Conservation and Sustainable Management of Trees

Report of the Third Regional Workshop

held at

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WORLD CONSERVATION
MONITORING CENTRE

The **World Conservation Monitoring Centre**, provides information services on the conservation and sustainable use of species and ecosystems and supports others in the development of their own information systems.

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INTRODUCTION

The Workshop was convened by the World Conservation Monitoring Centre (WCMC) as part of the joint WCMC and IUCN Species Survival Commission (SSC) project entitled the *Conservation and sustainable management of trees*, funded by the Government of the Netherlands.

The Workshop had three objectives:

- to review existing information on the conservation status of Asian tree species and to collect additional information on species of conservation concern;
- to discuss the development of the Tree Conservation Information Service appropriate for national, regional and international needs;
- to plan for the establishment of an SSC Asian Tree Specialist Group.

The Workshop Agenda is given as Annex 1 to this Report and the participants list is provided as Annex 2.

To aid discussions during the Workshop, a series of working documents was provided to participants as follows:

Working Document 1 *Tree Conservation Information Service – data management issues.*

Working Document 2 Guidelines for the application of the 1994 IUCN Red List Categories to trees

Working Document 3 Tree species for conservation evaluation

Working Document 4 Draft list of Asian species evaluated with the new IUCN categories and criteria

Working Document 5 Sustainable use and the conservation of tree species.

Working Documents 1, 2 and 5 are included as Annexes to this report. Working Documents 3 and 4 were draft outputs for review. The results of conservation evaluations for the species contained in Working Document 3 are given in Annex 6.

The Workshop was chaired by Sara Oldfield who welcomed participants on behalf of WCMC and SSC. She explained that Viet Nam was chosen as the location for the Workshop because of the tremendous conservation efforts for biodiversity taking place within the country, because of the convenience of Hanoi as a central location for delegates throughout Asia and for the renowned hospitality of the country.

The Chair thanked the Ministry of Science, Technology and the Environment for agreeing to act as the sponsor agency for the workshop and in particular, Dr Sinh, the Director of NEA and Tran Lien Phong and Ms Huong for their assistance in facilitating visas and other arrangements for the Workshop. Thanks were also given to Hans Friederich and Sulma Warne of the IUCN Viet Nam National Office for logistical support. Sincere thanks were expressed to the Government of the Netherlands for funding the Workshop and the project as a whole.

Opening speech
The Honourable Vice-minister Professor Chu Tuan Nha, MOSTE

It is my pleasure on behalf of the Government of Viet Nam to welcome all delegates to this international workshop on *the Conservation and sustainable management of trees*. The Ministry of Science, Technology and Environment, through its National Environment Agency is pleased to sponsor the workshop and to work closely with the Viet Nam National office of IUCN and the World Conservation Monitoring Centre to facilitate its success. It is my particular pleasure to welcome overseas visitors from Asia, Europe and North America to Viet Nam and I hope that you will find all aspects of your visit pleasurable and rewarding. Viet Nam is a country rich in tropical rainforests and monsoon ecosystems all with important tree resources. The protection of Viet Nam's natural ecosystems is vital for the country and for the world. Over the past decade Viet Nam has developed many important new initiatives to conserve its rich biodiversity. I am delighted therefore that representatives from the leading conservation agencies of Viet Nam including the Institute of Ecology and Biological Resources, the Institute of Ecological Economy, the Institutes of Tropical Ecology and Tropical Biology, the Forest Inventory and Planning Institute, the Forest Science Institute, together with Forest Departments of the Ministry of Agriculture and Rural Development, and the National Environment Agency, will be here with you this week to share our Viet Namese experiences of biodiversity conservation. We can, of course, all benefit from the exchange of ideas, scientific information and technology resulting from national initiatives and international cooperation.

Viet Nam is employing both *in situ* and *ex situ* conservation measures to protect its rich biodiversity and I am delighted that during the course of the workshop delegates will have the opportunity to visit one of Viet Nam's protected areas, Ba Vi National Park. I hope that delegates will also take the opportunity during their visit to see the Botanic Garden and Herbarium of the Institute of Ecology and Biological Resources here in Hanoi.

The abundance and diversity of Viet Nam's biological resources includes 12,000 plant species, 40% of which are endemic to the country. Around 700 tree species occur within our country and provide foods, medicines, timber and fuelwood with significant importance for both the national and rural economies. In addition to timber, about 2300 plant species are harvested for fruit, flowers, bark, roots, stems and resins used for food, medicine, construction, textile production and water proofing. Rapid population growth, decrease in forest cover, over-exploitation of certain resources, particularly for timber and fuelwood all contribute to the decline of tree species and the urgent need for their conservation.

In recognising the economic and cultural importance of its biodiversity, the overall framework for the conservation of biological resources in Viet Nam is provided by various strategic planning documents. These include the National Conservation Strategy produced in 1985, the National Plan for Environment and Sustainable Development (1991) and the Tropical Forestry Action Plan (1991). The Biodiversity Action Plan approved in 1995 builds on these documents and provides a broader integrated scope for action. Implementation of the Biodiversity Action Plan provides the mechanism for Viet Nam to meet its commitments to the Convention on Biological Diversity signed by Viet Nam in 1993 and ratified one year later. The Biodiversity Action Plan was designed to help national and international agencies understand biodiversity conservation in Viet Nam and to see where their inputs would be most effective. Implementation of the Action Plan reviews and strengthens institutional arrangements and international collaboration (particularly in Southeast Asia) for conservation management, laws and regulations governing biodiversity conservation, policies concerning property rights, protected areas and species. It is in this context that I welcome the discussions you will hold this week on the conservation and sustainable management of tree species. Up-to-date information on the conservation status, threats, uses and ecological requirements of tree species is vital to the success of their integrated conservation.

In opening this workshop it only remains for me to wish you once again every success with your meeting this week. I hope that your discussions will be fruitful and that the objectives of the workshop will be successfully reached.

Introduction to the project – its aims, activities and progress
Sara Oldfield

The Government of the Netherlands has provided funding for this three-year collaborative project in support of the worldwide conservation of trees. WCMC and SSC are the major partners and are working closely with a wide range of other national and international organisations to develop a *Tree Conservation Information Service*. The overall goal of the project is to provide a reliable and up-to-date information service on the distribution, conservation status, local uses and economic values of tree species worldwide in order to assist countries in the planning of sustainable forest management and biodiversity conservation through appropriate international or intergovernmental processes.

At an early stage in the project, following wide consultation, it was decided that we should focus on the collection of information on trees of conservation concern. It has thus been a primary objective to identify which tree species are under threat worldwide. The methodology used to gather and manage data for the project is described by Martin Sneary in Working Document 1. The 1994 IUCN categories and criteria have been applied through the project and their application to trees is described by Charlotte Jenkins in Working Document 2.

The ambitious tasks undertaken during the project have only been possible through a collaborative approach, through building on existing datasets and drawing on the strengths of the key partners. In order to place the activities of the project in context, I will describe the work of WCMC and SSC.

