State of Nature Conservation in Malaysia 2025, 199–215
doi: 10.62613/sonc2025.v1flc17

CHAPTER 17

Conservation of non-rattan palms in Peninsular Malaysia

SAW LENG GUAN*

Abstract: Malaysia has about 417 species of palms, about 205 species in Peninsular Malaysia, and about 271 species in Sabah and Sarawak. Recent work on the revision of the palms for the *Flora of Peninsular Malaysia* has completed drafts for the non-rattan genera of the family. This paper presents the results of the conservation assessments of these species, comprising about 112 species and their lower rank taxa, 51 (45.6%) of the taxa were preliminary assessed with conservation concern categories.

INTRODUCTION

Malaysia is home to approximately 417 palm species, with around 205 species recorded in Peninsular Malaysia and 271 species identified in Sabah and Sarawak on the island of Borneo, according to the Plants of the World Online [POWO; incorporating recent revisions and assessments by Saw (in prep., for the *Flora of Peninsular Malaysia* project)]. The Malaysian Nature Society's special publication on nature conservation, authored by Kiew and Pearce (1991), documented at least 385 palm species nationwide: 195 in Peninsular Malaysia and 213 in Sabah and Sarawak. More recently, Saw (2021) reviewed the palm conservation for Malaysia, addressing aspects such as diversity, habit, distribution, and ecology. In this work, Saw listed 417 palm species in total, with 205 species in Peninsular Malaysia and 271 species in Sabah and Sarawak.

Since Saw's compilation of Malaysian palm diversity in 2021, subsequent revisions have led to updates for several genera. Notably, Henderson's *Calamus* monograph (2020) revised the number of species from 163 to 139 for Malaysia; for *Iguanura*, numbers shifted from 15 species in Peninsular Malaysia to eight, while Sabah and Sarawak increased from 12 to 16 species (Saw 2023a; Henderson 2025). Additionally, a new species, *Licuala hairulii* Saw, has been described (Saw 2023b), and in *Pinanga*, a revision of Peninsular Malaysian species has been published (Saw 2024). Jeanson *et al*. (2025) reclassified *Arenga hastata* (Becc.) Whitmore as *Caryota hastata* (Becc.) Jeanson following molecular evidence. Table 1 presents an updated overview of palm diversity in Malaysia. Despite reductions in species counts, the palm flora of Malaysia remains highly diverse. Thirty genera in four subfamilies are native to Malaysia. Diversity is greater in Sabah and Sarawak in comparison to Peninsular Malaysia. *Calamus*, *Licuala*, *Pinanga*, *Areca*, *Iguanura* and *Korthalsia* are the most speciose genera.

This paper will not revisit topics addressed in Saw (2021), but will instead focus on conservation issues affecting non-rattan subfamilies recently revised for the *Flora of Peninsular Malaysia* (FPM) project (Saw, in prep.). The aim of this paper is to synthesise an updated diversity listing, endemism and provide preliminary national conservation status of non-rattan palms in Peninsular Malaysia. The non-rattan subfamilies include Nypoideae, Coryphoideae and Arecoideae.

With these recent revisions, palm species endemism remains high (Table 2). About 79 species (39%) are endemic to Peninsular Malaysian and 123 species (45%) are endemic to East Malaysia. In total, 201 species (48%) are Malaysian endemics. The decline in the

Forest Research Institute Malaysia, 52109 Kepong, Selangor.
***Corresponding author: sawlg55@gmail.com**

number of endemics is the results of broader species circumscriptions in some species in the revisions by Henderson (2020, 2025) and Saw (2023a, 2024) despite additional new taxa described in the revisions.

Table 1. An updated summary of palm species found in Malaysia arranged by subfamilies and genera.

Subfamily	Genera	Sabah & Sarawak	Peninsular Malaysia	Malaysia
CALAMOIDEAE	*Calamus*	96	71	139
	Eleiodoxa	1	1	1
	Eugeissona	4	2	6
	Korthalsia	14	9	18
	Metroxylon (naturalised)	(1)	(1)	(1)
	Myrialepis	-	1	1
	Plectocomia	2	3	3
	Plectocomiopsis	3	4	5
	Salacca	10	7	16
NYPOIDEAE	*Nypa*	1	1	1
CORYPHOIDEAE	*Arenga* (naturalised)	4	3(1)	6(1)
	Borassodendron	1	1	2
	Caryota	3	3	4
	Corypha	1	1	1
	Johannesteijsmannia	1	4	4
	Licuala	46	42	84
	Livistona	-	4	4
	Maxburretia	-	2	2
	Phoenix	-	1	1
	Pholidocarpus	1	2	3
	Saribus	1	-	1
ARECOIDEAE	*Adonidia*	1	-	1
	Areca (naturalised)	23 (1)	4 (1)	26 (1)
	Cocos	1	1	1
	Cyrtostachys	1	1	1
	Iguanura	16	8	24
	Nenga	2	3	4
	Oncosperma	2	2	2
	Orania	2	1	2
	Pinanga	34	22	53
	Rhopaloblaste	-	1	1
Total (naturalised)		**271 (2)**	**205 (3)**	**417 (3)**

Table 2. Regional palm species endemism.

	East Malaysia	Peninsular Malaysia	Malaysia
Total number of species	271	205	417
Number of endemic species	123	79	201
Percentage of endemism (%)	45.4	38.5	48.2

METHODOLOGY

Methods used for assessing conservation status

Assessment framework

The conservation assessment follows the IUCN Red List Categories and Criteria, Version 3.1, Second edition (2012). Methods used for the national assessment follow Saw *et al.* (2010) and Yong *et al.* (2021).

Assessment categories

Taxa of conservation concern were assigned to the following IUCN Red List categories: Extinct (EX), Critically Endangered (CR), Endangered (EN), and Vulnerable (VU). Non-threatened taxa were assigned to Near Threatened (NT), Least Concern (LC), or Data Deficient (DD). This assessment also includes the Rare (RA) category.

Use of the Rare (RA) category

The RA category was first introduced in *Flora of Peninsular Malaysia*, Series II, Volume 3 (Chua 2012) for narrow endemic taxa that are not exposed to any known direct or plausible threat, do not meet any of the five IUCN criteria, and occur in ≤ 2 sites or have an extent of occurrence (EOO) ≤ 100 km^2 or an area of occupancy (AOO) ≤ 10 km^2. Such species would otherwise be listed as Least Concern (LC). This approach is used in South Africa's national biodiversity assessment (https://nba.sanbi.org.za/content/integrated-findings/chl_rls_explained.html). These taxa are often found in protected areas. Including RA in the Malaysian Red List helps ensure that narrowly distributed endemic plants are recognised in national conservation planning, even when they are not currently threatened. Yong *et al.* (2021) followed the IUCN categories strictly and omitted RA, but it is retained here because of the conservation importance of rare, highly localised endemic species.

