



AGARWOOD (*AQUILARIA MALACCENSIS*) IN MALAYSIA

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Forest Research Institute Malaysia (FRIM). This document is prepared only for *Aquilaria malaccensis* found in Malaysia. Little information is available for other agarwood-producing species in Peninsular Malaysia, Sabah and Sarawak. Apart from the geographical distribution, no stocking, harvest and trade data are available.

I. BACKGROUND INFORMATION ON THE TAXA

1. BIOLOGICAL DATA

1.1 Scientific and common names

Aquilaria malaccensis Lam. (Thymelaeaceae). Common names: agarwood, aloeswood, eaglewood. Vernacular names: gaharu, karas (Indonesia and Malaysia). Twelve other native species, belonging to the genera *Aetoxylon*, *Aquilaria*, *Gonystylus* and *Wikstroemia* (all Thymelaeaceae), are thought to produce agarwood (Appendix 1). In Sarawak, it is *Aetoxylon sympetalum* that produces the 'true gaharu wood' (Anderson 1980).

1.2 Distribution

The phytogeographical region for *Aquilaria malaccensis* comprises India, Myanmar, Sumatra, Peninsular Malaysia, Singapore, Borneo and the Philippines. Its geographical distribution in Peninsular Malaysia is given in Fig. 1. Although the species is widespread, it occurs at low density.

Aquilaria malaccensis is absent from Sarawak while other species of this genus are reported to be generally rare (Tawan 2004). *Aetoxylon sympetalum*, a species that is a source of gaharu, was noted as being locally frequent in the heath forests in west Sarawak (Anderson 1980) and fairly common throughout the State (Tawan 2004). *Aetoxylon sympetalum* is absent from Sabah.

1.3 Biological characteristics

1.3.1 General biological and life history characteristics of agarwood

Aquilaria malaccensis produces seeds after 7–9 years while some other species produce seeds only once in their life cycle. Seed viability is approximately 1 week and germination takes place between 16–63 days (Ng 1992). Germination is epigeal and of the hypogeal type. Not all mature trees produce the gaharu resin. Germination rates may reach 90% for mature fruits that are sown immediately (Chang, pers. comm.). Trial planting on the grounds of the Forest Research Institute Malaysia have shown that survival of tissue-cultured plantlets 24 months after planting was 66.3% while that of seedlings was 40.3%. The initial and final plantlet heights were 43.1 and 136.6 cm, respectively, while those for the seedlings were 27.9 and 114.8 cm, respectively (Lok et al. 1999). A 0.9-ha research plot planted with 833 trees ha⁻¹ in 1928 had a density of 31 trees ha⁻¹ in 1995. The mean diameter at breast height (dbh) of the stand was 38.2 cm with a mean height of 26.7 m and a mean clear bole height of 15.7 m (Lok & A. Zuhaidi 1996).

The Third National Forest Inventory (NFI-3) conducted between 1991 and 1993 for Peninsular Malaysia showed that *Aquilaria* spp. occurred in both logged and primary forests (Chin et al. 1997). In the 'Best Virgin Forest' category, there were 1.79 stems per hectare in size classes above 10 cm dbh (Chin et al. 1997).

The Fourth National Forest Inventory (NFI-4), conducted between 2002 and 2004 for Peninsular Malaysia, provides the *Aquilaria* spp. stocking in the virgin, logged-over and stateland forests (Table 1; Anon. 2006a). It estimated 0.62 stem ha⁻¹ for size classes >10 cm dbh for all *Aquilaria* spp. These stems have an estimated timber volume of 0.311 m³ ha⁻¹. Trees 10–14.9 cm dbh made up 48% of the total stem number while trees 15–44.9 cm dbh provided 67% of the total volume (Anon. 2008). The state of Pahang has the highest volume of *Aquilaria* while Kelantan has the highest number of stems (Mohd Paiz 2006). The above estimates are for stem number and timber volume of all *Aquilaria* species, noting that not all stems produce the *gaharu* resin.