WCMC is an independent non-profit organisation, established by three of the key international organisations working in the field of biodiversity conservation; IUCN - The World Conservation Union, WWF - the World Wide Fund for Nature and UNEP - United Nations Environment Programme. The aim of WCMC is to provide information services on conservation and sustainable use of the world's living resources and help others to develop information systems of their own. To achieve this aim, WCMC offers three principal services: Information Services that provide and facilitate wide access to information on the status, value and management of biological diversity; Capacity-building Services, helping others to gather, manage, interpret and use information on living resources; and Data Management Services that include secure storage, sharing and management of data on behalf of other agencies and networks.

WCMC has recently gone through a period of restructuring and has identified a series of programme areas on which to focus its work. Current programmes include:

- Forests,
- Polar and Mountain Regions
- Seas, Coastlines and Freshwaters
- Biodiversity Assessment
- Trade and the Environment
- Protected Areas and Landscapes

The Forest Programme was established in 1995 with the aim to inform and guide international, regional and national policy and action on the conservation and sustainable management of forests and their biodiversity through the provision of integrated, timely and accessible information. It was the first programme area to be established at WCMC. One current activity of the Forest Programme is the development of the Global Forest Information Service (GFIS). This is an internet-service delivering integrated information on the world's forests. Initial funding has been provided by CIFOR and WWF. The *Conservation and sustainable mangement of trees* project will contribute to the development of integrated forest biodiversity information through the provision of data on trees in appropriate formats.

Programmatic activities at WCMC are supported by comprehensive data management systems. Conservation data are gathered by WCMC from a wide variety of sources, and are managed and maintained in a series of databases. Databases maintained at WCMC which are relevant to the *Conservation and sustainable management of trees* project include

The *Biodiversity Map Library* - a geographical interface which allows rapid access to a wide range mapped information on the world's biodiversity. It is designed to integrate much of the diverse informa managed by WCMC – on species, ecosystems and protected areas – into a common geographical for using ARC/INFO as the base tool. Mapped information in the Biodiversity Map Library inclu Ecofloristic zones; Global tropical forest coverage; Internationally important wetlands; Coastal ecosyst and Protected Areas.

The *Protected Areas Database* which has over 37,000 records and nearly 5,00 individual site sheets.

The *WCMC CITES Trade Database* holds over 2 million records on trade in wildlife species and t derivative products. It is managed for the Secretariat of the Convention on International Trade Endangered Species, to which there are currently 134 Parties. The information spans from 1975 to pre and information is updated from annual reports submitted by CITES Parties which are then entered ei manually or loaded directly into the database.

Species Databases – WCMC works closely with the IUCN Species Survival Commission Environmental Law Centre, BirdLife International, FAO, Botanic Gardens Conservation Internatio many herbaria, national wildlife departments and others to build and maintain the databases of threate and protected species of animals and plants. The data are managed in relational database applications a as far as possible, information from them is made available on the Internet. The *WCMC Animals Datab* is used to compile the *IUCN Red List of Threatened Animals* in collaboration with the SSC. The *WC Plants Database* currently records information on the distribution and status of over 100,000 plants, 30, of which are globally threatened following the old IUCN threat categories. Information stored in WCMC Plants Database was the starting point for information collection in the *Conservation sustainable management of trees* Project.

To maintain all the data managed by WCMC it is essential to follow a networking approach. WCMC has one of but works with various existing networks around the world. Data collection for the *Conservation and sustain management of trees* project has been undertaken in collaboration with SSC's network of experts.

SSC is one of the six volunteer commissions of IUCN. The mission of the SSC is to conserve biological diversity developing and executing programmes to save, restore and manage wisely species and their habitats. The goals of SSC are: to assess the conservation status of species worldwide; to identify conservation priorities for species their habitats and develop strategies for their conservation; to initiate the actions necessary for the surviva species; to develop and promote policies for species conservation; and to provide an expert resource network on conservation of biodiversity.

SSC Groups represented at this meeting include the Conifer Specialist Group; Temperate Broadleaved T Specialist Group; Palm Specialist Group; Indian Sub-continent Plants Specialist Group; South Korean P Specialist Group; and China Plants Specialist Group.

In addition to working with SSC Groups, we have also worked on the project with a wide range of other internati and national organisations. At an international level we have, for example, collaborated with FAO and IPGRI regard to the development of appropriate information management systems. These are:

REFORGEN – a database system developed by the Forest Resources Division of FAO. This gl database system is designed to house information related to the world's forest genetic resources.

TREESOURCE – a global information system on forest genetic resources. This represents a collabora effort between FAO, CIFOR, ICRAF and IPGRI and has been designed to provide readily, reliable accessible information on forest genetic resources.

An important source of information on Southeast Asian trees has been PROSEA. At a national level we h worked, for example, with the Forest Research Institute of Malaysia (FRIM) in the collection of data.

To ensure that the project is a success it will be necessary to continue working effectively in a collaborative manner. WCMC appreciates involvement from all interested individuals and organisations in this project and all input will be fully acknowledged.

We used the WCMC Plants Database as a starting point for the project. Data on trees within this has resulted from various previous initiatives. One of these was a pre-project study undertaken by WCMC for ITTO, entitled *Conservation Status of Tropical Timbers in Trade.* Following on from the pre-project report, published in 1991, the Government of the Netherlands offered support for a broader project looking at all trees, temperate and tropical, and not restricted to timber species.

We are now near the end of the project and are beginning to prepare the final outputs. Martin Sneary, in his presentation will describe the methodology we have followed for data collection during the project and the data management issues. The proposed outputs of the *Conservation and sustainable management of trees* project by the end of 1997 are:

- A world list of threatened trees using the 1994 IUCN threat categories
- A report on the sustainability of tree utilisation
- A world tree database made available to users in electronic format free of charge to all collaborators and other appropriate agencies
- On-line access to tree conservation information maintained by WCMC
- Development of an SSC network

Highlighting the results of the project, it is interesting to note that out of approximately 27,000 species currently recorded in the project database, nearly 4,000 are recorded as threatened or data deficient following evaluation with the new IUCN Red List Categories and Criteria. The interim results of species evaluations are shown in the table below.

Summary totals for the Tree Conservation Database (July 1997)	
Total number of trees	**27,513**
Total number of assessments	**5,776**
1994 IUCN Threat Category	**Number Assessed**
EX	48
EW	11
CR	649
EN	720
VU	2,070
LR	641
DD	375
NE	1,262
TOTAL	**5,776**

It is expected that the number of species recorded as threatened will increase significantly by the end of the project, on the basis of species currently being evaluated. In addition, a further 3,000 tree species were evaluated as globally threatened using the previous IUCN categories of threat. It may not prove possible to re-evaluate all these species, but where the data are considered reliable we will incorporate them as an annex in the published world list of threatened trees.

It is thus likely that we will document approximately 8,000 tree species as globally threatened by the end of the project. This is approaching 10% of the world's tree flora, and compares with approximate figures of 1,100 globally threatened mammals (20% of the total) and 1000 globally threatened birds (10% of the total). The information collected has clear implications for tree species conservation on a global scale. The data suggests a need for international policy review and potentially a shift in resource allocation within conservation programmes. Whereas over the past two years we have identified and documented the scale of threats to the tree flora, we are aware major gaps in our knowledge and the need for follow up work. One aspect which needs further attention is sustainability of uses of tree species.