Spatial analysis and mapping

The GeoCAT tool (Bachman *et al.* 2011) was used to calculate the geographic range of each assessed taxon, specifically EOO and AOO, both of which are core IUCN metrics. The AOO cell width was set at 2 km, following the IUCN default. Mapping was based mainly on herbarium records managed in the BRAHMS database – a software for the management of natural history collections. Where recent collections included global positioning system (GPS) coordinates, these were used directly. For specimens without GPS data, coordinates were estimated from the gazetteer information compiled in BRAHMS or derived from Google Earth. Imprecise or undecipherable localities were excluded from the analysis. The author confirmed the identification of each record during revision of each genus for the Flora of Peninsular Malaysia project, and only records from natural ecosystems were included.

Examples of mapped distributions

Figures 1 – 4 illustrate representative distribution patterns: a widespread species (*Licuala triphylla* Griff.), an endemic species with two centres of endemism (*Livistona endauensis* J.Dransf. & K.M.Wong), a Terengganu endemic species (*Pinanga cleistantha* J.Dransf.), and a narrow endemic species (*Maxburretia rupicola* (Ridl.) Furtado). On these maps, dots represent locality records, mostly from herbarium specimens; polygons are used to calculate EOO; and the squares or circular buffers around points are used to calculate AOO. Shaded areas indicate forest cover based on the Fifth National Forest Inventory for Peninsular Malaysia (Anon. 2014), which was used to estimate the loss of forest within the recorded range.

RESULTS AND DISCUSSION

Conservation status of non-rattan palms (including lower ranked taxa)

Overview of assessed taxa

Table 3 summarises the assessments by genus, while Appendix 1 lists the taxa (species and lower-ranked taxa) of the non-Calamoideae subfamilies revised for this project that were found to have conservation concern statuses. Non-threatened species are not included. Detailed justifications for each listing will be provided when the full family revision is published (Saw, in prep.).

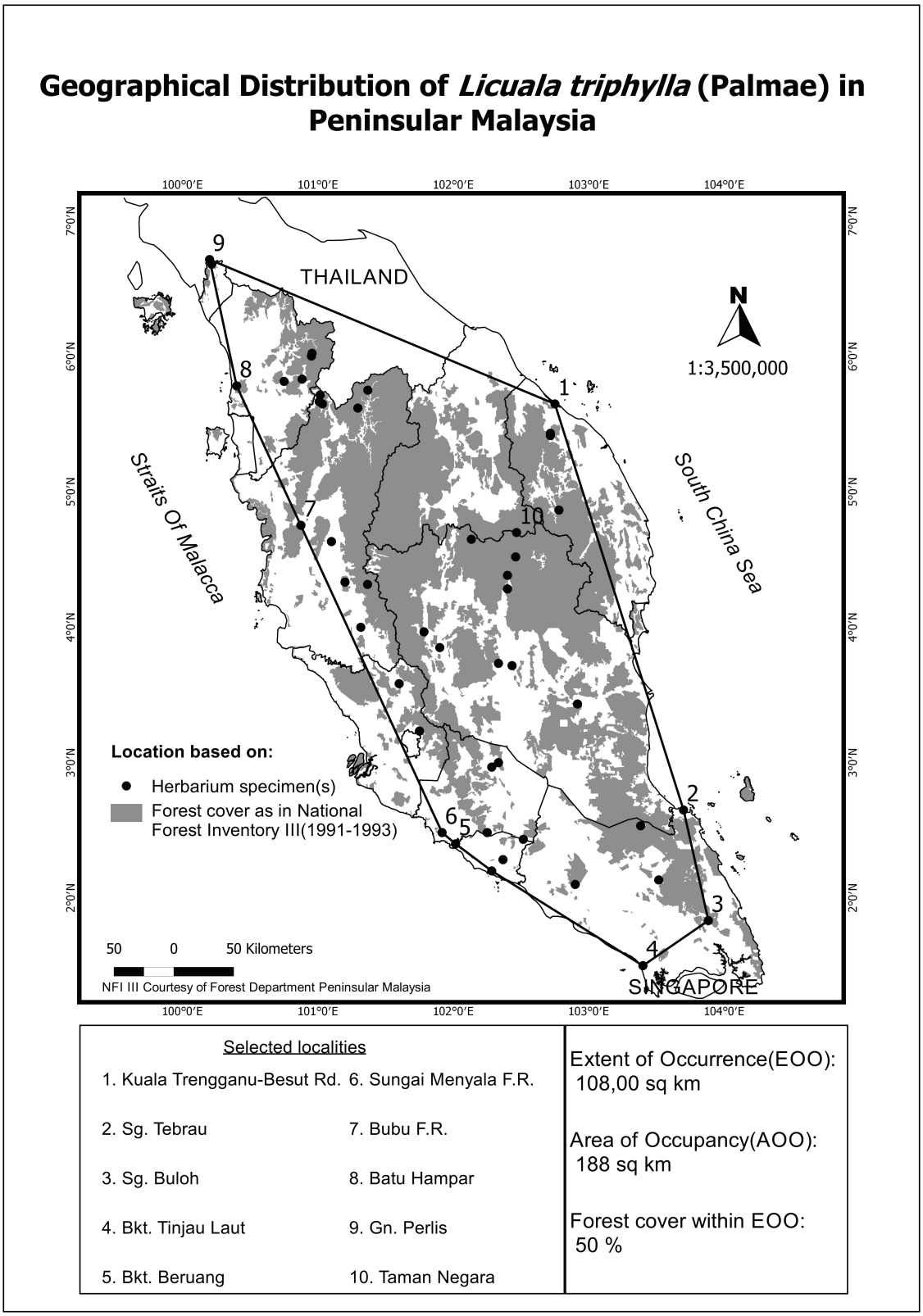
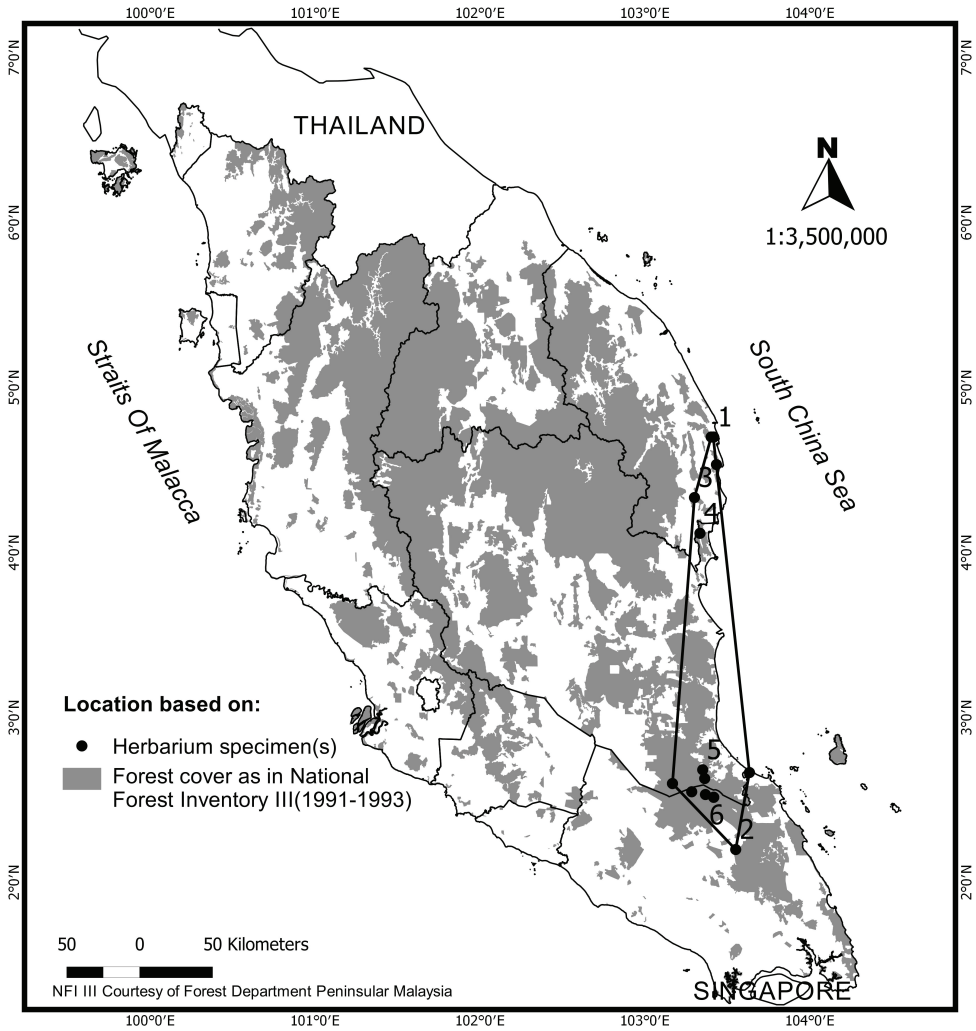