Results from a long-term, large-scale demographic study indicate a poor stocking of seedlings through natural regeneration in a primary forest. In the Pasoh 50-ha tree demographic plot, at least 125 trees above 1 cm dbh were recorded in 1985 (Manokaran et al. 1992). The individuals were distributed evenly throughout the plot with no indication of spatial patterning (Fig. 2), occurring on wet ground, hill slopes, on sand and clay (LaFrankie 1994). 53.6% of trees had diameters <5 cm with the largest tree 41.3 cm dbh. The density of trees >10 cm dbh was slightly less than one tree per hectare and assuming a reproductive

size of approximately 10 cm dbh, the juvenile to adult ratio was only 1.5. Based on a median inter-census period of 2.81 years, LaFrankie (1994) worked out the recruitment rate to be 1.42 trees year⁻¹ for the entire 50-ha plot. Growth rates ranged from 0 to 1.95 cm year⁻¹. The distribution of growth rates was strongly skewed with a mean value of 0.33 cm year⁻¹ and a median value of 0.22 cm year⁻¹.

Table 1. Stocking of *Aquilaria* spp. in the virgin, logged-over and stateland forests in Peninsular Malaysia between 2002?2004 according to dbh class.

State	DBH class 15-30 cm		DBH class 30-45 cm		DBH class >45 cm		Total	
	No. stem/ha	Volume (m ³ /ha)	No. stem/ha	Volume (m ³ /ha)	No. stem/ha	Volume (m ³ /ha)	No. stem/ha	Volume (m ³ /ha)
Johor	-	-	29,920	37,281	14,673	59,424	44,593	96,705
Kedah	83,869	26,502	16,282	20,624	10,855	22,795	111,006	69,921
Kelantan	1,413,067	181,084	-	-	-	-	1,413,067	181,084
Melaka	2,037	1,513	-	-	218	1,002	2,255	2,515
Negeri Sembilan	4,464	496	-	-	8,846	19,857	13,310	20,353
Pahang	570,169	310,030	377,034	392,636	25,261	101,045	972,464	803,711
Penang	5,674	2,459	-	-	-	-	5,674	2,459
Perak	106,919	60,602	160,457	149,194	41,568	60,966	310,944	270,762
Terengganu	122,873	23,566	18,853	15,711	50,437	342,650	192,163	381,927
Total	2,309,072	606,252	602,546	615,446	151,858	607,739	3,065,476	1,829,437

Source: Anon 2006a

Lee *et al.* (2002) reported approximately 278 stems of *Aquilaria beccariana* (>1 cm dbh) from a 52-ha long-term ecological research plot in Lambir Hills National Park (Fig. 3). However, Dawend *et al.* (2005) reported that most of the trees in this plot had been wounded by collectors and were felt to be too small to sustain the population. As for Sabah, there has been no recent study on agarwood-producing species.

1.3.2. Habitat types

Aquilaria malaccensis is widespread in the lowland dipterocarp and mixed dipterocarp forests at altitudes up to 270 m while *Aetoxylon sympetalum* occurs in the lowland mixed dipterocarp forest and heath forest at altitudes up to 100 m.

1.3.3 Role of the species in its ecosystem

The role of the species in its ecosystem is unknown.

1.4 Population

1.4.1 *Global Population size*

The Malaysian data is insufficient to extrapolate the global population size of the species since little is known about the regeneration pattern and size class distribution within the larger extent of its range.

1.4.2 *Current global population trends*

The population is decreasing. Many studies have reported a reduction in natural populations in Peninsular Malaysia (Mah *et al.* 1983, Giano 1986), Sarawak (Chin 1985, Dawend *et al.* 2005, Brookfield *et al.* 1995) and Sabah (Judeth *et al.* 2000, Henrik 2001, Anon. 2005b).

1.5 Conservation status

1.5.1 *Global conservation status* (according to IUCN Red List) VU A1cd (ver 2.3)

1.5.2 *National conservation status for Malaysia* VU A4c (2007)

1.5.3 *Main threats within Malaysia* Unsustainable harvest, habitat loss/degradation (human induced).

2 SPECIES MANAGEMENT IN MALAYSIA

2.1 Management measures

2.1.1 *Management history*

Harvesting in the Malaysian production forests follows the Selective Management System (SMS). All production forests of the Permanent Reserved Forests (PRFs) in Peninsular Malaysia are managed through the SMS. This system is currently intertwined with the Malaysian Criteria and Indicators for Forest Management Certification, a market-linked tool to promote and encourage sustainable forest management as well as to provide an assurance to buyers that the timber products they purchase come from sustainably managed forests. Prior to the SMS, Malaysia had practised the Malayan Uniform System, whereby the mature stand in a primary forest was cleared in a single commercial felling followed immediately by systematic silviculture treatments to release natural regeneration obtained from advanced growth (Wyatt-Smith 1995).