Forest and tree species conservation in Viet Nam
Professor Cao Van Sung

Viet Nam was originally almost completely forested. In 1943, the country had 43.7% forest cover. today this amount has decreased to 27.7%. In the current epoche of scientific and technological development and increasing population pressure, with natural resources being exploited and declining, the problem of protection and regeneration of forest areas proves to be an urgent task. Viet Nam considers this situation seriously and is paying attention to monitoring and measures for forest protection. The Institute of Ecology and Biological Resources (IEBR) is one of the main organizations responsible for these matters in Viet Nam.

The work of the Institute of Ecology and Biological Resources (IEBR)

IEBR's functions consist of studying the biological resources of Viet Nam, specifically the scientific basis for their rational utilization and conservation to meet the needs of people and the requirements for environmental protection.The Insitute has fourteen departments. These include the Departments of Botany, Plant Ecology, Plant Resources, Ethnobotany, Environment, Bioresources and Chemistry, which are responsible for investigating plant resources and for conservation, and are most relevant to the *Conservation and sustainable management of trees* project.

In recent times IEBR has carried out surveys and inventories of biological resources in different regions of the country. The surveys have assessed the current distribution, density and status of species with high scientific and economic value. The results of these surveys provided the basis for recommendations for utilization, restoration, protection and sustainable management of the biodiversity and precious resources. IEBR has closely collaborated with other institutions and organizations, both governmental and non-governmental, in completing and publishing the flora of Viet Nam. So far records have been made for 3000 species of plants, including 50 new species for science and 200 new ones for Viet Nam. The Institute has built a herbarium with more than 300,000 specimens, for the purposes of research, scientific exchange and the basis for management and conservation of plant resources.

During the period from 1971 to 1988, a series of books was completed and published, entitled *Viet Nam forest trees* consisting of 700 indigenous and exotic tree species found in the country. During recent years many new materials and information have been collected, increasing the total to 749 species (See Annex 7 to Workshop Report (Appendix 1)). This publication provides detailed information relating to name, description, distribution and habitat accounts, ecology, use and conservation status. It serves as a useful guide for assisting scientists, managers and conservationists in the forestry field. The summary totals of forest trees are provided in Table 1.

Table 1: Summary totals of forest trees covered in *Viet Nam forest trees*.

Division	Family	Genus	Species
Gymnospermaee	6	14	23
Angiospermae	84	333	726
Total	90	347	749

Forest conservation measures

One reason for forest destruction in Viet Nam is the shifting cultivation practised by ethnnic minorities in marginal areas. It is therefore necessary to conduct a review of the policy and strategy for settlement. This in turn will modify traditional work patterns, help improve living conditions for these people and promote improved methods of collection of forest products. The process must be based upon principles of protection and sustainable management of resources and also should serve both national interests and local people. The IEBR has set up model self-sufficient socio-forestry communes, using and developing indigenous trees for restoration of bare land and limestone forest and raising the income of local people in mountainous areas. We have already had success in restoration and plantation of indigenous species multicultures.

The natural resources, especially timber trees, are important in providing raw materials for construction and industry. They also provide a gene pool for improving the quality of traditional cultivated and regreening plants and beautiful elements of the natural landscapes. Being aware of the important role of biodiversity and biological resources in the development of social economy, the State of Viet Nam has issued policies and action plans for good managemen natural resources. For instance, Viet Nam has promulagated decision 433/QD dated August 4.1989 to protect exploitation and trade in seven species of rare trees.

New promulgation N° 34/HDBT of 3 February 1990 of the Council of Ministers concerns the prohibition in trad the protected species and some classes of round logs and exports of semi-processed wood of these species. In 19 the Government announced a ban on all wood exports aimed at ending widespread deforestation in parts of coun Prior to this Viet Nam had banned log exports and applied quotas for the export of sawn timber.

On January 17, 1992 the Council of Ministers issued Decision 18/HDBT stipulating a list on precious and species of forest plants and regulation concerning management and protection. This list consists of 13 spe belonging to Group 1 *First class prime timber*: Endemic species with special value; and 19 species to Grou *Second class prime timber:* Species with high economical value which are subject to over exploitation (See Anne to Workshop Report (Appendix 2)).

One of the important tasks contributing to the protection of wild biological resources is the production c threatened species list and a Red Data Book. The IEBR in close collaboration with scientists of different Instit (FIPI, Universities) has completed and published the *Red data book of Viet Nam* (1996) listing 356 specie vascular and lower plants. Criteria for listing in the RDB follow the IUCN threat categories (E=Endange V=Vulnerable; R=Rare, T=Threattened; K=Insufficiently known). For trees 151 species are listed.

Table 2: Forest trees in Viet Nam RDB

Division 1 Angiospermae	E	V	T	R	K	TOTAL
Class 1 Dicotyledones	2	28	33	43	17	123
Class 2 Monocotyledones			1	2		3
Division 2 Gymnospermae	4	5	2	12	2	25

The full text of these threatened species is found in Annex 9 to the Workshop Report (Appendix 3).

Economic and production activities resulting in exploitation of forests has caused reduction of forest area significant impacts on plant species. To counterbalance these impacts, the Government of Viet Nam has set system of protected areas, consisting of 90 special use forests with a total of 953,822 ha (6 National Parks, 52 na reserves, 32 cultural, historical and environmental sites). This system plays an important role in the protectio forest resources and their gene pools and provides conditions favourable for preserving *in situ* forest trees espec threatened species.

According to suggestions by Ministry of Agriculture and Rural Development (MARD) the system of protected a will increase to 2,092,527 ha. This includes 10 national parks (252,290ha), 61 natural reserves(1,692,351 ha) an cultural, historical and environmental sites(147,886 ha). By the year 2000 this system will account for 10% forested and forestry area of the country. The system of protected areas is of importance for conservatio endangered species because almost all these species are found in tropical rainforest and their populations l declined in the wild because of the demand for timber export market. With assistance from scientific institutions foreign scientists, MARD will revise the current lists of protected species. Legislation should be amended to imp these revisions and accommodate the need to control trade under the CITES convention. Moreover the Viet Government has declared that logging wood exploitation has been banned completely in forest areas.

Information networks

One of the tasks of the *Conservation and sustainable management of trees* project is to set up a networking data on threatened trees and their conservation. For monitoring and conservation of resources in general, and forest in particular, IEBR has close cooperation with different institutions such as FIPI, NEA and foreign organiza such as WWF, UNDP, PROSEA in building the database of biodiversity resources in Viet Nam. This task enhanced by Viet Nam's involvement in the PROSEA project with a Viet Nam country office established in IE Advanced technology such as GIS, computer using GPS is being encouraged for application to forest resc inventory, protection and management. The IEBR has documented and made available the existing wealt information on the plant resources, to make operational a computerized databank on the plant resources of S.E Asia. A documentation system has been developed for information storage and retrieval called SAPRIS and BIMS. We have made BASELIST providing a primary checklist of more than 6200 plant species. PREPHASE: Reference to literatures from S.E.Asia, TEXTFILE: All PROSEA publications and additional information.

Up to now there are collected 210 personym records from scientists, 48 organym and about 5000 references to literature with abstracts; and more than 3182 records have been computerized. Based on collected materials, 40 paper from 36 Viet Namese authors have registered to write for PROSEA handbook.

