Some threatened woody plant species recorded from forests over limestone of the Philippines

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Abstract: This study was conducted to determine threatened woody plants in forests over limestone in Samar Natural Park (SINP), Guian Marine Resource Protected Landscapes and Seascapes (GMRPLS), and other areas in the Philippines, in order to design a strategic framework for sustainable conservation of threatened species. Combined fieldwork using standard vegetation techniques and comparative literature review were done. Results revealed a total of 106 woody plant species belonging to 48 families, with 60 (DAO 2017-11) and 182 (IUCN) threatened woody plant species in the forests over limestone. The top 10 important species noted include three Critically Endangered: Diospyros longiciliata Merr., Cynometra cebuensis Seidenschwartz, F., and Shorea astylusa Foxw; three endangered: Cinnamonum cebuense Kosterm., Tectona philippinensis Benth. & Hook.f. and Vitex parviflora Juss.; and four vulnerable species: Agathis philippinensis Warb., Aquilaria cunningiana (Decne) Ridley, Dipterocarpus gracilis Blume, and Shorea polysperma (Blanco) Merr. A framework for sustainable conservation has been designed to prevent the loss of these threatened botanical treasures.

Keywords: Karst forest, native plants, Philippine teak, Samar Island, Verde Island Passage.

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INTRODUCTION

Forests over limestone (karst forests) have unique geomorphological features that result from the dissolution of soluble bedrock, usually carbonates (Day & Urich 2000). Tropical forests over limestone occur in southern Mexico, central America, the Caribbean, and southeastern Asia including the Philippines, which have roughly 35,000 km² of karst forests (Piccini & Rossi 1994). Generally, plants experience more stress in this type of forest due to shallow soil substrates, high temperature, and other limiting factors. Hence, unique plants abound and are expected to possess secondary metabolites with high potential against stressors. Plants in forests over limestone are valuable sources of wood and non-wood products for nearby village communities. They also serve as food, medicine, shade plants and perching materials for local fauna and forest pollinators, sustaining life cycles, and ecosystem dynamics. Anthropogenic pressures can result in overharvesting, deforestation, and biodiversity loss.

Karst forests in the Philippines harbor rich biodiversity, but some are also threatened due to human pressures. These include Mount Lantoy in Cebu Island, one of the 117 terrestrial areas designated as Key Biodiversity Areas (KBA) based on vulnerability and irreplaceability criteria (Lillo et al. 2019, 2020, 2021). The area has two Critically Endangered, two Endangered, four Vulnerable, and 16 restricted-range species (CI/DENR-PAWB/Haribon 2006). In another site Cadiz & Buot (2009, 2010) assessed the native trees and woody plants in Cantipla and Tabunan forests in Cebu City. The Cantipla forest clusters were once a continuous forest cover that was part of the Central Cebu National Park (CCNP) and the Kotkot-Lusaran Watershed. On the other hand, the Tabunan forest covers at least 40 ha and is the only large patch of natural virgin forest left in Metro Cebu Watershed and the home to the endemic but threatened Cinnamomum cubense (Quimio 2006). Another unique forest over limestone is found along Verde Island Passage, Batangas, Luzon Island where the endemic Philippine teak, Tectona philippinensis Benth. & Hook.f., is a dominant component (Caringal et al. 2019, 2021).

One of the most extensive forests over limestone in the Philippines is in Samar Island Natural Park (SINP) and Guian Marine Resource Protected Landscapes and Seascapes (GMRPLS). A number of studies have shown that these areas are rich in biodiversity (Fernandez et al. 2020; Tolentino et al. 2020; Madera et al. 2021; Obeña et al. 2021; Villanueva et al. 2021a,b; Delos Angeles et al. 2022; Tandang et al. 2022). In a series of biodiversity assessments conducted in various municipalities of Samar Island, it was revealed that the municipality of Paranas has been recorded to have 99 plant species from 63 genera and 44 families (Villanueva et al. 2021a). Furthermore, the municipality of Basey has a total of 67 plant species representing 54 genera and 38 families (Villanueva et al. 2021b), and 30 floral species representing 22 genera and 18 families were recorded in Taft, Eastern Samar (Obeña et al. 2021). Fernandez et al. (2020) recorded 41 floral species belonging to 17 families and 24 genera from Calicoan Island in Guian, eastern Samar.

Samar Island, specifically the SINP and the GMRPLS, have been severely degraded despite enforced protective policies such as the National Integrated Protected Areas System (NIPAS) Act of 1992. In the last 70 years, there has been significant logging and forest clearing for agricultural purposes in the area (UNDP-GEF 2014). Other threats (SEARCA 2004), include coal and chromite mining, unregulated limestone quarrying, charcoal production, over-harvesting of non-timber forest products (including rattans), pollution from industries, alien species invasion, and the proliferation of small-scale illegal logging. These activities contribute to forest destruction and pose a significant threat to the biodiversity of the island’s forests over limestone ecosystem. If current trends continue, these activities could have serious consequences for both plant populations and the livelihoods of the people who rely on forest resources. Unfortunately, species decline from various locations throughout the country has not yet been documented for inclusion in the Philippine red list or the IUCN. Hence, the need to investigate the threatened woody plants in forests over limestone and their conservation status and catalyze additional actions and potentially save a species from extinction (Zahler & Rosen 2013), particularly in areas where future plant species endangerment is expected to be high (Giam et al. 2010). The study specifically aims to: 1) determine the threatened woody plants species in forests over limestone in Samar Island and in other parts of the Philippines and 2) design a strategic framework for sustainable conservation of forests over limestone threatened species.

Information on threatened woody species in limestone forests in the Philippines is critical because it can have a direct impact on human well-being and will help decision makers and stakeholders in better understanding the significance of this study in achieving the United Nations Sustainable Development Goals,
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The study sites

The primary study area inventoried. Samar Island is the third-largest island in the Philippines archipelago, covering an area of 13,107 km² and extending between 10.75-12.75 °N & 124.25-124.75 °E (PhilGIS 2016). The island is considered a botanical diversity hotspot in both the country and the Malesian region (Madulid 2000). SINP (Figure 1) contains 333,300 ha of the protected area and 125,400 ha of buffer zone, making it the Philippines’ largest terrestrial protected area (UNDP-GEF 2014). The park was designated as a forest reserve in 1996, but it was elevated to the status of a natural park in 2003 by Presidential Proclamation No. 442 in accordance with Republic Act No. 7586 (NIPAS Act of 1992). The SINP is situated in Samar island’s low rugged central mountain range, which is shared by all three provinces on the island. SINP is made up of 13 municipalities and one city in the province of Samar, 19 municipalities in the province of Eastern Samar, and five municipalities in northern Samar. The interior natural habitats of Samar Island are dominated by lowland evergreen rainforests and limestone forests (UNDP 2007; Taylor et al. 2015). It also has an interior highland with distinct accordant peaks and a surrounding limestone or karst terrain. The landscape in the southern part is made up of jungle-covered limestone ridges. Its geology is predominantly Miocene and Holocene, with a sedimentary formation composed of basement rocks and overlying clastic rocks or limestone (Patindol 2016). It has high biodiversity and is a center of plant and animal diversity and endemism in the Philippines, home to several threatened species from the Eastern Visayas and Mindanao biogeographic regions (Madulid 2000).

GMRPLS (Figure 1), is a protected area located off the coast of the municipality of Guiuan situated in the Province of Eastern Samar, Philippines. It was designated as a protected area by virtue of Presidential Proclamation No. 469 in 1994 and consists of the following islands: Calicoan, Manicani, Suluaan, Tubabao, Victory, Homonhon, and other smaller islands and their surrounding reefs. It also includes the coastal area of mainland Guiuan, which totals 60,448 ha. The land that is now part of the conservation area was previously designated as a Marine Reserve and Tourist Zone in 1978, and it was placed under the administration and control of the Philippine Tourism Authority. It was re-proclaimed and re-classified as a protected landscape/seascape in 1994 under the National Integrated Protected Areas System Act of 1992.

Based on Modified Corona’s Climate Classification, Samar Island is divided into two regions. The northeastern part manifests the Type II climate which has no dry season and has a pronounced rain period, particularly during December and January. The southeastern region has a Type IV climate, with rainfall distributed fairly evenly throughout the year. Throughout the year, the island has a humid climate (Kintanar 1984).