Figure 1. Distribution map of *Licuala triphylla*, a widespread species found in Peninsular Malaysia.

Geographical Distribution of *Livistona endauensis* (Palmae) in Peninsular Malaysia



Selected localities

1. 1Bkt. Bauk F.R.
2. 2Kahang
3. 4Rasau-Kerteh-Ulu Chukai F.R.
4. 5Balok F.R., Bkt. Sah
5. 6Lesong F.R., Ulu Sg. Teroh
6. 8Kuala Jasin

Extent of Occurrence(EOO): 8268 sq km

Area of Occupancy(AOO): 48 sq km

Forest cover within EOO: 43 %

Figure 2. Distribution map of *Livistona endauensis*, a Peninsular Malaysian endemic species with two centres of distribution.

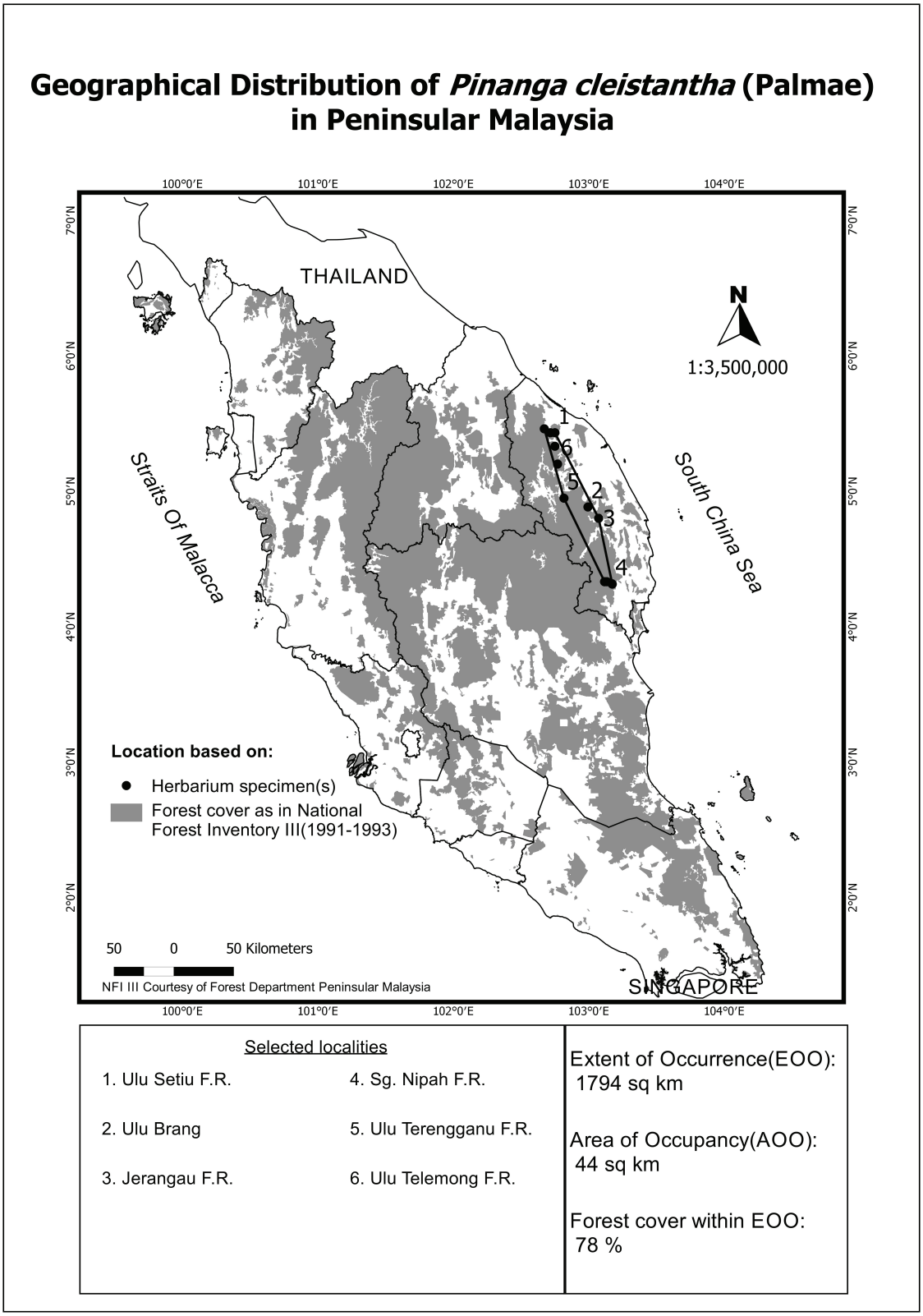


Figure 3. Distribution map of *Pinanga cleistantha*, a species endemic to the state of Terengganu.