For delivering the PROSEA books to users the Viet Nam country office has translated handbook volume PROSEA 1,2,5,6,7 into Viet Namese and has printed book 1,2,5,6. Moreover eight booklets summarized from four PROSEA books (Pulses, Edible Fruits and Nuts, Timber trees) have been printed and distributed to many institutions and offices over the country. In summary, all these activities have an important role in increasing collaboration in the development of a computerized data bank and providing information on the plant resources and sources of literature from Viet Nam and S.E Asian countries.

Clearly the up-to-date information service on the distribution, conservation status, Bioecological features, local use and economic values of tree species is important work in the planning of sustainable forest management and biodiversity conservation through international cooperation.

The conservation of the natural riches especially in tropical zones through protection management and sustainable utilization is a matter of high importance to Viet Nam. In this respect Viet Nam hopes to participate and contribute to the project *Conservation and sustainable management of trees.*

The Institute of Ecology and Biological Resources- a potential research unit in Viet Nam with strong staff of works related to tree inventory information on species of conservation concerns, data management and Asian database links - will play a network role in the international tree conservation information service.

Strategy for conservation of forest genetic resources an important part of biodversity conservation in Viet Nam

Dr Nguyen Hoang Nghia

Viet Nam has a very diverse flora and about 40% endemism. For various reasons, the area of natural forest has decreased considerably. The forest cover was reduced from more than 40% in 1943 to 26.2% in 1985. Some forest ecosystems are over-exploited, a number of plant species are in danger of extinction and numerous animal species have few options for survival. So far, the Viet Namese Government has approved 94 special-use forests including 10 National Parks, 56 nature reserves, and 28 culture-history-environment forests. This system is a complete system for nature conservation as well as conservation of forest plant genetic resources.

It must be noted that genetic conservation aims at preserving genes, gene complexes and genotypes, preventing extinction of landraces, provenances and in some extreme cases, it aims to prevent the extinction of the species. Genetic variation plays a very important role because that is the origin of diversity and it ensures the survival and stability of the species during the process of adapting to the environment. Water pine (*Glyptostrobus pensilis*) is an extreme case where the last 32 individual trees found in Trap Ksor are in danger of extinction. *Pinus kwangtungensis* occurs in only two small areas with a total number of less than 100 individuals.

Although genetic conservation and nature conservation have some similar objectives and activities, there are important differences between them. Genetic conservation pays more attention to preservation of genetic variation. For example, Da Nhim Protected Forest is able to protect genetic resources of *Pinus kesiya* only in Lam Dong province, while genetic resources found in other areas of the Western Highland as well as in North Viet Nam could not be included.

According to the strategy for genetic conservation, priority species have been categorized into four main groups:

- Endangered, economically very valuable species such as *Afzelia xylocarpa, Aquilaria crassna, Cupressus torulosa, Dalbergia spp., Diospyros mun, Fokienta hodginsii, Pterocarpus macrocarpus, Madhuca pasquieri, Parapentace tonkinensis, Markhamia stipulata, Taxus chinensis, Taxus wallichiana, Sindora siamensis, Sindora tonkinensis.*

- Endangered, rare, scientifically valuable species such as *Calocedrus macrolepis, Ducampopinus krempfii, Glyptostrobus pensilis, Pinus dalatensis, Pinus kwangtungensis, Podocarpus neriifolius, Cephalotaxus fortunei, Keteleeria calcarea, Anamoarya sinensis, Carya tonkinensis, Fagus longipetiolata, Garcinia fagraeoides, Hopea cordata, Chimonobambusa quadrangularis, Phyllostachys bambusoides* var *aucro.*

- Native tree species for planting such *as Cinnamomum cassia, Dendrocalamus spp.,* dipterocarps, *Erythrophloeum fordii, Chukrasia tabularis, Illicium verum, Pinus kesiya, Pinus merkusii.*

- Exotic tree species for planting such *as Acacia spp., Anacardium occidentale, Casuarina equisetifolia,* Eucalypts, pines, *Tectona grandis.*

In situ conservation is the most effective conservation method which is suggested for most native tree species in Viet Nam. It should be noted that our people have preserved many valuable tree species for hundreds of years, for example *Cinnamomum cassia, Illicium verum, Toxicodendron succedanea, Melia azedarach, Toona sinensis, Castanea mollissima, Camellia oleosa* and *Dendrocalamus membranaceus*, etc. This can also be considered as a form of on-farm conservation.

Ex situ conservation has been suggested for some species. In such cases seed collection and sampling should follow strict regulations in order to widen the genetic base of the species. Seeds of *Erythropholeum fordii* have been collected from nine areas within the distribution range of the species and *ex situ* conservation stands will be established at Cau Hai Silviculture Centre. Rooted cuttings of *Taxus wallichiana* trees will be planted for conservation at Lam Dong Silviculture Centre.

There is some scattered information and knowledge about genetic resources, however, there is a need to carry ou following urgent activities:

- Determining distribution of the species as well as the whole range of genetic variation which will serve as a for conservation work.
- Studying biological characteristics, ecological requirements of the species, flowering, fruit-setting, natura artificial regeneration, etc.
- Establishing plans and measures for conservation (*in situ* and *ex situ*) of priority species.
- Plans for sustainable use of genetic resources.
- Information collection and dissemination.

Additional recommendations are as follows:

- National Parks and Protected Forests are good areas for nature conservation, however less attention was pa genetic conservation. Therefore, genetic conservation of important tree species should be implem according to the strategy and plan suggested.
- Reasonable policies relating to conservation of plant genetic resources should be formulated to give a good for funding and cooperation.
- National Program for Genetic Conservation Research should be well designed to give a strong scientific ba conservation.
- More funds should be allocated to research and conservation work.

Forest tree genetic resources conservation activities at the Research Centre for forest tree improvement

Le Dinh Kha

Viet Nam's forest cover has decreased by over 20% since 1945. Many economically valuable tree species have been over-exploited and are currently endangered. Mean annual increment of natural forest is only 2-3 m^3/ha/year, with the highest value only 5-6 m^3/ha/year (Tran Xuan Thiep, 1996). The area of total forest plantations is only slightly more than one million hectares (Ministry of Agriculture and Rural Development of Viet Nam. 1997). Plantation establishment and protection, as well as conservation of forest genetic resources, are therefore the most important tasks to maintain and develop the current existing forest tree vegetation of the country. This will help to increase productivity of forest plantations and improve the ecological environment of Viet Nam.

Activities for the conservation of forest genetic resources at the Research Centre for Forest Tree Improvement (RCFTI)

The main steps in the conservation of forest genetic resources are:

- Inventory
- Collection of forest tree seed and specimens
- Evaluation
- Conservation
- Utilization

These are also the main components of tree improvement programmes together with other important activities. The main responsibilities of RCFTI in the field of forest tree improvement are:

- Selection of species and provenances which are adaptable to ecological conditions of Viet Nam (through the work of species/provenance trial).
- Selection of plus trees, progeny and clonal test as well as seed production areas and seed orchard establishment.
- Vegetative propagation by various methods including tissue culture, cuttings, grafting and air-layering.
- Carrying out hybridization to produce new seed sources.
- In-situ and ex-situ conservation of forest genetic resources.

In order to implement these activities, existing forms of geographical and ecological variations of forest tree species have to be identified, and seed sources selected from different geographical and ecological zones for the priority species (including both native and exotic trees). The next step is to establish different trials to select the most promising species and provenances that are adaptable for each ecological zone. These trials could also be considered as ex-situ conservation areas for forest genetic resources.