Other forests over limestone cited. Other forests over limestone were cited in available literature and included in the analysis (Figure 2). These are Cantipla forest (Cadiz & Buot 2009) and Mount Tabunan (Cadiz & Buot 2010) of Cebu City, Mount Lantoy of southern Cebu (Lillo et al. 2019, 2020, 2021), and the coastal landscapes and seascapes of the Verde Island Passage, Batangas, southern Luzon (Caringal et al. 2019, 2021).

Like the SINP and the GMRPLS, these other forests over limestone were threatened. Mount Lantoy forests declined significantly during the Spanish colonial period to provide lumber for the construction of Spanish galleons (Asia Magazine 1984). Recently, Bensel (2008) reported that agricultural expansion and fuelwood gathering are still increasing – putting pressure on this Cebu’s last remaining forests. Respondents also reported illegal logging, hunting, and widespread conversion of forests to agriculture. Despite these, Mount Lantoy KBA is rated moderately disturbed according to the Beynen & Townsend (2005) scoring system. This means that the recorded disturbances and threats in the area do not have critical effects yet on species diversity for the time being. It could not, however, deny the deterioration of native trees that affects the biodiversity, the ecosystem, and the community surrounding Mount Lantoy KBA.

Similarly, even though Cantipla forest was part of the CCNP and Tabunan forest is in the strict protection zone, their forest resources are still being exploited by the local residents. On its first botanical survey in May 1970, most of the dipterocarp forests in Cantipla had already been destroyed (Colina & Jumalon 1974), and the destruction was accelerated due to the widespread practice of swidden agriculture. Similarly, there is occasional tree cutting and rattan harvesting within the Tabunan forest, and its forest exterior is dominated by
Figure 1. Location of the research area where the authors did the actual fieldwork.

Figure 2. Locations of some forests over limestone included in the study.
agricultural activities of the local residents. In fact, these activities contributed significantly to the reduction of the forested area by approximately 0.3% of its original forest cover (SSC 1988), which is mostly confined to rocky limestone cliffs.

*Tectona philippinensis* in the forests over limestone along Verde Island Passage, Batangas is an endangered species that has long been regarded as one of the most important floristic elements of this coastal forests over limestone (Madulid & Agoo 1990; DENR-UNEP 1997; Cordon et al. 2004). The tree is also an iconic species, a living witness to the Filipino people’s economic and political history, as its wood was once used to repair galleon ships that plied the Manila-Acapulco route during the Spanish colonial era (ERDB 1998). Meanwhile, the number of remaining Philippine teak populations is decreasing due to rapid and continuous destructive human disturbances in the area. Land conversion (from forest to sugar apple plantation and coastal area to resorts), habitat destruction, ecotourism projects, quarry operation, development of road networks and lateral expansion of urban settlements, kaingin (slash and burn farming), accidental fire during summer months, and natural threats such as prolonged droughts caused by the El Nino phenomenon and pests and diseases are threats documented by Caringal (2004) and RDC-CALABARZON (2006).

**Inventory of the woody species composition**

The study was carried out through a combination of fieldwork using standard vegetation techniques in Samar Island, and extensive literature review of papers in forests over limestone in the Philippines. Two sets of field sampling methods were used to determine the plant composition. The quadrat or plot method (Mueller-Dombois & Ellenberg 1974) was used to assess trees (≥1 m) while the line intercept technique was used for understory species. The plots were purposely selected based on the heterogeneity of the plants and the presence and absence of human-related disturbances in the area. To assess the woody plant species, 27 20 x 20 m plots were established in SINP and GMRPLS last October 2019. Generally, 20 m is the longest distance that can be accurately surveyed in a dense forest (Dallmeier 1992). Two line transects, 5 m in length and subdivided with 1 m intervals, were established inside each sampling plot. Altitude and geographic location of each plot and plant species were determined using a geographic positioning system (GPS) device.

Besides fieldwork using standard vegetation techniques in Samar Island, extensive literature review was conducted, on papers related to forests over limestone in the Philippines. These include papers about the Cantipla forest, Cebu (Cadiz & Buot 2009), Mount Tabunan, Cebu (Cadiz & Buot 2010), Mount Lantoy, Cebu (Lillo et al. 2019, 2020, 2021), Verde Island Passage, Batangas (Caringal et al. 2021) and Basey, Samar (Villanueva et al. 2021).

Experts were consulted to ascertain tree species identification. Nomenclature follows that of Dictionary of Philippine plant names (Madulid 2001, 2001a), Co’s Digital Flora (Pelser et al. 2011 onwards), IPNI (2020), and POWO (2022).

**Determining threatened taxa**

The conservation status of woody plant species was determined using the list of threatened species identified by the Philippines’ DENR Administrative Order No. 11 series of 2017 (DAO 2017) and the International Union for Conservation of Nature (IUCN) (IUCN 2022). DAO No. 2017-11 (DAO 2017) is the national reference for threatened species of the Philippines. This is being used by researchers and planners as basis in decision-making related to forest management and conservation. IUCN (IUCN 2022), on the other hand, is the global reference for threatened species of various countries. So, in this study, we made use of these two relevant documents as bases in determining the threatened status of the woody species in forests over limestone.

**Designing a framework for conservation**

The study proposes a framework for sustainable conservation of threatened species to put a stop to the current and continuing loss of woody plant species in the country. The framework was developed in response to conservation gaps identified in scientific publications, existing policies, reports, and measures that must be taken seriously towards protection and conservation of floral species in forests over limestone. It highlights the practicality and locally doable in situ and ex situ strategies and the extent and dedicated engagement of the government and the community as well as the stakeholders towards the conservation of the threatened woody taxa.

**RESULTS AND DISCUSSION**

**Threatened woody plant species in forests over limestone**

The study found 196 woody plant species belonging to 48 families in the forest over limestone in the
Philippines (Table 1). About half (40%) of the recorded species are endemic to the Philippines (DAO 2017-11; Pelser et al. 2011 onwards). Additionally, Moraceae family is the most represented family, having 16 documented species, followed by Fabaceae (16 species), Euphorbiaceae and Dipterocarpaceae, having 15 species each, and Rubiaceae and Sapindaceae, with 10 species each.

Meanwhile, for SINP and GMRPLS alone, a total of 85 (out of 196) woody plant species, including 37 families, were recorded, including the flora checklist in the municipality of Basey, Samar.

As shown in Table 1, 60 woody plant species in Philippine forests over limestone have conservation status recorded in DAO 2017-11, Philippines as follows: 11 Critically Endangered (CR), nine Endangered (EN), 30 Vulnerable (VU), and 10 other threatened species (OTS). The 37 (out of 60) species are endemic to the Philippines. On the other hand, IUCN classified 182 woody plant species in the Philippine forests over limestone with seven Critically Endangered (CR), 23 Endangered (EN), 26 Vulnerable (VU), 15 Near Threatened (NT), 110 Least Concern (LC), and one Data Deficient (DD) (Table 1). The 75 of the 182 woody species determined by IUCN are Philippine endemics. In addition, it was noticed that among the woody plant species in the Philippines, there are only five Endangered species, and seven Vulnerable species have the same conservation status in DAO 2017-11 and the IUCN.

