

Annex 1 Case studies matrix

	Timber species					Non-Timber species		
	A.	B.	C.	D.	E.	F.	G.	H/
Estimation of species range area								
National level	Green	Blue	Green	Green	Green	Blue	Green	Red
Subnational level	Green	Blue	Green	Blue	Green	Red	Green	Red
Management units	Green	Green	Green	Blue	No applicable	Red		Red
Population parameters								
Periodic measurements	Green	Red	Green	Red	Red	Red	Green	Red
Indicators of sustainable management	Green	Green	Green	Blue	Red	Red	Red	Red
Local reference values	Green	Red	Green	Red	Red	Red	Red	Blue
Management principles, methods & indicators								
Silvicultural system	Green	Blue	Green	Blue	Red	Red	Blue	Blue
Silvicultural treatments	Blue	Red	No applicable	Red	Red	Red	Red	Blue
Harvest systems	Green	Red	Green	Blue	Blue	Red	Blue	Red
Regeneration	Green	Red	Green	Blue	Red	Red	Blue	Red
Conservation	Blue		Green	Green	Green	Blue	Green	Red
Commercial plantations & domestication?	Red	Red	No applicable	Blue	Blue	Blue	Green	Blue
Monitoring & verifying harvests, processing & conservation								
Determination of annual production quotas	Green	Blue	Red	Red	No applicable	Blue	Green	Red
Optimization of product processing		Red	Blue	Red	Red	Green	Green	Blue
Monitoring & verification	Green	Red	Blue	Red	Blue	Blue	Green	Red
Level of knowledge	High	Green	Middle	Blue	Low	Red		

CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES
OF WILD FAUNA AND FLORA



Seventeenth meeting of the Plants Committee
Geneva (Switzerland), 15-19 April 2008

Timber issues

Bigleaf mahogany

INTERNATIONAL WORKSHOP OF EXPERTS ON NON-DETRIMENT FINDINGS
ON BIGLEAF MAHOGANY (CANCUN, APRIL 2007): ENDORSEMENT AND ADOPTION
OF GUIDELINES FOR MAKING NDFS FOR MAHOGANY

1. This document has been prepared by Mexico, as Chairman of the Bigleaf Mahogany Working Group of the Plants Committee.
2. The document comprises two Annexes, described below, and has been drafted in order for the Committee to review and endorse at the present meeting the results of the International Workshop of Experts on Non-Detriment Findings on Bigleaf Mahogany (*Swietenia macrophylla*), held in Cancun, Quintana Roo, Mexico, from 10 to 13 April 2007.

Annex 1: Results of the International Workshop of Experts on Non-Detriment Findings on Bigleaf Mahogany (*Swietenia macrophylla*); and

Annex 2: Working group's interpretation of the term 'planes de ordenación de la caoba' (mahogany management plans).

Background

3. At its 16th meeting (Lima, July 2006), and further to Decision 13.58, the Plants Committee decided *inter alia* (see the PC16 summary record):
 - i) to encourage the issuance of new recommendations to exporting countries regarding necessary elements for the formulation of non-detriment findings for timber species, and
 - ii) to organize a course on non-detriment findings for timber species that will focus on how to identify the information necessary for evaluating and documenting non-detriment findings.
4. Mexico, as Chairman of the Mahogany Working Group, organized the International Workshop on Non-Detriment Findings on Bigleaf mahogany. The main purpose of this workshop was to define a feasible methodological approach that could be used to formulate non-detriment findings (NDFs) for the bigleaf mahogany, in order to improve the implementation of the provisions of CITES Appendix II and to ensure the sustainability of the harvesting of and international trade in the species.

5. Mexico, as Chairman of the Mahogany Working Group, submitted the results of the workshop as information document CoP14 Inf. 24 at the 14th meeting of the Conference of the Parties (The Hague, 2007).
6. At that meeting, the Conference adopted Decision 14.145 which states: "The Conference of the Parties adopted the 'Action plan for the control of international trade in bigleaf mahogany (*Swietenia macrophylla*)', attached as Annex 3 to these Decisions."
7. The *Action plan* states the following:
 - 1) *All range States of the bigleaf mahogany should:*
 - e) *facilitate the making of non-detriment findings by:*
 - i) *preparing, adopting and implementing, as a priority, forest management plans at a national and/or local levels that include specific requirements for the bigleaf mahogany, as outlined in the results of the International Workshop of Experts on Non-Detriment Findings on Bigleaf Mahogany held in Cancun (April 2007) (see document CoP14 Inf. 24) after its endorsement and adoption by the Plants Committee;*
 - ii) *developing and conducting forest inventories that enable specific identification and data analysis of the bigleaf mahogany, as well as programmes to monitor the distribution, population size and conservation status of the bigleaf mahogany, based on the results of the International Workshop on Non-Detriment Findings on Bigleaf Mahogany, after its endorsement and adoption by the Plants Committee, and incorporating the three basic requirements for non-detriment findings highlighted in document MWG2 Doc. 7, paragraphs 44 a) to c).*

Recommendation

8. In order to comply with the request made to the range States in the *Action plan*, in particular with the making of non-detriment findings, the Plants Committee is invited to review and adopt the recommendations that resulted from the workshop and which are included in Annex 1 of the present document.

RESULTS OF THE INTERNATIONAL WORKSHOP OF EXPERTS
ON NON-DETRIMENT FINDINGS ON
BIGLEAF MAHOGANY (*SWIETENIA MACROPHYLLA*)*

Cancun, Quintana Roo, Mexico (10-13 April 2007)

I. PROGRESS OF THE MEETING

The Workshop was held in Cancun, Quintana Roo, Mexico, April 10 – 13, 2007.

The workshop was attended by 46 participants, representing 12 range states (Belize, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, Guatemala, Honduras, Mexico, Nicaragua, Panama and Peru); the European Union in its capacity as importers (Belgium and Spain); the Chair of the CITES Plants Committee; a representative of the CITES Secretariat; a representative of the International Tropical Timber Organization (ITTO); two representatives of non-governmental organizations and a representative of the International Importers Association (Annex 4).

The event took place as described in the workshop agenda (Annex 3). The workshop was inaugurated by Mr. Francisco Javier Díaz Carvajal, Minister of Urban Development and the Environment of the Government of the State of Quintana Roo. The following officials were present: Dr. Steve Johnson (Associate Director of ITTO), Mr. José Cibrián Tovar (Director General of the National Forestry Commission - CONAFOR), Mr. Martín Vargas Prieto (Director General of Wildlife of the Ministry of the Environment and Natural Resources - SEMARNAT, CITES Administrative Authority in Mexico), Professor Ana Luisa Guzmán (Executive Secretary of the National Commission for the Knowledge and Use of Biodiversity - CONABIO, CITES Scientific Authority in Mexico), Dr. Francisco García García (Director General of Forestry and Soil Management - SEMARNAT and President of the Mahogany Working Group - MWG), Mr. Manuel Mercado Béjar (Director General of Contamination Source Scrutiny of the Federal Environmental Protection Agency - PROFEPA, representative of the CITES Law Enforcement Authority in Mexico).

In the first session, Dr. Margarita Clemente (Chair of the Plants Committee) gave the following presentation; "Mahogany in CITES and the Mahogany Working Group". Dr. Rafael Navarro (Spain) completed this presentation with a preliminary proposal on the use of remote sensors for the formulation of non-detriment findings (NDFs) on mahogany, based on acquired experience with *Prunus africana*. Mrs. Milena Sosa Schmidt (CITES Secretariat), gave a presentation on "Non-Detriment Findings", followed by Dr. Steve Johnson's presentation: "ITTO and CITES" and Dr. Patrick Van Damme's (Belgium) presentation on "Relevant Information for the Formulation of Non-Detriment Findings". The session concluded with Dr. Patricia Dávila's overview of the summarized outcomes of the Mahogany Comprehensive Report (CoP14 Doc. 64) and an explanation by biologist Hesiquio Benítez of the workshop logistics and desired outcome.

Based on the conclusions of the Mahogany Working Group's (MWG) comprehensive report, four thematic sessions took place. Each thematic session was structured as follows: 1) Presentation by the moderator of the main conclusions of the MWG comprehensive report; 2) Presentation by the experts of the proposals on methodology and analysis of the necessary actions; 3) Discussion of the experts' proposals and 4) Feedback from the audience regarding the experts' proposals and drafting of conclusions.

The panel comprised five mahogany experts: Dr. Laura Snook (Bioversity International), Dr. Carlos Manuel Navarro Pereira (Costa Rica), Dr. James Grogan (United States of America), Mr. Luis Alfonso Argüelles Suárez (Mexico) and Dr. Roberto Kometter Mogrovejo (Peru), who held discussions and issued recommendations thus fulfilling the goals of the workshop. Four more specialists contributed to the guidance and development of the workshop: Dr. Patrick Van Damme (Belgium), Dr. Kenneth Farr (Canada), Dr. Rafael M^a. Navarro Cerrillo (Spain) and Dr. Alfonso García-Ferrer Porras (Spain).

* Text from document CoP14 Inf. 24.

The moderators for each session were: Theme 1.- Classification Plans (Marina Rosales, Peru); Theme 2.- Range Area (Patricia Dávila, Mexico); Theme 3.- Population and Environmental Parameters (Kenneth Farr, Canada) and Theme 4.- Management principles, criteria and indicators (Rafael Navarro, Spain).

A field trip to the Noh-Bec forest community, located in the Felipe Carrillo Puerto Municipality in the State of Quintana Roo, was organized in order to demonstrate community-based forest management activities for mahogany.

The following is a list of the basic elements for the formulation of Non-Detriment Findings on Mahogany (Section III) which were suggested, based on the results of the theme sessions.

1. Estimation of Mahogany range areas,
2. Population parameters,
3. Management principles, methods and indicators

The workshop also analyzed the cost of silviculture as well as the tools necessary to monitor and verify conservation and processing activities (Sections IV and V of Annex I). In addition, the workshop analyzed the working group's interpretation of the term "planes de ordenación de la caoba" (mahogany management plans), as a problem with the translation of this term has been identified which has affected the response of Countries of origin regarding compliance with Decision 13.58 (Annex 2).

The workshop ended with a presentation by Dr. Patricia Dávila on conclusions reached, followed by the Closing Ceremony with the participation of Dr. Francisco García García, Dr. Margarita Clemente Muñoz and Mr. José Luis Funes, representative of the Government of the State of Quintana Roo.

II. ESSENTIAL ELEMENTS FOR THE FORMULATION OF NON-DETRIMENT FINDINGS (NDFS) ON BIGLEAF MAHOGANY (*SWIETENIA MACROPHYLLA*)

II.1. ESTIMATION OF MAHOGANY RANGE AREAS

Based on territorial classification at the country level, it is appropriate to identify the range area of mahogany at the national (potential), sub-national (departments, states, provinces, water basins) and local (management unit) levels. Some of the available tools for each of the three levels are:

1. National level

- a. National ecologic forest mapping (such as, Holdridge Life Zones map)
- b. National forest maps
- c. National forest inventories
- d. Available imagery (such as NOAHH, MODIS, Landsat, ASTER).