There was no specific management plan for agarwood-producing species under the SMS. Agarwood is treated as a minor forest product.

Global demand prior to 1975 was specific to niche markets and harvesting was done selectively. Harvesting only became unsustainable when the price of *gaharu* escalated.

No harvesting is permitted in areas gazetted as Totally Protected.

2.1.2 *Purpose of the management plan in place*

The SMS was formulated in 1978 to recognize the importance of a balance between sustainability of harvesting with long-term conservation. It was also designed to achieve sustainability of harvest with minimum development costs and optimise harvesting under prevailing conditions.

2.1.3 *General elements of the management plan*

Since agarwood is treated as a minor forest product, harvesting of the species is not subjected to the restrictions imposed in the SMS, i.e., there is no cutting cycle and the minimum diameter limit of 45 cm is not observed.

A Standard of Procedures was developed in 2005 to control and monitor harvesting, processing and trade activities (Anon. 2005a). With regards to the harvest license, a deposit of MYR10,000 (approx. US \$3,125) is imposed on each license approved. Trees <20 cm diameter and trees in flower and fruit are not allowed to be harvested. The harvest quota is set at 500 kg of wood chips per month per license and a royalty rate of 10% *ad valorem* per kg (depending on the grade) is charged on the amount of *gaharu* taken. Any person who contravenes any terms and conditions stipulated in the license is liable to be blacklisted or subjected to the cancellation of the license. In addition, the licensee is required to supply 3,000 seedlings per annum to the State Forestry Department and to submit a monthly shuttle return. With regards to licensing for the purpose of processing and trade, manufacturers and traders must have a valid license, are required to maintain a log book indicating the amount of *gaharu* processed and traded, and to submit monthly shuttle returns. Where export is concerned, a CITES permit is required. The exporter is also required to register with the Malaysian Timber Industry Board (MTIB).

2.1.4 *Restoration or alleviation measures*

Trial planting of *Aquilaria malaccensis*, as part of both government and private sector initiatives, is being conducted in Peninsular Malaysia, Sabah and Sarawak (Mohd Paiz 2006, Dawend *et al.* 2005, D. Alloysius, Yayasan Sabah, pers. comm.). Research attempts are being carried out on inoculation, chemical analysis of the resin, growth performance under plantation conditions, and large-scale planting in

Malaysia. Experimental planting of this species has not yet expanded to commercial scale because of several reasons. Not all inoculated trees develop the resin which indicates a significant degree of phenotypic variation with regards to disease resistance in natural populations. Genotypes differ in their behaviour as host when attacked by pathogens. Different genotypes of the same pathogenic species may be successful to different degrees as parasites on different host genotypes. Certain strains or land races may be more sensitive or responsive to fungal attack than others. Other factors that limit large-scale planting are the scarcity of planting materials and low seed viability. Research efforts are currently underway to mass-propagate plantlets containing desired traits.

2.2 Monitoring system

2.2.1 *Methods used to monitor harvest*

As mentioned in section 2.1.3.

2.2.2 *Confidence in the use of monitoring*

As will be seen in section 3.3., the regulation of harvest, processing and trade through licenses requires improvement. There are inherent difficulties in attempting to regulate harvesting activities undertaken by indigenous communities and foreign collectors. In view of the lucrative nature of the trade, Nicholas (2000) and Lim *et al.* (in. prep.) observed that personnel from enforcement agencies have also been engaged in the trading of agarwood.

2.3 Legal framework and law enforcement

Malaysia has general laws that include the governing of agarwood collection (protection of flora), cultivation, processing and manufacture, domestic and international trade. The laws for the protection of agarwood-producing species include two aspects, i.e., the establishment of protected areas and the regulation of harvest. Laws that address both of these aspects include the *National Forestry Act 1984* (amended 1993), *Sarawak Forests Ordinance 1958* (amended 1999), *Sabah Forest Enactment 1968* (amended 1992), *Protection of Wildlife Act 1972*, *Sabah Wildlife Conservation Enactment 1997* and *Sarawak Wildlife Protection Ordinance 1998*.