Figures 3 and 4 show a comparison of the conservation status of threatened species found on Samar Island, Cebu, and Batangas based on DAO 2017-11 and IUCN. In contrast to the DAO 2017-11 assessment, many of the species found in limestone forests were classified in the IUCN conservation status assessment, as shown in Figure 3. Samar Island has 43 species classified by DAO 2017-11, with seven CR, five EN, 22 VU, and nine OTS, and 80 species classified by IUCN, with six CR, 13 EN, 17 VU, nine NT, and 35 LC. Mt. Tabunan has four species classified by DAO 2017-11 (one CR and three VU), and 41 species classified by IUCN (one CR, two EN, one VU, three NT, 33 LC, and one DD). *Mangifera altissima* Blanco is the only DD species found on Mt. Tabunan. This species was, however, classified as vulnerable in DAO 2017-11. Additionally, Mt. Cantipla has three species classified by DAO 2017-11 (two CR and one EN), while 23 species classified by IUCN, (seven EN, three VU, two NT, and 11 LC). Mt. Lantoy has 17 species classified by DAO 2017-11 (two CR, three EN, nine VU, and three OTS), and 12 species classified by IUCN (two EN, three VU, one NT and six LC). Verde Island Passage has three species classified by DAO 2017-11, with two EN and one VU, and 50 species classified by IUCN, with two EN, three VU, and 45 LC, respectively (see Table 1; Figure 3, 4). Based on DAO 2017-11 and IUCN assessments, Samar Island has the highest number of CR, EN, VU, OTS, and NT species, while Verde Island Passage in Batangas has the highest number of Least Concern (LC) species (see Figure 2,3). The low number of species classified by DAO 2017-11 could be attributed to the fact that the Philippine red list was out of date, as the listing was made in 2017. This figure may change if the assessment and listing of threatened species in the Philippines are completely updated.
| Family & scientific name | Common name | Location | Endemicity | Conservation status | DAO 2017-11 | IUCN | References |
|-------------------------|-------------|----------|------------|---------------------|--------------|------|------------|
| 1 Achariaceae | Hydnocarpus subfalcatus Merr. | Damol, Ngeret | Basey, Samar | Native | - | LC | Quimio (2016); Villanueva et al. (2021b) |
| 2 Anacardiaceae | Dracontomelon dao (Blanco) Merr. & Rolfe | Dao | Basey, Samar | Native | VU | LC | Quimio (2016); Villanueva et al. (2021b) |
| | Mangifera altissima Blanco | Paha | Mount Tabunan, Cebu | Endemic | VU | DD | Cadiz & Buot (2010) |
| | Mangifera monandra Merr. | Malapaho, Malipajo | Paranas, Samar | Endemic | VU | NT | Villanueva et al. (2021a) |
| 3 Annonaceae | Annona squamosa L. | Sugar Apple, Ats | Verde Island Passage, Batangas | - | - | LC | Caringal et al. (2021) |
| | Goniolobus elmeri Merr. | Lanutan | Mount Tabuanan, Cebu | Endemic | - | LC | Cadiz & Buot (2010) |
| | Goniolobus lancifolius Merr. | Monat | Paranas, Samar | Endemic | EN | EN | Villanueva et al. (2021a) |
| | Orophea cumingiana S. | Amunat, Karasakat, Lobanti | Paranas, Samar | Endemic | OTS | NT | Villanueva et al. (2021a) |
| 4 Apocynaceae | Alstonia macrophylla Wall. Ex DC. | Batino, Devil Tree | Mount Tabunan, Cebu | Native | - | LC | Cadiz & Buot (2010) |
| | Alstonia scholaris (L.) R. Br. | Dita | Mount Tabunan, Cebu; Calicoan, Guiuan | Native | - | LC | Cadiz & Buot (2010); Fernandez et al. (2020) |
| | Kibatalia serrata Woodson | Merrill Pasnit | Paranas, Samar | Endemic | VU | EN | Villanueva et al. (2021a) |
| | Kibatalia tuberosa Merr. | Pasit-mabolo | Paranas, Samar | Endemic | EN | EN | Villanueva et al. (2021a) |
| | Tabernaemontana pandacaquensis Poit. | Banana Bush, Pandakaki | Verde Island Passage, Batangas | Native | - | LC | Caringal et al. (2021) |
| | Voacanga globosa (Blanco) | Bayag-usa, Testicle Tree, Albibut | Verde Island Passage, Batangas | Endemic | - | LC | Caringal et al. (2021) |
| | Wrightia pubescens R. Brown subsp. Laniti (Vidal) Ngan | Lanete | Verde Island Passage, Batangas | Native | - | LC | Caringal et al. (2021) |
| 5 Araliaceae | Osmoxylon serratifolium (Elmer) Philipson | - | Mount Tabunan, Cebu | Endemic | - | EN | Cadiz & Buot (2009, 2010) |
| | Polyscias nodosa (Blume) Seem. | Malapapaya | Paranas, Samar | Native | - | LC | Villanueva et al. (2021a) |
| 6 Araucariaceae | Agathis philippinensis Warb. | Almaciga | Basey, Samar | Native | VU | - | Quimio (2016); Villanueva et al. (2021b) |
| 7 Areaceae | Caryota rumphiana Mart. | Pugahan | Calicoan, Guiuan; Paranas, Samar | Native | - | LC | Fernandez et al. (2020); Villanueva et al. (2021a) |
| | Heteropappus intermedia (Becc.) Fernando | Banga, Marighoi | Calicoan, Guiuan; Taf, Eastern Samar; Paranas, Samar | Endemic | - | VU | Fernandez et al. (2020); Obiena et al. (2021); Villanueva et al. (2021a) |
| | Oncosperma trigonum (Jack) Ridl. Syn. Filamentosus Blume. | Anibong | Paranas, Samar | Native | VU | - | Villanueva et al. (2021a) |
| | Saribus rotundifolius (Lam.) Blume | Anahaw | Calicoan, Guiuan; Taf, Eastern Samar | Native | OTS | - | Fernandez et al. (2020); Obiena et al. (2021) |
| 8 Bignoniaceae | Radermachera pinnata (Blanco) Seem. Syn. R. Quadripinnata | Banaybanay | Basey, Samar | Native | - | LC | Quimio (2016); Villanueva et al. (2021b) |
| 9 Boraginaceae | Cordia dichotoma Forst.f. | Anonang, Soap Berry | Verde Island Passage, Batangas | Native | - | LC | Caringal et al. (2021) |
| 10 Burseraceae | Canarium hirsutum Willd. | Milipi, Dult | Cantipla, Cebu; Paranas, Samar; Basey, Samar | Native | - | LC | Cadiz & Buot (2009); Quimio (2016); Villanueva et al. (2021a, b) |
| Family & scientific name | Common name | Location | Endemicity | Conservation status | References |
|--------------------------|-------------|----------|------------|---------------------|------------|
| Canarium ovatum Engl.    | Pili        | Basey, Samar | Native     | OYS                 | Quimio (2016); Villanueva et al. (2021b) |
| Garuga floribunda Decne var. Floribunda | Bogo, Kedondong | Verde Island Passage, Batangas | Native | - | LC Caringal et al. (2021) |
| Calophyllaceae           |             |          |            |                     |            |
| Calophyllum soulattri Burm. F. | Pamintaogon | Mount Tabunan, Cebu; Calicoan, Guian; Taft, Eastern Samar; Paranas, Samar | Native | - | LC Cadiz & Buot (2010); Fernandez et al. (2020); Obeña et al. (2021); Villanueva et al. (2021a) |
| Cannabaceae              |             |          |            |                     |            |
| Celtis philippensis Blanco | Malaiino; Celtis, Malaikmo, Magabuyo | Mount Tabunan, Cebu | Native | - | LC Cadiz & Buot (2010) |
| Trema orientalis (L.) Blume | Andraezina | Verde Island Passage, Batangas | Native | - | LC Caringal et al. (2021) |
| Capparidaceae            |             |          |            |                     |            |
| Crateva religiosa Forst. F. | Balay-lamok | Verde Island Passage, Batangas | Native | - | LC Caringal et al. (2021) |
| Casuarinaceae            |             |          |            |                     |            |
| Gymnostoma rumphianum (Miq.) L. Johnson | Agoho del Monte, Mountain Agoho | Mount Lantoy, Cebu; Paranas, Samar | Native | OTS | - Lillo et al. (2019), Villanueva et al. (2021a) |
| Clusiaceae               |             |          |            |                     |            |
| Garcinia rubra Merr.     | Kamandis     | Paranas, Samar | Endemic | - | NT Villanueva et al. (2021a) |
| Combretaceae             |             |          |            |                     |            |
| Terminalia calamosanai (Blanco) Rolfe | Malakalumpit | Cantipla, Cebu | Native | - | LC Cadiz & Buot (2009) |
| Terminalia catappa Linn. | Talisay      | Verde Island Passage, Batangas | Native | - | LC Caringal et al. (2021) |
| Cycadaceae               |             |          |            |                     |            |
| Cycas riuminiana Regel  | Pitogo, Bayit | Taft, Eastern Samar | Endemic | VU | EN Obeña et al. (2021) |
| Dilleniaceae             |             |          |            |                     |            |
| Dillenia philippinensis Rolfe | Katmon     | Basey, Samar | Endemic | - | NT Quimio (2016); Villanueva et al. (2021b) |
| Dipterocarpaceae         |             |          |            |                     |            |
| Dipterocarpus gracilis Blume | Panau       | Basey, Samar | Native | VU | VU Quimio (2016); Villanueva et al. (2021b) |
| Hopea faxworthyi Elmer   | Dalingdingan | Basey, Samar | Endemic | CR | EN Quimio (2016); Villanueva et al. (2021b) |
| Hopea malibato Foxw.     | Yakal-kalot  | Basey, Samar | Endemic | CR | VU Quimio (2016); Villanueva et al. (2021b) |
| Hopea philippinensis Dyer | Gisok-gisok, Gisok | Mount Tabunan, Cebu; Taft, Eastern Samar, Paranas, Samar | Endemic | CR | EN Cadiz & Buot (2010); Obeña et al. (2021); Villanueva et al. (2021a) |
| Hopea quisumbingiana Gutierrez | Quisumbing Gisok | Paranas, Samar | Endemic | CR | EN Villanueva et al. (2021a) |
| Hopea samarensis Gutierrez | Samar Gisok  | Paranas, Samar | Endemic | CR | EN Villanueva et al. (2021a) |
| Parashorea molsolomonon (Blanco) Merr. | Bagtikan | Mount Tabunan, Cebu | Native | - | LC Cadiz & Buot (2010) |
| Shorea almon Foxw.       | Almon       | Basey, Samar | Native | VU | NT Quimio (2016); Villanueva et al. (2021b) |