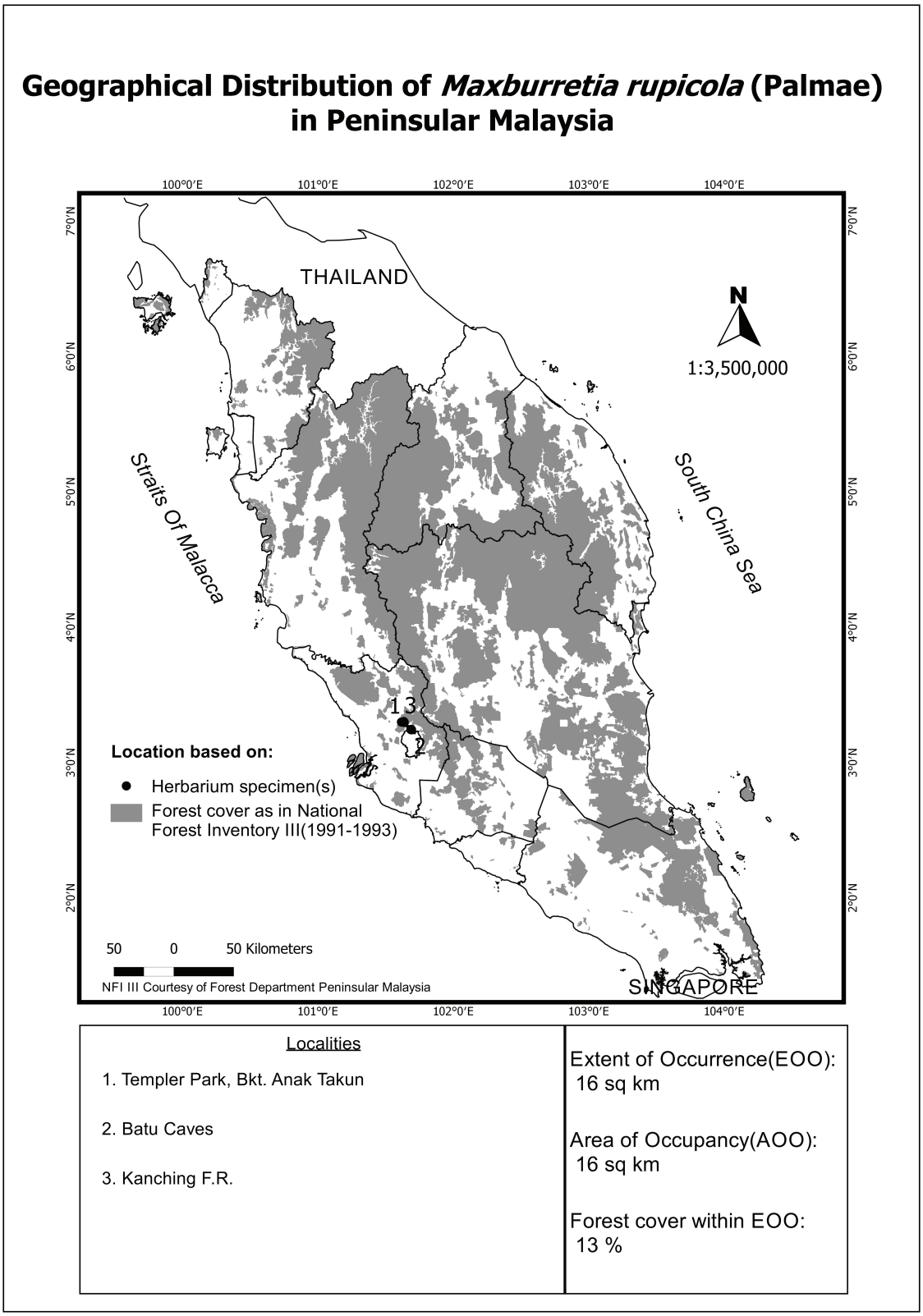


Figure 4. Distribution map of *Maxburretia rupicola*, a narrow endemic species found on two limestone outcrops in Selangor (Batu Caves and Bukit Takun-Bukit Anak Takun limestone hills).

Table 3. Summary of the genera assessed for conservation status of non-rattan species using IUCN categories and criteria for national assessment. *The Rare (RA) category was included in this assessment to include species although not threatened as their distributions are found in protected areas, but they have restricted and narrow ranges (narrow endemics), see methods for details.

Subfamily	Genera	CR	EN	VU	Threatened	RA*	NT	LC	DD	Total
Nypoideae	*Nypa*				0			1		1
Coryphoideae	*Arenga*				0		1	2		3
	Borassodendron		1		1					1
	Caryota				0			3		3
	Corypha				0			1		1
	Johannesteijsmannia		3		3			1		4
	Licuala	6	15	3	24	4	6	8	3	45
	Livistona	1		1	2	1	1			4
	Maxburretia	1			1		1			2
	Phoenix		1		1					1
	Pholidocarpus			2	2					2
Arecoideae	*Areca*			1	1		2	1		4
	Cocos				0			1		1
	Cyrtostachys				0		1			1
	Iguanura	2		2	3		1	2		8
	Nenga			1	1			2		3
	Oncosperma				0			2		2
	Orania				0			1		1
	Pinanga	5	6		11		5	8		24
	Rhopaloblaste				0			1		1
Total		**15**	**26**	**10**	**51**	**5**	**18**	**34**	**3**	**112**

Extent of conservation concern

Of the taxa assessed, 51 (45.5%) were found to be of conservation concern: 15 taxa were assessed as Critically Endangered (13.3%), 26 as Endangered (23.2%), and 10 as Vulnerable (8.9%). These values are higher than the average reported for taxa already assessed under the FPM project (Yong *et al*. 2021), which covered 1,292 taxa (see Table 4 for comparison).

Table 4. Summary of conservation status assessment of plants of Peninsular Malaysia under the FPM project for volumes published until 2021 (Yong *et al.* 2021; *Flora of Peninsular Malaysia* Series I, volumes 1–8, Series II, volumes 1–3). The summary included Dipterocarpaceae, which although have not been published in the FPM project, but there was already an earlier assessment (Chua *et al.* 2010).

