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Tree species diversity and conservation in Ban Tin Tok community forest, Phitsanulok Province, Thailand

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Abstract. *Rakarcha S, Thammarong W, Panyadee P, Muenrew J, Nuammee A, Tharawoot T, Saensouk P, Saensouk S. 2026. Tree species diversity and conservation in Ban Tin Tok community forest, Phitsanulok Province, Thailand. Biodiversitas 27 (1): d270146. https://doi.org/10.13057/biodiv/d270146*. This study assessed tree species composition, ecological importance, conservation status and local utilization in Ban Tin Tok community forest, Phitsanulok Province, northern Thailand. Data were collected from twenty 10 × 10 m plots (totaling 0.2 ha), recording all trees with DBH ≥5 cm. A total of 28 species from 27 genera and 15 families were identified. The forest was co-dominated by *Pentacme siamensis*, *Pterocarpus macrocarpus* and *Canarium subulatum*, which exhibited the highest importance value indices. The forest exhibited moderate species diversity and moderate-to-high evenness with a Shannon-Wiener index (H′) of 2.40 and a Pielou's evenness index (J′) of 0.72, reflecting a relatively stable community structure. The conservation assessment revealed that while most recorded species are categorized as Least Concern (LC), a significant proportion requires attention: one species (*P. macrocarpus*) is classified as Endangered (EN) and three species (*Shorea obtusa*, *Dipterocarpus obtusifolius* and *Dalbergia cultrata*) are Near Threatened (NT); these four species together account for 14.29% of the total 28 species recorded. Ethnobotanical surveys documented 18 species utilized by the local community for purposes, including food, medicine and materials. These findings highlight the high socio-ecological value of this forest. These results suggest that community forests in northern Thailand can serve as vital refuges for threatened species and sustain traditional ecological knowledge. This quantitative baseline supports the necessity for integrated management strategies that balance biodiversity conservation with sustainable local livelihoods.

Keywords: Community forest, ethnobotany, IVI, northern Thailand, threatened species

INTRODUCTION

Biodiversity conservation is a global priority due to accelerating deforestation and climate variability (Farooqi et al. 2022; IPCC 2022; Younis et al. 2022; Kuang et al. 2024; Yatar et al. 2024). Forest ecosystems, particularly community forests, are vital for ecological stability and human well-being, providing essential provisioning, regulating, and cultural services (Diansyah et al. 2021; Thammanu et al. 2021; Peng et al. 2025). In tropical Asia, community forestry has emerged as a key strategy to balance conservation with local socio-economic needs, empowering communities to protect natural resources while maintaining cultural practices (Njurumana et al. 2020; Diansyah et al. 2021; Agarwal et al. 2022). Consequently, the long-term success of community-based conservation relies on a profound understanding of the synergy between biodiversity maintenance and sustainable resource utilization. Detailed site-specific data on floristic composition are essential to develop management strategies that reconcile ecological integrity with the socio-economic dependencies of local inhabitants.

Thailand is recognized as one of the biodiversity hotspots in Southeast Asia, harboring diverse flora across various forest types, ranging from evergreen forests to mixed deciduous forests (Maxwell 2004; Trisurat et al. 2023; Saensouk et al. 2025a, 2025b). These forests provide habitats for numerous tree species with ecological, cultural and economic value. However, pressures from land conversion, illegal logging and unsustainable resource use have threatened both plant diversity and forest structure. Community forestry initiatives have been promoted to address these challenges, enabling local stakeholders to participate in conservation and sustainable utilization of forest resources (Thammanu et al. 2020; Agarwal et al. 2022). These initiatives not only conserve forest resources but also safeguard non-timber forest products, medicinal plants and traditional ecological knowledge (TEK).

In the context of Thailand diverse silvicultural zones, the role of specific tree species in maintaining forest structure and carbon sequestration capacity is of paramount importance. As land-use patterns shift, documenting the baseline floristic composition becomes essential to prevent the silent loss of rare taxa that may hold untapped ecological or economic potential. Therefore, systematic assessments of

tree diversity are not only academic exercises but also critical tools for monitoring the efficacy of community-based management in preserving the country's natural heritage.

Ban Tin Tok community forest, established in 2018 in Chat Trakan district, Phitsanulok, covers approximately 1,182 rai (1.89 km²) within a national reserved forest area (Royal Forest Department 2018). This dry dipterocarp ecosystem supports a rich diversity of plant species directly linked to local food security and healthcare. The area significance as a reservoir for rare and endemic taxa is evidenced by notable botanical records from the broader area, such as *Curcuma sabhasrii* (Rakarcha et al. 2022) and the presence of *Cornukaempferia aurantiiflora*. While these understory species represent contextual botanical value, they underscore the forests overall conservation importance as a refuge for biodiversity, further justifying the need for a targeted quantitative assessment of its tree community. The ecological dynamics of this dry dipterocarp ecosystem are characterized by unique adaptive traits of its flora, which have co-evolved with seasonal drought and fire. Beyond the presence of endemic ginger species, the woody component of the forest acts as the primary architectural framework, providing micro-habitats for diverse understory biota and serving as a critical resource base for the local inhabitants who depend on these seasonal forest products.