The Customs Act 1967 and the *Sales Tax Act 1972* regulate the sale and export of *gaharu* in Malaysia by imposing a 5% sales tax and a 10% export duty on 'gaharu wood chips' (*Customs Duties Order 1996*, HS Code 1211.90 200). The export duty was however removed in 2003 (*Customs Duties (Amendment) (No. 5) Order 2003*). *The Customs*

(*Export Prohibition*) Order 1998 and the *Customs (Import Prohibition) Order 1998* both require that all exporters and importers of logs (HS Code 44.03 which includes logs of agarwood-producing species) obtain a license from MTIB. In addition, the *Customs (Prohibition of Imports) (Amendment) (No. 4) Order 2006*, which came into operation on 01 June 2006, requires that all imports of agarwood into Malaysia be accompanied by an import permit as stipulated under CITES, issued by or on behalf of the Director General of MTIB (Sch 4, 51(5)(b); 52(5)(b)).

The *Sale of Drugs Act 1952* regulates the sale of gaharu oil, perfume and medicine while the *Control of Drugs and Cosmetics Regulations 1984* made under this Act requires that these products be registered with the Drug Control Authority and that all manufacturers, importers and wholesalers be licensed. Also of some relevance is the *Local Government Act 1976* which has provisions for the licensing of the retail sales of goods.

Peninsular Malaysia and Federal Territories

The National Forestry Act 1984 (amended 1993) regulates the collection of minor forest produce through the application of licenses. There is no specific category for agarwood in the *State Forest Rules* made under the Act. In Peninsular Malaysia, wood chips, powder and oil are classified as minor forest products in accordance with Section 2(b) of the Act and a license is required for collecting. However, for the purpose of the collection of royalties, *gaharu* comes under an open clause of the Royalty Rate List that states 'Minor Forest Produce: Miscellaneous – Forest produce not mentioned above' (e.g. *Pahang Forest Rules 1987* Sch II (ii) 2.11 (d)). Such harvest requires a license or permit issued by the State Forestry Department. There is no provision in Peninsular Malaysia that declares agarwood-producing species as totally protected. Any individual caught without a license will be charged and on conviction will be fined not more than MYR 500,000 (approx. US \$156,250) or imprisoned for not less than one year but not more than 20 years or both.

Sabah

The *Sabah Forest Rules 1969* fix the royalty rate on gaharu at 10% of the value (Sch II, Pt A, s(h) 'Minor Forest Produce (Damar, Fossil, Gums, *Gaharu*, Cinnamon, Sticks, Tengawang, etc)'). The *Rules* originally listed *Aquilaria malaccensis* as a Commercial Species, Class J, with a minimum felling diameter of 60 cm dbh (Sch I). However, effective 02 January 2004, the Sabah Forestry Department has classified *A. malaccensis* as a prohibited species to be retained inside Forest Reserves (Sch C;

Clause 1(31) of the *Standard Sustainable Forest Management Licence Agreement – s 15(1) Forest Enactment 1968*). In addition, the *Sabah Wildlife Conservation Enactment 1997* requires a permit for harvesting any species listed in Appendices I and II of CITES. Beginning in 2004, Sabah imposed a ban on *gaharu* extraction from its Forest Reserves while the local CITES Management Authority has been requested to verify extraction permits with the State Forest Department.

Sarawak

Although the State *Forest Rules* made under the *Forest Ordinance 1958* contain detailed prescriptions governing the collection of royalties and fees, as well as collection of latex and resin from a number of tree species, there is no specific provision for agarwood. Provision for the collection of royalties on *gaharu* harvested in Sarawak under license is set out in section 52(2). Sch I, Class III, Miscellaneous, 'Other forest produce not specified above', with the rate specified as 10% *ad valorem*. Fee to collect is set at MYR1.00 per month (Sch 2 H. 'Other forest produce') payable at the time of the issue of the permit (s 52(4)).

