarpus pentapetalus (Roxb.) Radlk.	+	-	-	+	DD
	Nephelium cuspidatum Blume	+	+	+	-	LC
	Nephelium maingayi Hiern	-	+	-	-	LC
	Nephelium ramboutan-ake (Labill.) Leenh.	-	+	+	-	DD
	Nephelium uncinatum Radlk. ex Leenh.	-	-	+	+	LC
	Oroxylum indicum (L.) Kurz	-	-	+	-	DD
	Paranephelium xestophyllum Miq.	-	-	+	-	LC
	Pometia pinnata J.R.Forst. & G.Forst.	+	+	+	+	LC
	Xerospermum noronhianum (Blume) Blume	+	+	-	-	DD
Sapotaceae	*Madhuca pallida* (Burck) Baehni	+	-	-	-	NT
	Palaquium hexandrum (Griff.) Baill.	-	-	+	-	NT
	Palaquium obovatum (Griff.) Engl.	-	+	-	-	LC
	Payena acuminata (Blume) Pierre	-	-	+	-	LC
	Planchonella maingayi (C.B.Clarke) P.Royen	+	-	-	-	NT
Simaraubacaeae	*Eurycoma longifolia* Jack	+	-	-	-	DD
Solanaceae	*Physalis angulata* L.	+	-	-	+	LC
Symplocaceae	*Symplocos cochinchinensis* (Lour.) S.Moore	+	-	-	-	DD
Theaceae	*Schima wallichii* (DC) Korth.	-	-	+	-	LC
Thymelaeaceae	*Gonystylus forbesii* Gilg	+	-	-	-	NT
Torricelliaceae	*Aralidium pinnatifidum* (Jungh. & de Vriese) Miq.	+	+	-	-	LC
Ulmaceae	*Gironniera nervosa* Planch.	+	+	-	-	DD
Urticaceae	*Debregeasia longifolia*(Burm.f.) Wedd.	-	+	-	-	LC
	Poikilospermum suaveolens (Blume) Merr.	+	-	+	-	DD
Violaceae	*Rinorea anguifera* (Lour.) Kuntze	+	+	-	-	DD
Vitaceae	*Ampelocissus cinnamomea* (Wall.) Planch.	-	+	-	-	DD
	Leea indica (Burm. f.) Merr.	+	+	+	+	LC
	Leea rubra Blume	+	-	-	-	DD

Note: Provinces: SB: West Sumatra; RI: Riau; JA: Jambi; BK: Bengkulu. Conservation Status: DD: Data Deficient; LC: Least Concern; NT: Near Threatened; LR: Lower Risk; VU:Vulnerable; -: absent; +: present

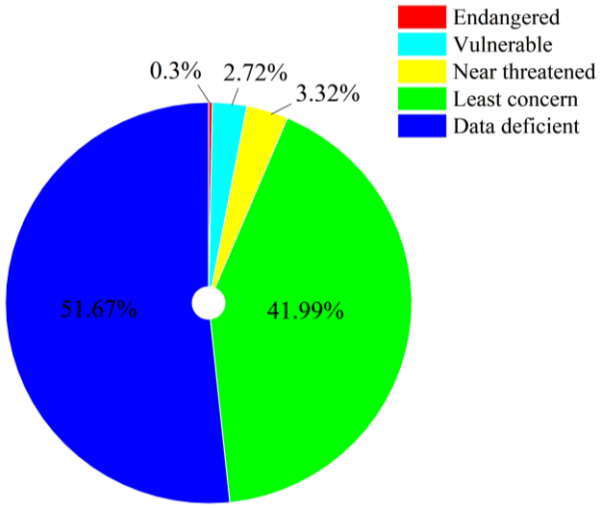

Figure 3. Number of WEFs on the IUCN Red List of Threatened Species classified by class and risk category

Table 3. The Dominance, Shannon Diversity, and Evenness Indexes of four provinces

Province	No. of species	Shannon-Diversity Index (H')	Dominance Index (C)	Evenness Index (E)
West Sumatra	176	3.85	0.03	0.92
Riau	121	3.25	0.05	0.95
Jambi	172	3.84	0.03	0.95
Bengkulu	76	3.40	0.04	0.94