Despite its ecological significance, systematic quantitative studies on tree species composition and diversity in Ban Tin Tok community forest are lacking. Specifically, there has been no formal evaluation using the Importance Value Index (IVI) or the IUCN Red List status for its tree flora. This study aims to document tree species composition, calculate the IVI, analyze local utilization, and evaluate conservation status within sampled plots of Ban Tin Tok community forest. These quantitative and ethnobotanical data are intended to provide a scientific foundation for community-based forest management and strategic conservation planning for rare and endemic species in the region. This comprehensive assessment is crucial for developing evidence-based management plans that ensure both the ecological integrity and the socio-economic sustainability of the Ban Tin Tok community forest.

MATERIALS AND METHODS

Study area

The study was conducted in Ban Tin Tok community forest, located in Ban Dong Sub-district, Chat Trakan District, Phitsanulok Province, northern Thailand (17°15'35"N, 100°28'25"E to 17°19'30"N, 100°25'00"E) (Figure 1). The forest covers approximately 1,182 rai (~1.89 km²) within a reserved forest area and is characterized by dry dipterocarp forest (Royal Forest Department 2018). The predominance of dry dipterocarp forest types at the site provides ideal conditions for the dominance of species in the families Dipterocarpaceae and Fabaceae. These environmental conditions specifically support the high importance values of key species such as *Pentacme siamensis* and *Pterocarpus macrocarpus*. The terrain consists of gently sloping areas and low hills, with typical tropical seasonal climate conditions. The forest supports a variety of tree species, including economically, ecologically and culturally important taxa, as well as endemic species.

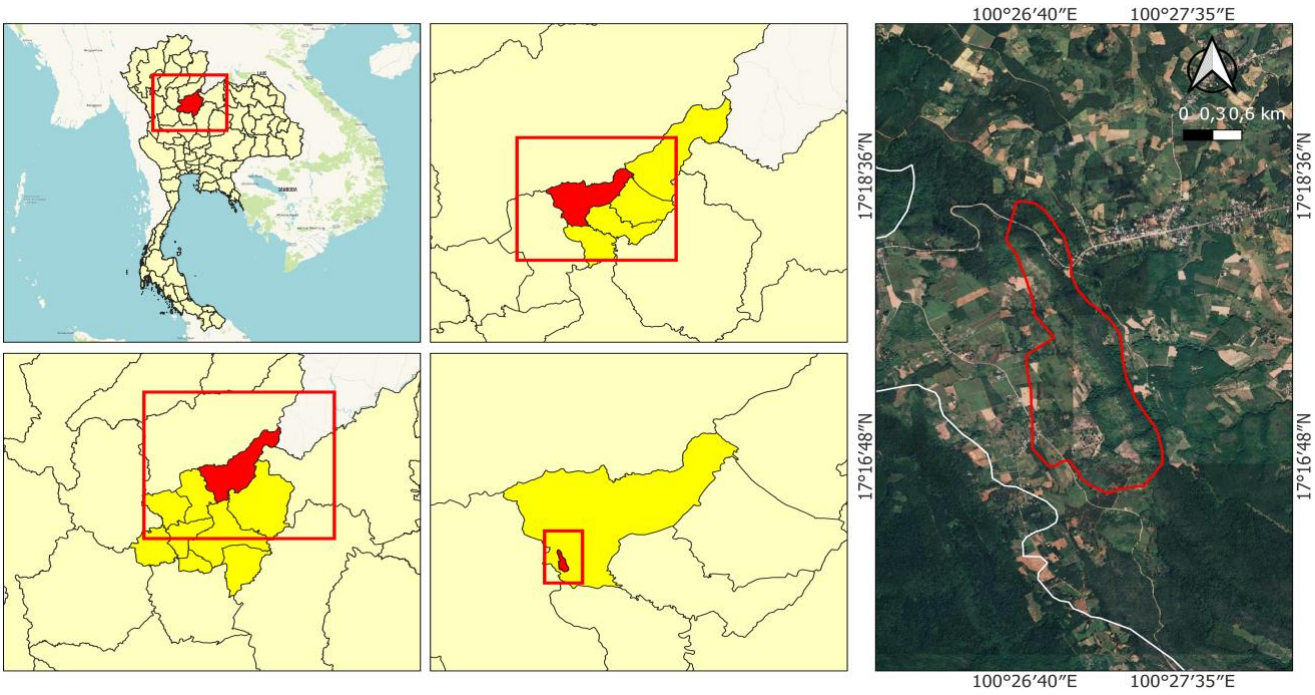

Figure 1. Map of the study area: Ban Tin Tok community forest, Ban Dong Sub-district, Chat Trakan District, Phitsanulok Province, Thailand