Up to now, a set of more than 300 provenance seedlots of the main planting species, both native and exotic, had been gathered by RCFTI for establishing species/provenance trials. As a result, some fast growing seed sources that are adaptable to environmental conditions of major ecological zones of Viet Nam have been selected and are currently used for reforestation.

Tree species being tested in trials are *Acacia sp.* (for low-land and highland areas and for dry zones), *Eucalyptus sp.* (for low-land and highland area), *Pinus sp.*, *Casuarina sp.* (for coastal area and hill sites) as well as *Azadirachta indica, Chukrasia tabularis, Erythrophloeum fordii, Melaleuca cajuputi ...*

Selection of plus trees according to their economical utilization has also been successfully conducted. Up to now, hundreds of plus trees for some main planting species have been selected by RCFTI and different kinds of progeny tests, seed stands and seed orchards established. In addition, within the framework of UNDP/FAO Regional Project on Forest Tree Improvement (FORTIP Project), seeds collected from hundreds of plus trees selected in c countries had been supplied to our RCFTI for establishment of seedling seed orchards in different ecological z of Viet Nam. Such seedling seed orchards are in fact very important genetic resources for further improvement and could also be considered as *ex-situ* conservation areas for these selected tree species.

Cutting propagation had also been successfully carried out for some species such as *Acacia sp., Eucalyptus Casuarina equisetifolia, Pinus sp.,Fokienia hodgensii, Calocedrus macrolepis, Taxus sinensis. Cephalotaxus ol* and *Chukrasia tabularis*. Moreover, some suitable rooting stimulators in powder form had been success prepared by RCFTI for cutting propagation of some main planting species.

Meristem tissue culture of forest tree species is quite a new technology for the Viet Nam forestry sector. RCFTI not able to import this new technology from overseas as other Viet Namese institutions have done. However, relatively short time meristem tissue culture has been successfully carried out for some tree species such a *mangium x A. auriculiformis* hybrids, *E. camaldulensis x E. exserta* hybrids as well as *Calamus platyacanthus Chukrasia tabularis.*

Controlled hybridization was first conducted in Viet Nam by RCFTI and positive results have also been obtaine some exotic species, particularly for *Eucalyptus* species. Natural hybrids between *A. mangium* and *A. auriculifc* have been identified. Plus trees of these acacia hybrids have been selected and clonal tests established from cu propagation. These hybrid clones have the potential to significantly contributed to the increase of plant productivity in Viet Nam.

Conservation of forest tree genetic resources was started in 1989. In the first year, a book on Conservation of F Tree Genetic Resources was prepared and published to introduce the theoretical basis of conservation of fores genetic resources. Thus all relevant people and authorities were made aware of the importance of conserv activity as well as the relationship between conservation of forest tree genetic resources and natural and biodiv conservation. Together with conservation of medical plant genetic resources and agriculture crop genetic reso conservation of forest tree genetic resources have set up a conservation system for plant genetic resources that basis for further breeding work of plant species in general.

Due to the immense variations and diversity among forest tree species, we cannot have conservation program f presently existing forest tree species. Therefore, conservation activity needs to concentrate on the main tree spec

In the past, the following activities for conservation of forest tree genetic resources have been implemented:

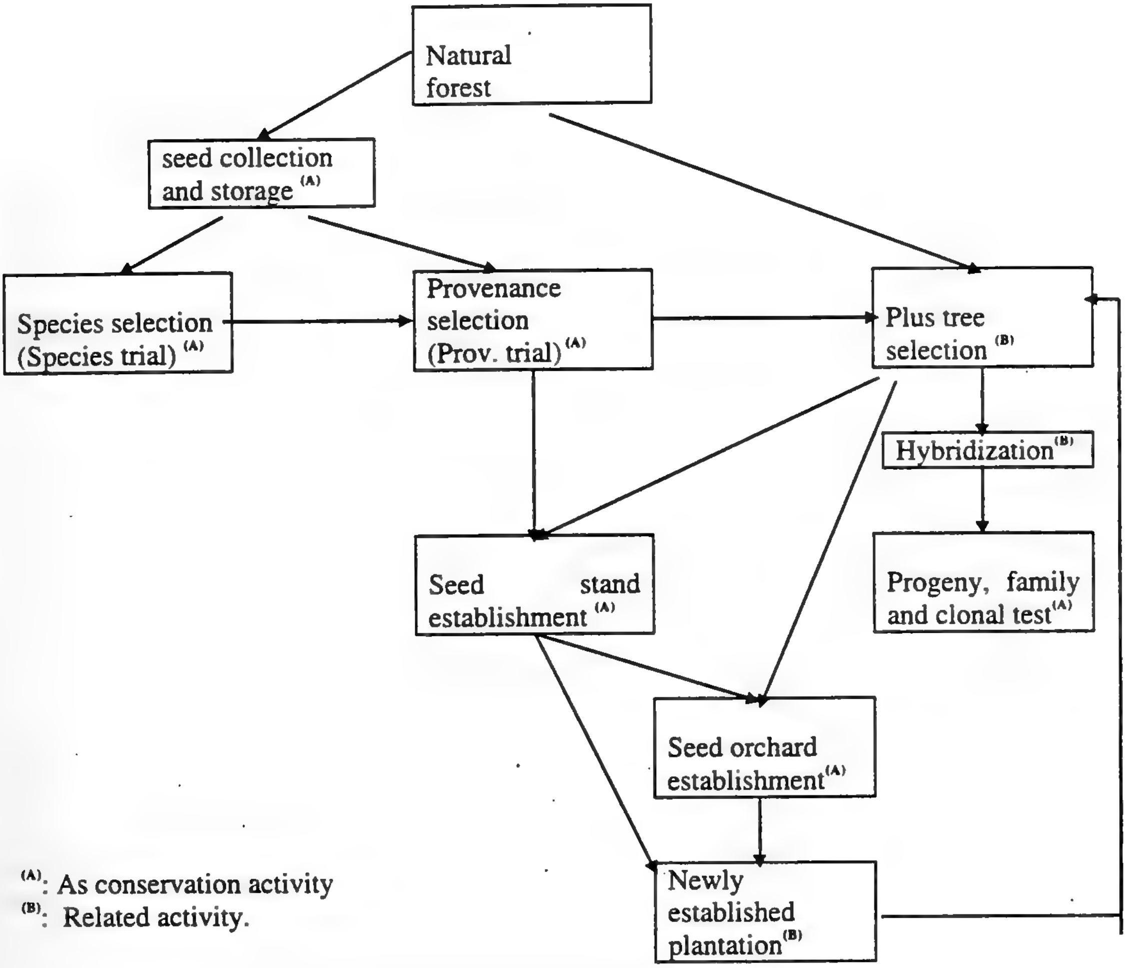
- Investigation, setting up of conservation plans and carrying out in-situ and ex-situ conservation activiti cooperation with different national parks and some other organizations) for some rare and valuable tree sp such as *Pinus krempfii, P. dalatensis, Glyptostrobus pensilis, Calocedrus macrolepis, Fokienia hodgensii.*

- Up-grading and establishing herbarium gardens at Trang Bom (South-eastern Viet Nam), Cau Hai (Vinl province) and Ba Vi (Ha Tay province) for ex-situ conservation of economically valuable wooden tree, and bamboo species as well as tree species used for scenery planting.