Conservation status	Number of taxa (%)
Extinct (EX)	3 (0.15%)
Critically Endangered (CR)	77 (5.96%)
Endangered (EN)	120 (9.29%)
Vulnerable (VU)	173 (13.39%)
Total Conservation Concern Taxa	370 (28.63%)
Near Threatened (NT)	213 (16.49%)
Least Concern (LC)	627 (48.53%)
Data Deficient (DD)	79 (6.11%)
Total	**1,292 (100%)**

Critically Endangered taxa

Fifteen taxa – 14 species and a lower-ranked taxa – were assessed as critically endangered (CR): *Iguanura mirabilis*, *I. parvula*, *Licuala ahlidurii*, *L. cameronensis*, *L. corneri*, *L. palas*, *L. scortechinii*, *L. whitmorei*, *Livistona saribus*, *Maxburretia rupicola*, *Pinanga acaulis*, *P. auriculata* var. *merguensis*, *P. badia*, *P. sarmentosa*, and *P. sembilan*. See Table 5 for details of the critically endangered taxa, the threat these taxa are facing and some proposed conservation measures to safeguard the taxa.

Table 5. Taxa assessed as nationally critically endangered (CR) in Peninsular Malaysia with details of distribution, threat and some proposed conservation actions.

Species	Distribution	Main threat	Proposed conservation actions
Iguanura mirabilis	Endemic to Terengganu, only known from Seitu F.R.	The species is only known from a single locality which is currently a forest reserve in the lowlands which is subjected to logging.	It is proposed making the areas where the species is found as a High Conservation Value Forest (HCVF) to safeguard the population and its ecology.
Iguanura parvula	Restricted distribution in Perak (Bintang Hijau F.R.) and Kedah (Gunung Inas F.R.). The species is also recorded in S. Thailand.	The EOO was calculated as 27 km^2 and it is only known from two localities. It has a restricted distribution in Peninsular Malaysia, distributed only in forest reserves. Its population may be subjected to logging, and this will pose a threat.	It is proposed making the areas where the species is found as a High Conservation Value Forest (HCVF) to safeguard the populations and its ecology.
Licuala ahlidurii	Endemic to Terengganu, only known from Bukit Bauk.	Although the forest is a Virgin Jungle Reserve, it is not a totally protected area and in recent years the edges of the forest reserve has been subjected to land clearance for road extension. The species is only found on the lower slopes of the forest where it is most threatened.	It is proposed making the area where the species is found as a High Conservation Value Forest (HCVF) on top of its current listing as a virgin jungle reserve to further safeguard the population and its ecology.
Licuala cameronensis	Endemic to Pahang, only known from 2 localities, one in Cameron Highlands and the other Kampung Sekam, about 3.4 km apart.	Population is better monitored in Cameron Highlands beside a tea estate. Very small number of individuals there.	The population in Cameron Highlands is adjacent to a tea estate. There can be encroachment into the forest reserve. It is proposed making the area where the species is found as a High Conservation Value Forest (HCVF) to safeguard the population and its ecology.

Licuala corneri	Endemic to Terengganu, only known from Kemaman district (Sg. Nipah F.R., Bukit Bandi F.R., Jeram Tanduk)	Narrowly endemic to Kemaman district of Terengganu, restricted to lowland forest. All these forest reserves have been previously logged. There is concern that subsequent relogging of these reserves can further impact existing populations.	It is proposed making the areas where the species is found as a High Conservation Value Forest (HCVF) to safeguard the population and its ecology.
Licuala palas	Endemic to Terengganu, only known from Ulu Setiu F.R.	It is the dominant understory palm there. The forest reserve can be subjected to forest conversion.	It is proposed making the area where the species is found as a High Conservation Value Forest (HCVF) to safeguard the population and its ecology.
Licuala scortechinii	Distributed mainly in Kedah (Gunung Jerai F.R.) and Bukit Tapah F.R., Perak. The species is also known from S. Thailand	It has a very restricted distribution in Gn. Jerai and in S. Thailand; endemic to this small region.	It is proposed making the area where the species is found as a High Conservation Value Forest (HCVF) to safeguard the population and its ecology. Although Gn. Jerai is a virgin jungle reserve (VJR), a further identification of the area where the species is found will further safeguard the species.
Licuala whitmorei	Endemic to Johor, only known from Mersing F.R.	The forest reserve is subjected to logging.	It is proposed making the area where the species is found as a High Conservation Value Forest (HCVF) to safeguard the population and its ecology.
Livistona saribus	Along riverbanks in Perak (e.g. Bagan Serai, Taiping Zoo), Penang (Nibong Tebal, Seberang Perai), Selangor (Klang River, Kampung Perapat, Sungai Tinggi) and Terengganu (Sungai Paka, Cukai).	In Peninsular Malaysia, all known populations are in urban areas, often near towns or residential areas. Much of the land where these populations occur is subject to potential urban development. Globally, BGCI (2021) assessed the species as Least Concern. Dowe (2009) assessed it as Vulnerable.	In Cukai, Terengganu and Seberang Prai, Penang where the species is found in heathy populations, these areas are not forest reserves and are state land reserves. They can be subjected to land conversion. It is proposed that these sites be protected.

Maxburretia rupicola	Endemic to Selangor, only known from the limestone hills of Batu Caves and Bukit Takun.	Although generally protected in Batu Caves and Bukit Takun, the population on Batu Caves have in the past been threatened by wildfires.	Although Batu Caves is protected, there is a need to ensure that a proper buffer is set around the limestone hill to safeguard it from wildfires often set off by residence living around the hill. It is proposed that the state government safeguard the hill with proper buffer zones. Bukit Takun is better protected as it is surrounded by a golf course and a forest reserve.
Pinanga acaulis	Endemic to Perak, only known from Kledang Saing F.R. and Sg. Siput.	Both forest reserves are subjected to logging.	It is proposed making the areas where the species is found as a High Conservation Value Forest (HCVF) to safeguard the population and its ecology.
Pinanga badia	Known from a single collection from Mata Ayer F.R. at the border with Thailand. The species is also recorded in S. Thailand	It has a very restricted location at the Malaysian -Thai border. The international land border can be subjected to security action that can poise a threat to the species.	The small area on the international border can be identified as a HCVF for the species.
Pinanga auriculata var. *merguensis*	Only known from Mata Ayer F.R. in Peninsular Malaysia, the species has been recorded in S. Thailand and Myanmar.	It is critically endangered in Peninsular Malaysia due to its restricted distribution only in Mata Ayer Forest Reserve, Perlis.	It is proposed making the area where the species is found as a High Conservation Value Forest (HCVF) to safeguard the population and its ecology.
Pinanga sarmentosa	Endemic to Terengganu, only known from Sg. Nipah F.R.	The species is only known from the type locality, no other sighting was seen in the area.	It is proposed making the area where the species is found as a High Conservation Value Forest (HCVF) to safeguard the population and its ecology.
Pinanga sembilan	Endemic to Negeri Sembilan, only known from Telepa Buruk, Gunung Berembun F.R..	The forest reserve can be subjected to logging.	It is proposed making the area where the species is found as a High Conservation Value Forest (HCVF) to safeguard the population and its ecology.