Data collection

Tree species diversity and ecological importance

To quantitatively assess the tree species diversity and ecological importance, 20 permanent plots, each plot measuring 10 × 10 m (100 m^2), were established using a systematic sampling design. The sampling was conducted along a primary transect following the 9.2 km longitudinal axis of the forest area. Plots were established at fixed intervals of approximately 480 m to ensure uniform coverage. The initial plot was positioned at the forest boundary, with subsequent plot coordinates predetermined using Google Earth Pro to ensure a systematic grid. Ban Tin Tok community forest is situated at an elevation of 160-240 m above sea level, characterized by a relatively flat topography and a homogeneous dry dipterocarp forest structure. Given this ecological uniformity and minimal altitudinal variation, a total sampling area of 0.2 ha was employed.

While this sampling intensity is considered appropriate for capturing the dominant woody species within this relatively homogeneous dry dipterocarp structure, we acknowledge that it may not fully account for rare or low-density taxa. Nevertheless, it provides a robust and representative baseline for understanding the relationship between local utilization and the forest's core biodiversity. During field implementation, coordinates were located using a Global Positioning System (GPS). In cases of physical obstacles or inaccessible terrain, a 'nearest safe location' protocol was applied, allowing for a maximum shift of 30 m from the original coordinate. These adjustments were strictly constrained to stay within the same forest type to maintain sampling consistency and researcher safety. Within each plot, all trees with a diameter at breast height (DBH) of ≥5 cm were recorded.

Comprehensive data were collected for each tree species to characterize the forest structure and composition. The recorded variables included taxonomic classification (family, genus and species), DBH in cm, abundance (number of individuals) and frequency of occurrence across the sampled plots. The basal area (BA) for each tree was calculated based on the DBH. Since DBH was initially recorded in centimeters (cm), it was converted to meters (m) before applying the formula (Curtis and McIntosh 1951):

$$BA = \frac{\pi(DBH)^2}{4}$$

Where BA is the basal area (m^2), π is approximately 3.14159, DBH is the diameter at breast height in meters. Species identification was carried out in the field and verified through the use of herbarium specimens and established reference floras (Kanis 1970; Keng 1972; Phengklai 1981a, b; Santisuk 1987; Pooma 1999; Parnell and Chantaranothai 2002; Chayamarit and van Welzen 2005; Chayamarit 2010; Chantaranothai 2011; Pooma et al. 2017; Phuphathanaphong et al. 2019; Puff et al. 2021).

Conservation status assessment

The global conservation status for each documented species was determined by consulting the IUCN Red List of Threatened Species (IUCN 2025). This assessment was conducted using the official online database (https://www.iucnredlist.org) to assign the most current threat category for each species (e.g. Endangered (EN), Near Threatened (NT) or Least Concern (LC)).

Ethnobotanical study and plant resource utilization

To document the utilization of plant resources by the local community residing near the Ban Tin Tok community forest in Ban Dong Subdistrict, Chat Trakan District, Phitsanulok Province, we employed a qualitative approach centered on Focus Group Discussions (FGDs). A total of six key informants comprising three males and three females, aged 35-70 years (n = 6) from the village were selected based on their established expertise in local flora and TEK. These informants were identified through purposive sampling and recommendations from community leaders, specifically targeting individuals with over 15 years of forest-related experience, such as community forest committee members, local herbalists, and experienced foragers. Ethical procedures were strictly followed; oral informed consent was obtained from all participants after explaining the study objectives, and anonymity was maintained by reporting data in aggregate. To ensure the reliability and validity of the information, data were cross-checked through 'walk-in-the-woods' interviews during plot surveys for in-situ identification. The qualitative data from FGDs were analyzed using thematic coding to identify consensus on plant uses while documenting individual variations in harvesting patterns. The resulting qualitative data were subsequently organized and classified based on two main parameters: (i) The plant part used (including the root, stem/branch, leaf, flower and fruit) and (ii) The utilization category and method of use, which grouped the primary functional applications into food, traditional medicine and material (Martin 1995; Maneewong et al. 2025; Saensouk et al. 2025a). Finally, the compiled data were validated through member checking with the informants to ensure the accuracy of the documented ethnobotanical knowledge.

Data analysis

Information on plant taxonomic groups (family, genus and species), conservation status, utilization and potential for medicinal use was systematically classified and analyzed. For quantitative analysis, we calculated key structural and diversity indices. The forest structure was characterized using the IVI, which integrates Relative Density (RD), Relative Frequency (RF) and Relative Dominance (RDo) (Curtis and McIntosh 1951; Kent 2011). Species diversity was assessed using the Shannon-Wiener Diversity Index (*H'*) (Shannon 1948) and Pielou's Evenness Index (J') (Pielou 1966).