| Shorea astylosa Foxw.    | Yakal       | Calicoan, Guian; Taft, Eastern Samar; Paranas, Samar; Basey, Samar | Endemic | CR | EN Quimio (2016); Fernandez et al. (2020); Obeña et al. (2021); Villanueva et al. (2021a, b) |
| Shorea contorta Vidal    | White Lauan, Lawaan na Puti | Mount Tabunan, Cebu; Parana, Samar | Endemic | VU | LC Cadiz & Buot (2010); Villanueva et al. (2021a) |
| Shorea falcoferoides Foxw. [= Shorea gisok Foxw.] | Yakal-yamban | Paranas, Samar | Native | VU | CR Villanueva et al. (2021a) |
| Shorea malibato Foxw.    | Yakal-malibato | Cantipla, Cebu | Endemic | CR | VU Cadiz & Buot (2009) |
| Family & scientific name | Common name | Location | Endemicity | Conservation status | References |
|--------------------------|-------------|----------|------------|---------------------|------------|
| **Ebenaceae**             |             |          |            | DAO 2017-11 IUCN    | References |
| Shorea negrosensis Faux. | Red Lauan, Takuban | Calicoan, Guiuan; Taft, Eastern Samar; Paramas, Samar | Endemic | VU | LC | Fernandez et al. (2020); Obeña et al. (2021); Villanueva et al. (2021a) |
| Shorea polysperma (Blanco) Merr. | Tanguile | Mount Lantoy, Cebu; Basey, Samar | Endemic | VU | LC | Quimio (2016); Lillo et al. (2019); Villanueva et al. (2021b) |
| Shorea squamata (Turcz.) Dyer ex S. Vidal | Mayapis | Basey, Samar | Endemic | - | LC | Quimio (2016); Villanueva et al. (2021b) |
| **Elaeocarpaceae**        |             |          |            |                    |            |
| Elaeocarpus fulvus Elmer | Lajanoughting-dilau | Pailig, Amilik, Baranti, Bagambang | Native | VU | - | Cadiz & Buot (2009) |
| **Euphorbiaceae**         |             |          |            |                    |            |
| Diospyros longiciliata Merr. | Itom-itom | Mount Lantoy, Cebu | Endemic | CR | EN | Lillo et al. (2019) |
| Diospyros pilosanthera Blanco | Bolong-eta | Mount Lantoy, Cebu | Native | VU | - | Lillo et al. (2019) |
| **Macaranga tanarius** (L.) Müll.Arg. | Minunga, Binunga | Mount Tabunan, Cebu; Calicoan, Guiuan | Native | - | LC | Cadiz & Buot (2010); Fernandez et al. (2020); Villanueva et al. (2021a) |
| Macaranga hispida (Blume) Müll. Arg. | Lagapak | Mount Tabunan, Cebu | Native | - | LC | Cadiz & Buot (2010) |
| Macaranga bicolor Müll. Arg. | Pailig, Arnilk, Barants, Bagambang | Mount Tabunan, Cebu; Calicoan, Guiuan | Endemic | - | LC | Cadiz & Buot (2010); Villanueva et al. (2021a) |
| Mallotus cumingii Muell.-Arg. | Apanang | Mount Tabunan, Cebu; Basey, Samar | Native | - | LC | Cadiz & Buot (2010); Villanueva et al. (2021a) |
| Mallotus philippensis (Lam.) Muell-Ang | Kamala Tree, Banato | Verde Island Passage, Batangas | Native | - | LC | Caringal et al. (2021) |
| Melanolopsis multiglandulosa (Reiniv. Ex. Blume) Rchb. F. & Zoll. | Alim | Mount Tabunan, Cebu; Verde Island Passage, Batangas | Native | - | LC | Cadiz & Buot (2010); Caringal et al. (2021) |
| Neoscortechinia arborea (Elmer) Pax & K.Hoffm. Syn. N. Nicobarica (Hook.f.) Pax & Hoffm. | Magong | Cantipla, Cebu | Native | - | LC | Cadiz & Buot (2009) |
| Neoscortechinia parvifolia (Merr.) Syn. N. Philippinensis (Merr.) | Magon-litian | Cantipla, Cebu | Native | - | LC | Cadiz & Buot (2009) |
| Tritaxis isoreoides (C.B.Rob.) R.Yiu & Welzen | Agindulong | Paramas, Samar | Endemic | - | VU | Villanueva et al. (2021a) |
| Family & scientific name | Common name | Location | Endemicity | Conservation status | References |
|--------------------------|-------------|----------|------------|---------------------|------------|
| **23 Fabaceae**          |             |          | DAO 2017-11 | IUCN               |            |
| *Acacia farnesiana* (L.) Willd. Syn. Vachellia farnesiana | Aroma | Verde Island Passage, Batangas | - | LC | Caringal et al. (2021) |
| *Acacia mangium* Willd. | Mangium | Cantipla, Cebu | - | LC | Cadiz & Buot (2009) |
| *Adenanthera intermedia* Merr. | Tanglin | Mount Lantoy, Cebu | Endemic | OTS | VU | Lillo et al. (2019) |
| *Afzelia rhomboidea* (Blanco) Vidal | Tindalo | Mount Lantoy, Cebu | Native | EN | - | Lillo et al. (2019) |
| *Albizia philippinensis* Nielsen | Unik | Verde Island Passage, Batangas | Endemic | - | VU | Caringal et al. (2021) |
| *Albizia procera* (Roxb.) Benth. | White Siris | Verde Island Passage, Batangas | Native | - | LC | Caringal et al. (2021) |
| *Albizia saponaria* (Lour.) Miq. | Salingkugi | Basey, Samar | Native | - | LC | Quimio (2016); Villanueva et al. (2021b) |
| *Archidendron clypearia* (Jack) I. C. Nielsen | Alobahay, Inep | Mount Tabunan, Cebu | Native | - | LC | Cadiz & Buot (2010) |
| *Bauhinia malabarica* Roxb. | Aibangbang | Verde Island Passage, Batangas | Native | - | LC | Caringal et al. (2021) |
| *Cassia spectabilis* L. | Antsoan-dilau | Cantipla, Cebu | - | - | LC | Cadiz & Buot (2009) |
| *Cynometra cebuensis* F.Seid. | Nipot-nipot | Mount Lantoy, Cebu | Endemic | CR | - | Lillo et al. (2019) |
| *Cynometra copelandii* (Elmer) Elmer | Matolog | Mount Taburan, Cebu | Endemic | - | CR | Cadiz and Buot (2010) |
| *Gliricidia sepium* (Jacq.) Kunth ex Walp. | Madre de Cacao | Verde Island Passage, Batangas | - | - | LC | Caringal et al. (2021) |
| *Intsia bijuga* (Cleb.) Kunze | Ipil | Mount Lantoy, Cebu | Native | VU | NT | Lillo et al. (2019) |
| *Tamarindus indica* Linn. | Tamarind, Sampalok | Verde Island Passage, Batangas | - | - | LC | Caringal et al. (2021) |
| *Wallisiodendron celebicum* Koord. | Banuyo, Salonggigi | Mount Lantoy, Cebu; Calicoan, Guiuan; Taft, Eastern Samar; Paranas, Samar | Native | VU | - | Lillo et al. (2019); Fernandez et al. (2020); Obena et al. (2021); Villanueva et al. (2021a) |
| **24 Fagaceae**           |             |          |            |                    |            |
| *Lithocarpus celebicus* (Miq.) Rehder (= *Lithocarpus llanosii* (A.DC.) Rehder) | Ulaian | Basey, Samar | Native | - | LC | Quimio (2016); Villanueva et al. (2021b) |
| **25 Gesneriaceae**       |             |          |            |                    |            |
| *Teijsmanniodendron pteropodum* (Miq.) Bakh. | Tikoko | Basey, Samar | Native | - | LC | Quimio (2016); Villanueva et al. (2021b) |
| **26 Gnetaceae**          |             |          |            |                    |            |
| *Gnetum gnemon* L. | Bago | Mount Tabunan, Cebu; Calicoan, Guiuan; Taft, Eastern Samar; Basey, Samar | Native | - | LC | Cadiz & Buot (2010); Quimio (2016); Fernandez et al. (2020); Obena et al. (2021); Villanueva et al. (2021b) |
| **27 Hypericaceae**       |             |          |            |                    |            |
| *Cratoxylum sumatranum* (Jack) Blume subsp. *Sumatranum* | Kansilay, Guyong-guyong | Verde Island Passage, Batangas | Native | - | LC | Caringal et al. (2021) |
| **28 Icacinaceae**        |             |          |            |                    |            |
| *Stemonurus gitingensis* (Elmer) Sleumer | Tugbak | Cantipla, Cebu | Endemic | - | EN | Cadiz & Buot (2009) |
| **29 Lamiaceae**          |             |          |            |                    |            |
| *Callicarpa erioclona* Schauer | Tambalabasi | Verde Island Passage, Batangas | Native | - | LC | Caringal et al. (2021) |
| *Gmelina arborea* Roxb. | Gmelina | Verde Island Passage, Batangas | - | - | LC | Caringal et al. (2021) |
| *Premna congesta* Merr. Syn. *Pseuropiptos* L. | Alakaag | Cantipla, Cebu | Native | - | LC | Cadiz & Buot (2009) |
| *Stachyophyto jamaiicensis* (L.) Vahl | Jamaica Vervain | Verde Island Passage, Batangas | - | - | LC | Caringal et al. (2021) |
| Family & scientific name | Common name | Location | Endemicity | Conservation status | References |
|--------------------------|-------------|----------|------------|---------------------|------------|
| Tectona philippinensis Benth. & Hook.f. | Philippine Teak | Verde Island Passage, Batangas | Endemic | EN | EN | Caringal et al. (2021) |
| Vitex parviflora Juss. | Molave | Mount Lantoy, Cebu; Verde Island, Batangas | Native | EN | LC | Lillo et al. (2019); Caringal et al. (2021) |
| Vitex quinata (Lour.) F.N. Williams | Kalipapa Saú, kalipapa, Hamulawen | Basey, Samar | Native | - | LC | Quimio (2016); Villanueva et al. (2021b) |
| Vitex turczaninowii Merr. Syn. Vitiopremna philippinensis (Turcz.) H.J. Lam. | Lingo-lingo | Mount Tabunan, Cebu; Parana, Samar | Native | - | LC | Cada & Buot (2010); Villanueva et al. (2021a) |
| Lauraceae | | | | | |
| Alseodaphne malabonga (Blanco) Kosterm. Syn. Nothaphoebe umbelliflora (Blume) | Malabunga, Yaban | Verde Island Passage, Batangas | Native | - | LC | Caringal et al. (2021) |
| Cinnamomum cebuense Kosterm. | Kalingag, Cebu Kalingag | Mount Lantoy, Cebu; Basey, Samar | Endemic | EN | EN | Cadiz & Buot (2009); Lillo et al. (2019) |
| Cinnamomum mercadoi S.Vidal | Mercadoi, Kalingag | Mount Lantoy, Cebu; Basey, Samar | Endemic | OTS | LC | Quimio (2016); Lillo et al. (2019); Villanueva et al. (2021b) |
| Cryptocarya amplo Merr. | Bagarilau | Mount Lantoy, Cebu | Endemic | VU | LC | Lillo et al. (2019) |
| Dehiaasia triandra Merr. Syn. D. incurassato (Jack) Nees | Makuhay | Verde Island Passage, Batangas | Native | - | LC | Caringal et al. (2021) |
| Litsea tomentosa Blume | Bakar-mabolo | Mount Tabunan, Cebu | Native | - | LC | Cada & Buot (2010) |
| Malvaceae | | | | | |
| Bombax ceiba DC. | Malabulak, Red Silk Cottontree | Verde Island Passage, Batangas | Native | - | LC | Caringal et al. (2021) |