- Moreover, within the framework of the forest tree improvement programme, a number of conservation are the most important native and exotic species, have established in different ecological zones of Viet nam.

- As a result of research, different kinds of forest tree seeds had been collected and stored at RCFTI, togethe the seedlots from seed exchange with other countries. Moreover, numerous trials had also been estab within the frame - work of international network of species/provenance trial.

Relationship between conservation of forest tree genetic resources and forest tree improvement work could be figured as follows



General process of forest tree improvement programme

Future activities

The aim of forest tree genetic resources conservation is to serve the work of forest tree improvement, both long term and short term, as well as for inland use and international germplasm exchange. Therefore, conservation work in Viet Nam in the forthcoming years will be concentrated on the following activities:

1. Determination of tree species necessary for conservation: As mentioned above, genetic resources of forest trees in Viet Nam are immensely diversified and have a scattered distribution. Therefore, immediate

objectives of genetic resources conservation can only be concentrated on the most important tree spe (See Annex 10).

Thus, tree species necessary for genetic resources conservation should include three groups that endangered, economically and scientifically valuable or widely used tree species for reforesta programme. Belongs to endangered group are tree species of the 3 subgroups as classified by IUCN (19 They are Critically endangered (CR), Endangered (EN) and Vulnerable (VU).

2. Investigation to determine the genetic diversity and collection of seeds or specimens of selected tree spec

   It includes field survey, bio-chemical analysis in laboratories and data analysis. Therefore, this activi quite costly, time consuming and requires a lot of laborers. In order to conduct this activity, internati donors and assistance, as well as cooperation with other research organizations within Viet Nam, inclu universities and research institutes, are needed. To obtain standardized data about investigated specie use in other countries of the region, characteristics needed for evaluation and standard of speci collection have to be prepared and agreed among countries in the region. The required characteristics standards to be as simple as possible, easily implemented and require less amount of money so tha participated countries in the region are in position to implement.

3. Providing technical and financial assistance to national parks, natural conservation areas and provi forestry units to maintain and extend conservation areas for indigenous tree species having particularly economic value. Moreover, new conservation areas should also be established (including establishme new herbarium gardens).

4 Providing technical and financial assistance to forestry research organization to maintain, protect monitor the existing species/provenance trials, seed stands and seed orchards. In addition, species/provenance trials, seed stands and seed orchards have to be established.

5. Providing necessary assistance for setting up a cool room used for seed and specimen storage as we necessary assistance for plant tissue culture laboratory to maintain germplasm specimens in-vitro.

6. Participating in international seed exchange according to general regulation: In order to implement activity, government approval as well as agreement between participated countries are needed.

Conclusion

Conservation of forest tree genetic resources is an important activity within tree improvement programmes. I past years, within frame work of tree improvement programmes, conservation activity of forest tree genetic reso have been conducted at different level for the most important tree species. A close cooperation between res institutions within Viet Nam as well as with other countries in the field of genetic resources conservation would and facilitate the work of forest tree improvement as well as conservation of forest tree genetic resources to de further.

Scientific value of *Pinus krempfii* in Viet Nam
Claire Williams

Southeast Asia is one of two centers of *Pinus* species diversity. Of the 100 *Pinus* species, 24 are found in Asia. To underscore the scientific value of this region and, in particular the scientific value of the rare, endangered pine-like species *P. krempfii*, I will briefly summarise its discovery, its putative evolutionary importance and research needs.

In 1921, Krempf found a pine-like species which was described by Le Comte (1921) as *P. krempfii*. In 1944, Chevalier elevated this species to the category of monospecific genus, *Ducampopinus*. Ferre (1948, 1953) noted that the basis for a new genus to be premature, noting the variation in leaf size.

The debate over the taxonomic classification continues today largely because of inaccessibility to Krempf's pine. *P. krempfii* is restricted to the Da lat Plateau in the central highlands of Viet Nam. Reproductive biology has not been studied and seed collection is constrained by seed ripening in the rainy season. No botanical garden collections include this tree and very few herbaria have a specimen.

Further study of this important tree is imperative. Mirov (1967) considered *P. krempfii* to be a tertiary relic, linking P*inus* to other, more primitive genera in the Pinaceae: *Keeteleria* and *Pseudolarix*. Limited molecular phylogeny studies both support and refute Chevalier's reclassification of *P. krempfii* as a separate genus.

If *P. krempfii* is indeed a putative tertiary relic, and progenitor of all Asian pines then its scientific value to the international community is immeasurable. Molecular phylogeny, taxonomy, population dynamics and genomic architecture will provide valuable insights for pine evolution.

Conservation Status of trees of Yunnan (Mainly NW Part)

Weibang Sun

Yunnan accounts for about 4% of the land area of China and has over 50% of the plant diversity. There is a tremendous range of different habitat types within Yunnan, accounting for the diverse flora.

There are about 8,000 woody plant species in China, of which some 5,300 can be found in Yunnan. Among Yunnan's 5,300 woody plants, about 800 species are trees. The most important trees consisting the main forests in Yunnan are about 200 species belonging to the families of Pinaceae, Toxodiaceae, Fagaceae, Lauraceae, Theaceae and Magnoliaceae. Yunnan is not only rich in tree speices, but is also renowned for its ancient trees.. Approximately 1600 tree specimens from 338 species in 178 genera of 77 families have been recorded as over 100 years in age. These are found in their natural habitats, public parks, temples and villages. They are provincial treasures and worthy of protection.

Assessment of the conservation status of threatened plants can be problemmatic because of differing views of botanists. A list of 183 threatened tree species with IUCN categories has been provided for the *Conservation and sustainable management of trees* project. The categories given are based on the Red Data Book for China, the Yunnan Red List and personal observations based on extensive travels throughout the province. Illustrations of over 30 threatened tree species were shown during the presentation.

Conservation measures

The Natural Preserves

About 24 natural preserves in Yunnan were planned in 1959. The project of the natural preserves conducted by the Forestry Department of Yunnan government has been developed rapidly since 1980. So far, there are 30 different natural preserves for plants and animals and 5 others in Yunnan have been established. The total area covered for preserves are 1,212,071 ha., which is about 12,152 square kilometers. So about 3.1% of 390,000 square kilometers of Yunnan has been used for conserving the plants and animals, as well as other natural importances.

Table 1 The natural preserve types in Yunnan

Preserve types	Nunber	Covered Area (sq. km)	% of Yunnan
Tropical	9	3362.5	0.86
S. Subtropical	3	253.4	0.06
C. Subtropical	11	2238.7	0.57
Temperate& Alpine	4	3848.4	0.99
Plateau Lakes	3	247.3	0.06
Others	5	2201.4	0.56
Total	**35**	**12151.7**	**3.1**

Botanic Gardens and other Organisations

Kunming Botanic Gardens (KBG) - Founded in 1938; belongs to the Chinese Academy of Sciences. It is one of the most important institutions for conserving the subtropical and temperate plants in China. The Botanic Gardens is located in N Kunmng, the capital of Yunnan. The Botanic Garden has 44 hectares and more than 5,000 living plant collections so far, and about 300 rare and endangered plants listed for protection by the government.