2. Sub-national (optional) level

- a. GIS resulting from national level analysis.
- b. National databases (management units)
- c. Sub-national forest inventories
- c. Sub-regional mapping derived from projects or other available sources
- d. Available imagery (such as Landsat, ASTER, SPOT)

3. Management plan comprising two levels:

- a. Forest management unit
 - GIS of the areas under management
 - Statistical sampling (exploratory inventories from Forest Management Plans)
 - High or medium resolution images (e.g. ASTER, IKONOS, QuickBird)
- b. Harvesting plots (areas)
 - GISs of harvesting areas
 - Commercial censuses at 100% (geo-referenced databases)

The information obtained and analyzed at these three levels should make it possible to obtain potential and present distribution maps of the species throughout the country as well as to define its commercial harvesting areas.

II.2. POPULATION PARAMETERS

In order to assess Bigleaf mahogany populations (and related species) as well as the environmental conditions under which mahogany grows, periodical documentation of certain biological parameters and indicators of sustainable management is essential, as is incorporation of reference values.

1. Periodic measurement parameters

1.1 Characterization of the structure of mahogany populations:

- a. Direct
 - Diameter [measuring trees with a Standard Diameter (SD)/DBH > 10 cm, based on an appropriate sampling method for a population with an irregular spatial distribution].
 - Total and commercial height, measured or estimated (optional).
 - Eco-physiographic situation [information on the populations (distribution), as well as geomorphologic, edaphic and climatic data at the location of said populations].
- b. Subsequent
 - Density (trees/ha; trees/100 ha), by size classification
 - Volume (m³)
 - Base area (optional and additional to density)

1.2. Estimation of seed production based on annual stratified sampling of a statistically appropriate number of trees, according to a range of diameter classes, preferably before and after harvesting. In order to evaluate the regularity of seed production and to observe changes over time, it is advisable to have sampling trees located in areas that are not subjected to harvesting.

1.3. Estimation of standing trees to be harvested in the subsequent cycle (reserve trees, future harvest): trees that will be incorporated to the commercial size classification (<Minimum diameter cutting limit MDC).

2. Sustainable management indicators

These indicators make it possible to identify the level of success of forest treatments (bearing in mind that an equivalent population of mahogany trees must be established for regeneration and maintenance purposes, so as to replace the ones that were harvested), by monitoring the following elements:

- a. Potential seed-bearing trees
- b. Regeneration rate / recruitment (natural or through enrichment planting)
- c. Replacement rate in number of trees across the range of size classifications.
- d. Number of trees available for future harvest.

3. Local reference values

These values allow monitoring of the population parameters of Bigleaf mahogany under management (in a given region) over time, providing information for adjusting future harvesting levels.

- a. Testimonial information derived from compliance with the Management Plan and the annual cutting Plans. Said local references are useful to monitor harvested trees and their relationship with geo-referenced inventories.
- b. Growth rate, which is obtained from permanent sampling plots or from individual mahogany trees measured regularly (preferably annual measurements). This specific type of monitoring may be simultaneously used to follow-up on other harvested species.

II.3. Management principles, methods and indicators

II.3.1. PRINCIPLES

- a. There is sufficient knowledge about the ecology and forest parameters of the species to establish a basic silviculture. However, more detailed information on some aspects of the species' ecology (i.e., reproductive ecology) and on some forest parameters (i.e., growth, seed tree selection criteria, MDC or target diameter, etc.) is still needed.
- b. The available information suggests that mahogany, within its range, follows certain relatively homogeneous growth and/or development patterns. This, together with the relevant precautions, allows the establishment of some common reference values for silviculture of the species throughout its range area.
- c. An adaptive mahogany silviculture is essential. It must be based on current knowledge, but must be subject to modification based on the results of regeneration and growth sampling practices carried out in the management areas (as per the abovementioned guidelines). Likewise, it must be founded on relevant auto-ecologic data (reproductive physiology and ecology, etc.) and must be implemented through silvicultural management parameters (rotation, cutting diameters, growth, etc.). This adaptive silvicultural principle is based on the assessment of the results obtained in management activities and must be incorporated to the species management plans.
- d. Management plans constitute the foundation for the biological and/or silvicultural arguments necessary to establish the minimum diameter cutting limit and, where appropriate, the maximum diameter cutting limit, taking into consideration the seed bearing age, the annual diametric growth (available information indicates that annual growth varies between 0.4 and 0.7 cm) and the timber quality of the trees.
- e. Despite the fact that this species is the primary harvesting objective, it is essential that mahogany silviculture incorporate harvesting of additional species. Doing so results in increased harvesting profitability and healthier silvicultural practices (i.e., regeneration of forest stands based on the creation of appropriately sized openings).

f. Although multiple species harvest planning may initially represent an additional cost, it provides financial support to harvest areas (by making additional resources available) and promotes comprehensive and sustainable forest management.

g. Management entails different intensity levels, ranging from intensive silviculture in plantations, semi-intensive silviculture in managed secondary forests, up to extensive silviculture in low-mahogany-density primary forests. Community and industrial forest management are two-additional possibilities. However, similar minimum management guidelines and principles may be applied in both cases.

h. The outcomes of successful management programs, such as the Noh-Bec Community Forest (Mexico), must be broadly disseminated in order to enhance silvicultural knowledge of the species and improve management programs in other areas.

II.3.2. METHODS THAT GUARANTEE THE SUSTAINABILITY OF MAHOGANY POPULATIONS.

a. Logging planning strategies

- To define the type of logging to be undertaken according to the terrain and the populations.
- Depending on the type of logging, to define the type of silviculture that will be implemented based on the distribution of the desired initial and final diametric classifications.

b. Logging: Based on the terrain and mahogany populations, different types of logging may be carried out:

- Thinning / Selection-cutting Method
- Uniform shelterwood cutting / Protective cutting
- One- or two-step clearance cutting / One- or two-step clearcutting / Cutting down to a stump
- Thinning / Clearing

c. Regeneration. Given the low natural regeneration levels of mahogany, it is necessary to define and implement the following:

- Protection of the trees to be retained for future harvests (those that will be cut during the subsequent cycle), based on inventories and silvicultural measurements.
- Opening of clearings or forest product concentration yards in the cutting area (known as "bacadillas" in Mexico). These should ideally be areas of more than 2,000 m², although their size can vary and therefore should be defined in each processing area.
- Enrichment of clearings through planting.
- Encouraging retention and protection of seed trees, bearing in mind available information indicates that trees with a DBH of >75cm and a broad crown bear significantly more seeds than do smaller trees. However, this value may vary and therefore would need to be defined for each harvesting area.
- Establishing the maximum distance between seed trees (taking into account requirements for successful pollination).
- Development of other silvicultural treatments such as: liana cutting, directed cutting and log removal optimization (planning log removal work).

d. Conservation

- To protect the different populations found throughout the mahogany range in order to ensure that the variety and diversity of the populations will be preserved.

- Establishing reserve areas (possibly areas of low density, or areas having healthy or inadequate diametric structures).
- Adequate seed selection for enrichment plantings.
- Sowing selected seeds or planting seedlings grown in nurseries, according to the ecological and productive conditions of the area.
- Coordinating a mahogany seed collection and management program between national and regional seed banks and accurately documenting seed collection locations; protecting seed trees and stands, creating seed orchards.

e. Commercial Planting

- Establishing pure and mixed plantings and plantings in agro-forestry systems as a medium-term alternative for mahogany harvesting in natural populations.

Note 1: The drafting of a document that includes basic silvicultural guidelines for this species was suggested. Said document could be used as the basis for establishing the most important silvicultural parameters for mahogany management under CITES.

Note 2: It is important to promote and encourage training and the exchange of experience and information among the mahogany range states, so as to harmonize the knowledge of management criteria and indicators, silvicultural techniques and regeneration programs. Likewise, countries must share their experiences on subjects such as logging regulations, regulations on domestic transport control and exports. This proposal had already been made at previous Working Group meetings.

II.3.3 LOGGING AND PROCESSING

a. Determining quotas

Establishing quotas necessarily implies an accurate knowledge of populations. Therefore, when quotas are established without knowledge of populations and based solely on commercial and pre-commercial stocks, it is impossible to ensure the impact that exports will have on the populations. Likewise, establishment of quotas must be done at the management unit level, since the characteristics of the populations may vary.

- Implementation of minimum viable population models, so as to supplement the calculation of the maximum volume (number of trees) subject to harvesting. It is advisable to include growth and regeneration/recruitment data to determine harvesting volumes.
- Analysis of harvesting/export quotas based on the available yield studies (i.e., methodology proposed by Dr. James Grogan), so as to reflect losses inherent to processing round wood into sawn timber; export quality percentage; stem/bole quality (holes or poor condition) in order to identify physical and pathologic defects, and elements such as bark thickness, stem shape and others relating to size and age. Failure to take these values into consideration will probably result in an overestimation of export quotas.
- Establishing quotas one year in advance whenever possible in order to ensure verification capability.

b. Timber use and processing optimization

- A continuous training program for the staff involved in logging activities is required.
- In the course of census-taking activities, drafting of geo-referenced maps of harvestable and future crop trees is recommended.

c. Monitoring and verification

- Whenever possible, establishment of permanent plots is advisable in order to gain a detailed and long-term understanding of the impact of logging in mahogany forests.

Note: The establishment of databases and electronic exchange systems is recommended: (a) establishing a domestic and international database network on the existing plots for information exchange purposes; and (b) establishing a database that incorporates existing scientific information (CITES Web).

III COST OF SILVICULTURE

Various research studies indicate that the correct implementation of silvicultural management activities for mahogany and associated tropical species will guarantee harvesting sustainability as well as increase mahogany regeneration and establishment in range areas. However, appropriate silviculture does imply additional costs necessary to meet requirements such as promoting regeneration, low-impact harvesting, timber traceability, maintenance of conservation areas, certification processes or maintenance of logging roads.

- Implementing non-detriment harvesting plans for mahogany requires external financial support. Each country should estimate the cost, according to its situation and needs. In order to determine the actual cost of harvesting plans, the creation of a cost and activity matrix has been proposed.
- Funding of a National Management Plan for mahogany should be one of a series of actions aimed at the sustainable harvesting of forest timber species, strengthening the Administrative Authority's power to control said harvesting activities.
- It is necessary to evaluate the role that the various institutions play in the creation and implementation of a national management plan, so as to define responsibilities and make efficient and transparent use of resources.
- The experience of the BOLFOR project in Bolivia may be regarded as an exemplary international forest enhancement project at the national level.
- The high cost of sustainable harvesting plans may reduce the competitiveness of timber on the international market. Therefore, it is important to revise the marketing chain so that both costs and benefits may be shared by import and export intermediaries, logging companies and end users.