The key agarwood-producing species in Sarawak, *Aetoxylon symptalum*, *Aquilaria beccariana* and *A. microcarpa*, are specifically listed as 'protected plants' under the Sarawak's *Wildlife Protection Ordinance 1998* (Part II of the Second Schedule). A permit from the Controller of Wildlife is required to harvest and trade in these species as well as any plant species included in CITES Appendices I and II. The application fee for such permits is MYR100 per year. Any party that contravenes this Ordinance will be charged and on conviction a fine of MYR10,000 (approx. US \$3,125) or one year imprisonment. In addition, the *Sarawak National Parks and Nature Reserves Ordinance 1998* makes it an offence for any person to collect or remove *gaharu* from any national park or nature reserve.

There is an apparent disregard for these laws as seen from the increase in illegal harvest activities. Numerous attempts have been made to control the illegal collection of *gaharu* undertaken either by foreigners or extracted from areas protected by law. Between 1992 and 2005, at least 197 *gaharu*-related arrests were reported (Lim *et al.* in prep.). Enforcement agencies have worked together to address the problem of illegal harvest by foreign collectors. Police and the Armed Forces are regularly assisting the State Forestry Departments, State Departments of Wildlife and National Parks (DWNP), Johor National Parks Corporation and other agencies in charge of protected areas. Army patrols have been sent into national and state parks to investigate incursions by illegal collectors while DWNP and the Police have established 'round-the-clock patrols' in Taman Negara and along the

East-West highway in Peninsular Malaysia (Anon. 1995). In 1999, the Perak State Government announced an informant reward system to curb *gaharu* smuggling (Anon. 1999). In addition, crack-down operations are intermittently conducted in the respective states. Despite the close cooperation between all enforcement agencies, reports indicate that illegal *gaharu* collection continues to escalate (Anon. 2004a).

The International Trade in Endangered Species Act 2008 [Act 686] was passed by Parliament on 24 December 2007. The Act provides for the administration and management of international trade in endangered species to ensure that the trade does not threaten the survival of any species of wild fauna and flora. The Act will be gazetted soon and regulations are being drafted to ensure its smooth implementation.

3 UTILIZATION AND TRADE FOR MALAYSIA

3.1 Type of use (origin) and destinations (purposes)

Agarwood is used for medicinal, aromatic and religious purposes in Buddhist, Jewish, Christian, Muslim and Hindu societies. The centuries-old trade was initially confined to very specific markets but has increased dramatically since the 1970s with economic growth, especially in the Middle East and northeast Asia consumer markets.

Historically, *gaharu* uses in Malaysia included the aromatic range (i.e., perfumery, fragrance, pharmaceutical (medicine and aromatherapy)), religious, ceremonial and spiritual rituals (burnt offerings, idols, rosary), and decorative carvings. The use of a piece of agarwood largely depends on its grade and the ethnicity of the user.

Agarwood-producing species are traded in a variety of forms ranging from whole plants (seedlings) and logs to chips, flakes, oil and spent powder wastes. The terms 'agarwood' and '*gaharu*' are usually taken to refer only to resin-impregnated pieces of wood (Grade C and above) that have been at least partially shaved of non-impregnated wood (the CITES terminology for these pieces is wood chips). Most forms of semi-processed or raw *gaharu* in trade only reach about 10 cm in length and can be accurately referred to as chips, fragments, shavings and splinters, even breaking down to tiny particles of powder and dust.

Major importing countries include the Middle East, Taiwan, Japan and Korea while the minor markets are the US and Europe. Singapore is a major entrepot. All derivatives are derived from wild specimens.

3.2 Harvest

3.2.1 *Harvesting regime*

Being a commodity that only in 1975 saw an increase in consumer demand, there are no operating provisions within the SMS imposing a harvesting regime on agarwood-producing species in natural forests except for the recently established Standard of Procedures (see section 2.1.3).

There are two main methods of harvesting *gaharu*: fatal harvest and sub-lethal harvest. The more commonly reported method is fatal harvest, whereby the whole tree is chopped down to harvest the *gaharu*. Early reports indicate that fatal harvests of *Aquilaria* in Peninsular Malaysia were already occurring in Johor (Bland 1886) and Selangor (Skeat 1900) during the 19th Century. Although such harvest generally kills the tree, many trees are able to coppice profusely (Green 1999). Corner (1978) found that the bark of *Aquilaria malaccensis* coppiced 7–8 months after being damaged. This allows the sub-lethal harvesting method to be employed. A report by the Thailand-based WildAid Foundation found that *Aquilaria* trees are relatively robust and can be tapped by chipping or cutting the infected part for over 10 years before they die (Anon. 2004b). Local communities involved in collection in Peninsular Malaysia routinely practise this harvest method on a rotation of 2–3 months where trees are still alive after 15 years of coppicing (Yamada 1995).