Xishuangbanna Tropical Botanic Gardens - This also belongs to the Chinese Academy of Sciences. Founded in 1959, it is located in Xishuangbanna of S Yunnan. It is one of the most important institutions to conserve the tropical and subtropical plants in China. The Garden has 1,000 hectares and some 4,000 more plant species have been collected and cultivated.

The Arboretum of Yunnan Academy of Forestry - Located in Heilongtan of.N Kunming, about 12 kilometers the centre of the city. The Arboretum has 30 hectares and about 500 different trees have been planted. About third of the trees are rare and endangered introduced from Yunnan and other parts of China.
Kunming Gardening Botanic Gardens

Founded in 1986, this garden belongs to the City Council of Kunming. The garden is situated by the golden tem famous tourist point in Yunnan. So far about 2,000 living plant species have been collected and cultivated garden, among them abut 100 species are rare and endangered plants listed by the Government.

The Center of Yunnan Rare and Endangered Plants - This belongs to Yunnan Institute of Environmental Sc The center was created about 8 years ago. It has 5 hectares. So far some 200 rare and endangered living plants been collected and cultivated.

Public Parks and Temples - A number of parks and temples in Yunnar have living plant collections. All the parl temples belong to the City Council of Kunming or the Local City Council. Some temples have lots of very old for example Caoxi Temple in Kunming has a 700 year Magnolia delavayi. Parks and temples are important for plant conservation.

Private Nurseries and Family Gardens - At present some private nurseries in Yunnan specialise in propagatin cultivating wild plant species both for business and conservation purposes. Some families grow plants in the li yard or garden space, the most popular plants grown are Orchidaceae, Theaceae, Magnoliaceae, Liliaceae Eriaceae.

Lijiang Alpine Botanic Gardens - About two years ago, the Lijiang Government and the Yunnan Government tr create an Alpine Botanic Garden in Lijiang where the famous Jade Dragon Snow Mountain is located. One main purposes in establishing this Garden was to conserve the rare and endangered alpine plants both in Yunna part of Sichuang. Kunming Botanic Garden conducted a Feasibility Study and produced a Report. However, t the Botanic Garden is still not established.

See Annex 11 for a priority list of tree species of conservation concern in NW (NE Yunnan).

Conservation status of tree species in Taiwan

Fuh-Juinn Pan

Taiwan is located off the southeast coast of mainland China with an area of 3,577, 700 ha. It lies between 120° 00' 04" and 120° 02' 16", 21° 53' 42" and 25° 17' 48". To the west are groups of islands called Penghu, and to the east Lanyu (Botel Tobago) and Lutao. Most areas of Taiwan are mountains of more than 1,000 m, with more than 200 peaks over 3,000 m. Recent aerial surveys indicate that 58.53% of the total area of Taiwan is covered by forest (Taiwan Forest Bureau, 1995). There has been tremendous loss of germplasm in the composition of the flora due to expansion of human habitation, cultivation, and forest destruction. In order to protect the natural resources and ecological systems, and prevent forest gene-pools from extinction, both *in situ* and *ex situ* conservation has been attempted in Taiwan since the late 1970's (Yang and Pan, 1995), so that the maximum amount of genetic variability remaining to the plant species can be saved to allow their chance of survival.

In the flora of Taiwan, there are 4,102 species (including infraspecific taxa) of native vascular plants, and ¼ of which 1,069 species, are woody species (Liu *et al.*, 1994). Among the native flora, 502 species were preliminary identified as rare or endangered (Lai, 1991) and 97 of them were woody and endemic. Recent revision of the work on identification is being undertaken by the Taiwan Forestry Research Institute based on the criteria indicated by IUCN (IUCN, 1994), ie. 10 threat categories are used. The first volume titled '*Rare and Endangered Plant Species (I)*' has been published (Lu and Pan, 1996). It is planned to publish 5 volumes for the whole work, one volume each year. Field survey and status reports of potentially rare and endangered species are being undertaken.

In situ Conservation

One hundred and seven natural forest stands have been established to prevent the future destruction of forest. There were also 24 protected areas and 18 nature reserves designated within national forest ecosystems. Many of them were established to protect rare or endangered plants and their associated ecosystems. For example, Pinlin Taiwan Keteleeria Reserve was set aside to protect *Keteleeria davidana* var. *formosana*, and Taitung Honyeh Reserve to conserve the endangered and relic *Cycas taitungensis*.

Taiwan has established six national parks, ranging from 4,750 to 105,409 ha, since 1984. The total area of the six parks is 322,107 ha, occupying about 8.6% of the total land area of Taiwan. The entire ecosystem, including rare and endangered plant species within the parks is strictly preserved.

Laws have been passed to authorize the designation and protection of the above areas: Cultural Heritage Preservation Law, and the National Park and Forest Law. Eleven plant species are in danger of extinction or serious genetic erosion caused by destruction of habitats, and have been put on the rare and valuable list under very strict protection. These species are: *Amentotaxus formosana, Cycas taitungensis, Keteleeria davidana* var. *formosana, Fagus hayatae, Bretschneidera sinensis, Rhododendron hyporythrum, R.. kanehirai, Podocarpus costalis, Juniperus sargentii, Epilobium nankotaizanense* and *Isoetes taiwanensis*. Most of them are woody species except the last two, which area perennial herb and small fern respectively.

Ex situ Conservation

Seeds are the most convenient parts of plants for storage. Taiwan Forestry Research Institute has a seed bank for storing and testing tree seeds. The construction possesses modern storage facilities, with rooms of different temperatures of 5°C - 0°C, -10°C and -20°C, and humidity of 65%.The seed bank constantly houses 200 species of forest tree seeds, including some 50 threatened tree species, to ensure their long-term survival. Some species such as *Taiwania cryptomerioides* have been stored for at least 30 years. The viability of each sample to germinate is tested at regular intervals, ie. every 1-5 years. Orthodox seeds in storage usually retain viability much longer than those of recalcitant, the latter must be replaced by new seed collections each year.

Botanic gardens have long been involved in the assessment and study of plant resources and have played a very significant part in the practice of resource conservation. They undertake conservation work through investigations of propagation, maintenance and growth, and provide a convenient environment for long-term studies. Taiwan has now eight botanic gardens and arboreta: Taipei Botanic Garden, Fu-Shan Botanic Garden, Heng-Chun Tropical Botanic Garden, Chia-I Tropical Arboretum, Hsia-Ping Tropical Arboretum, and Shuan-Shi Tropical Arboretum. They are tasked to maintain germplasm of rare and endangered plant species in Taiwan.

Tissue and cell culture is being increasingly used for the micropropagation of rare and endangered species (Yan Lee, 1993). It is especially used in the propagation of *Taiwania cryptomerioides*, *Taxus celebica*, *Chamaec spp.* and *Pseudotsuga wilsoniana* (Tsai, 1989). The problems of storage of meristems, callus have not yet adequately solved (Yang and Lee, 1993).