IV MONITORING AND VERIFICATION TOOLS FOR CONSERVATION AND HARVESTING ACTIVITIES

It is necessary to follow up conservation and harvesting activities in order to reduce illicit activities that could encourage illegal mahogany logging. Therefore, the following measures were suggested by the Group:

- Establish a timber marking and traceability system (thus strengthening the chain of custody), from harvesting to export. The model implemented by Brazil is suggested, along with prior validation of the methodology through different technical alternatives.
- Establish a verification system based on forest inventories (quality of inventories), on-site inspection of forest management plans and annual plans, as well as monitoring systems utilizing remote sensors.
- On-site verification in large mahogany harvesting areas, using a statistical sampling that guarantees compliance with the approved management and logging measures. To supplement field inventories through the use of images derived from high spatial resolution sensors (such as IKONOS or QuickBird).
- Strengthen the implementation of management plans by means of control systems combined with severe penalties in case of noncompliance, reinforced by the timber traceability systems.
- Strengthen the chain of custody of forest certification and of traceability systems as a means of intensifying the control on legally and illegally logged timber.

WORKING GROUP'S INTERPRETATION OF THE TERM "PLANES DE ORDENACIÓN
DE LA CAOBA" (MAHOGANY MANAGEMENT PLANS)

Decision 13.58, subparagraph a), states that:

The range states of *Swietenia macrophylla* (Mahogany) should:

- a) Prepare and officially adopt, as a priority, forest management plans for mahogany at a national and sub-regional level.

On this subject, a semantic problem was identified. The English version of Decision 13.58, the PC14 WG7.1 working documents and those derived from CoP13: E13-COM1.04 and S13/COM1.04, refer to Management Plans for mahogany. The Spanish version of Decision 13.58 uses the term "Planes de ordenación de caoba". It was concluded that the correct reference is "Planes de manejo de caoba". This explains why, throughout the compilation exercise of the national reports on mahogany, most of the countries stated that they did not have specific management ("ordenación") plans for the species, since the term was mistaken for "ordenamiento" (classification), which refers to an instrument of higher hierarchical status (at the national or sub-national level) that surpasses the implementation scope of the NDFs. Therefore, it was acknowledged that the appropriate domain for the formulation of the NDFs is at the Management Plan level.

The Working Group's interpretation of Classification Plans is as follows:

1. Territorial classification at two levels:

National: Land classification based on its increased use capacity (forest, agricultural, livestock, urban, protection, conservation, etc.). At this level, it is necessary to chart a basic national map that includes coverage of the various types of plants and life zones (1:250,000), for identification of potential harvesting (production forests) and conservation areas. This is a necessary undertaking which is within the capabilities of all range states. Virtually all range states have such maps and it would be advisable to up-date them regularly.

Tools:

- Mapping of plant types and life zones
- National forest maps
- National forest inventories
- Use of 250m images (such as Modis, at no cost), or 30m images (such as Landsat)

Sub-national.- Classification of forest types at the level of states, provinces, departments, water basins or other smaller units at country scale. At this level, it is necessary to have larger scale maps to identify of the types (maturity level, sucesional stages) and current state of forests (plant communities that contain the species), whose information will be subject to on-site verification. The human resources (universities, research centers, government agencies, corporations, etc.) that are necessary to carry out this activity are available in the range states.

Tools:

- Mapping of plant types
- 30m and 15m images (such as Landsat and Aster, respectively)

Note: Teleidentification requires training plots and on-site verification.

CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES
OF WILD FAUNA AND FLORA

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DEVELOPING A NON-DETRIMENT FINDING METHODOLOGY FOR AGARWOOD-PRODUCING TAXA

Compiled by TRAFFIC, the wildlife trade monitoring network, for the CITES Secretariat

Acknowledgements: This paper was produced with funding from the CITES Secretariat and the United Kingdom Foreign and Commonwealth Office, via the British High Commission in Kuala Lumpur, Malaysia. TRAFFIC's ongoing work analysing the global trade dynamics of agarwood has involved working with stakeholders from both range and consumer States, in particular Indonesia and Malaysia – globally the two largest exporters of agarwood products. It also acknowledges sharing of expert information at the 1st International Agarwood Conference (Viet Nam, 2003), the CITES Agarwood Experts Group Meeting (Malaysia, 2006) and the 2nd International Agarwood Conference (Thailand, 2007).

Lim Teck Wyn, James Compton and Anders Jensen are thanked for their contributions to the development of this document, as well as Plants Committee Members for Oceania (Dr Greg Leach) and Asia (Tukirin Partomihardjo). Milena Sosa Schmidt, Henry Heuveling van Beek, Dr Tonny Soehartono, Frank Barsch, David Newton, Tong Pei Sin and Steven Broad also provided valuable feedback and peer review on earlier drafts.

SECTION 1 – INTRODUCTION

1.1 Background on Agarwood-producing taxa

Agarwood is a non-timber forest product valued for its aromatic, medicinal and cultural uses, and is also known as eaglewood, aloeswood, *gaharu* (Malay), *chen xiang* (Chinese), *jin-koh* (Japanese), *oudh* (Arabic) *mai kritsana* (Thai), and *tram huong* (Vietnamese) among many other vernacular and trade names (Barden *et al.*, 2000). Primarily sourced from two tree genera, *Aquilaria* and *Gyrinops*, agarwood's aromatic and medicinal properties derive from resinous deposits in the tree's heartwood that probably are produced as a response to wounding or infection – but this will not occur in every tree. Wild populations of agarwood trees are found in the lowland and montane tropical forests, with habitat varying for different species. Agarwood-producing taxa are distributed from north-east India eastwards through continental Southeast Asia and the Indo-Malesian bio-geographic realm as far east as Papua New Guinea, and north to the south-east provinces of China. There are 14 known range States (Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, India, Indonesia, Lao PDR, Malaysia, Myanmar, Papua New Guinea, Singapore, Thailand and Viet Nam¹). All range States (excepting Singapore, which does not allow export of its native species) share a common characteristic of declining wild tree populations due to persistent over-harvesting and increasing habitat conversion (TRAFFIC Southeast Asia, 2004).

Concern over the effect of international trade led to the genus *Aquilaria* (along with one other agarwood-producing genus, *Gyrinops*) being listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which came into effect in 2005, 10 years after a single agarwood-producing species, *Aquilaria malaccensis*, was first listed in CITES Appendix II². In general, a CITES Appendix II listing aims to ensure that the international trade is conducted legally and maintained within sustainable levels – it is not a trade ban.

Agarwood-producing taxa are linked to several genera in the family Thymelaeaceae, with the genus *Aquilaria* being the most important (Hou, 1960). However, not all species within these genera are known to produce agarwood. Furthermore, no standard biochemical parameters have been determined to define agarwood, with the make-up of the substance's various constituent compounds varying between different specimens from the same tree.

For agarwood-producing taxa listed in CITES Appendix II: *Aquilaria* spp. and *Gyrinops* spp, the provisions of CITES apply to all parts and derivatives under Annotation #1.

1.2 Requirements of the Convention for exports of Appendix II specimens

CITES requires that the export by range States of Appendix II species is not detrimental to the survival of that species in the wild. To ensure this, the CITES Scientific Authority (SA) of the State of export is required to make what is commonly referred to as a 'non-detriment finding' (NDF) prior to the issuance of any export permits by the CITES Management Authority (MA). The text of the Convention states that: "An export permit shall only be granted when the following conditions have been met: (a) a Scientific Authority of the State of export has advised that such export will not be detrimental to the survival of that species; ..." (Article IV paragraph 2(a)). The CITES *Resolution Conf. 10.3* on the designation and role of the Scientific Authority recommends, *inter alia*, that NDFs and advice from the SA of the country of export be based on the scientific review of available information on the population status, distribution, population trend, harvest and other biological and ecological factors, as appropriate, and trade information relating to the species concerned (see Section 1.4 of this document for more detail on the relevance of *Resolution Conf. 10.3*).

The term 'export' for the purposes of CITES only applies to the trade of specimens originating in the country where harvest has taken place. 'Re-export' applies to the trade of specimens originating from a country other than the exporting country, in such instances specimens only require a Re-export Certificate. 'Country of origin' is defined as the country in which a specimen was taken from the wild or

¹ There is some uncertainty whether the Philippines is also a range State.

² The genus *Gonystylus*, better known for its Ramin timber but which also produces agarwood, has also been listed in Appendix II owing to concerns about the sustainability of the international trade in its timber.

artificially propagated. These definitions have been adapted from Resolution Conf. 12.3 (*Rev. CoP14*) on permits and certificates, Annex 2.

In practice, NDFs are often incorporated into an annual export quota system which can eliminate the need for a NDF to be conducted for each individual shipment of CITES specimens. This provides a basis for monitoring the trade and may facilitate the issuance of export permits (see *Resolution Conf. 14.7* on the management of nationally established export quotas).

The Convention also requires the CITES SA of the State of export to determine when to limit the granting of export permits for Appendix II species “in order to maintain that species throughout its range at a level consistent with its role in the ecosystems in which it occurs, and well above the level at which the species might become eligible for inclusion in Appendix I” (Article IV paragraph 3).

Although the primary responsibility for making NDFs rests with the CITES SA of the State of export, Article XIII vests authority with the CITES Secretariat to communicate with a Party when there are believed to be problems with implementation. Furthermore, the Conference of the Parties to CITES adopted *Resolution Conf. 12.8 (Rev. CoP13)* on the review of significant trade in specimens of Appendix II species that directs the Plants Committee to identify when Appendix II species are subject to unsustainable trade and recommend remedial actions through what is known as the “Review of Significant Trade”. This can include, for example, the establishment of export quotas, development and implementation of management plans or, as a last resort, restrictions on exports for the species concerned³.

1.3 Approaches to conducting NDFs for agarwood-producing taxa

Since a single agarwood-producing taxon, *Aquilaria malaccensis*, was first included in Appendix II in 1995, studies in agarwood range States, particularly Indonesia and more recently, Malaysia, have made efforts toward gathering information that would assist the formulation of NDFs for agarwood (Soehartono and Newton, 2000; Soehartono and Newton, 2001; Soehartono and Newton, 2002; Anon., 2003b; Walujo and Wiriadinata, 2006; FDP, 2006). These efforts were made parallel to similar NDF initiatives for other CITES-listed tree species, particularly Big-leaf Mahogany (Oldfield and Newton, 2003; Magin, 2006; CoP14 Inf24) and Ramin (Anon., 2002; Anon., 2003a). However, these efforts have all been somewhat hampered by the fact that no standard methodology has been developed for making NDFs.