The formulas used for these calculations were:

Relative Density (RD):

$$RD\ (\%) = \frac{\text{Number of individuals of species i}}{\text{Total number of individuals of all species}} \times 100$$

Relative Frequency (RF)

$$RF\ (\%) = \frac{\text{Number of plots in which species i occurs}}{\text{Sum of frequencies of all species}} \times 100$$

Relative Dominance (RDo)

$$\text{RDo (\%)} = \frac{\text{Basal area of species i}}{\text{Total basal area of all species}} \times 100$$

Importance Value Index (IVI)

IVI = RD + RF + RDo

Shannon-Wiener Diversity Index (H′)

$H' = -\Sigma (p_i \ln p_i)$

Pielou's Evenness Index (J′)

$$J' = \frac{H'}{\ln S}$$

Where p_i is the proportion of individuals of species i relative to the total number of individuals, and S is the total number of species. The IVI and related indices were calculated for all tree species recorded in the 20 plots, providing a quantitative assessment of species dominance, ecological significance and potential priority for conservation. Species diversity indices, including the H′ and J′, were calculated by pooling the tree abundance data from all 20 plots into a single cumulative dataset. This pooled approach was selected to provide a consolidated and representative baseline of the 0.2-ha sampled area, capturing the total cumulative richness of the relatively homogeneous dry dipterocarp forest. While this method does not provide plot-level variance estimates, it offers a robust overview of the site's core biodiversity value for management purposes.

RESULTS AND DISCUSSION

Species composition and ecological Importance Value Index (IVI)

The survey across 20 sampling plots documented a total of 28 tree species belonging to 27 genera and 15 families (Figure 2). The forest structure exhibited a distinct dominance pattern (Table 1), primarily characterized by members of the Dipterocarpaceae and Fabaceae families. *Pentacme siamensis* emerged as the primary structural component with the highest IVI (62.83), achieving a RD of 21.88% and RDo of 26.14%. Other ecologically significant species included *Pterocarpus macrocarpus* (IVI = 58.63), *Canarium subulatum* (IVI = 35.93), *Shorea obtusa* (IVI = 28.64) and *Adina trichotoma* (IVI = 21.97). This result indicates that *P. siamensis*, alongside *P. macrocarpus*, defines the physiognomy and composition of this community forest. This co-dominance of Dipterocarpaceae with three species (*P. siamensis*, *S. obtusa* and *Dipterocarpus obtusifolius*) ranking among the top six is consistent with the established ecological characteristics of dry dipterocarp forests in northern Thailand (Khamyong et al. 2018). Furthermore, this structural uniformity, where fire-tolerant dipterocarps dominate the canopy, is a defining feature of deciduous ecosystems extending across the dry lowlands of northeastern, central and western Thailand (Smitinand 1966).

Table 1. N, RD, RF, RDo and IVI of tree species documented in the Ban Tin Tok community forest sampling plots (n = 20)

Species	Family	N	RD (%)	RF (%)	RDo (%)	IVI
Pentacme siamensis (Miq.) Kurz	Dipterocarpaceae	70	21.88	14.81	26.14	62.83
Pterocarpus macrocarpus Kurz	Fabaceae	69	21.56	13.33	23.73	58.63
Canarium subulatum Guillaumin	Burseraceae	42	13.13	11.11	11.69	35.93
Shorea obtusa Wall.	Dipterocarpaceae	31	9.69	9.63	9.32	28.64
Adina trichotoma (Zoll. & Moritzi) Benth. & Hook.f. ex B.D.Jacks.	Rubiaceae	22	6.88	7.41	7.68	21.97
Dipterocarpus obtusifolius Teijsm.ex Miq.	Dipterocarpaceae	20	6.25	8.15	6.69	21.09
Mitragyna diversifolia (Wall. ex G.Don) Havil.	Rubiaceae	9	2.81	5.93	2.18	10.92
Xylia xylocarpa (Roxb.) W.Theob.	Fabaceae	8	2.50	3.70	3.73	9.93
Gluta usitata (Wall.) Ding Hou	Anacardiaceae	8	2.50	3.70	1.01	7.21
Aporosa villosa (Lindl.) Baill.	Euphorbiaceae	7	2.19	2.96	1.26	6.41
Irvingia malayana Oliv. ex A.W.Benn.	Irvingiaceae	2	0.63	1.48	2.54	4.65
Lannea coromandelica (Houtt.) Merr.	Anacardiaceae	6	1.88	2.22	0.31	4.40
Buchanania lanzan Spreng.	Anacardiaceae	5	1.56	2.22	0.45	4.23
Millettia brandisiana Kurz	Fabaceae	3	0.94	1.48	0.60	3.02
Dalbergia cultrata T.S.Ralph	Fabaceae	3	0.94	1.48	0.42	2.84
Morinda pubescens Sm.	Rubiaceae	2	0.63	1.48	0.02	2.13
Anneslea fragrans Wall.	Theaceae	1	0.31	0.74	1.00	2.06
Fernandoa adenophylla (Wall. ex G.Don) Steenis	Bignoniaceae	2	0.63	0.74	0.43	1.80
Pterocymbium tinctorium (Blanco) Merr.	Malvaceae	1	0.31	0.74	0.25	1.30
Terminalia corticosa Pierre ex Craib & Hutch.	Combretaceae	1	0.31	0.74	0.18	1.23
Syzygium cumini (L.) Skeels	Myrtaceae	1	0.31	0.74	0.14	1.19
Bombax anceps Pierre	Malvaceae	1	0.31	0.74	0.07	1.12
Pavetta tomentosa Roxb. ex Sm.	Rubiaceae	1	0.31	0.74	0.06	1.12
Ochna integerrima (Lour.) Merr.	Ochnaceae	1	0.31	0.74	0.04	1.09
Vitex pinnata L.	Lamiaceae	1	0.31	0.74	0.03	1.08
Diospyros ehretioides Wall. ex G.Don	Ebenaceae	1	0.31	0.74	0.01	1.06
Croton oblongifolius Buch.-Ham. ex Wall.	Euphorbiaceae	1	0.31	0.74	0.01	1.06
Bridelia retusa (L.) A.Juss.	Euphorbiaceae	1	0.31	0.74	0.01	1.06