Table 4. Sorenson Similarity Index in the study area

	West Sumatra	Riau	Jambi	Bengkulu
West Sumatra		0.23	0.26	0.33
Riau			0.24	0.25
Jambi				0.23
Bengkulu				

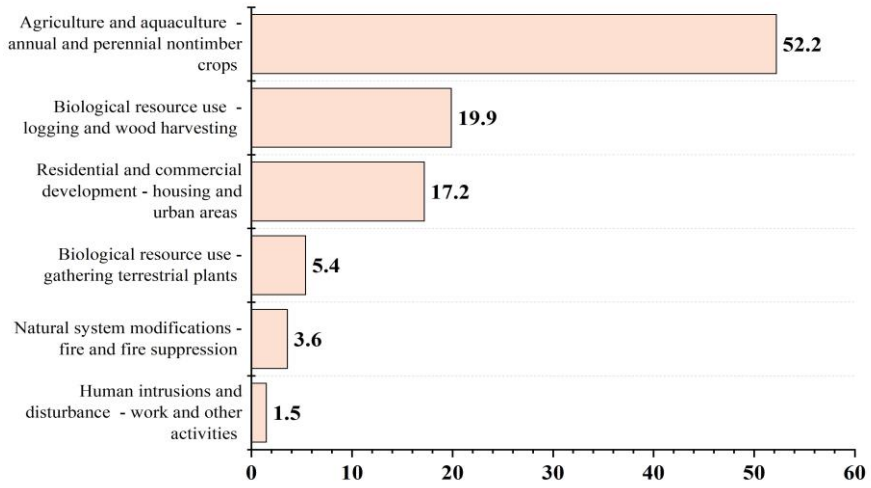

Figure 4. Major threats to WEFs in the study area

Castanopsis argentea is a wild edible fruit plant species listed as endangered. At the same time, *S. bracteosa, M. similis, C. parvifolius, C. scortechinii, D. graveolens, D. lowianus, A. angustifolia, A. anisophyllus,* and *H. polyspherula* are the eight wild edible fruit plant species listed as Vulnerable. The IUCN red list, on the other hand, lists only two wild edible fruit plant species found in the study area as data deficient, while 169 species are yet to be listed. This study supports Suwardi et al.'s (2022b) findings, who discovered that more than half of the wild edible fruit species in Aceh Province, Indonesia lacked global conservation assessments in the IUCN Red List Index for Plants. Borelli et al. (2020) noticed that in the IUCN Red List Index for Plants, just under one-third of known wild fruit plant species have global conservation assessments.

The findings revealed that the main threat to the availability of WEFs in the study area is the expansion of agricultural land. The agriculture sector, particularly the growth of annual and perennial non-timber crops, threatens the future existence of more than half of the WEFs in the study area. However, biological resource use, particularly logging and wood harvesting, account for 19.9% of the threat (Figure 4).

Conservation of wild edible fruit plant species

Sumatra is rich in wild edible fruit species, essential to local communities livelihoods. Moreover, this area has available land, and the climate is suitable for the survival of wild edible fruit species. However, various human activities, particularly land use change, significantly threaten wild edible fruit species' existence. According to the IUCN red list, 22 of the 331 species discovered in the study area are classified as threatened. As a result, conservation efforts, both in-situ and ex-situ, must begin as soon as possible. In-situ conservation efforts include the

protection and management of wild edible fruit plant habitats, as well as the restoration of wild plant populations (Nduche et al. 2023). Wild edible fruit plants need suitable habitats to survive; therefore, protecting natural habitats suitable for these plants is critical. Limiting human access to the habitat, monitoring and reducing human activities threatening the habitat, and restoring damaged environmental conditions are essential strategies for natural habitat protection and management (Hofmann 2022). Plant extinct or endangered wild fruit trees and strengthening existing wild plant populations are considered to restore species richness to their natural habitats. In addition, by disseminating information on wild plants, providing in situ conservation training, and involving the public in conservation activities, it is believed that in-situ conservation efforts for wild edible fruit plants will be strengthened, and their existence not be threatened with extinction.