In a generic attempt to address the methodological gap, IUCN developed a *Checklist to assist in making Non-Detriment Findings for Appendix II exports* (Rosser and Haywood, 2002) (‘the IUCN Checklist’)⁴. This checklist approach is also known as a ‘rapid vulnerability assessment’ (RVA) (Wong *et al.*, 2001). Such a RVA helps to determine whether a species may be at risk from overexploitation. However, a RVA does not actually provide quantitative information to assist in determining harvest limits or export quotas, two mechanisms that have been used to maintain harvests and trade within sustainable levels by a number of CITES Parties.

The IUCN Checklist consists of two parts: ‘Table 1’ is an initial review at the national level on the types of harvest, the degree of control over the harvest, the segment of the population harvested, the level of total off-take (for domestic and international use), the reason for the harvest, and the end users of the harvest. There are also checks to distinguish between regulated and illegal or unmanaged harvesting. Concerns captured in Table 1 can then be dealt with in more detail in ‘Table 2’, which compiles information on management history and planning, harvest management, status of land on which harvesting takes place, capacity for monitoring the harvest, benefits and risks of harvest, and levels of strict protection (Rosser and Haywood, 2002). Scoring is done on a scale of 1-5, where 1 shows the lowest level of confidence for the category concerned.

IUCN stressed that while the Checklist itself does not constitute a finding of non-detriment, its use should inform non-detriment finding methodologies. However, if the majority of factors are scored closer to 1, indicating a high degree of uncertainty, a Scientific Authority may conclude that insufficient information

³ A review of significant trade was conducted for one Agarwood-producing species, *Aquilaria malaccensis*, in 2003, which resulted in recommendations being made to key range States, namely India, Indonesia and Malaysia with regard to implementation of Article IV of the Convention.

⁴ This IUCN Checklist has been presented to the CoP as CITES Inf. 11.3 but has not been formally adopted.

exists on which to base a finding of non-detriment. In such a case it is recommended that most Parties should choose not to allow commercial trade until information quality is improved (Rosser and Haywood, 2002).

While a useful starting point, the generic IUCN Checklist has limitations in terms of its applicability to certain tree species and countries. The case of agarwood is very different from other CITES-listed tree species harvested for their timber – the fact that it is traded a non-timber forest product which is found irregularly in only 10-20% of agarwood trees makes the development of a NDF methodology even more challenging.

A national workshop held in Malaysia in March 2006 sought to assess the extent to which this generic checklist met the needs of making a non-detriment finding for *Aquilaria*; concerns were raised with the definition and clarity of checklist terms as applied to a national setting (Anon., 2006)⁵.

Recognising the need for greater clarity in carrying out NDFs for agarwood-producing taxa, the Conference of the Parties to CITES (CoP) has recommended that a standard method for determining the population status of CITES-listed agarwood-producing taxa be developed to assist CITES SAs in carrying out NDFs: “Such a standard method could be used to verify populations across all agarwood-producing areas, and not allow only the setting of appropriate quotas but also allow the verification of species being harvested” (CITES Decision 12.70; CITES Decision 13.65(d)).

More generally, the CoP has decided to “develop guidelines for Parties to establish, implement, monitor and report national export quotas for CITES-listed taxa” (CITES Decision 13.66). In pursuit of these objectives, the CITES Secretariat contracted TRAFFIC Southeast Asia to develop a NDF methodology for agarwood-producing taxa. The first draft of such a methodology was prepared for discussion and further development by an international CITES Agarwood Experts Group Meeting involving government, scientific and industry representatives from key agarwood-trading countries held in Malaysia from 14-17 November 2006. Feedback from workshop participants has been incorporated into the present draft.

The term “not be detrimental to the survival of that species” is interpreted in the context of the full text of Article IV which notes the need to “maintain that species throughout its range at a level consistent with its role in the ecosystems in which it occurs, and well above the level at which the species might become eligible for inclusion in Appendix I”.

This wording can be broken down into a number of components: (1) the range of the species; (2) the abundance of the species consistent with its ecological role; (3) eligibility for inclusion in Appendix I. Further details on these components are found in the Biological Criteria for Appendix I which were adopted by the 13th meeting of the Conference of the Parties in 2004 (*Resolution Conf. 9.24 (Rev. CoP14)*) on criteria for amendment of Appendices I and II, Annex 1). However, *Res. Conf. 9.24* does not actually specify criteria for the threshold levels at which species become eligible for inclusion in Appendix I.

1.4 Contextual and institutional references for CITES non-detriment findings

It is important to consider any NDF methodology in the context of the local governance framework (i.e. national or sub-national), including both legislation and institutional responsibility. This will include the framework for the management of species and habitats as well as the framework for the management of international trade. In terms of CITES implementation, the NDF is placed in the context of a wide range of responsibilities designated to the CITES MAs and SAs of each CITES Party.

Resolution Conf. 10.3 on Designation and Role of Scientific Authorities is a key reference in this regard, and illustrates the importance of having a functional and interactive relationship between SA and MA institutions. Several paragraphs of this Resolution are particularly important when considering the implementation of NDFs, including a), c), g), h), j) With reference to the fact that several agarwood-producing taxa have transboundary populations between range States, paragraphs d) and e) encourage co-operation and sharing of resources towards provision of the scientific findings required under the

⁵ See Annex 1 of this document for examples of outputs from using the IUCN Checklist for agarwood trade in Indonesia and Malaysia.

Convention. Paragraph m) of the same Resolution is relevant for the exports of cultivated agarwood products under the CITES definition of 'artificial propagation'.

Before the MA requests the SA to make NDFs for specimens of agarwood-producing taxa, it should determine that all applications for CITES permits to export these specimens are in order (*Resolution Conf. 12.3* (Rev. CoP14) on Permits and Certificates, Annex 2). In particular, the MA should ensure that the exporter has indicated the species, type, source and quantity of specimens on the standard permit specified in Article VI paragraph 2.

Prior to requesting advice from the SA, the MA should be satisfied that each specimen was not obtained in contravention of the laws of that State for the protection of fauna and flora (Article IV paragraph 2(b)). NDFs and any quotas resulting from NDFs should not be used to legitimise illegal harvest of agarwood. Legality is generally considered to be a pre-requisite for sustainability and therefore the assessment of legality should be made prior to any NDF (for individual exports), or in conjunction with the issuance of export permits within the limits of any existing national quota. The first part of the IUCN Checklist ('Table 1') encourages the SA to make an initial review, at the national level, of the degree to which harvest is regulated (or legal).

The export of certain specimens of agarwood may not require advice from the SA. Examples include specimens that were artificially propagated (often referred to as cultivated agarwood) (with valid certificates of artificial propagation or proof of cultivation), pre-Convention specimens (with valid pre-Convention certificate) and non-commercial trade between scientists and scientific institutions. Agarwood seedlings may come under the category of plants that are artificially propagated in accordance with *Resolution Conf. 11.11* (Rev. CoP14) on regulation of trade in plants, paragraph a. Agarwood from cultivated sources (home gardens, plantations) could come under the category of parts and derivatives of plants that were artificially propagated (CITES Source Code 'A'). Such specimens may be exported under the provisions of Article VII, paragraph 5, of the text of the Convention.

Finally, it is important that the SA does not consider its role complete once NDFs have been made. The Convention requires SAs to monitor the exports of specimens of Appendix II species. In this regard, it is important that, in the spirit of adaptive management, SAs work closely with the relevant Management Authorities, Customs and other relevant law enforcement agencies to assist with species identification and control of the chain of custody. The role of the SA should also be to advise on a practical permanent monitoring system to ensure levels of international trade (and by extension the harvest levels to supply those exports), do not become detrimental to the survival of the species in the wild.

1.5 How to use this document

Section 2 details a methodology for going through a NDF process with stakeholders towards assessing the impact of international trade levels on the status of agarwood-producing taxa. It suggests relevant categories of information, and the possible sources of such information, to assess the status of the harvest and trade relative to wild populations, identify knowledge gaps, and to examine any resulting trends or uncertainties in lieu of exhaustive field studies to enable CITES Authorities in relevant range States to evaluate the likelihood of detriment posed by current levels of trade.

Section 3 outlines technical specifications in the wider management context that encompass a resource assessment at more precise resolutions. Collection of such information would ensure that subsequent NDF assessments would benefit from an increasing degree of accuracy.

It also emphasises that the monitoring and verification systems that should be set up (or strengthened) in parallel to the NDF assessment process. Such systems will form the basis of an adaptive management system. Without a framework to pick up any iterative advances in quality and category of information, the management system will not be sensitive to change.

This document is presented in line with CITES Decision 14.143, directed to the Plants Committee and the Secretariat regarding Agarwood-producing taxa, which specifies that:

On the basis of the work on non-detriment findings for agarwood-producing species, that has been developed by TRAFFIC Southeast Asia and the Secretariat, the Plants Committee, in consultation with range States and the Secretariat, shall develop principles, criteria and indicators for the formulation of non-detriment findings for agarwood-producing species.

As such, the Plants Committee is invited to provide comments on this draft, and to consider how to further develop principles, criteria and indicators for the formulation of non-detriment findings for agarwood-producing taxa.

SECTION 2 – SOME STEP-WISE APPROACHES TO DECISION MAKING FOR NON-DETRIMENT FINDINGS

2.1 Define the scope of the assessment

Determine the current taxonomic status of the agarwood-producing species to be included in the assessment. Decide whether the assessment is addressing one or more species. Define the location subject to NDF assessment in terms of agarwood-producing species composition, geographic coverage as well as political and administrative limits⁶. If any previous NDFs have been made for the species, at the national level or any smaller geographic frame of reference within the national boundary, reference to these existing NDFs should be made when estimating values for scientific and management criteria (see step 2.3).

2.2 Check for existing quotas

Check whether any existing harvest and / or trade quotas have been set, and whether they were determined by any previous NDF assessment for the species defined in step 2.1. Determine whether these quotas are current and valid for the particular population of the species, taking into consideration any new information regarding the species.

2.3 Estimate values for fundamental scientific and management criteria

The IUCN document *Guidance for CITES Scientific Authorities: Checklist to assist in making non-detriment findings for Appendix II exports*, will provide a useful qualitative starting point for determining biological status, management history and planning, harvest management, status of land on which harvesting takes place, capacity for monitoring the harvest, benefits and risks of harvest, and levels of strict protection.

To assist with the accuracy of scoring the Checklist, and to assemble as much information about the status of the population being harvested, carry out a review of the existing literature⁷. In terms of quantitative information relevant to wild population status, the minimum, maximum and best estimates for the following factors will be relevant:

- a) Total number of individuals (including seedlings, saplings, small trees, big trees)
- b) Number of fruit-producing individuals
- c) Level and pattern of recruitment
- d) Number of sub-populations
- e) Effective number of fruit-producing individuals in each sub-population
- f) Level and pattern of exploitation, including for international trade
- g) Area of natural distribution
- h) Area of present occurrence
- i) Quality of habitat
- j) Integrity (fragmentation) of area of distribution

Further detail for structuring the resource assessment component of a NDF can be found in **Section 3.2** of this document.