Note: Number of Individuals: N, Relative Density: RD (%), Relative Frequency: RF (%), Relative Dominance: RDo (%)

Figure 2. Some plant species found in the Ban Tin Tok community forest, Chat Trakan District, Phitsanulok Province. A. *Dipterocarpus obtusifolius*, B. *Pentacme siamensis*, C. *Xylia xylocarpa*, D. *Mitragyna diversifolia*, E. *Canarium subulatum*, F. *Pavetta tomentosa*, G. *Ochna integerrima*, H. *Morinda pubescens*

Table 2. Quantitative assessment of tree species diversity (H′) and evenness (J′) in Ban Tin Tok community forest

Index	Value
Shannon-Wiener Diversity Index (H')	2.40
Pielou's Evenness Index (J')	0.72

In terms of diversity, Ban Tin Tok community forest yielded a H′ of 2.40 and the J′ (0.72) (Table 2). These values indicate a moderate level of diversity and moderate-to-high evenness, consistent with recorded ranges for dry dipterocarp and mixed deciduous forests in northern Thailand (Khamyong et al. 2018). Similarly, ecological studies in northeastern Thailand have reinforced the structural importance of Dipterocarpaceae using comparable IVI methods (Saensouk et al. 2025c). While the forest exhibits distinct co-dominance by *P. siamensis* and *P. macrocarpus*, the moderate to high evenness (J' = 0.72) suggests that the remaining species maintain a well-distributed population structure across the sampled plots. This indicates that the dominance of a few taxa has not led to a complete suppression of minor species. Such ecological characteristics reflect a complex deciduous forest structure, which aligns with the objectives of community-based management and local governance in maintaining forest integrity over time (Thammanu et al. 2021).

The observed ecological balance is vital for forest resilience and the protection of biodiversity. A significant finding is the sharp contrast between structural dominance and ethnobotanical importance. In this study, canopy-defining species were operationalized as those possessing an IVI ≥ 10.0. Under this criterion, only 7 out of 28 species (25% of total richness) define the forest canopy, yet they collectively account for a cumulative IVI of 204.01 out of 300 (approximately 68%). Conversely, the vast majority of the community (21 species with IVI < 10.0) exhibit low structural dominance but are identified as high-value resources. Structurally minor species, such as *Irvingia malayana*, *Ochna integerrima* and *Pavetta tomentosa* are identified as high-value resources in food, medicine, and cultural categories. This indicates that while the forest is physically structured by a few dominant Dipterocarpaceae and Fabaceae species, its socio-ecological value is largely sustained by the diversity of low-density species. This distinction underscores why community-based management is essential: it protects the biodiversity that supports local livelihoods and traditional practices, which might otherwise be overlooked in management plans focused solely on dominant timber or structural biomass. However, the high IVI of EN and NT) timber species, such as *P. macrocarpus*, highlights a critical vulnerability. This intersection of high ecological importance and threatened status necessitates urgent priority conservation planning to ensure the long-term integrity of the community forest ecosystem and the sustainable provision of resources to the local community.

Conservation status assessment

The study documented a total of 28 plant species across 15 families. An assessment of conservation status according to the IUCN Red List (IUCN 2025) revealed that 57.14% (n = 16) of the species are categorized as LC, indicating relatively stable populations (Table 3 and Figure 3). This group includes widely utilized tree species such as *P. siamensis*, *X. xylocarpa* and *I. malayana*, which collectively contribute to the current forest structure. However, the coexistence of threatened taxa within the families Dipterocarpaceae and Fabaceae highlights the ecological vulnerability of this community forest. The continued presence of economically valuable timber species, notably *P. macrocarpus*, despite high extraction pressures, leads to the qualitative inference that community-based forest management practices may play a crucial role in mitigating overexploitation. This observation is consistent with observations from other community forests in northern Thailand (Thammanu et al. 2021; Saensouk et al. 2025c).