| Camptostemon philippinensis (S. Vidal) Bess. | Gapas-gapas, Dandult | Basey, Samar | Native | EN | EN | Quimio (2016); Villanueva et al. (2021b) |
| Calona serratifolia Cav. | Anilao | Verde Island Passage, Batangas | Native | - | LC | Caringal et al. (2021) |
| Kleinovia hospita Linn. | Tan-ag | Parana, Samar | Native | - | LC | Villanueva et al. (2021a) |
| Pterocymbium tinctorium (Blanco) Merr. | Taloto | Mount Tabunan, Cebu | Endemic | - | LC | Cada & Buot (2010); Caringal et al. (2021) |
| Pterospermum diversifolium Blume | Bayo, Bayok | Verde Island Passage, Batangas | Native | - | LC | Caringal et al. (2021) |
| Thespesia populnea (Linn.) Soland. Ex Correa | Banalo, Portia Tree | Verde Island Passage, Batangas | Native | - | LC | Caringal et al. (2021) |
| Urena lobata L. | Dalupang, Kulotan, Caesar Weed | Verde Island Passage, Batangas | - | - | LC | Caringal et al. (2021) |
| Marantaceae | | | | | |
| Phrynium minutiflorum Sukasahan & Borchs. | Hagkhik (Bicol-Catanduanes) | Parana, Samar | Endemic | VU | - | Villanueva et al. (2021a) |
| Moraceae | | | | | |
| Artocarpus blancoi (Elm.) Merr. | Antipolo | Mount Tabunan, Cebu; Calicoan, Guiuan | Endemic | - | LC | Cada & Buot (2010); Fernandez et al. (2020) |
| Artocarpus odoratissimus Blanco | Marang | Mount Tabunan, Cebu | - | - | NT | Cada & Buot (2010) |
| Artocarpus rubrovenius Warb. | Tugop, Kalulot | Calicoan, Guiuan; Taft, Eastern Samar; Parana, Samar | Endemic | OTS | - | Fernandez et al. (2020); Obega et al. (2021); Villanueva et al. (2021a) |
| Family & scientific name | Common name | Location | Endemicity | Conservation status | References |
|--------------------------|-------------|----------|------------|---------------------|------------|
| Ficus ampeloides Burm.f. | Upling-gubat | Mount Tabunan, Cebu; Calicoan, Guian; Paranas, Samar | Native | - | LC | Cadiz & Buot (2010); Fernandez et al. (2020); Villanueva et al. (2021a) |
| Ficus congesta Roxb. | Malatbig | Cebu | Native | - | LC | Cadiz & Buot (2009) |
| Ficus drupacea Thunb. Var. Drupacea | Payapa, Norok, Brown Woolly Fig | Verde Island Passage, Batangas | Native | - | LC | Caringal et al. (2021) |
| Ficus lineanfolia Elmer | Tabog | Mount Tabunan, Cebu | Endemic | - | LC | Cadiz & Buot (2010) |
| Ficus minahassae (De Vriese & Teijsm.) Miq. | Hagimit | Mount Tabunan, Cebu; Calicoan, Guian | Endemic | - | LC | Cadiz and Buot (2010); Fernandez et al. (2020) |
| Ficus nota (Blanco) Merr. | Tibig | Mount Tabunan, Cebu | Native | - | LC | Cadiz & Buot (2010) |
| Ficus odorata (Blanco) Merr. | Pakiling | Mount Tabunan, Cebu | Endemic | - | LC | Cadiz & Buot (2010) |
| Ficus septica Burm. F. | Hawili, Labnog | Mount Tabunan, Cebu | Native | - | LC | Cadiz & Buot (2010) |
| Ficus stipulosa Miq. Syn. F. Caulocarpa (Miq.) | Dalakit | Calicoan, Guian | Native | - | LC | Fernandez et al. (2020) |
| Ficus sumatranus Miq. Var. Microcarya Corner | Baleang-an, Baleang-iitan | Verde Island Passage, Batangas | Native | - | LC | Caringal et al. (2021) |
| Ficus ulmifolia Lam | Is-is | Verde Island Passage, Batangas | Endemic | - | VU | Caringal et al. (2021) |
| Ficus variegata Blume | Tangisang Bayawak | Mount Tabunan, Cebu | Native | - | LC | Cadiz & Buot (2010); Caringal et al. (2021) |
| Streblus asper Lour. | Kalios | Verde Island Passage, Batangas | Native | - | LC | Caringal et al. (2021) |
| Streblus ilicifolius (Vid.) Corner syn. Taxotrophis ilicifolia | Kuyos-kuyos | Verde Island Passage, Batangas | Native | - | LC | Caringal et al. (2021) |
| Morella javanica (Blume) I.M.Turner [=Myrica javanica Blume] | Hindang | Basey, Samar | Native | - | LC | Quimio (2016); Villanueva et al. (2021b) |
| Horsfieldia ardisiifolia (A.DC.) Warb. | Dagoan, Tigan-tigan | Paranas, Samar | Endemic | - | VU | Villanueva et al. (2021a) |
| Horsfieldia samarensis W.J.de Wilde | Samar Yabnob | Paranas, Samar | Endemic | VU | CR | Villanueva et al. (2021a) |
| Knema stellata ssp. Stellata | Durogo, Panigan | Paranas, Samar | Native | - | VU | Villanueva et al. (2021a) |
| Myristica agusanensis Elmer | Agusan Duguan | Mount Tabunan, Cebu | Endemic | - | NT | Cadiz & Buot (2010) |
| Myristica laevis subsp. Loevis de Wilde | - | Basey, Samar | Endemic | - | VU | de Wilde (1997); Villanueva et al. (2021b) |
| Myristica philippinensis Gand. | Duguan | Basey, Samar | Endemic | OTS | - | Quimio (2016); Villanueva et al. (2021b) |
| Myristica pilosigemma W.J.de Wilde | - | Paranas, Samar | Endemic | OTS | CR | Villanueva et al. (2021a) |
| Discocalyx euphlebia Merr. | Dikai-dikaian | Cebu | Endemic | - | EN | Cadiz & Buot (2009) |
| Eugenia tulanan Merr. [=Jossinia tulanan (Merr.) Merr.] | Tulanan | Basey, Samar | Endemic | - | EN | Quimio (2016); Villanueva et al. (2021b) |
| Psidium guajava L. | Guava | Verde Island Passage, Batangas | - | - | LC | Caringal et al. (2021) |
| Syzygium mindorensis (C.B. Rob.) Merr. | Butor | Verde Island Passage, Batangas | Endemic | - | VU | Caringal et al. (2021) |
| Syzygium hutchinsonii (C.B. Robinson) Merr. | Malatambis | Basey, Samar | Endemic | - | CR | Quimio (2016); Villanueva et al. (2021b) |
| Syzygium striatulum (C.B. Rob.) Merr. | Malaruhat Sapa | Basey, Samar | Endemic | - | VU | Quimio (2016); Villanueva et al. (2021b) |
| Syzygium trianthum (Merr.) Merr. | Tubal | Cebu | Endemic | - | EN | Cadiz & Buot (2009) |
| Tristania micrantha Merr. | Tiga | Basey, Samar | Endemic | - | EN | Quimio (2016); Villanueva et al. (2021b) |
| Family & scientific name | Common name | Location | Endemicity | Conservation status | References |
|--------------------------|-------------|----------|------------|---------------------|------------|
| *Tristaniopsis decorticata* (Merr.) Wilson & Waterhouse | Malabayabas | Mount Lantoy, Cebu | Endemic | VU | LC | Lillo et al. (2019) |
| *Opiliaceae* | | | | | | |
| *Champearea maniliana* Blume | Garimo, Liyong-liyong | Mount Tabunan, Cebu | Native | - | LC | Cadiz & Buot (2010) |
| *Phyllanthaceae* | | | | | | |
| *Antidesma ghaesembilla* Gaertn. var. *Ghaesembilla* | Binayuyo | Verde Island Passage, Batangas | Native | - | LC | Caringal et al. (2021) |
| *Antidesma pentandrum* (Blanco) Merr. syn. *A. Montanum* Blume | Bignai-pogo | Verde Island Passage, Batangas | Native | - | LC | Caringal et al. (2021) |
| *Bryonia cernua* (Poir.) Muell.-Arg. | Matang-ulang | Mount Tabunan, Cebu | Native | - | LC | Cadiz & Buot (2010) |
| *Bryonia vitis-idaea* (Burm. F.) | Matang-hipon | Verde Island Passage, Batangas | Native | - | LC | Caringal et al. (2021) |
| *Bridelia glauca* Blume | Anislag | Calicoan, Samar; Paranas, Samar | Native | - | LC | Fernandez et al. (2020); Villanueva et al. (2021a) |
| *Rubiaceae* | | | | | | |
| *Antherostele grandistipula* | Kurudan | Basey, Samar | Endemic | EN | VU | Obico & Alejandro (2013); Villanueva et al. (2021b) |
| *Antherostele samoensinis* Obico & Alejandro | Basey, Samar | Endemic | CR | - | Obico & Alejandro (2013); Villanueva et al. (2021b) |
| *Anthirhoe livida* Elmer | Lumangog | Basey, Samar | Endemic | VU | VU | Quimio (2016); Villanueva et al. (2021b) |
| *Astracocarpus obscurenervius* (Merr.) Puttock | Kalangi | Cantipla, Cebu | Endemic | CR | VU | Cadiz & Buot (2009) |
| *Dolicholobium philippinense* Treenteuse | - | Cantipla, Cebu | Endemic | - | NT | Cadiz & Buot (2009) |
| *Guetarda speciosa* Linn. | Banaro | Verde Island Passage, Batangas | Native | - | LC | Cadiz et al. (2021) |
| *Mussaenda philippica* A. Rich | Kahoy-dalaga | Verde Island Passage, Batangas | Endemic | - | LC | Cadiz et al. (2021) |
| *Neonauclea formicaria* Elm. | Hambabalalud, Ambabalod | Calicoan, Guiuan; Paranas, Samar; Taft, Eastern Samar; Basey, Samar | Endemic | - | LC | Quimio (2016); Fernandez et al. (2020); Obena et al. (2021); Villanueva et al. (2021a, b) |
| *Tarenia littoralis* Merr. syn. *Capitosperma littorale* | Bosiling-dagat | Verde Island Passage, Batangas | Endemic | - | LC | Caringal et al. (2021) |
| *Timonius appendiculatus* Merr. | Upong-upong, Pututan | Basey, Samar | Endemic | - | VU | Quimio (2016); Villanueva et al. (2021b) |
| *Rutaceae* | | | | | | |
| *Lunasia amara* Blanco | Lunas | Mount Tabunan, Cebu | Native | - | LC | Cadiz & Buot (2010) |
| *Sapindaceae* | | | | | | |
| *Dimocarpus foxtato* (Radlk.) Leenh. | Mahugis, Pamingtin | Verde Island Passage, Batangas | Endemic | - | EN | Caringal et al. (2021) |
| *Dimocarpus longan* Lour. Ssp. *Longan var. Malexianus* | Alupag Lalaki, Longan Tree | Mount Tabunan, Cebu | - | - | NT | Cadiz & Buot (2010) |
| *Dodonaea viscose* (Linn.) Jacquin | Kalapinay | Verde Island Passage, Batangas | Native | - | LC | Caringal et al. (2021) |
| *Gloeocarpus patentivalvis* (Radlk.) Radl. | - | Mount Tabunan, Cebu | Native | - | LC | Cadiz & Buot (2010) |
| *Glycosperma potentivialis* (Radlk.) Radl. | Yambo, Igiw | Paranas, Samar | Endemic | EN | NT | Villanueva et al. (2021a) |
| *Guioa discolor* Radl. | Alahan-puti | Paranas, Samar | Endemic | VU | VU | Villanueva et al. (2021a) |
| *Harpullia arbores* (Blanco) Radl. | Puwas, Uwos | Verde Island Passage, Batangas | Native | - | LC | Caringal et al. (2021) |
| *Litchi chinensis* Sonn. Subsp. *Philippinensis* (Radlk.) Leenh. | Alupag | Mount Lantoy, Cebu | Native | VU | VU | Lillo et al. (2019) |
| *Lepisanthes fruticosa* (Roxb.) Leenh. | Linawnaw | Mount Tabunan, Cebu | Native | - | LC | Cadiz & Buot (2010) |
updated based on recent activities since the previous assessment.