⁶ Article IV paragraph 2(a) requires the assessment of the conservation status of the species at a global level, at a subspecies level or at the level of geographically separate populations.

⁷ This should include all relevant 'baseline data' derived from existing forest inventories, field-based assessments, botanical and ecological studies, and yield studies.

2.4 Conduct interview-based surveys with industry participants

Once the existing information and data have been reviewed, and key harvesting areas have been identified, the most important source of up-to-date information is likely to be from individuals and groups involved in harvesting and trading of agarwood. These industry participants, or stakeholders, may be located around the harvesting area, at intermediate points of consolidation and trade, at processing centres, or at points of warehousing and export. Field-based forestry officers, as well as those involved in issuing permits for harvest and/or trade, are also likely to be an important source of information, particularly if revenue is being collected from agarwood harvest and trade. Interview-based research could focus on the following information:

- a) Numbers of industry participants and scale of industry (formal and informal) – including connection to international investment and demand, and how this relates to international trade dynamics.
- b) Location of present harvesting areas – to determine where present supply is sourced from.
- c) Extent of cultivated agarwood investment and whether any agarwood is being produced from cultivated sources.
- d) Levels of trade – are these rising, declining or stable in both volume (quantity) and grade (quality)?
- e) What understanding exists in terms of the existing institutional and regulatory system for agarwood harvest and trade (laws, permits, regulations)? Is it clear to trade participants which government agency has responsibility for monitoring the agarwood industry?
- f) Annual value – national revenue from sale/export, how many stakeholders involved in earning an income [fewer participants may equal trade declining].

2.5 Examine additional factors that may assist with NDF assessment

Comprehensive information is unlikely to be available on population status, particularly at the national level, at the initial stages of carrying out a NDF. Therefore, in addition to analysing published data collected in step 2.3, and interview-based information collected under step 2.4, several other contextual indicators may assist in assessing the ability of the population to withstand the impact of harvest.

- a) Are wild harvesting areas getting increasingly further away from urban trade centres?
- b) Has volume of agarwood gathered per harvesting trip ('catch-per-unit-effort') decreased in terms of quantity (volume)?
- c) Has quality (grades of agarwood) of agarwood declined?
- d) Is the international market price rising?
- e) Is any existing harvest quota from certain geographical areas being met? Are any trade (export) quotas fulfilled to the maximum level?
- f) What size (diameter at breast height – dbh) trees are available for harvest in the wild?
- g) Is harvested product coming from wild or cultivated sources? Can these be distinguished from each other?
- h) Do any stockpiles of harvested (wood chips, pieces) or processed (e.g. oil, powder) agarwood products exist, and if so, how are these monitored or managed?
- i) Are 'outsiders' involved in harvesting activities, including foreign nationals?
- j) Are current harvesting areas inside or outside protected areas?
- k) What evidence exists for illegal harvest and trade, and how does this compare to legal activities?
- l) Are threats other than exploitation for trade (e.g. habitat conversion, fire) getting more severe?

2.6 Calculate the international trade threshold

Depending on the outputs from steps 2.3-2.5, an estimate of the maximum quantity of agarwood which can be exported from a range State without detriment to the survival of remaining populations can be calculated. This export trade threshold should be based upon a level of harvest that does not exceed the ability of the species to regenerate.

An allowance for illegal harvest and trade should be deducted from the export trade threshold to incorporate an additional precautionary element.

The calculation will need to determine the conversion factor between the quantity (and the form or product type) of specimens entering international trade and the number of trees removed from the wild population in order to produce this quantity. Any domestic or national use of agarwood should also be taken into account.

For wood chips, this would need to address the number of live individual trees harvested per kg of wood chips in trade – or the number of kg of wood chips in trade per live individual tree lost⁸.

For agarwood oil, this would need to address the volume (mass in kg) of agarwood chips used to produce resultant oil volume (litres), including an established metric for conversion. Once the volume/mass of wood (chips) is determined, that would also have to be calculated in terms of trees lost.

Based on these conversion factors, calculate the maximum quantity of agarwood (major products being wood chips and oil) that may enter international trade per year for the next five years before a species satisfies at least one of the Biological Criteria for inclusion in CITES Appendix I (A to C)⁹. Cultivated agarwood, however, and products derived from these controlled production systems, should be treated separately from wild-harvested agarwood, and production from cultivated systems should be differentiated to ensure it is not mixed or confused with wild harvested product (see **Section 3.1.3d** of this document for more detail).

7. Determine management interventions

There are likely to be several ‘unknowns’ or information gaps in the NDF assessment, so incorporating precautionary approaches is recommended. Depending on the reliability of available information, several management interventions may be deemed necessary.

These may include, for example: preparation of a management plan; zoning of agarwood habitat into separate delimited areas for harvesting and conservation; population surveys of ecologically representative agarwood harvesting areas; setting size limits (tree dbh) for harvest; specifying product types allowed for export, designation of processing centres and points (ports) of export; and strengthening monitoring of any existing management systems applied to agarwood-producing taxa. A more detailed technical list is given in **Section 3** of this document, outlining elements which Parties may consider to incorporate into an adaptive management system.

However, given agarwood’s nature as a high-value, predominantly open access resource, harvest and trade is likely to continue alongside any management interventions. Therefore annual limits to harvest and trade – in the form of quotas – may need to be set.

A national quota may be composed of several subordinate quotas relative to available habitat, harvesting locations, and political administrations. In the case of agarwood, the quota should specify to which species and product types it applies and in what volumes. The total national quota should be well below the quantity identified as a threshold in step **2.6** and should be tied to a calendar year (1 January to 31 December)¹⁰. The period after which a re-evaluation of a NDF for the species should be carried out should also be specified.

⁸ In the case of specimens of agarwood, the conversion factor will be a function of a number of variables including (1) the proportion of trees harvested which actually yield agarwood of the particular grade of the specimen; (2) the mortality rate of trees harvested; and (3) the conversion rate of processing activities, for example from trees to wood chips, and wood chips to agarwood oil (see **Annex 3** of this document for conversion rate examples). In 2006, Malaysia presented an explanation to the CITES Secretariat detailing the process of calculating a cautious harvest quota for *Aquilaria malaccensis* for the year 2007. This included considerations of a size limit for wild populations (trees above 30cm dbh), volume of potential annual harvest over a 50 year rotation, estimation of yield per tree for both wood and resinous deposits, while factoring the likelihood of agarwood formation at 10% of trees in the total wild population. Malaysia may wish to present the detail of this example to the Plants Committee for discussion with other range States.

⁹ *Res. Conf. 9.24 (Annex I) (Rev. CoP14)*.

¹⁰ Ensure that the CITES Secretariat is informed of this annual export quota (in compliance with *Resolution Conf. 12.3 (Rev. CoP14)*, s VIII a).

8. Advise on whether proposed agarwood exports will be detrimental, or not, to the survival of the species

The Scientific Authority, having taken into account all available information, ultimately needs to advise the appropriate Management Authority whether the export of the proposed quantity of agarwood will or will not be detrimental to the survival of the species.

If information gleaned from steps 2.3-2.6 indicates a predominantly negative trend, i.e. towards detrimental impact on the survival of the species in the wild, then the management interventions under **step 2.7** may also consider the cessation of trade. This amounts to a (self-imposed) zero quota by the Party concerned, and will allow time for certain information gaps to be filled in order to consider whether managed wild harvest and export should resume. A comprehensive list of management criteria is outlined in **Section 3** of this document, which aims to present a list of options for CITES Authorities of range States to consider towards improving the sustainable management of wild agarwood populations.

SECTION 3 – SOME TECHNICAL SPECIFICATIONS TO INFORM ADAPTIVE MANAGEMENT FOR AGARWOOD-PRODUCING TAXA (*Aquilaria/Gyrinops spp.*)¹¹

3.1 – MANAGEMENT PRINCIPLES, METHODS AND INDICATORS

3.1.1 Management plans and principles

- a) Establishment of management plans at national levels, accommodating State/province and smaller geographic units of management, will form the foundations of short, medium and long-term interventions towards a goal of legal and sustainable wild agarwood harvest and trade.
- b) An adaptive management approach is essential, allowing for new information to be taken into account as it comes to hand and implementation of modifications as necessary. In addition to conducting a resource assessment (see **Section 3.2**) factors such as harvest area rotation, allowable dbh sizes, growth, regeneration, levels of legal and illegal harvest, levels of threat posed by logging and other land conversion of agarwood habitat, would need to be considered.
- c) Management plans should incorporate considerations and needs of different production systems to acknowledge both populations in natural forests, as well as cultivated agarwood in plantations and home gardens, whether managed by private enterprise or local communities. Best-practice management guidelines and principles can be adapted for all agarwood production systems.
- d) The outcomes of successful cultivated agarwood production systems (whether small-scale home gardens through to plantations with differing degrees of management inputs), such as those in place in Bangladesh, India, Lao PDR, Thailand and Viet Nam, should be studied. Where possible, information should be widely disseminated in order to enhance silvicultural knowledge of the species and allow for adaptation towards enhanced management of remaining wild populations.
- e) In addition, any knowledge gleaned from the study of natural populations should be applied to *ex situ* cultivated agarwood production systems.

3.1.2 Factors that need to be considered for the sustainability of *in situ* agarwood populations

- a) *Harvest planning strategies:*
 - Define the type of harvest (destructive/non-destructive) to be undertaken according to age/size classes of agarwood tree populations and assessment of resin content in the tree;
 - Depending on the type of harvest, to define the type of silviculture that will be implemented based on the distribution and proportion of seed-bearing mother trees, and harvestable agarwood-bearing trees.

¹¹ The structure of this section is adapted from a template developed by Mahogany range States regarding "Essential Elements for the Formulation of Non-Detriment Findings for Bigleaf Mahogany *Swietenia macrophylla*", presented to CITES CoP14 by Mexico as part of CoP14 Inf. 24, and presented again to the Plants Committee as Annex I of PC 17 Doc 16.1.2.