Distribution pattern of Critically Endangered taxa. All taxa, except *Livistona saribus* and *Pinanga auriculata* var. *merguensis*, have narrow distributions. Most are restricted to a single state, and some are known from only one locality, i.e., *Iguanura mirabilis*, *Licuala ahlidurii*, *L. palas*, *L. whitmorei*, *P. samentosa*, and *P. sembilan*. The collection of *Pinanga badia* was made at the Malaysian Thai border close to the other known record from Peninsular Thailand. So, the species is very restricted to that small area. *Livistona saribus* is naturally widespread, ranging from Southeast China and Indochina to Peninsular Malaysia, Indonesia (Sumatra and Java), the Philippines, and Borneo (Kalimantan). However, in Peninsular Malaysia it is the most endangered of the four native *Livistona* species because all known populations occur in swamp habitats near urban areas and are therefore highly exposed to habitat loss (Saw 2025). *Pinanga auriculata* var. *merguensis* occurs mainly in Peninsular Thailand and extends marginally into Perlis, where it is known from Mata Ayer Forest Reserve. Its very small national extent of occurrence places it in the Critically Endangered category for the national assessment.

Table 5 provide some recommendations towards safeguarding these critically endangered species/taxa. For species occurring in forest reserves, the best option is for the Department of Forestry to earmark such areas as High Conservation Value Forest (HCVF), such classification will provide some level of protection for these species against conversion and logging activities. For species outside forest reserves, state governments and relevant authorities will require to legislate protection of such areas.

Factors contributing to elevated threat levels

The comparatively high proportion of threatened palms is associated with two main factors. First, palms in Peninsular Malaysia show higher endemism and a greater concentration of species with restricted distributions than the general flora. Endemism among Peninsular Malaysian plants is about 30%, whereas palms reach about 37%. Of these endemic palms, 37 taxa (31%) are narrow endemics, confined either to a single state or to areas straddling the border between two adjacent states. Second, palm diversity is concentrated in lowland and hill forests, habitats that are especially vulnerable to loss and degradation.

Reasons for the restriction distribution of these palms can be factors of habitat specialisation (e.g., *Livistona endauensis* restricted to sandstone outcrops, *Maxburretia* spp. on limestone hill ridges, *Pholidocarpus* spp. on swampy habitats). However, it does not explain the patterns observed for many species in lowland to hill forests. Other factors of geology, geological past, individual species ecology and evolution may be contributing to the isolation of these species.

Assessment criteria and broader comparison

The threatened categories were most often supported by evidence of reduction or deterioration in geographic range under criterion B, typically through B1 (extent of occurrence, EOO), B2 (area of occupancy, AOO), or both. This pattern is similar to that for Dipterocarpaceae, in which 52% of assessed taxa (91 of 174) were also considered of conservation concern (Yong *et al.* 2021). Although dipterocarps are much larger plants, they share broadly similar habitat requirements and distribution patterns with non-rattan palms. Many of dipterocarps, similar to palms are species of per humid climate and will not fair well in climatic conditions with distinct dry seasons. The distribution patterns across the different soil types are also similar to palms. Both groups are vulnerable to forest conversion and lowland habitat loss. The major differences between these two groups are in the stature of the plants, dipterocarps are mostly large forest trees whereas palms are primarily understory plants with different reproductive ecologies.

Rare (RA) taxa

Five species were assessed as Rare (RA): *Licuala hairulii*, known only from Royal Belum State Park; *L. moyseyi*, known only from the mountains of Terengganu (Gunung Lawit and Gunung Padang); *L. thoana*, restricted to Endau-Rompin State Park; *L. tiomanensis*, known only from the summit area of Gunung Kajang on Pulau Tioman; and *Livistona tahanensis*, known only from the upper slopes and ridges towards Gunung Tahan in Taman Negara. Although these species do not fall within the IUCN (2012) threatened categories (i.e., they should be listed as Least Concern), they remain nationally important because of their highly restricted distributions. Park managers and other relevant authorities should be aware of their presence so that these species must be considered for in site management and conservation planning. They also warrant special attention as distinctive components of these parks and reserves.

Overview of state-level patterns

Table 6 presents the distribution of the 56 threatened and rare taxa across the states of Peninsular Malaysia. The table also summarises the total number of palm species recorded in each state, the number of non-rattan taxa, their conservation categories by state, and the numbers of endemic, narrow endemic, and threatened non-rattan taxa, arranged from highest to lowest. The data were extracted from recent revisions prepared for the *Flora of Peninsular Malaysia* (Saw, in prep.), and the state species totals have been updated from Saw (2021). In this paper, narrow endemic taxa are defined as those restricted to a single state or occurring across the border of two adjacent states.

Table 6. State-level distribution of non-rattan palm taxa and conservation categories in Peninsular Malaysia. The number of palm species in each state was determined from herbarium specimens the Forest Research Institute Malaysia (KEP) and Singapore Botanic Gardens (SING) herbaria.

State	Total palm spp.	Total non-rattan taxa								Total Threatened	Endemic	Narrow endemic
		CR	EN	VU	RA	NT	LC	DD	Total			
Terengganu	129	8	9	8	1	9	28	0	63	25	24	16
Perak	121	2	8	5	1	11	26	1	53	15	12	4
Pahang	140	1	6	6	1	17	30	1	61	13	23	9
Johor	107	1	5	6	0	12	23	0	47	12	26	6
Kedah	65	0	7	2	0	5	20	0	34	9	5	0
Selangor	85	1	3	4	0	9	22	0	39	8	5	1
Negeri Sembilan	70	1	3	2	0	4	24	0	34	6	6	1
Kelantan	66	0	0	5	0	9	22	1	36	5	4	1
Penang	24	1	3	0	0	0	12	0	16	4	3	1
Perlis	18	1	2	0	0	1	10	0	14	3	0	0
Melaka	25	0	0	1	0	3	16	0	20	1	1	0

State-level concentration of threatened taxa

Terengganu has the highest number of threatened taxa, with 25, followed by Perak, Pahang, and Johor, each with 12 – 15 taxa. Palm diversity is also high in these states. For non-rattan palms, Terengganu and Pahang have the greatest numbers of taxa (63 and 62, respectively), followed by Perak, Johor, Selangor, Kelantan, and Negeri Sembilan. This pattern suggests that higher overall diversity is associated with a higher number of threatened taxa. Terengganu also has the largest number of narrow endemic taxa (16), followed by Pahang (9), Johor (6), and Perak (4). The concentration of narrow endemics in Terengganu is likely an important factor why it also has the greatest number of threatened species.