The island of Samar, where SINP and GMRPLS are located, has been subjected to anthropogenic pressures such as timber cutting due to extensive logging, rattan extraction, and kaingin extraction (clearing of land through slash-and-burn agriculture) (Fernandez et al. 2020; Obeña et al. 2021; Villanueva et al. 2021a). Mount Cantipla (Cadiz & Buot 2009), Mount Tabunan (Cadiz & Buot 2010), Mount Lantoy (Lillo et al 2019, 2021) forest in Cebu and Verde Island Passage in Batangas (Caringal et al. 2021) have been harmed by illegal logging and land use change activities. This is indeed true as also reported in several studies (Dirzo & Raven 2003; Rodrigues et al. 2006; Wright 2010; Croteau & Mott 2011). A variety of human activities, including habitat destruction, logging operations, shifting cultivation, fragmentation and degradation, pollution, the introduction of non-native species, and over-exploitation resulting from the conversion of natural vegetation such as forests into other uses amidst aggravating climate change issues, contribute to species endangerment and eventual local plant extinctions in the tropics. Many dipterocarp species, for instance, are particularly vulnerable in Southeast Asia because they play a unique role in forest ecology and are highly valued for their timber (Ashton & Kettle 2012; Maycock et al. 2012), and hence, are prone to exploitation through overharvesting (Sodhi et al. 2004; Fernando et al. 2015; McKinney 1997). If these anthropogenic threats are not mitigated and prevented, the number of woody plant species will decline and likely become extinct in the future. In fact, Koh et al. (2004) predicted that 6,300 species would become endangered if their host species become extinct. This is critical in the context of our forests over limestone not only those in Samar Island and the entire Philippines, but throughout the tropics. The ecosystem is already in severe stress due to microhabitat agroclimatic challenges, thus, if other
Woody plant species from forests over limestone of Philippines