- Given the nature of wild agarwood populations as an ‘open-access’ resource, and the predominance of local harvesters, it is important to consider who will conduct harvest monitoring and verification measures (i.e. the local community, or an external government extension officer?).
- b) *Harvesting Methods*: Based on the type of local/cultural approach to harvesting, and perceived economic viability, different harvesting methods may be carried out:
- Non-destructive:
 - Harvest of selected resin-bearing sections of tree, and/or stems where multiple stems exist or where coppicing has taken place, without killing the tree;
 - Harvest of whole trees, but leaving roots/stump for regeneration and coppicing (acknowledging uncertainty of future resin formation and fruit/seed production)¹².
 - Destructive:
 - Harvest of whole tree, often including roots, which kills the organism.
 - If this is not properly managed, the felling of the tree may also kill surrounding wildlings and small trees.
- c) *Regeneration*: Natural regeneration has been observed to be abundant when ecological conditions are optimal and mother trees are present in primary forest¹³. To sustain a viable population¹⁴, it may be necessary to implement the following:
- Ensure retention and protection of seed trees, and recording their location to assist with monitoring;
 - Ensure agarwood regeneration is considered in the management of an area, assuming multiple species are being harvested from that management area;
 - Collection of viable seeds to establish nurseries to supply seedlings for enrichment planting;
 - Establish the maximum distance between seed trees (taking into account requirements for successful pollination);
 - Protection of agarwood trees to be retained for future harvests, based on likelihood of agarwood formation and oleoresin production (natural or induced);
 - Enrichment of harvested areas through planting (e.g. can be implemented by local harvesters/traders as part of their licensing requirements).
- d) *Conservation*: To protect the different species and their localised geographic populations found throughout each national agarwood range, and in order to ensure that the variety and diversity of the populations will be preserved, the following actions need to be considered:
- *In Situ*: Establishing strictly protected agarwood conservation stands in ecologically representative locations. This will ensure the maintenance of genetic variation, and aid with production of seeds and the establishment and monitoring of sample plots. Such zones could be linked to existing protected area systems.
 - Coordinating an agarwood seed collection and management program, accurately documenting seed collection locations; and creating nurseries to supply seedlings from viable and carefully selected seed stock for enrichment planting in selected locations.

3.1.3 Agarwood supply chain management

- a) *Monitoring and verification*: this is probably the most critical element of a working adaptive management system to support NDF for agarwood-producing taxa, and includes elements of law enforcement further detailed in **Section 3.3**.
- Compliance monitoring referenced to existing regulatory system for managing agarwood harvest and trade (including taxa-specific management plans if they exist).
 - Annual allowable cut (tree harvest volume) should be monitored in conjunction with product stockpiles (e.g. wood chips/pieces, powder, oil) and associated conversion ratios (particularly trees → wood chips; and wood chips → agarwood oil), and cross-referenced with levels of export trade in various agarwood product types.

¹² In many cases, non-lethal (non-destructive) harvesting may not be economically viable.

¹³ As agarwood-producing species are an upper-understory tree, the more light available will increase the speed of seedling growth (Anders Jensen, *in litt.* to TRAFFIC).

¹⁴ For conservation stands, or seed sources, a viable population should include 30 fruiting and flowering trees at least 100m apart (Anders Jensen, *in litt.* to TRAFFIC).

- Where possible, establishment of permanent monitoring plots (in both harvested and non-harvested areas) is advisable in order to gain a detailed and long-term understanding of the impact of harvesting from agarwood habitats.
 - Establishment of information databases and an expert group list-server is essential to support domestic and international information exchange on management of agarwood harvest and trade, including any associated scientific advances.
- b) *Training/expertise and field data collection:*
- Define minimum training criteria and standards for harvesters.
 - Devise an ongoing training programme for personnel (experts to train novice harvesters, whether local or outsiders) involved in harvesting activities to minimise destructive harvesting, and the selection of appropriate size and age classes of trees.
 - Training programme for regulatory staff to ensure understanding of relevant range State regulations including harvesting criteria and indicators.
 - In the course of population assessments and monitoring, drafting of geo-referenced maps of harvesting areas is recommended.
- c) *Determining quotas for harvest and trade for wild-harvested agarwood:* Accurate quota establishment depends on adequate knowledge of wild populations. If quotas are established without knowledge of wild populations and levels of harvest (current and historical), and instead referenced only to domestic stockpiles and previous export volumes, it is impossible to assess the impact that exports will have on wild populations. The following steps should therefore be considered:
- Select an ecologically representative array of agarwood harvesting areas to determine minimum viable populations, to assist with calculation of the maximum volume (number of trees) subject to harvesting. This could also be paired with data on tree growth and regeneration/recruitment data to determine harvesting volumes, as well as considerations of any non-destructive harvesting.
 - Harvest quotas will ideally be established with reference to a specific geographic area (including a defined collection area), to acknowledge variance in population structures, while also acknowledging any political management unit and associated regulatory procedures. This information can then be used as a baseline for establishing export quotas.
 - As the current status of knowledge indicates 10-20% of trees in naturally occurring wild populations contain resinous agarwood deposits of commercial value, the number of harvested trees (including those with no agarwood deposits) should be referenced to volume of yield of resinous agarwood to reflect losses inherent from processing trees into agarwood chips¹⁵.
 - Export quotas should take into consideration the diversity of major products in trade and any associated conversion factors. In particular, the conversions of trees to wood chips, and wood chips to essential oil will both be critical considerations when setting annual thresholds/limits for exports¹⁶.
 - Quotas should be established one year in advance whenever possible in order to enable monitoring and verification.
- d) *Separating cultivated agarwood production from wild-harvested sources:* Differentiation between wild and cultivated agarwood production systems and products in trade is necessary both for efficient management and monitoring of the agarwood supply chain, and a component of NDFs. This may involve:
- Registers of cultivated agarwood plantations and home gardens.
 - Conducting NDFs for cultivated agarwood production referenced to outputs from these registered locations, whether wood chips, oil or finished products.

¹⁵ In an intensively managed production system (e.g. cultivated plantations or home gardens), this may also enable information to be collected on the mix of quality/grades of agarwood harvested from age/size classes of trees.

¹⁶ This should then be related back to harvest monitoring, and linked closely with the monitoring of agarwood industry members processing wood chips into oil.

- Upon application, verification of agarwood product source before issuance of CITES export permits with Source Code 'A', designating 'artificial propagation' or production from non-wild sources under controlled conditions¹⁷.

3.2 – RESOURCE ASSESSMENT– to determine crucial baseline biological and ecological information

3.2.1 Distribution

Determine range and distribution of agarwood-producing taxa at the national level. This is clearly dependent on agarwood-producing taxa being included at genus, if not species, level in national forest inventory specifications, or in production forest assessments of smaller geographic units. Some existing sources of information at the national level (which may be aggregated from smaller units of information such as State/province, or forest management area) are:

- National forest inventories – which may give indications of agarwood-producing taxa at genus level;
- Available satellite imagery – in the case of agarwood, this may only give indications of suitable habitat, but will not give more precise information for a typically widespread species which has clumped distribution;
- Any existing mapping of production forest areas at sub-national (i.e. State or province) level, or smaller localised levels of forest management (including protected areas) where species composition has been assessed.
- The most important source of information on agarwood presence/absence at the local level is likely to come from field-based forest rangers and individuals and/or groups involved in harvesting and trading of agarwood. These industry participants, or stakeholders, may be located around the harvesting area, at intermediate points of consolidation and trade, at processing centres, or at points of warehousing and export.
- Over time, key harvesting areas can be identified and inventories can be conducted in an ecologically representative selection of agarwood habitat. Given the widespread but irregular (clumping) distribution, techniques such as distance sampling and adaptive cluster sampling may be most appropriate¹⁸.
- Reference set of herbarium specimens at national, regional and international herbaria and forestry research centres – useful only for determining some extent of natural (historical) distribution, and with understanding background ecological conditions

By analysing available information, some indication of the historical and current distribution of agarwood-producing taxa may be determined, and key areas identified for harvest management and conservation. Collated information may also allow for systematic comparison of current status to historical distribution of wild populations.

3.2.2 Population parameters

In order to assess populations of agarwood-producing taxa, regular monitoring of selected biological parameters and indicators of sustainable management must be carried out in representative harvesting areas within, for example, a monitoring interval of five years. Baseline figures are therefore essential to this process.

1. Monitoring parameters

- Structure of agarwood populations:
 - Diameter at breast height (dbh), based on an appropriate sampling method
 - Height of trees, measured or estimated
 - Density (# agarwood trees/ha; # agarwood trees/100 ha), by size classification
 - Number of seed-bearing (mother) trees

¹⁷ noting that the CITES definitions for 'artificial propagation' of agarwood or other non-timber forest products need examination with reference to *Res. Conf. 11.11 (Rev. CoP13)*.

¹⁸ Areas assigned as *in situ* conservation stands for seed collection would be additionally useful for detailed tree inventories, and monitoring of seed trees. These conservation stands should be located across a representative range of ecological zones within each national jurisdiction.

- b) Assessment of whether seed stock is being replenished (to determine recruitment potential)
- c) Natural regeneration – estimate number of seedlings, saplings, small trees¹⁹;
- d) Growth rate (of standing trees at dbh) – as agarwood is an upper-understorey species, growth would vary depending on degree of canopy closure.
- e) Indicative probability of agarwood formation in localised wild tree populations, based on information obtained from communities surrounding harvesting areas (depending on location).

2. Sustainable management indicators for viable agarwood tree populations

These indicators make it possible to identify the relative population dynamics to ensure that an equivalent population of agarwood trees is established for regeneration and maintenance purposes, so as to replace the trees that were destructively harvested:

- a) Identification of seed-bearing (mother) trees, and monitoring of their mortality rate, within managed harvest areas. This would allow comparison with monitoring of mother trees in any protected / conservation zoned areas.
- b) Regeneration rate / recruitment (natural or through enrichment planting), including considerations of seedling mortality.
- c) Felling rate.
- d) Retention rate of large trees (>50cm dbh).
- e) Number of trees available for future harvest.
- f) Ability of non-destructively harvested trees to allow agarwood formation.

3. Information gaps

In order to establish a basic silviculture for wild populations of agarwood-producing taxa, the following parameters need to be further understood by range State resource managers:

- reproductive biology, including pollination and dispersal mechanism;
- life history of all agarwood-producing taxa, including age at which agarwood formation and oleoresin production is most likely to occur;
- annual growth, regeneration;
- habitat and ecology (including soils, elevation, terrain, drainage, climate), including considerations of spatial distribution of agarwood trees in natural forest;
- phenology;
- agarwood formation process (and possible application of inducement technology to improve the speed and quality of resin formation²⁰);
- minimum / maximum dbh appropriate for harvesting;
- agarwood content and quality in trees;
- techniques or tools on how to detect presence of resinous agarwood deposits in the tree without felling, including indigenous ethnobotanical knowledge;
- long-term morbidity associated with non-lethal harvest (and considerations of economic viability of non-lethal harvesting).

3.3 – MONITORING AND VERIFICATION TOOLS FOR CONSERVATION, HARVEST AND TRADE ACTIVITIES

It is necessary to support conservation and legal harvesting activities with monitoring and law enforcement in order to ensure compliance and reduce illicit activities driving illegal agarwood harvesting. These recommendations take note of outputs from the CITES Agarwood Experts Group meeting (Malaysia, 2006) and the 2nd International Agarwood Conference (Thailand, 2007):

- a) Ensure clear definitions for aspects of the agarwood industry, particularly the parameters of ‘cultivated agarwood’ or plantation-sourced materials, a rapidly emerging component of future

¹⁹ Strictly protected conservation stands would likely be managed specifically for recruitment, collection and planting elsewhere (whether in plantations or theoretically enrichment planting in wild population stands).