3.2.2 *Harvest management/control (quotas, seasons, permits, etc.)*

The commercial harvesting of *gaharu* requires a license and removal pass issued by the State Forestry Departments in Peninsular Malaysia and Sabah and the Sarawak Forestry Corporation. The removal pass is issued as proof that all fees have been paid and that the logs were harvested from a licensed area. The Forestry Department has not reported the issuance of licenses for the collection of *gaharu* in Peninsular Malaysia.

Malaysia subscribes to the setting of a harvest quota and permit requirement of CITES. The harvest and export quota for 2007 and 2008 have been submitted to the Secretariat. In Sabah, official records indicate that agarwood is extracted only for its timber and not for other purposes. However, the production and trade of agarwood oil in Malaysia is not well monitored. The Malaysian Management Authorities for agarwood are MTIB (Peninsular Malaysia and Sabah) and Sarawak Forestry Corporation (Sarawak).

3.3 Legal and illegal trade levels

During 1995–2005, 6,092,024 kg of *gaharu* were exported from Malaysia (Anon. 2006b). During the same period, CITES permits were issued only for c. 3,000,000 kg of *gaharu*. In 2003 and 2004, the volume stated in CITES permits actually exceeded the volume of exports reported officially. The switch between declaration under HS Chapter 12 and Chapter 44 is the main cause of this large discrepancy.

As national stocks rapidly declined, collectors began to illegally harvest agarwood in neighbouring countries. Foreign nationals have been reported to be involved in illegal harvesting in Malaysia since 1987 (Anon. 2004a). These foreigners are predominantly from Thailand, Cambodia, Indonesia and the Philippines. The harvesting took place both in the Permanent Reserved Forests and totally protected areas. Notable cases of illegal harvesting took place in Taman Negara and Endau Rompin National Park, a National Park and State Park respectively, with totally protected status. Collection of *gaharu* by local communities has been impeded by the presence of foreign collectors (Faedah 1995, Anon., 2004c), many of whom are equipped with firearms (Anon. 2002).

Collectors from Thailand were also reported to be active in Sabah in 1999 and in Sarawak in 2005 (Dawend et al., 2005). Given the extensive border shared between Indonesian and Malaysian Borneo, Indonesian collectors have probably been active in Sabah and Sarawak for many years. In addition, collectors from the Philippines have also been reported to be collecting *gaharu* in Sabah and Sarawak. Several arrests had been made in Sabah and Sarawak since 2000.

II. NON-DETRIMENT FINDING PROCEDURE (NDFs)

1. IS THE METHODOLOGY USED BASED ON THE IUCN CHECKLIST FOR NDFS?

The NDF is preliminary.

2. CRITERIA, PARAMETERS AND/OR INDICATORS USED. BIOLOGICAL CHARACTERISTICS OF THE SPECIES, REGULATION OF HARVEST AND TRADE STATISTICS.

The criteria, parameters and/or indicators used to prepare the non-detriment finding for *Aquilaria malaccensis* are:

- density and demography of selected populations occurring in the various Permanent Sample Plots (PSPs) and plots laid out for national forest inventories (NFIs);
- harvesting limits employed under the Standard of Procedures; and
- pattern and level of exploitation for international trade, including trade statistics.

3. MAIN SOURCES OF DATA, INCLUDING FIELD EVALUATION OR SAMPLING METHODOLOGIES AND ANALYSIS USED

The data for density and demographic patterns are obtained from field evaluation on the above-mentioned plots and plots established for academic research. For the plots established under PSP and NFI, the published data is data that has been analysed. National Forest Inventories are conducted only for Peninsular Malaysia. Also see literature cited.

4. EVALUATION OF DATA QUANTITY AND QUALITY FOR THE ASSESSMENT

None.