Image 1. Critically Endangered (CR) species: a—Hopea philippinensis Dyer | b—Shorea astylusa Foxw. | c—Hancea wenzeliana (Silk) S.E.C. Sierra, Kulju & Welzen. © CONserve-KAIGANGAN.

Image 2. Endangered (EN) species: a—Tectona philippinensis Benth. & Hook.f. | b—Cinnamomum cebuense Kosterm | c—Camptostemon philippinense (S. Vidal) Becc. © a—Caringal, A.; b—Cebu Cinnamon Tree FB page; c—Buot et al. 2022.

Image 3. Vulnerable (VU) species: a—Aquilaria cumingiana (Decne.) Ridl. | b—Wallaceodendron celebicum Koord. | c—Shorea negrosensis Foxw. © CONserve-KAIGANGAN.
anthropogenic disturbances occur, growth and survival of indigenous and endemic flora as well as fauna will be negatively affected. Also, these activities could have serious consequences on the livelihood of the local people who rely on them.

Unfortunately, the decline in number of some threatened woody plant species from various locations throughout the country has not yet been documented for inclusion in the Philippine red list or the IUCN. With 95% of plant species yet to be assessed on a global scale, new approaches to conservation assessment are urgently needed (Lughadha et al. 2005; Krupnick et al. 2009; Schatz 2009; Miller et al. 2012).

Notes on some threatened species in forests over limestone with economic importance

**Agathis philippinensis Warb.**

*Agathis philippinensis*, commonly known as almaciga, can be found in the Philippines, Moluccas and Sulawesi. It is tapped and produces high quality of resin commercially known as Manila copal, which is used as raw material for varnish, lacquer, paper paint driers, linoleum, and ink, among others (Brown 1921; Samiano & Ella 2014). Due to the current high market demand for resin, sustained pressure from logging and resin collection, as well as unsustainable tapping methods, has contributed to declining populations of *A. philippinensis* in the Philippines (Jose 2018).

Conservation status: Vulnerable (DAO 2017-11).

**Antirhea livida Elmer**

*Antirhea livida* is an endemic found in Luzon and Mindanao. Based on the IUCN (2022) assessment, this species will continue to decline due to the habitat-threatening effects of commodity-driven deforestation, shifting agriculture, urbanization, and losses from forest plantations and natural forest harvesting. Despite having a relatively large distribution, the species is still classified as Vulnerable due to its limited number of locations, small area of occupancy (AAO) value, and current threats to population and habitat quality. As such, immediate and active conservation measures must be considered to prevent the species from being pushed into a more threatened category in the future (IUCN 2022).

Conservation status: Vulnerable (DAO 2017-11 & IUCN).

**Aquilaria cumingiana** (Decne.) Ridl.

*Aquilaria cumingiana* is a shrub or small tree which is found in the Philippines and Indonesia. *A. cumingiana* most famous product is agarwood, a resin containing heartwood produced from old and diseased trees (Tawan 2003) that is used for ornamentation, perfume and aromatic purposes (Swee 2008). Anthropogenic pressure on lowland primary forest within the range is reducing the amount of available habitat across its range (Lemmens & Bunyaaphraphatsara 2003).

Conservation status: Vulnerable (DAO 2017-11 & IUCN).

**Camptostemon philippinensis**

According to the IUCN (2022) assessment, this species is extremely rare and has a limited and patchy distribution in Indonesia and the Philippines. Throughout its range, it is severely threatened by the removal of mangrove areas for fish and shrimp aquaculture, as well as coastal development. It is estimated that there are less than 2,500 mature individuals left and there has been a least 30% decline in mangrove area within this species range since 1980 (one generation length).

Conservation status: Endangered (DAO 2017-11 & IUCN).

**Cinnamomum cebuense** Kosterm.

*Cinnamomum cebuense* is an endemic tree species in the Philippines. Based on the assessment of IUCN (2022), the population of this species is expected to continuing declining due to the habitat threatening effects of commodity-driven deforestation, urbanization, unsustainable farming practices, and large-scale forestry operations. The species occurs naturally in Cebu Protected Landscape, providing some passive conservation. However, more proactive measures (e.g., artificial propagation, reintroduction to various arboreta in the country) should be implemented to prevent the species from becoming more threatened in the future.

Conservation status: Endangered (DAO 2017-11 & IUCN).

**Dipterocarpus gracilis** Blume

*Dipterocarpus gracilis* is native to the Philippines. The wood of this species is used for general building construction, particularly for house posts and frames, planking in lighters and ships, flooring, piling, bridge construction, wharves, and railroad ties (NRMC 1986). Due to continued deforestation and overexploitation, the DAO 2017-11 and IUCN (2022) classified this species as Vulnerable. The IUCN (2022) recommended that species harvest and trade be monitored, that remaining
habitats be protected, and that research into the genetic diversity of the species be conducted.

Conservation status: Vulnerable (DAO 2017-11 & IUCN).

*Dracontomelon dao* (Blanco) Merr. & Rolfe

*Dracontomelon dao* species according to NRMC (1986), is used for sliced and rotary veneers, furniture making, cabinet work, tables, panels, boxes, and matches. Because of logging, kaingin making, and conversion of low elevation forest to agricultural lands, its ecological status has depleted.

Conservation status: Vulnerable (DAO 2017-11) / Least Concern (IUCN).

*Goniothalamus lancifolius* Merr.

*Goniothalamus lancifolius* is an endemic tree. The species is assessed as endangered in IUCN due to population declines caused by illegal logging, shifting cultivation and land conversion. It is expected to decline as a result of these threats (IUCN 2022).

Conservation status: Endangered (DAO 2017-11 & IUCN).

*Guioa discolor* Radlk.

*Guioa discolor* is an endemic tree. Based on the assessment of IUCN (2022), this species will continue to decline due to the habitat-threatening effects of commodity-driven deforestation, shifting agriculture, urbanization, and losses from forest plantation and natural forest harvesting. Immediate and active conservation measures are needed to keep the species from becoming more threatened in the future.

Conservation status: Vulnerable (DAO 2017-11 & IUCN).

*Hopea foxworthyi* Elmer

*Hopea foxworthyi* is endemic. Its wood is used for general house construction, posts, bridge timber, and other wood applications that require strength and durability (NRMC 1986).

Conservation status: Critically Endangered (DAO 2017-11) / Endangered (IUCN).

*Hopea philippinensis* Dyer

*Hopea philippinensis* is endemic to the Philippines. Based on NRMC (1986), this species is used locally for house posts and temporary railroad ties, but it is not widely used in construction due to its small size. However, *H. philippinensis* is depleted as a result of logging and kaingin making.

Conservation status: Critically Endangered (DAO 2017-11) / Endangered (IUCN).

*Kibatalia puberula* Merr.