²⁰ Application of inducement technologies to wild agarwood populations should be examined under protocols agreed with the SA of the range State concerned.

supply that would need to be separated from, but informed by, wild harvest regulations. Other definitions that need to be established are agarwood powder/dust, wood chips, logs, wood pieces, oil, non-timber forest product, incense (as this refers to raw agarwood in some cultures) and even 'agarwood' itself (separate from the tree). A glossary of terms should be developed that considers cultural aspects of the agarwood industry and trade in order to allow better understanding between producers, traders and consumers, including government regulators.

- b) Strengthen the chain of custody from forest (point-of-harvest) to point(s) of processing and/or export as a means of intensifying the control on legally and illegally harvested agarwood.
 - Investigate options for an agarwood marking and traceability system to strengthen the chain of custody for product tracking, and to differentiate between cultivated and wild-sourced agarwood. This could also be extended to verify agarwood imports, right through to final sale of certain products (e.g. agarwood oil).
- c) Establish a verification system for harvesting and supply chain management from production areas (at various levels e.g. national, State/province, or harvest site), carried out by the MA with the participation of the SA and any licensed harvest/trade participants, which may include:
 - On-site (annual) inspection of harvesting areas to measure compliance with the approved harvest management protocols (acknowledging that these will vary between range States). under forest management plans, as well as monitoring systems utilizing available technology.
 - Control systems for supply chain management from harvest area to point of processing, sale or export, in compliance with relevant regulations and procedures in each range State.
- d) Under national management plans, establish national registers of industry participants in an effort to formalise the agarwood trade structure²¹. Such a register could also be referenced to licensing systems for harvesters, collectors, processors, vendors and exporters, depending on the regulations of each range State.
 - Establish a register of cultivated agarwood plantations (including inventory of trees and stocks) at national levels, to enable better separation of production systems for cultivated agarwood and wild harvested agarwood.

SECTION 4 – CONCLUSIONS

This paper considers a range of options for carrying out a non-detriment finding (NDF) assessment for agarwood-producing species in compliance with the provisions of CITES. The text of CITES does not provide detailed guidance in regards to NDF, however the numerous decisions, resolutions and information papers of the CITES Conference of Parties does lay a foundation upon which the recommendations of this paper are built.

In practice, the lack of comprehensive information will inevitably render NDF assessments subject to a degree of uncertainty. Furthermore, there are numerous practical difficulties with the regulation of the agarwood trade that have been recognised and have yet to be resolved. Nevertheless, the practical implementation of NDF by the Scientific Authorities of the various Parties will begin to bring the trade in agarwood closer in line with the criteria of legality and sustainability.

However, the effectiveness of implementing a NDF rests on the fundamental assumption that range States have a functional and objective Scientific Authority (as defined by *Resolution Conf 10.3*), and an interactive relationship between the SA and MA focused on monitoring the legality and sustainability of Appendix II exports.

Through a process of continual improvement of the quality of data specific to agarwood-producing taxa, Parties can implement an adaptive management system that will aim to safeguard remaining wild populations.

²¹ Note that this has been done in some range States already (e.g. India, Indonesia, Thailand), to different degrees.

SECTION 5 – RECOMMENDATIONS

In line with CITES Decision 14.143, it is recommended that the Plants Committee consider this draft and examine how to further develop principles, criteria and indicators for the formulation of non-detriment findings for agarwood-producing taxa.

It is recognised that for robust implementation of a NDF, prescriptive management interventions may be needed to support harvesting sustainability. For agarwood-producing taxa, meeting goals of promoting regeneration, agarwood product traceability, establishment and maintenance of conservation areas, monitoring systems, and law enforcement will require financial investment and technical support²². As such, the following considerations should be taken into account:

- a) Range States should consider costing out activities required for sustainable management of agarwood harvest and trade in compliance with compatible NDF methodology, for the benefit of in-country value addition, related industry development (considering both wild harvest as well as cultivated production) as well as species management and conservation. Implementing management plans for agarwood will require additional financial investment.
- b) If a National Management Plan is deemed appropriate, it may be necessary to evaluate the role that various institutions play in the oversight of agarwood harvest and trade in each range State, including monitoring and law enforcement. Clearly defined institutional responsibilities may improve the efficiency and transparent use of resources. One suggestion is to centralise administration of the agarwood industry to one government institution to streamline operations and ensure a clear 'rulebook' for industry participants.
- c) Development (including funding) of any management plans for agarwood should be integrated into overall sustainable forest management strategies as they pertain to commercial tree species.
- d) The cost of implementing sustainable harvest management plans may have an effect on the price competitiveness of agarwood sourced from legal and sustainable production systems (both wild-harvested and cultivated agarwood). This should be carefully considered as part of an ongoing dialogue between stakeholders in range and consumer States (both government and private sector).
- e) By examining the supply/market chain for opportunities for cost and benefit sharing, practical co-operation could be facilitated between producers (including harvesters, collectors, processors), traders (import and export intermediaries), established agarwood industry members, and end users. For example, if end-use markets require particular qualities of wild-harvested or cultivated agarwood, private sector industry participants or end users may consider investment in supporting legal and sustainable production, harvest and export from range States.

²² This takes note of related discussions by Mahogany range States to recognise the need for cost effectiveness and streamlining institutional actions for NDF implementation, as detailed in CoP14 Inf. 24, and presented again to the Plants Committee as Annex I of PC 17 Doc 16.1.2.

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CITES Resolution Conf. 12.3 (Rev. CoP14) *Permits and certificates*
CITES Resolution Conf. 12.8 (Rev. CoP14) *Review of Significant Trade in specimens of Appendix-II species*
CITES Resolution Conf. 14.7 *Management of Nationally Established Export Quotas*
CITES Inf. 11.3 *Checklist to Assist in Making Non-Detriment Findings for Appendix II Exports*
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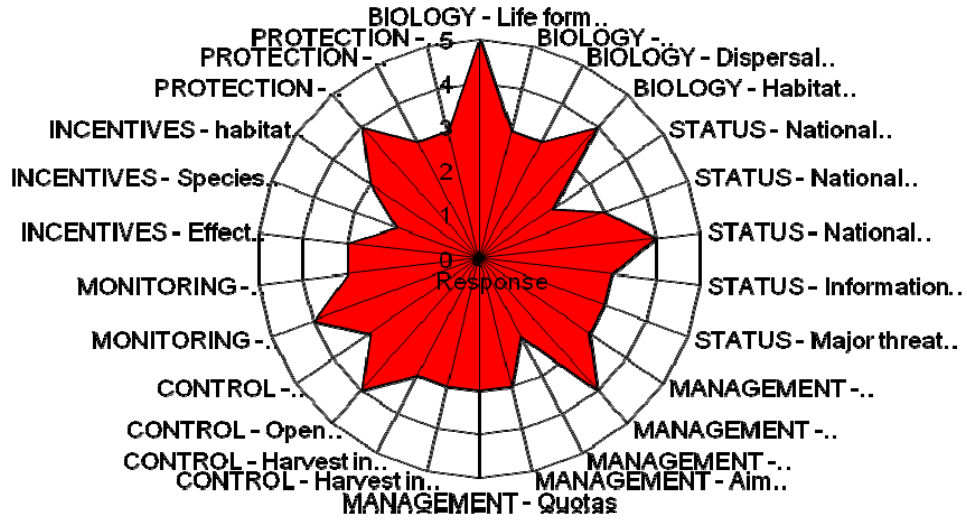
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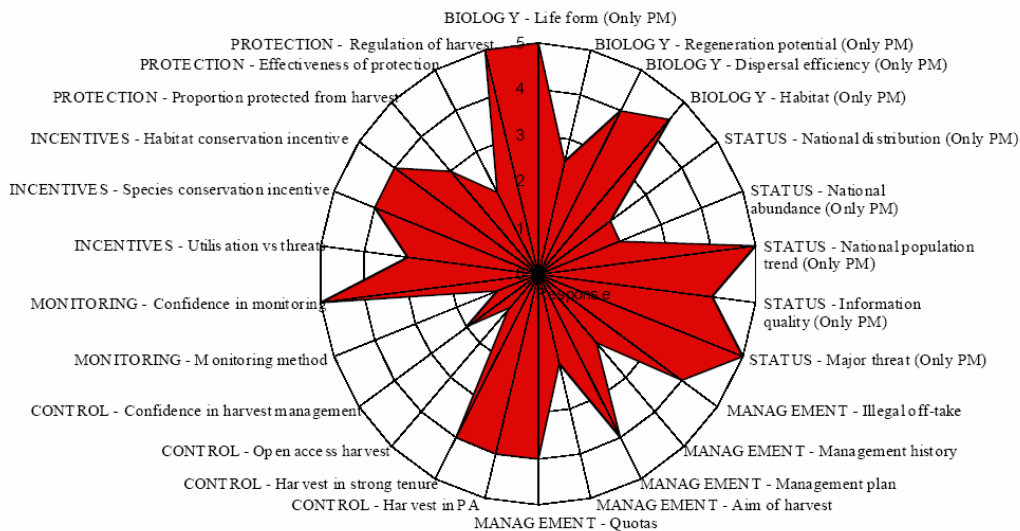
EXAMPLES OF IUCN CHECKLIST OUTPUTS FOR AGARWOOD

**Figure 1 - Assessment of *Aquilaria malaccensis* in Indonesia (2003)
Plot of responses to questions to IUCN Checklist**



Source: Samedy and Wiradinata, *in litt.* to TRAFFIC Southeast Asia 2003.

Figure 2: Outcome of Working Groups, Malaysia National Workshop 2 March 2006 – Plot of responses to questions in related to agarwood-producing taxa



Note: Some of the attributed values here were referenced to a sub-national set of information (in this case Peninsular Malaysia) rather than a complete national overview.