5. MAIN PROBLEMS, CHALLENGES OR DIFFICULTIES FOUND ON THE ELABORATION OF NDF

The major problems include:

- Very little is known about *Aquilaria malaccensis's* population distribution patterns, demography, ecology, flowering phenology, reproductive behaviour, fruit production, recruitment and regeneration patterns, natural mortality, and mortality/regeneration caused by stem damages. Its widespread but low density occurrence exacerbates this problem.
- Little information is available on the response and rate of infection in naturally occurring trees, on the quality of infected resinwood, and on recovery rates (volume) of chips, particularly those used for oil production. The grade of the *gaharu* resin in trees cannot be easily determined with full certainty and infected trees lack definitive external signs indicating resin grade. This leads to indiscriminate harvesting which poses many problems to sustainability and regulation of legal harvests. In cases where the resin is absent, felled trees and stumps are left standing in anticipation that a resin-producing reaction will take place.
- The scenario for other species of *Aquilaria* is even more acute. The discord between taxon recognition and the inability of the industry/trade to segregate harvest products according to taxon as

required by CITES should be addressed. Any procedures that aim to control harvests must recognize the above limitations.

- Current procedures to control harvesting, manufacturing and trade need to be reviewed for effective monitoring.
- As different agencies are tasked with managing the same forested areas where agarwood occurs, a coordinated approach towards monitoring is crucial.

There have been some management interventions such as licensing and establishment of cultivated *Aquilaria*. Malaysia has yet to produce agarwood from these cultivated trees.

6. RECOMMENDATIONS

Recommendations must be relevant to the major problems outlined above. In view of these, the criteria, parameters and/or indicators currently used to prepare the non-detriment finding for *Aquilaria malaccensis* are deemed to be appropriate. The data quantity and quality for NDF can only be evaluated with respect to current stocking.

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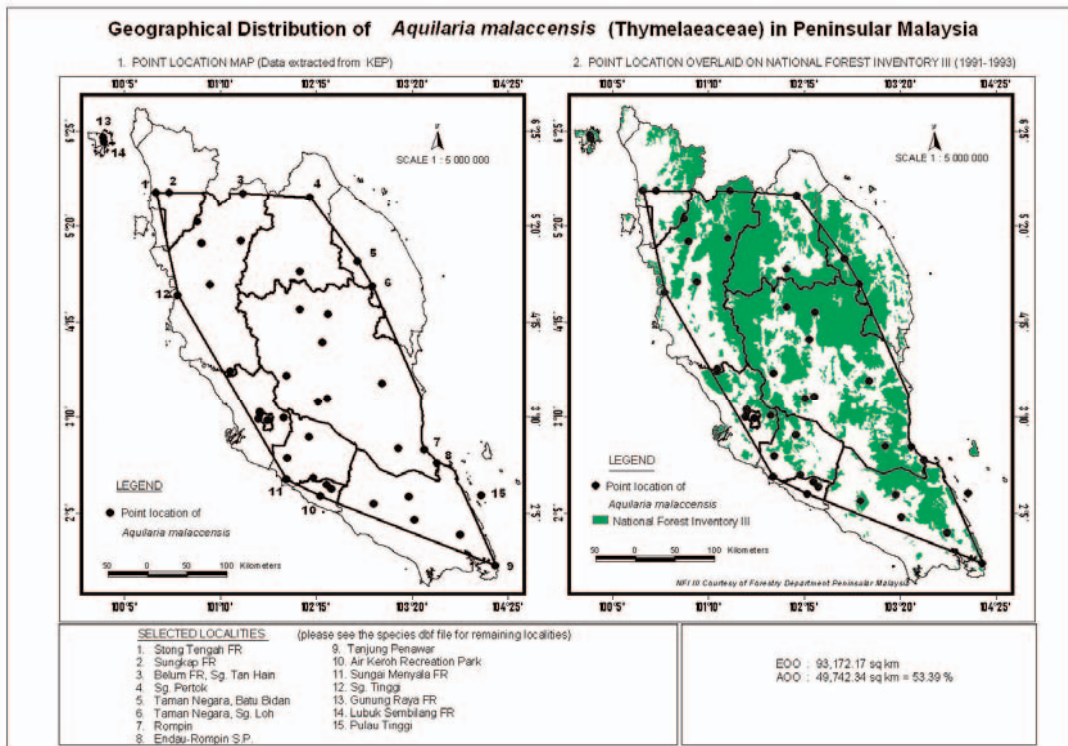


Figure 1. The geographical distribution of *Aquilaria malaccensis* in Malaysia.