Table 3. Categorization of plant species by taxonomic group, global conservation status and documented local utilization in Ban Tin Tok community forest

Family	Species	IUCN (2025)	Used		
			Part used	Category	Application
Anacardiaceae	*Gluta usitata* (Wall.) Ding Hou	NE	-	-	-
	Lannea coromandelica (Houtt.) Merr.	LC	Young shoots	Food	Side vegetable (consumed fresh or blanched)
			Wood	Material	Furniture production
	Buchanania lanzan Spreng.	LC	Young shoots	Food	Side vegetable
			Bark	Medicine	Bark decoction treats inflammation from toxic plants (e.g., sap of *G. usitata*)
			Latex and root	Medicine	Treat diarrhea
Bignoniaceae	*Fernandoa adenophylla* (Wall. ex G.Don) Steenis	NE	Young flowers	Food	Blanched for eaten with chili paste
Burseraceae					
	Canarium subulatum Guillaumin	LC	Seed	Food	Edible seeds
Combretaceae					
	Terminalia corticosa Pierre ex Craib & Hutch.	NE	Wood	Material	Fuelwood and charcoal production
Dipterocarpaceae					
	Pentacme siamensis (Miq.) Kurz	LC	Wood	Material	Heavy construction and agricultural equipment
	Shorea obtusa Wall.	NT	Wood	Material	Heavy construction and agricultural equipment
			Wood	Material	Fuelwood and charcoal production
			Bark and wood	Medicine	Astringent, hemostatic, treats chronic wounds/blisters (applied as a paste with lime water)
	Dipterocarpus obtusifolius Teijsm. ex Miq.	NT	Wood	Material	Construction materials
			Leaves	Material	Roofing and walling materials
Ebenaceae	*Diospyros ehretioides* Wall. ex G.Don	LC	-	-	-
Euphorbiaceae	*Aporosa villosa* (Lindl.) Baill.	LC	Fruit	Food	Ripe fruit pulp is sweet and sour with a distinct aroma; eaten as a fruit
	Croton oblongifolius Buch.-Ham. ex Wall.	NE	-	-	-
	Bridelia retusa (L.) A. Juss.	LC	-	-	-
Fabaceae	*Pterocarpus macrocarpus* Kurz	EN	Wood	Material	Construction and timber products
	Xylia xylocarpa (Roxb.) W.Theob.	LC	Wood	Material	Construction and timber products
	Millettia brandisiana Kurz	LC	Wood	Material	Construction and agricultural tools
	Dalbergia cultrata T.S.Ralph	NT	Wood	Material	Construction, tool handles, and handicrafts
Irvingiaceae	*Irvingia malayana* Oliv. ex A.W.Benn.	LC	Seed	Food	Edible seeds (processed as snacks)
			Wood	Material	Household utensils and interior construction
Lamiaceae	*Vitex pinnata* L.	LC	-	-	-
Malvaceae	*Pterocymbium tinctorium* (Blanco) Merr.	LC	-	-	-
	Bombax anceps Pierre	NE	-	-	-
Myrtaceae	*Syzygium cumini* (L.) Skeels	NE	Fruit	Food	Edible fruit
Ochnaceae					
	Ochna integerrima (Lour.) Merr.	LC	Stem and root	Medicine	Stem and root decoction relief of musculoskeletal pain
Rubiaceae	*Adina trichotoma* (Zoll. & Moritzi) Benth. & Hook.f. ex B.D.Jacks.	LC	-	-	-
	Mitragyna diversifolia (Wall. ex G.Don) Havil.	LC	-	-	-
	Morinda pubescens Sm.	LC	Leaves	Medicine	Anti-parasitic (pediculosis treatment)
	Pavetta tomentosa Roxb. ex Sm.	NE	Root	Medicine	Galactagogue (promoting lactation)
Theaceae	*Anneslea fragrans* Wall.	NE	-	-	-

Note: EN: Endangered, NE: Not evaluated, NT: Near threatened, LC: Least concern

The analysis identified a critical need for focused conservation efforts. Four species (14.29% of the total recorded richness) are of conservation concern. Specifically, 10.71% (n = 3) are listed as NT, including *S. obtusa* and *D. obtusifolius*, and valuable timber species *Dalbergia cultrata*. These species are traditionally prized for construction and

general purposes. While their NT reflects a regional population decline, it suggests potential vulnerability of these taxa within the study area. Given their high local utility, monitoring harvesting intensities is recommended to ensure sustainable use. Most critically, the primary timber species *P. macrocarpus* is categorized as EN. Its documented utilization for high-value applications underscores a critical intersection between human resource dependency and species viability. These findings suggest that the integration of conservation-led management, such as the establishment of specific protection zones or community-led propagation programs, could be explored as strategy for long-term survival. Prioritizing *P. macrocarpus* in local conservation plans may help balance community need with biodiversity preservation.