Ex-situ conservation of wild edible fruit plants is accomplished by conserving plants in places other than their natural habitats, such as botanical gardens, seed banks, and other facilities. Botanic gardens offer an excellent opportunity to conserve plant diversity ex-situ and play an important role in species extinction prevention through integrated conservation action (Mounce et al. 2017). Botanical gardens can be used to preserve and exhibit wild edible fruit species and conduct investigations on their biology and ecology. In addition, establishing seed banks is a crucial strategy to conserve wild plant species, including wild edible fruit species, considering seeds can survive for many years, allowing for long-term genetic storage and important for agricultural, forestry, and livestock development (León-Lobos et al. 2012). Seed banks can also be used to restore extinct or endangered wild edible fruit plant populations. Community-based conservation through the domestication of wild edible fruit plant species also is considered for the conservation of wild edible fruit plants. Local communities can grow wild edible fruit by combining them with crops in their orchard, home gardens, or farmland (Suwardi et al. 2023c). The selection, management, and cultivation of wild edible fruit plant species may necessitate applying silvicultural and horticultural concepts (Akinnifesi et al. 2007). Development of propagation techniques such as tissue culture, cuttings, grafting, and seed germination can be used to propagate wild edible fruit species. Promoting and domesticating wild edible fruit plant species improve the nutritional status and livelihoods of local communities while also protecting these fruit species from extinction in the wild (Rathore 2009). By implementing these efforts, it is hoped that ex-situ conservation for wild edible fruit plants will be strengthened, and their existence can be maintained even if their natural habitat is destroyed or endangered.

In conclusion, our study documented a total of 331 wild edible fruit plant species at four studied sites in Sumatra, consisting of 73 families. The highest number of fruit plant species was recorded in West Sumatra Province, i.e., 176 species, followed by Jambi (172 species), Riau (121 species), and Bengkulu (76 species). The diversity of wild edible fruit plant species was higher in West Sumatra Province (3.85) but lower in Riau Province (3.25). *A. integer, B. lanceolata, B. macrocarpa, B. polyneura, G. atroviridis, G. xanthochymus, M. foetida, M. laurina, M. odorata*, and *P. pinnata* were the most frequently recorded wild fruit plant species in all of the study area. However, 76 wild edible fruit plant species were discovered only in West Sumatra, 44 in Riau, 75 in Jambi, and 9 in Bengkulu. Among the 331 wild edible fruit species in the present study, 1 taxon was classified as endangered (0.30%), 9 taxa (2.72%) as vulnerable, 11 taxa (3.32%) as near threatened, and 139 taxa (41.99%) as least concern, and 171 taxa (51.67%) as Data Deficient.

ACKNOWLEDGEMENTS

We are grateful to all people in the studied villages for their kind hospitality and knowledge sharing. We are grateful to all people in the studied villages for their kind hospitality and knowledge sharing. The study received funding from the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia in 2022-2023 through a Dissertation Research Grant/PDD (083/E5/PG.02.00/PT/2022) and National Innovation Research Agency of the Republic of Indonesia through the Expedition and Exploration Research Grant/PEE in 2022 (01/PEE/PPK-DFRI/2022).

REFERENCES

Adnan, Navia ZI, Silvia M, Antika M, Suwardi AB, Baihaqi, Yakob M. 2022. Diversity of herbs and spices plants and their importance in traditional medicine in the South Aceh District, Indonesia. Biodiversitas 23 (7): 3836-3843. DOI: 10.13057/biodiv/d230761.

Akinnifesi FK, Leakey RRB, Ajayi OC, Sileshi G, Tchoundjeu Z, Matakala P, Kwesiga F. 2007. Indigenous Fruit Trees in the Tropics: Domestication, Utilization and Commercialization. CAB International, UK. DOI: 10.1079/9781845931100.0000.

Begossi A, Hanazaki N, Tamashiro JY. 2002. Medicinal plants in the Atlantic Forest (Brazil): Knowledge, use, and conservation. Hum Ecol 30: 281-299. DOI: 10.1023/A:1016564217719.