*Kibatalia puberula* is endemic to the Philippines. Based on IUCN (2022), information, *K. puberula* is restricted only in Samar and Leyte where it is known from dipterocarp forests or riverbanks, at elevation ranging from 100 to 250 meters asl. The species has a small area of occupancy and extent of occurrence, and it is declining due to threats to its habitat such as unlawful logging, poaching, charcoal making and firewood collection in Mt. Nacolod. These factors contribute to population decline of this species.

Conservation status: Endangered (DAO 2017-11 & IUCN).

*Litchi chinensis* Sonn.

*Litchi chinensis* is native to the Philippines and New Guinea. According to Pareek (2016), this species is cultivated commercially in more than 20 countries. It is a high-value tropical fruit on the international fruit market (Miranda-Castro 2016). Because it is the best source of gutta-percha in the Philippines, destructive harvesting of the trees for gutta-percha in the past has severely eroded population levels (Brown 1920).

Conservation status: Vulnerable (DAO 2017-11 & IUCN).

*Palaquium luzoniense* (Fern.-Villar) S. Vidal

*Palaquium luzoniense* is a native species in the Philippines and Sulawesi. The timber constitutes the majority of red nato in the Philippines. It is used to make furniture and cabinets, cigar boxes, and ship planking, as well as veneer and plywood. The latex of this species is used to make gutta-percha (Lemmens 1993).

Conservation status: Vulnerable (DAO 2017-11 & IUCN).

*Shorea almon* Foxw.

*Shorea almon* is native to the Philippines and Borneo. The wood of *S. almon* is used for furniture and interior work of all kinds, boat planking and decking patterns, and for uses requiring a moderately hard and comparatively light wood with a beautiful ribbon figure. This species is in great demand for plywood both of rotary and sliced veneer. However, *S. almon* is now depleted due to logging and kaingin making (NRMC 1986).

Conservation status: Vulnerable (DAO 2017-11) / Near Threatened (IUCN).
Shorea astylosa Foxw.

*Shorea astylosa* is a Philippine endemic. It is used for high-grade construction, bridges and wharves, mine timber and other installations requiring high strength and durability. However, due to logging and kaingin making, *S. astylosa* is now threatened (NRMC 1986).

Conservation status: Critically Endangered (DAO 2017-11) / Endangered (IUCN).

Shorea contorta Vidal

*Shorea contorta* is a Philippine endemic. According to NRMC (1986), the wood of this species is used for general construction, veneer, hardboard and plywood making, and cabinet and furniture making. *S. contorta* is now depleted due to logging and kaingin making.

Conservation status: Vulnerable (DAO 2017-11) / Least Concern (IUCN).

Shorea malibato Foxw.

*Shorea malibato* is endemic to the Philippines. This species as stated in NRMC (1986), this species is primarily used in permanent and general construction, ship framing, wharves, railroad ties, and other applications requiring strength and durability. *S. malibato* is now under threat due to logging and kaingin making.

Conservation status: Critically Endangered (DAO 2017-11) / Vulnerable (IUCN).

Shorea negrosensis Foxw.

*Shorea negrosensis* is an endemic tree. It is commonly used for furniture and cabinet work of all kinds, veneer, hardboard and plywood, sash and millwork, boat planking and decking, and general building construction. However, the ecological status of this species is depleted due to logging and kaingin making (NRMC 1986).

Conservation status: Vulnerable (DAO 2017-11) / Least Concern (IUCN).

Tectona philippinensis Benth. & Hook.f.

*Tectona philippinensis* is endemic to the Philippines. It is restricted only in coastal forests, littoral cliffs, and inland limestone ridges. This species is highly threatened due to its habitat preference, which is vulnerable to land conversion and development. It is also harvested for its timber and used to make fuelwood and charcoal (IUCN 2022).

Conservation status: Endangered (DAO 2017-11 & IUCN).

Vitex parviflora Juss.

*Vitex parviflora* can be found throughout the Philippines. This wood of this species is used for construction work that requires strength and durability, such as railroad ties, bridge posts, etc. Its ecological status is depleted due to logging and kaingin making (NRMC 1986).

Conservation status: Endangered (DAO 2017-11) / Least Concern (IUCN).

Framework for sustainable conservation of threatened taxa

We developed and are proposing a framework for sustainable conservation of forests over limestone threatened species (Figure 5) to arrest their continuous decline. The framework illustrates an integrated practice of in situ and ex situ conservation strategies supportive of enhanced onsite protection and plant reintroduction (Buot 2008a,b,c; Kawelo et al. 2012; Miller et al. 2016; Tobias et al. 2021). If implemented with the aid of community participation, localized and national policy implementation, this could help save the species from extinction.

The framework emphasizes the enhancement of the ecosystem structure, function, and processes through practical and locally doable in situ and ex situ strategies. The integrity of the ecosystems rests in having a rich species composition and diversity (structure) and stable and dynamic ecosystem function and processes (Sulistiyowati & Buot 2013, 2016, 2020; Sulistiyowati et al. 2017). In situ strategy via the protected area systems, remain the country’s best hope for preserving plant biodiversity and genetic resources onsite (Fernando et al. 2015), such as those found in some areas in Samar Island forests over limestone and many other types of forests in the country (e.g., Cebu’s Mounts Tabunan, Cantipla, Lantoy) and in other parts of the world. There are still large tracts of forests over limestone which are not yet covered by national or even local protection (e.g., in GMRPLS).

Ex situ strategy, on the other hand, can be used to preserve groups of species that have experienced rapid declines as a result of anthropogenic activities, especially land use conversion. This conservation strategy can take the form of cultivation in botanic gardens and gene banks, nursery propagation, backyard gardening (Tobias et al. 2021), and establishment of forest groves and patches, to name a few. These forms of ex situ strategy will ensure the preservation of the species gene pool and can be used in reforestation and reintroduction in the natural habitat.
Some enabling mechanisms are critical for the framework to be a success. In Figure 8, enabling mechanisms are divided into two columns. The left side enumerates the usual enabling strategies which have failed in many instances in the past. In this proposed framework, we included a PLUS (+) sign to illustrate the importance of the second column. As usual, there should be livelihood opportunities for the community (DENR-PAWB et al. 2003). The economic currency is of utmost importance for the community to understand the ecological contexts of conservation of the forests over limestone. Then, local community motivation is essential to participate in conservation strategies because success and failure of any task, is largely dependent on local people (Toit 2002), the empowered local people (Mathur 1997). Alongside this, there should be sustained forest conservation advocacy and the availability of appropriate community education and public awareness (CEPA) materials (Tolentino et al. 2019; Buot 2020; Buot & Buhay 2022). Additionally, coupled with localized conservation policies (Villanueva & Buot 2020) and national executive orders (Chanthavong & Buot 2019; Betts et al. 2020; Buot & Buhay 2022), we are positive to have a good enabling mechanism for conservation of threatened taxa.

The aforementioned had been done in the past and yet, we still are struggling to stop escalating depletion of plant resources leading to extinction. Hence, we thought of adding the second column of the Enabling Mechanism in Figure 5. We emphasize the PLUS sign (+). We envision the need for passionate leadership examples, sincere efforts of the local government units and a highly motivated local community to attain success in our conservation efforts. The success of these conservation strategies and initiatives is dependent on the extent and dedicated engagement of the innovator with the local government unit and the community members, themselves. The change agent/innovator should have the passion and sincere intentions to earn community’s trust and attention.

CONCLUSION AND RECOMMENDATION

The findings of the study revealed that 40.81% of the threatened species found in forests over limestone in SINP, GMRPLS, Mt. Lantoy, Tabunan, Cantipla forest, and Verde Island Passage are indigenous and endemic to the Philippines. These species are primarily threatened by natural (typhoons, landslides, climate change) and anthropogenic activities such as unlawful logging and land conversion. There is an urgent need to address the steady increase in the number of these endangered species in recognition of their critical role in ecosystem structure and processes that would keep the integrity of the forests over limestone ecosystems in the country and in the world. A framework has been suggested in this paper to stop the continued species loss by integrating in situ and ex situ conservation strategies along with enabling mechanisms like enhancing livelihood, community awareness and participation to name a few, in order to stabilize species richness and diversity and hence, ecosystem function, processes, and dynamics. These will lead to the overall conservation of forests over limestone ecosystems, and hence, sustaining the life of the community in the vicinities through the sustained provision of ecosystem services.

The findings of this study will help achieve the
Sustainable Development Goals (SDGs) by protecting and conserving biodiversity, promoting, and sustainably managing resources, and preventing human pressures in forests over limestone in the Philippines.

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