Furthermore, the analysis revealed a significant data gap, with several species, including *Gluta usitata*, *Fernandoa adenophylla*, *Terminalia corticosa*, *Croton oblongifolius*, *Bombax anceps*, *Syzygium cumini*, *P. tomentosa* and *Anneslea fragrans* currently NE. This absence of formal assessment underscores the critical importance of conducting localized conservation assessments and taxonomic verification, especially for regionally endemic or lesser-known species that may be overlooked by broader evaluations. Similar patterns of unassessed taxaare evident in ethnobotanical surveys across Thailand, where many culturally or locally used species remain un- or under-assessed (Hein et al. 2025; Jitpromma et al. 2025; Saensouk et al. 2025d, 2025e). Addressing this deficiency is thus essential for developing effective, site-specific management strategies that integrate both ecological risk and community use. Overall, the coexistence of species with varying conservation statuses within the Ban Tin Tok community forest fundamentally demonstrates its profound ecological importance. The forest functions as both a refuge for common taxa and a vital sanctuary for threatened and endemic species. This value is further reinforced by the occurrence of the locally endemic *C. sabhasrii* (Rakarcha et al. 2022). These findings contribute to the evidence that community forests can serve as essential complements to national protected areas, although further longitudinal data would be required to confirm long-term conservation outcomes.

Ethnobotanical study and plant resource utilization

Material and economic utilization

Material use, primarily for timber, emerged as the dominant utilization category, represented by ten species (Table 3). High-density hardwoods including *P. macrocarpus*, *X. xylocarpa* and *Millettia brandisiana* constitute the foundation of durable construction and agricultural tool production. This enduring dependence on *P. macrocarpus* exemplifies the socio-economic and cultural difficulty of substituting these species with non-threatened alternatives. In addition, specialized uses demonstrate refined TEK: *I. malayana* wood is employed in crafting mortars and pestles, while *D. obtusifolius* leaves are used for traditional roof thatching practices that reflect long-standing cultural adaptation to available forest resources.

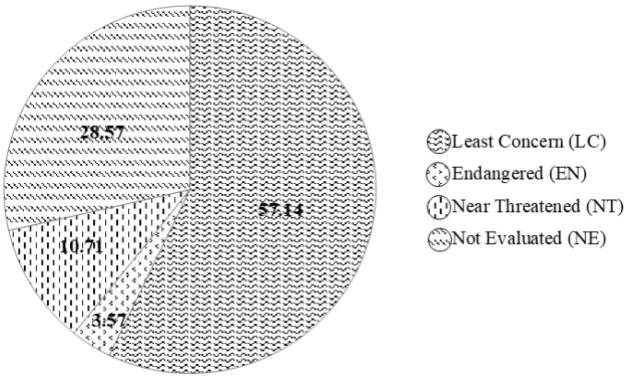

Figure 3. Global conservation status of documented species in Ban Tin Tok community forest, Chat Trakan District, Phitsanulok Province, based on the IUCN Red List of Threatened Species (IUCN 2025)

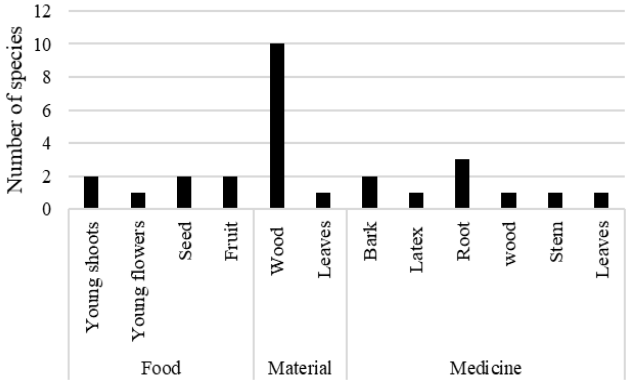

Figure 4. Number of species used traditionally, classified by plant parts and major use categories, in Ban Tin Tok community forest, Chat Trakan District, Phitsanulok Province

Food security and foraging practices

Seven plant species were recorded as food sources, emphasizing the forest crucial contribution to food security and dietary diversity (Table 3). The consumption of wild vegetables and seasonal foraged materials such as the young shoots of *Lannea coromandelica* and *Buchanania lanzan* and the flowers of *F. adenophylla* illustrates the persistence of localized foraging traditions. Nut and seed utilization, particularly from *C. subulatum* and *I. malayana*, provides a valuable source of fats and proteins, with these resources often prepared through roasting or baking. Such practices are integral to household nutrition while simultaneously reinforcing ecological knowledge and sustainable harvesting behavior.