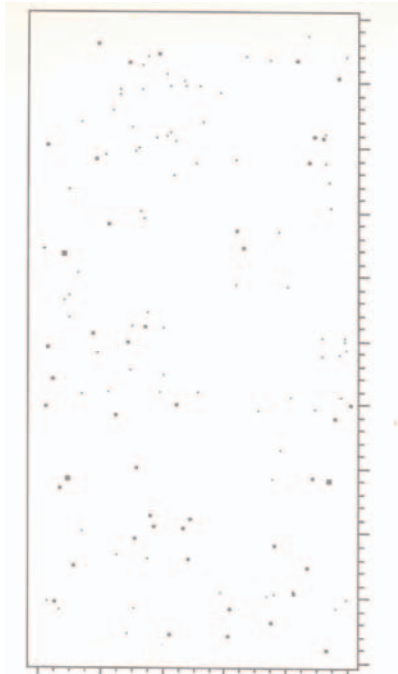


Figure 2. The distribution of *Aquilaria malaccensis* in the Pasoh 50-ha tree demographic plot.

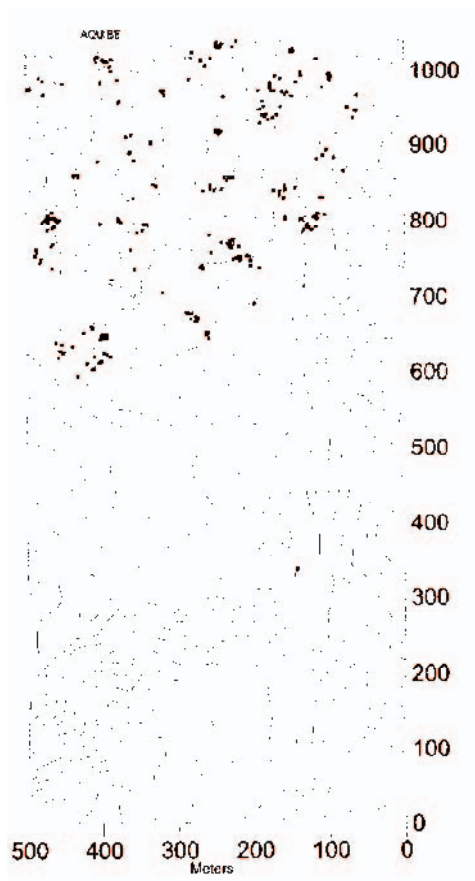


Figure 3. The distribution of *Aquilaria beccariana* (>1 cm dbh) in the 52-ha plot in Lambir Hills National Park.

Appendix 1. Major agarwood-producing species native to Malaysia.

Species	Distribution in Malaysia (State)
<i>Aetoxylon sympetalum</i> Airy Shaw	Sarawak
<i>Aquilaria beccariana</i> Tiegh.	Johor, Sabah, Sarawak
<i>Aquilaria hirta</i> Ridl. Johor)	Peninsular Malaysia (Terengganu, Pahang,
<i>Aquilaria malaccensis</i> Lam.	Peninsular Malaysia, Sabah, Sarawak
<i>Aquilaria microcarpa</i> Baill.	Sabah, Sarawak
<i>Gonystylus brunnescens</i> Airy Shaw	Peninsular Malaysia, Sabah, Sarawak
<i>Gonystylus confusus</i> Airy Shaw	Peninsular Malaysia
<i>Gonystylus macrophyllus</i> (Miq.) Airy Shaw	Peninsular Malaysia, Sabah, Sarawak
<i>Wikstroemia androsaemifolia</i> Decne.	Peninsular Malaysia, Sabah, Sarawak
<i>Wikstroemia polyantha</i> Merr.	Peninsular Malaysia, Sabah, Sarawak
<i>Wikstroemia ridleyi</i> Gamble Pahang)	Peninsular Malaysia (Kelantan, Terengganu,
<i>Wikstroemia tenuiramis</i> Miq.	Sabah, Sarawak