Bhardwaj DR, Tahiry H, Sharma P, Pala NA, Kumar D, Kumar A, Bharti. 2021. Influence of Aspect and elevational gradient on vegetation pattern, tree characteristics and ecosystem carbon density in Northwestern Himalayas. Land 10 (11): 1109. DOI: 10.3390/land10111109.

Bhat JA, Kumar M, Negi A, Todaria N, Malik ZA, Pala NA, Kumar A, Shukla G. 2020. Altitudinal gradient of Species diversity and community of woody vegetation along altitudinal gradient of the Western Himalayas. Glob Ecol Conserv 24: e01302. DOI: 10.1016/j.gecco.2020.e01302.

Borelli T, Hunter D, Powell B, Ulian T, Mattana E, Termote C, Pawera L, Beltrame D, Penafiel D, Tan A, Taylor M, Engels J. 2020. Born to eat wild: An integrated conservation approach to secure wild food plants for food security and nutrition. Plants 9: 1299. DOI: 10.3390/plants9101299.

BPS (Badan Pusat Statistik Republik Indonesia). 2021a. Angka Deforestasi Netto Indonesia di Dalam Dan di Luar Kawasan Hutan Tahun 2013-2020. Badan Pusat Statistik Republik Indonesia, Jakarta. [Indonesian]

BPS (Badan Pusat Statistik Republik Indonesia). 2021b. Jumlah Penduduk Hasil SP2020 Menurut Wilayah Dan Jenis Kelamin. Badan Pusat Statistik Republik Indonesia, Jakarta. [Indonesian]

Broegaard RB, Rasmussen LV, Dawson N, Vongvisouk T, Grogan K. 2017. Wild food collection and nutrition under commercial