Source: Anon. (2006a)

CONCEPTUAL MODELS OF RELEVANCE TO NON-DETRIMENT FINDINGS

Figure 3: Adaptive Management Model (Peters, 1994)

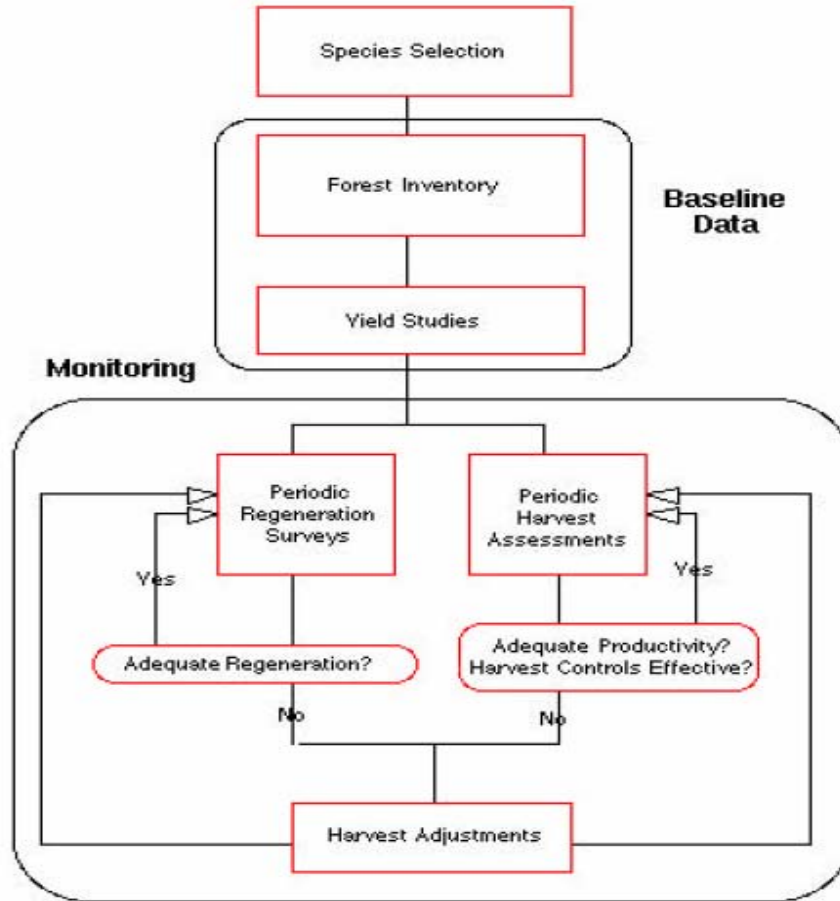
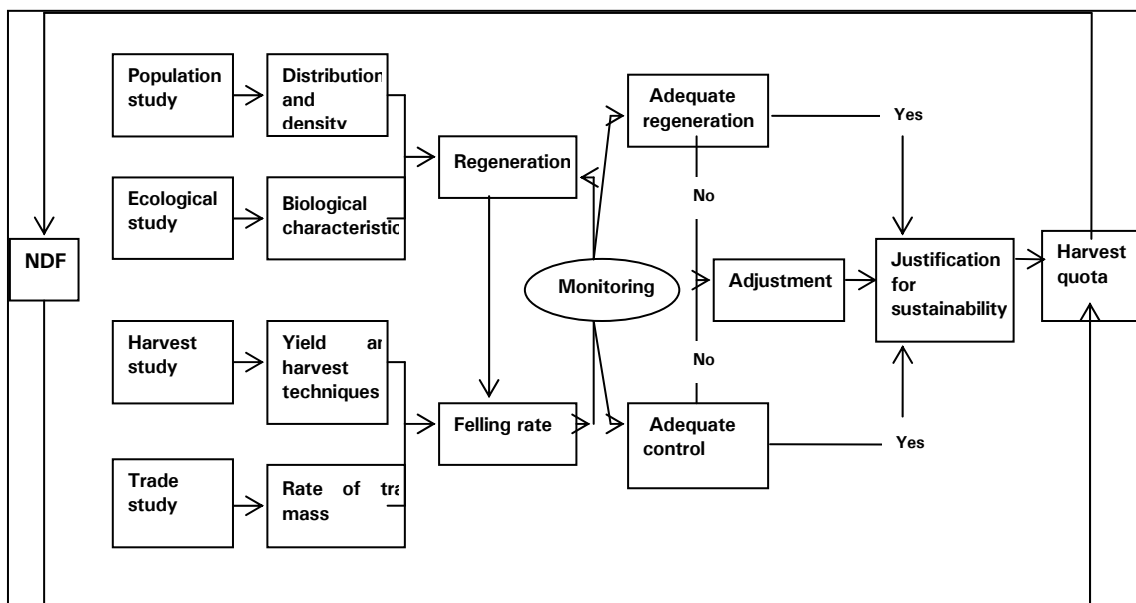


Figure 4: Schematic for assessing sustainability of harvest quota and making a NDF for agarwood (T.Soehartono *in litt.* to TRAFFIC Southeast Asia, 2006)

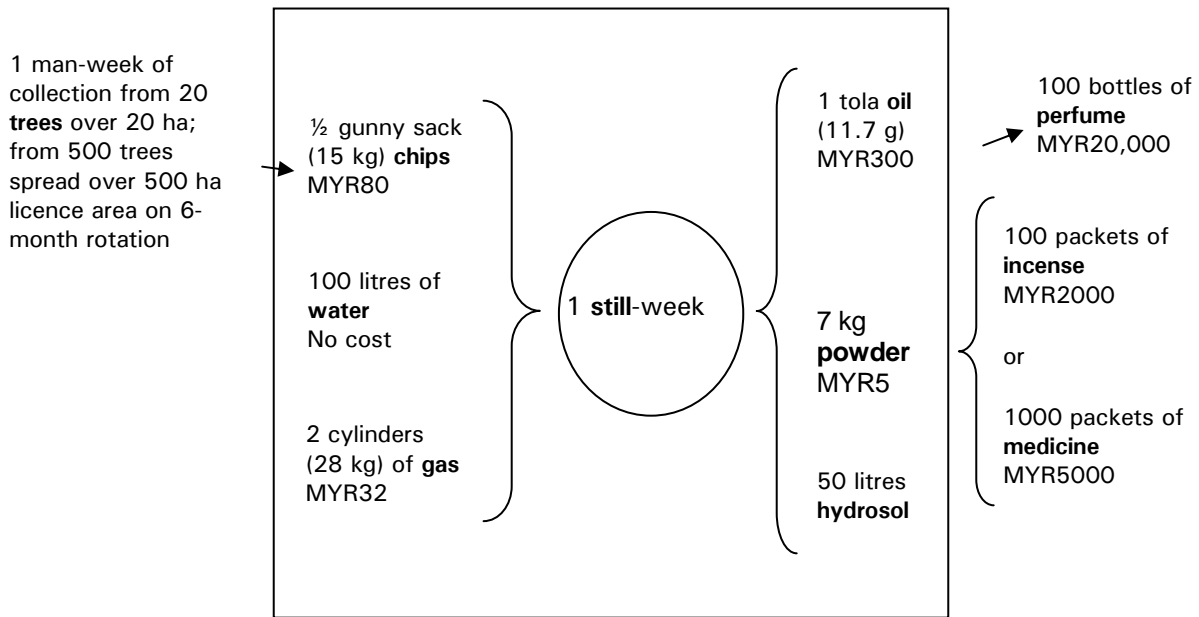


EXAMPLES OF CONVERSION RATES FROM TREES TO FINISHED PRODUCTS

- 1) Field work carried out by TRAFFIC in **Malaysia** has found that the yield from *gaharu* (agarwood) distilleries was in the order of 0.1%, i.e. roughly 1 kg of wood chips yielded 1 g of oil. However, distillation was considered a profitable enterprise as MYR1 (USD0.26) of chips could be converted into MYR3 (USD0.79) of oil (**Figure 1**).

Figure 1

Schematic diagram of the economics of *gaharu* distillation in Malaysia



MYR – Ringgit Malaysia (MYR3.8 = USD1 at 2005 rates)
 Source: TRAFFIC research, Kelantan, Malaysia 2005.

- 2) In the United Arab Emirates, a benchmark conversion level has been set following the calculation:
 To derive 6 *toulas*²³ of pure agarwood oil, 10 kg of wood is required. Therefore, to produce 1 litre of pure agarwood oil, approximately 143 kg of agarwood are used (Source: TRAFFIC research, 2006).

²³ A *toula* is a traditional unit of measurement in the markets of the Middle East (and India), approximately equal to 11.6 millilitres. Therefore, there is approximately 86 *toula* in 1 litre.

Trees Working Group Guidelines

Second document of the Working Group

1. Information about the target species or related species
Biological & species status:
ELEMENT 1: SPECIES DISTRIBUTION AREA (RANGE) AT RELEVANT SCALES
OBJECTIVE: Characterize the species' distribution at different spatial and jurisdictional scales so that production and conservation areas can be identified.
ELEMENT 2: POPULATION PARAMETERS AS INDICATORS OF SUSTAINABLE MANAGEMENT
OBJECTIVE: Characterize species population status (standing stocks & dynamics) to provide standards for evaluating harvest impacts.
Takes/uses (e.g. harvest regime):
ELEMENT 3: MANAGEMENT SYSTEMS & HARVEST RATES
OBJECTIVE: With sufficient knowledge of distribution and population parameters determine whether management systems are appropriate to species populations subject to harvest AND whether harvest levels are sustainable.
Management, monitoring and conservation:
ELEMENT 4: MONITORING & VERIFYING HARVESTS
OBJECTIVE: Determine whether adequate monitoring & verification systems are in place to ensure the sustainability of harvest and to reduce illegal activities & illegal trade.
ELEMENT 5: CONSERVATION & THE PRECAUTIONARY PRINCIPLE
OBJECTIVE: Determine whether safeguards are in place to ensure that representative natural populations and phenotypic & genetic diversity represented in harvested populations are conserved.
2. Field methodologies and other sources of information.

Biological and species status data:

See NDF Guidelines for Trees

Harvesting and trade data:

See NDF Guidelines for Trees

3. Data integration for NDF elaboration

Consider the elements in the NDF Guidelines for Trees with specific reference to the following:

- Estimation of species range area
- Population parameters
- Management principles
- Monitoring & verifying harvests, processing
- Conservation

4. List and describe the ways data quantity and quality may be assessed

See NDF Guidelines for Trees

5. Summarize the common problems, errors, challenges or difficulties found on the elaboration of NDF.

The analysis of case studies helped identify elements in which information or action were inadequate. In particular:

- Population parameters considered basic to evaluating harvest impacts were generally unavailable within range States
- Silvicultural practices for reducing impacts and fostering post-harvest population recovery were considered rudimentary or inadequate
- Monitoring systems for verifying management practices and chain-of-custody were lacking
- Conservation measures were also frequently lacking
- There is a high frequency of look-alike species within the relevant taxa
- Effective taxonomic identification of species in trade (and in finished products containing a mixture of species) is often lacking

More generally, the Trees WG considered that the existence (or not) of the following conditions would impact the making of NDF:

- Political will & long-term commitment
- Human & economic resources
- Availability of accurate data
- Time constraints
- Effective monitoring

6. Summarize the main recommendations which could be considered when making an NDF for this taxonomic group.

It is recommended that a Scientific Authority be in place with expertise in the taxa concerned.

Consult the range of expertise available, including other range States and their experience with NDF.

Use available tools (e.g. species, trade and other databases on the CITES website, among others).

Encourage capacity building (including e-learning tools) focused on training & long-term development of Scientific Authority expertise

Promote research on:

- Population parameters considered basic to evaluating harvest impacts
- Silvicultural practices for reducing impacts and fostering post-harvest population recovery
- Monitoring systems for verifying management practices and chain-of-

custody and conservation measures

Training in species identification

7. Useful references for future NDF formulation.

See references included in the case studies