Conservation actions for threatened palms

The Red Listing assessment serves as a tool for prioritising species in need of conservation intervention. Yong *et al.* (2021) outlined key steps for implementing conservation actions for threatened taxa. These recommended actions are particularly relevant for palm conservation efforts in Peninsular Malaysia. Additional conservation activities may also be considered to further support the protection of threatened species.

In situ conservation

In situ conservation is often considered the best method to safeguard species due to its ability to preserve entire ecosystems and natural habitats. It allows species to continue to adapt, evolve and thrive in their natural environments. This is crucial for maintaining ecosystem functions and species interactions. Palms in Peninsular Malaysia have many species with restricted distribution and with the high number of threatened taxa, *in situ* conservation is the best option towards safeguarding the survival of these taxa in terms of cost and ecological functions. Distribution patterns are uneven for palms, and some states have greater diversity of endemic and threatened taxa. It is important that these states take special efforts towards conserving the state endemics and threatened taxa.

For taxa with narrow endemism or found in single localities, that states should identify these taxa and their locations and institute procedures to safeguard these plants in their habitats as *in situ* conservation areas. Current instruments for in situ conservation include National and State Parks, Wildlife Sanctuaries, Virgin Jungle Reserves, High Conservation Value Forest (HCVF), and other effective area-based conservation measures (OECM). For taxa range outside in these protected categories, the relevant authorities (e.g. Forest Department) can designate such forest as HCVF.

Conservation strategies for endangered taxa

Peninsular Malaysia does not have any legislative framework to protect threatened plant species. It is necessary that such legislative framework be established to underpin and guide conservation actions for threatened taxa, ensuring there is a legal basis for protection and recovery measures. Once the legislative framework is in place, it should be followed by processes that conduct comprehensive studies of the threatened taxa, including population assessments, habitat requirements, and threats analysis, to inform targeted conservation strategies. Based on the findings of these studies, prioritise conservation efforts towards taxa classified as “Endangered” and “Critically Endangered”, focusing resources where they are most urgently needed. Some species-specific recommendations are given in Table 5 using currently available tools for species- and site-specific circumstances, e.g. HCVF. Where *in situ* conservation is insufficient or not immediately feasible, employ *ex situ* methods such as cultivation in botanic gardens to safeguard genetic diversity and support potential future reintroductions.

Institutional responsibilities

The Forest Research Institute (FRIM) is currently taking the lead in plant conservation efforts under the Forest Biodiversity Division for Peninsular Malaysia. The role of FRIM is mostly towards providing the scientific basis for assessments and identification of threatened species. For effective conservation of threatened species, there is a need to coordinate the work of biologists (researchers) with forest managers. Currently findings from researchers are passed to forest managers in Forest Department and other stakeholders. There is also a need to set up a centre towards such coordination for a more systematic and efficient management to safeguard threatened taxa. Similar proposals should be also considered for conservation efforts in Sabah and Sarawak.

CONCLUSION

To prevent the extinction of native plant species, it is essential that conservation initiatives are carried out in a systematic and coordinated manner. Given the current patterns of land use, active human intervention is often necessary because species are frequently put at risk, sometimes without our awareness. In the context of palm conservation in Malaysia, some foundational steps have already been undertaken. While these steps are aligned with the broader plant conservation strategies developed within the country, they remain insufficient on their own. Continued and enhanced efforts are needed to ensure the long-term survival of Malaysia's native palms. Effective conservation must ultimately be implemented at the state level. Given Terengganu's high palm diversity, strong endemism, and large number of threatened taxa, it should be prioritised for targeted surveys, habitat protection, and conservation planning for narrow endemic palms. Other states facing similar circumstances should also be prioritised for comparable surveys and conservation action.

Acknowledgements : I am grateful to the *Flora of Peninsular Malaysia* project for providing the opportunity to revise the palms of Peninsular Malaysia. My sincere thanks to Wendy Yong who helped prepare the maps. I am also grateful to the anonymous reviewer who made some useful comments on the original manuscript.

REFERENCES

Anon. 2014. Laporan Inventori Hutan Nasional Kelima (IHN-5). Kuala Lumpur: Jabatan Perhutanan Semenanjung Malaysia. 275 pp.

Bachman, S., Moat. J., Hill. A.W., de la Torre. J. and Scott. B. 2011. Supporting Red List threat assessments with GeoCAT: geospatial conservation assessment tool. *ZooKeys* 150: 117–126. https://doi.org/10.3897/zookeys.150.2109

Chua, L.S.L 2012. Conservation. In *Flora of Peninsular Malaysia*. Series II: Seed Plants, Vol. 3, R. Kiew, R.C.K. Chung, L.G. Saw and E. Soepadmo (Eds.), pp. 3–10.

Chua, L.S.L., Suhaida, M., Hamidah, M. and Saw, L.G. 2010. *Malaysia Plant Red list – Peninsular Malaysian Dipterocarpaceae*. Research Pamphlet No. 129. Kepong: Forest Research Institute Malaysia.

Kiew, R. and Pearce, K.G. 1991. Palms. In *The State of Nature Conservation in Malaysia*, R. Kiew (Ed.), pp. 95–100. Petaling Jaya: Malayan Nature Society.

Henderson, A. 2020. A revision of Calamus (Arecaceae, Calamoideae, Calaminae). *Phytotaxa* 445: 1–656.

Henderson, A. 2025. A revision of Iguanura (Arecaceae, Arecoideae, Areceae). *Phytotaxa* 690(2): 135–188.

IUCN. 2012. *IUCN Red List Categories and Criteria: Version 3.1*. Second edition. Gland: IUCN.

Jeanson, M.J., Couvreur, T.L.P. and Henderson, A. 2025. A revision of tribe Caryoteae (Arecaceae, Coryphoideae). *Phytotaxa* 719: 1–141.

Saw, L.G. 2021. Palms of Malaysia and their conservation. *Malayan Nature Journal* 73: 521–529.

Saw, L.G. 2023a. A revision of the genus *Iguanura* Blume (Arecaceae) in Peninsular Malaysia. *Gardens' Bulletin Singapore* 75: 73–117,

Saw, L.G. 2023b. A new species of *Licuala* from Royal Belum State Park, Perak, Malaysia. *Palms* 67(3) 115–120.