Traditional medicinal applications

Ethnomedicinal documentation revealed five species with reported traditional medicinal uses, primarily addressing towerd-specific health concerns (Table 3). For maternal and musculoskeletal health, informants reported that a root decoction of *P. tomentosa* is used to stimulate lactation, while *O. integerrima* decoctions are used for musculoskeletal pain. Locally, *S. obtusa* bark and wood are used for antiseptic

and anti-parasitic purposes, and *Morinda pubescens* leaf poultices for lice removal. *Buchanania lanzan* is used to treat diarrhea (latex and roots) and for topical inflammation caused by contact with the toxic sap of *G. usitata* (bark decoction).

Collectively, these practices illustrate a living repository of TEK that serves as a supplementary source of traditional remedies within the community. The ethnobotanical findings from the Ban Tin Tok community forest highlight the interconnection between ecological knowledge, livelihood practices, and cultural traditions. As a community-managed ecosystem, the forest functions as a biodiversity reservoir and a potential contributor to socio-ecological resilience that supports local well-being. These patterns align with other ethnobotanical studies in Thailand, which emphasize the dual roles of community forests (Berkes 2007; Thammanu et al. 2021; Jitpromma et al. 2025; Saensouk et al. 2025f; Pannil and Inpin 2025). The presence of high-value hardwoods like *P. macrocarpus* reflects the persistence of culturally significant resources and the inherent challenge of balancing conservation with the subsistence needs of the community. This dynamic underscores the role of community-level governance in negotiating the use of resources, which is essential for fostering socio-ecological resilience (Pannil and Inpin 2025).

The intensive utilization of high-value timber species, particularly *P. macrocarpus* (EN) and *D. cultrata* (NT), creates significant conservation pressure. However, it can be inferred that local community rules, such as strict harvest limits for mature timber, the protection of designated seed trees to ensure natural regeneration, and enrichment planting act as vital mechanisms to mitigate overexploitation and safeguard the long-term viability of these threatened taxa. The documented utilization of timber species, particularly *P. macrocarpus* (EN), underscores the importance of existing local rules such as harvest limits and the protection of seed trees as vital mechanisms to mitigate potential overexploitation. Furthermore, the forest supplementary role in providing food and medicinal resources illustrates the enduring relevance of TEK. Similar patterns reported in Yasothon and other rural Thai communities (Inta et al. 2025; Saensouk et al. 2025g) suggest that edible and medicinal plants can complement household nutrition and healthcare. While this study focuses on the specialized knowledge held by community experts, it provides a crucial baseline of the forest's ethnobotanical potential.

Future research investigating intra-community variations such as how knowledge differs across gender, age groups, and occupations would further clarify the dynamics of cultural continuity and the effectiveness of intergenerational knowledge transfer. Collectively, these observations suggest that conserving biodiversity in community forests is closely linked to safeguarding traditional knowledge systems. Overall, the Ban Tin Tok forest exemplifies a multifunctional socio-ecological system where conservation, cultural continuity, and local livelihoods can be mutually reinforcing through participatory approaches. While these findings offer valuable insights into the socio-ecological role of the forest, it is important to recognize certain limitations of the present work. As a snapshot ethnobotanical survey, the study primarily documents traditional knowledge and perceived uses at a specific point in time. Consequently, the observations regarding forest resilience and the mitigation of overexploitation should be viewed as qualitative inferences rather than conclusions based on direct quantification of harvesting pressure or governance-performance metrics. Further longitudinal research and ecological monitoring would be essential to empirically validate the long-term sustainability of these local management practices and their impact on species viability.

In conclusion, Ban Tin Tok community forest comprises 28 tree species from 27 genera and 15 families, exhibiting moderate diversity ($H' = 2.40$) and moderate to high evenness ($J' = 0.72$). The forest structure is characterized by the co-dominance of *P. siamensis* (IVI = 62.83) and *P. macrocarpus* (IVI = 58.63), while 21 low-IVI species (<10) contribute to ecological complexity. Conservation assessment revealed *P. macrocarpus* as EN, *S. obtusa*, *D. obtusifolius* and *D. cultrata* as NT. Of the total species, 16 (57.14%) are listed as LC and 8 (28.57%) remain NE. Ethnobotanical findings documented widespread use of these species for food, medicine, and materials, reflecting the deep integration of TEK. Beyond the tree-plot results, the ecological value of this area is further contextualized by the reported presence of the endemic species *C. sabhasrii*. While this taxon was not part of the primary tree survey dataset, its documented occurrence underscores the forest's value as a refuge for rare taxa. Together with the identified EN and NT tree species, these findings suggest that current participatory management practices are compatible with the conservation of threatened flora. This provides a vital baseline for sustainable forest governance that balances ecological resilience with local well-being.

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