agriculture expansion in agriculture-forest landscapes. For Pol Econ 84: 92-101. DOI: 10.1016/j.forpol.2016.12.012.
Buckland ST, Borchers DL, Johnston A, Henrys PA, Marques TA. 2007. Line transect methods for plant surveys. Biometrics 63: 989-998. DOI: 10.1111/j.1541-0420.2007.00798.x
Cabrera-Meléndez JL, Iparraguirre-León D, Way M, Valenzuela-Oré F, Montesinos-Tubée DB. 2022. The applicability of similarity indices in an ethnobotanical study of medicinal plants from three localities of the Yunga district, Moquegua region, Peru. Ethnobot Res Appl 24 (16): 1-17. DOI: 10.32859/era.24.16.1-18.
Calder IR, Aylward B. 2006. Forest and floods: Moving to an evidence-based approach to watershed and integrated flood. Manag Water Intl 31: 87-99. DOI: 10.1080/02508060608691918.
Chua-Barcelo RC. 2014. Ethno-botanical survey of edible wild fruits in Benguet, Cordillera administrative region, the Philippines. Asian Pac J Trop Biomed 4 (Suppl 1): S525-S538. DOI: 10.12980/APJTB.4.201414B36.
Dreher ML. 2018. Whole fruits and fruit fiber emerging health effects. Nutrients 10: 1833. DOI: 10.3390/nu10121833.
Erskine W, Ximenes A, Glazebrook D, da Costa M, Lopes M, Spyckerelle L, Williams R, Nesbitt H. 2015. The role of wild foods in food security: The example of Timor-Leste. Food Sec 7: 55-65. DOI: 10.1007/s12571-014-0406-9.
FAO (Food and Agriculture Organization). 2020. Global Forest Resources Assessment 2020: Main Report FAO Forestry, Rome, Italy.
Gebauer J, Adam YO, Sanchez AC, Darr D, Eltahir ME, Fadl KE, Hunsche M. 2016. Africa's wooden elephant: the baobab tree (*Adansonia digitata* L.) in Sudan and Kenya: A review. Genet Resour Crop Evol 63: 377-399. DOI: 10.1007/s10722-015-0360-1.
George MV, Christopher G. 2019. Structure, diversity and utilization of plant species in tribal homegardens of Kerala, India. Agrofor Syst 94: 297-307. DOI: 10.1007/s10457-019-00393-5.
Hanazaki N, Zank S, Fonseca-Kruel VS, Schmidt IB. 2018. Indigenous and traditional knowledge, sustainable harvest, and the long road ahead to reach the 2020 Global Strategy for Plant Conservation objectives. Rodriguésia 69 (4): 1587-1601. DOI: 10.1590/2175-7860201869409.
Harianja, AH, Sinaga AM, Hawari FA, Fauzi R. 2021. The importance of the utilization of forest fruits in Batak Toba community. Indones J For Res 8 (1): 1-12. DOI: 10.20886/ijfr.2021.8.1.1-12.
Hazarika TK, Singh TS. 2018. Wild edible fruits of Manipur, India: Associated traditional knowledge and implications to sustainable livelihood. Genet Resour Crop Evol 65: 319-332. DOI: 10.1007/s10722-017-0534-0.
Hofmann S. 2022. Challenges and opportunities of area-based conservation in reaching biodiversity and sustainability goals. Biodivers Conserv 31: 325-352. DOI: 10.1007/s10531-021-02340-2.
Hortal J, de Bello F, Diniz- Filho JAF, Lewinsohn TM, Lobo JM, Ladle RJ. 2015. Seven shortfalls that beset large- scale knowledge of biodiversity. Ann Rev Ecol Evol Syst 46: 523-549. DOI: 10.1146/annurev-ecolsys-112414-054400.
IUCN. 2020. The IUCN Red List of Threatened Species 2020.1. https://www.iucnredlist.org/
Karun NC, Vaast P, Kushalappa CG. 2014. Bioinventory and documentation of traditional ecological knowledge of wild edible fruits of Kodagu-Western Ghats, India. J For Res 25: 717-721. DOI: 10.1007/s11676-014-0513-7.
Klimas CA, Kainer KA, de Oliveira Wadt LH. 2012. The economic value of sustainable seed and timber harvests of multi-use species: An example using *Carapa guianensis*. For Ecol Manag 268: 81-91. DOI: 10.1016/j.foreco.2011.03.006.
Kumar A, Pinto MC, Candeias C, Dinis PA. 2021. Baseline maps of potentially toxic elements in the soils of Garhwal Himalayas, India: Assessment of their eco-environmental and human health risks. Land Degrad Dev 32: 3856-3869. DOI: 10.1002/ldr.3984.
Laumonier Y, Setiabudi B, Uryu Y, Hadian O. 2010. Eco-floristic sectors and deforestation threats in Sumatra: Identifying new conservation area network priorities for ecosystem-based land use planning. Biodivers Conserv 19: 1153-1174. DOI: 10.1007/s10531-010-9784-2.
León-Lobos P, Way M, Aranda PD, Lima-Junior M. 2012. The role of ex situ seed banks in the conservation of plant diversity and in ecological restoration in Latin America. Plant Ecol Divers 2012: 1-14. DOI: 10.1080/17550874.2012.713402.