Saw, L.G. 2024. *Pinanga* of Peninsular Malaysia and Singapore. *Palms* 68(4): 160–203.

Saw, L.G. 2025. *Livistona saribus* (Palmae), the critically endangered swamp Serdang of Malaysia. *Malaysian Naturalist* 79.1: 24–29.

Saw, L.G., Chua, L.S.L., Suhaida, M., Yong, W.S.Y. and Hamidah, M. 2010. Conservation of some rare and endangered plants from Peninsular Malaysia. *Kew Bulletin* 65: 681–689.

Yong, W.S.Y., Chua, L.S.L., Lau, K.H., Siti-Nur Fatinah, K., Cheah, Y.H., Yao, T.L., Rafidah, A.R. *et al.* 2021. Malaysia Red List. Vol. 1, Part 1. Research Pamphlet No. 151. Kepong: Forest Research Institute Malaysia. 107pp.

APPENDIX

Appendix 1. List of threatened and rare non-rattan palms of Peninsular Malaysia with their preliminary conservation status assessments. *Denotes species endemic to Peninsular Malaysia; **denotes narrow endemic species (restricted to a single state or found in an area bordering between two adjacent states). The extend of occurrence (EOO) and area of occupancy (AOO) are also provided in the analysis. The criterion for each assessment follows IUCN (2012).

Species	Threat Category	Criteria	EOO (km^2)	AOO (km^2)
Areca ridleyana Becc. ex Furtado *	VU	B1ab(iii)	17,920	80
Borassodendron machadonis (Ridl.) Becc.	EN	B2ab	24,207	32
Iguanura bicornis Becc.	VU	B1ab(iii)	6,380	36
Iguanura brevipes Hook.f.	VU	B1ab(iii)	14,307	88
Iguanura mirabilis C.K.Lim **	CR	B2ab(ii,iii)	9	12
Iguanura parvula Becc.	CR	B1ab(iii)	27	12
Johannesteijsmannia lanceolata J.Dransf.*	EN	A4acd,B1ab(ii,iii), C2a(i)	3,738	36
Johannesteijsmannia magnifica J.Dransf.*	EN	B1ab(ii,iii,iv), C2a(i)	1,306	32
Johannesteijsmannia perakensis J.Dransf.*	EN	A4acd,B1ab(ii,iii,iv),C2a(i)	3,115	52
Licuala ahlidurii Saw **	CR	B2ab(iii)	0.12	4
Licuala bayana Saw **	EN	A4c; B1ab(i,iii) +2ab(i,iii)	1,241	28
Licuala cameronensis Saw **	CR	B1 b(iii), C2(a,i)	28	12
Licuala corneri Furtado **	CR	B1ab(i,ii,iii)	48	28
Licuala fractiflexa Saw **	EN	B1a,b(i,iii)	3,670	92
Licuala hairulii Saw **	RA		3	8
Licuala kamarudinii Saw **	EN	B1ab(i,iii)	934	16
Licuala kemamanensis Furtado **	EN	B1ab(i,iii)	704	36
Licuala khoonmengii Saw **	EN	B1ab(i,iii)	4,545	48
Licuala kingiana Becc. **	EN	B1ab(i,ii,iii) +2ab(i,ii,iii)	1,837	76
Licuala lanuginosa Ridl. **	EN	B1ab(i,iii)	3,002	64
Licuala longipes Griff. *	VU	B1ab(i,iii)	6,072	124
Licuala malajana Becc. var. *humilis* Saw **	EN	B1ab(i,iii)	181	16
Licuala mirabilis Furtado *	EN	B1ab(i,iii)	4,059	56
Licuala modesta Becc.	VU	B1ab(i,iii)	13,855	68
Licuala moyseyi Furtado **	RA		211.00	16
Licuala mustapana Saw **	EN	B1ab(i,iii)	1,273	16
Licuala palas Saw **	CR	B1ab(i,iii), B2ab(ii,iii)		4
Licuala peltata Roxb. ex Buch.-Ham	EN	B1ab(i,iii)		4
Licuala ruthiae Saw **	EN	B1ab(i,iii)	189	12
Licuala sallehana Saw var. *incisifolia* Saw **	EN	B1ab(i,iii)	1,450	16
Licuala sallehana Saw var. *sallahana* **	EN	B1ab(i,iii)	318	16
Licuala scortechinii Becc.	CR	B1 (b,i,iii,iv)	39	12
Licuala tenuissima Saw *	VU	B1ab(i) (iii)	12,454	32
Licuala terengganuensis Saw *	EN	B1ab(i) (iii)	4,344	56
Licuala thoana J.Dransf. & Saw**	RA		3.7	12
Licuala tiomanensis Furtado **	RA			8
Licuala whitmorei Saw **	CR	B1, B2b(i,ii,iii,iv)		8
Livistona endauensis J.Dransf. & K.M.Wong *	VU	B1b(i)	8,268	52
Livistona saribus (Lour.) Merr. ex A.Chev	CR	A1(a,c), 3, 4	48,065	48
Livistona tahanensis Becc. **	RA		0.53	8
Maxburretia rupicola (Ridl.) Furtado **	CR	B1a	16	16
Nenga grandiflora Fernando *	VU	B2a	10,498	68
Phoenix paludosa Roxb.	EN	B2ab(i) (ii) (iii)	55,375	36
Pholidocarpus kingianus (Becc.) Ridl. *	VU	B2ab(i) (ii) (iii)	44,322	40
Pholidocarpus macrocarpus Becc.	VU	B2ab(i) (ii) (iii)	62,304	40

Pinanga acaulis Ridl. **	CR	B1 B2b(i,iii)	90	16
Pinanga adangensis Ridl.	EN	B1 B2b(ii) (iii)	8	16
Pinanga auriculata Becc. var. *merguensis* (Becc.) C.K.Lim	CR	B2a b(ii,iii)		4
Pinanga badia Hodel	CR	B2a b(ii,iii)		4
Pinanga cleistantha J.Dransf. **	EN	B2b(i,iii)	1,794	44
Pinanga malaiana (Mart.) Scheff. var. *johorensis* (C.K.Lim & Saw) Saw **	EN	B2a b(ii,iii)	2,840	28
Pinanga pantiensis J.Dransf. **	EN	B2a b(I, iii)	180	20
Pinanga pectinata Becc. *	EN	B1(b,i,iii)	4,020	44
Pinanga riparia Ridl.	EN	B2b(ii,iii,iv)	28,476	48
Pinanga sarmentosa Saw **	CR	B2(a,bii)		4
Pinanga sembilan C.K.Lim **	CR	B2(a,bii)		8