Lomolino MV. 2004. Conservation biogeography. In Lomolino MV, Heaney LR (eds). Frontiers of Biogeography: New Directions in the Geography of Nature. Sinauer Associates, Inc., Sunderland, Massachusetts.
Ludwig JA, Reynolds JF. 1988. Statistical Ecology: A Primer Methods and Computing. John Wiley & Sons, US.
Magurran A. 2004. Measuring Biological Diversity. Blackwell Publishing, Oxford, UK.
Mahapatra AK, Panda PC. 2012. Wild edible fruit diversity and its significance in the livelihood of indigenous tribals: Evidence from Eastern India. Food Sec 4: 219-234. DOI: 10.1007/s12571-012-0186-z.
Milow P, Malek SB, Juliedo, Ong HC. 2014. Malaysian species of plants with edible fruits or seeds and their valuation. Intl J Friut Sci 14: 1-27. DOI: 10.1080/15538362.2013.801698.
Mounce R, Smith P, Brockington S. 2017. Ex situ conservation of plant diversity in the world's botanic gardens. Nat Plant 10 (2017): 795-802. DOI: 10.1038/s41477-017-0019-3.
Myers N, Mittermeier RA, Mittermeier CG, Da Fonseca GA, Kent J. 2000. Biodiversity hotspots for conservation priorities. Nature 403 (6772): 853-858. DOI: 10.1038/35002501.
Navia ZI, Adnan, Harmawan T, Suwardi AB. 2022b. Ethnobotanical study of wild medicinal plants in Serbajadi protected forest of East Aceh District, Indonesia. Biodiversitas 23 (10): 4959-4970. DOI: 10.13057/biodiv/d231001.
Navia ZI, Suwardi AB, Baihaqi. 2021. Ethnobotanical study of medicinal plants used by local communities in Sekerak Sub-district, Aceh Tamiang, Indonesia. Biodiversitas 22 (10): 4467-4473. DOI: 10.13057/biodiv/d221019.
Navia ZI, Suwardi AB, Harmawan T. 2022a. Ethnobotanical investigation of *Baccaurea* spp. (Phyllantaceae) used by local people near Gunung Leuser National Park, Aceh, Indonesia. Ethnobot Res Appl 24 (41): 1-12. DOI: 10.32859/era.24.41.1-12.
Nazarudeen A. 2010. Nutritional composition of some lesser-known fruits used by ethnic communities and local folks of Kerela. Ind J Tradit Knowl 9 (2): 398-402.
Nduche MU, Brehm JM, Parra-Quijano M, Maxted N. 2023. In situ and ex situ conservation gap analyses of West African priority crop wild relatives. Genet Resour Crop Evol 70: 333-351. DOI: 10.1007/s10722-022-01507-2.
Nguyen CH, Averyanov L, Egorov A, Nguyen CV, Tran TT. 2021. Edible wild plants in the flora of Pu Luong Nature Reserve, Thanh Hoa Province, northern Vietnam. Earth Environ Sci 876: 012054. DOI: 10.1088/1755-1315/876/1/012054.
Odum EP. 1996. Dasar-Dasar Ekologi. Edisi Ketiga. Universitas Gajah Mada Press, Yogyakarta. [Indonesian]
Ramaidani, Navia ZI. 2022. Documentation of the traditional Gayo food in Lokop Village, East Aceh, Indonesia. Biodiversitas 23 (4): 2017-2024. DOI: 10.13057/biodiv/d230437.
Ramos MB, Diniz FC, de Almeida HA, de Almeida GR, Pinto AS, Meave JA, Lopes SF. 2020. The role of edaphic factors on plant species richness and diversity along altitudinal gradients in the Brazilian semi-arid region. J Trop Ecol 36 (5): 199-212. DOI: 10.1017/S0266467420000115.
Rathore M. 2009. Nutrient content of important fruit trees from arid zone of Rajasthan. J Horticult For 1 (7): 103-108.
Šamonil P, Král K, Hort L. 2010. The role of tree uprooting in soil formation: A critical literature review. Geoderma 157: 65-79. DOI: 10.1016/j.geoderma.2010.03.018.
Shaltout K, Bedair H. 2022. Diversity, distribution and regional conservation status of the Egyptian tree flora. Afr J Ecol 60 (4): 1155-1183. DOI: 10.1111/aje.13071.
Solikin. 2019. Plants diversity and similarity in three sites growing area of *Stachytarpheta jamaicensis* (L.) Vahl. AIP Conf Proc 2120: 030011. DOI: 10.1063/1.5115615.
Song C, Lee WK, Choi HA, Kim J, Jeon SW, Kim JS. 2016. Spatial assessment of ecosystem functions and services for air purification of forests in South Korea. Environ Sci Pol 63: 27-34. DOI: 10.1016/j.envsci.2016.05.005.
Sutrisno IH, Suwardi AB, Navia ZI, Baihaqi B, Fadhilah MA. 2021. Documentation of the traditional Alas food in Southeast Aceh District, Indonesia. Biodiversitas 22 (8): 3243-3249. DOI: 10.13057/biodiv/d220818.
Suwardi AB, Navia ZI, Harmawan T, Seprianto, Syamsuardi, Mukhtar E. 2022b. Diversity of wild edible fruit plant species and their threatened status in the Aceh Province, Indonesia. Biodiversitas 23 (3): 1310-1318. DOI: 10.13057/biodiv/d230315

Suwardi AB, Navia ZI, Harmawan T, Syamsuardi, Mukhtar E. 2022a. Importance and local conservation of wild edible fruit plants in the East Aceh Region, Indonesia. Intl J Conserv Sci 13 (1): 221-232.

Suwardi AB, Navia ZI, Mubarak A, Mardudi. 2023c. Diversity of home garden plants and their contribution to promoting sustainable livelihoods for local communities living near Serbajadi protected forest, Aceh Timur region, Indonesia. Biol Agric Horticult 2023: 1-13. DOI: 10.1080/01448765.2023.2182233.

Suwardi AB, Navia ZI. 2022. Sustainable use and management of wild edible fruit plants: A case study in the Ulu Masen protected forest, West Aceh, Indonesia. J Sustain For 2022: 1-20. DOI: 10.1080/10549811.2022.2123355.

Suwardi AB, Syamsuardi, Mukhtar E, Nurainas. 2023a. The diversity and traditional knowledge of wild edible fruits in Bengkulu, Indonesia. Ethnobot Res Appl 25 (15): 1-17. DOI: 10.32859/era.25.15.1-17.

Suwardi AB, Syamsuardi, Mukhtar E, Nurainas. 2023b. Potential geographic distribution of *Durio oxleyanus* (Malvaceae): A threatened wild fruit plant species in Sumatra, Indonesia. Pol J Environ Stud 32 (3): 2845-2853. DOI: 10.15244/pjoes/161669.

Syamsuardi, Mukhtar E, Nurainas, Suwardi AB. 2022b. Diversity and use of wild edible fruit plants in the Bukit Rimbang-Bukit Baling Wildlife Reserve, Kampar, Riau, Indonesia. Biodiversitas 23 (10): 5035-5042. DOI: 10.13057/biodiv/d231009.

Syamsuardi, Nurainas, Taufiq A, Harmawan T, Suwardi AB. 2022a. Aneuk Jamee traditional foods in the South Aceh District, Indonesia. Biodiversitas 23 (1): 443-454. DOI: 10.13057/biodiv/d230146.

Uji T. 2007. Review: Species diversity of indigenous fruits in Indonesia and its potential. Biodiversitas 8 (2): 157-167. DOI: 10.13057/biodiv/d080217.

Vié JC, Hilton-Taylor C, Pollock C, Ragle J, Smart J, Stuart SN, Tong R. 2009. The IUCN Red List: A Key Conservation Tool. Wildlife in a Changing World- An Analysis of the 2008 IUCN Red List of Threatened Species, 1. IUCN, Gland, Switzerland.

Von Rintelen K, Arida E, Häuser C. 2017. A review of biodiversity-related issues and challenges in megadiverse Indonesia and other Southeast Asian countries. Res Ideas Outcomes 3: e20860. DOI: 10.3897/rio.3.e20860.

Wahyuni H, Suranto. 2021. Dampak deforestasi hutan skala besar terhadap pemanasan global di Indonesia. Jurnal Ilmiah Ilmu Pemerintahan 6 (1): 148-162. DOI: 10.14710/jiip.v6i1.10083. [Indonesian]

Whittaker RJ, Araújo MB, Paul J, Ladle RJ, Watson JEM, Willis KJ. 2005. Conservation biogeography: Assessment and prospect. Divers Distrib 11: 3-23. DOI:10.1111/j.1366-9516.2005.00143.x

Zhang Y, Yuan H, Yu M. 2011. Assessment of threaten status on the wild plants under state protection in China. Biodivers Sci 19 (1): 57-62. DOI: 10.3724/SP.J.1003.2011.06133.

Ziraluo YPB, Duha M. 2020. Diversity study of fruit producer plant in Nias Islands. Jurnal Inovasi Penelitian 1 (4): 683-694. DOI: 10.47492/jip.v1i2.55. [Indonesian]