Conservation practices of rare tree species in Taiwan Forestry Research Institute

Conservation in Experimental Forests

The Institute has six branch stations located in each part of Taiwan island. Each station is characterized by its u ecosystem and vegetation type. All of them comprise large areas of experimental forests, in which natural fore plantation are well managed. Both *in situ* and *ex situ* conservation of rare or endangered plant species are practised in the experimental forests. For example, the rare species of *Cinnamomu pseudomelastoma* is confi Fu-Shan area and scattered only in the experimental forest of Fu-Shan Branch. Survey of phenology and asso vegetation, and reproductive biology of the species were made in the habitats. Rooting cuttings of the species f purpose of establishing field gene banks were also proceeded. The lowland species, *Cinnamomun reticu*, *Decussocarpus nagi*, *Euonymus pallidifolia*, *Gleitsia rolfei*, are distributed or restricted in the experimental for Heng-Chun Branch. Conservation progress of both *ex situ* and *in situ* programmes were well developed in the s (Pan and Yang, 1995). A large area of natural vegetation, which is 1250 ha in area and 2100-3300 m in elevatic adjacent to the planned alpine botanic garden, can also be used for *in situ* conservation of high elevation specie

Field gene bank of rare and endangered tree species

It was suggested to plant the specimens in semi-natural habitats alongside the botanic gardens if there is e space in the gardens. So far, six botanic gardens and arboreta have been established, under the administration Taiwan Forestry Research Institute. Taipei Botanic Garden is one of the oldest gardens, and is located in Taipe It is responsible for the design of conservation programmes of rare and endangered tree species for all other b gardens and arboreta of Taiwan Forestry Research Institute. Heng-Chun Tropical Botanic Garden, elevation 150, was designated to collect and establish field gene banks for 44 lowland species. Fuh-Shan Botanic G elevation 650~1100 m, was taking responsibility for 22 species that are distributed in the northern part of Tai on mountain slopes at elevations of 650~1500 m. There is one planning alpine garden, Chia-Yang Botanic G which is located in elevations of 2100~2500 m, to collect and conserve 32 species occurring in the mount 1500~3000 m. Conservation is far more than just cultivating a few specimens of a threatened plant in a (IUCN, 1989). The collection of each rare or endangered species includes as many accessions as p representing most of the populations in its distribution to maintain the diversity of germplasm. Therefor collection has to comprise a certain number of individuals. For example, at least 50 individuals must be collec tree species of each accession and 100~200 individuals for shrubs and vine species. The plantation of fiel banks for each rare or endangered species is thus more than 1 ha. To avoid competition from other specie stands were established within the same category. The three gardens also have exhibition areas for the endangered species, and seed orchards for biological studies and seed collection.

Genetic and variation studies of Rare and Endangered Tree Species

There is a need to ensure that the genetic base of the populations concerned in the conservation programmes i enough. Before sampling a species for *ex situ* collections, a study should be made of the variation acr geographical and ecological range. Genetic and variation data can be used to direct the conservation strat threatened species. It will also increase our understanding of how to manage populations. Variations of 16 r endangered species have been conducted since 1991, and their distribution patterns and variation types hav well understood. Among them, four are gymnosperm species and 12 anigosperms. Isozyme variation with among different populations of the species could allow decisions to be made as to the sampling methods, are sampled and probable number of samples needed when proceeding with the conservation programmes. RAF proved to be a powerful tool for the same purpose. Variation patterns and other threatened species occu Taiwan by using isozyme or DNA markers are under inventory. Taiwan Forestry Research Institute, togeth scientists of other institutes and universities, are planing to finish surveying at least five species each year un support of the government agencies.

Discussion and conclusion

Conservation of rare or endangered plants has attracted more attention of the people and the government of Taiwan. Council of Agriculture (Central government) and Taiwan Provincial Government have offered relatively large funding, about US$800.000 and US$200,000 respectively, directly supporting the conservation studies for 1997-1998 fiscal year. By now, the rare or endangered species have been identified, and ranking based on IUCN category are being initiated. Field surveys of the species need to be made to evaluate the current distribution and status of them. However, there is a need to encourage researchers of the country to assess biology and ecology of the threatened species. Knowledge of the breeding system and reproductive biology is especially important since it determines the pattern of variation and genetic diversity. Knowledge of pollinators and dispersal agents is also essential for maintenance of the materials in cultivation. Besides, some species such as *Cycas taitungensis, Keteleeria davidiana* var. *formosana* are poor in regeneration, and it is necessary to remove competing plants and do regular weeding to provide open ground for seedlings. Work needed in the future should include cultivation requirements, reproductive biology of rare and endangered species. The information is essential to reintroduce the plants back into the wild and to provide material for restoring and rehabilitating natural habitats.

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Overview of trade in gaharu in Indonesia

Tonny Soehartono

Introduction

Gaharu, karas, gumbil, kelambak depending on the region, is the trade name of the fragrant wood theat originates from the infected trees of *Aquilaria* spp. and other species such as *Gonystylus* spp. The wood is also known in English as agarwood, eaglewood, aloewood (Sidiyasa, 1986; Cakrabarty *et al.*, 1994; Wiriadinata, 1995; Jalaluddin, 1977; Chang and Kadir, 1997; Soehartono and Mardiastuti, 1997). The wood is popular in Chinese and Arab communities due to its aromatic products which have high commercial value for incense, perfume, traditional medicine, preservative products and accessories (Ding Hou, 1960; Burkill, 1966; Charkrabarty *et al.*, 1994; Jalaluddin, 1977; Chang and Kadir, 1997; Soehartono and Mardiastuti, 1997).

The aromatic wood comes from the dying trees of the above mentioned species due to the effects of infection by by certain species of fungi (Jalaluddin, 1977; Santoso, 1996; Chang and Kadir, 1997) or wounding (non-pathologic) (Nobuchi and Siripatanadilok, 1991). The fragrant wood appears to be light brown to dark brown or nearly black in colour depending on resin substances. The favourite and commercially valued gaharu, due to its aroma is the wood from trees of *Aquilaria* spp. (Burkill, 1966; Chang and Kadir, 1997).

In natural populations, the trees of *Aquilaria* spp. are only infected at certain ages (Chang and Kadir, 1997). Sadgopal (1960) indicated that the best gaharu yields from trees aged 50 years or above. Approximately 10 % of *Aquilaria* spp. in the forest produce oleoresins from decaying wood in the infected trees (Gibson, 1977). Traditionally, local people in India, Malaysia and Sumatera only select and log the dying and infected trees (Chakrabarty *et al.*,1994; Jalaluddin, 1977; Chang and Kadir, 1997; Soehartono and Mardiastuti, 1997). However, for the last ten years, as the wood has high value, trade in the wood has increased significantly leading to excessive harvest of *Aquilaria* spp. throughout the area where the species occur.

Indonesia is a major exporting country for gaharu. The export destination from Indonesia are countries in Asia such as Hong Kong, Japan, Taiwan, Singapore, Saudi Arabia, United Arab Emirate, Oman and Yemen (Departemen Perdagangan, 1995; Departemen Kehutanan, 1996; Sidiyasa and Suharti, 1987; Soehartono and Mardiastuti, 1997). The export volume of gaharu from Indonesia between 1976 to 1996 ranges from 20-300 tons per year (Sidiyasa and Suharti, 1987; Departemen Kehutanan, 1996). This paper presents the situation of trade in gaharu in Indonesia.

Taxonomy

Aquilaria spp. is a genus of trees belonging to the family Thymeleaceae which consists of 50 genera with 500 species of trees, shrubs and climbers (Beniwal, 1987; CIFOR, 1996). The genus is taxonomically poor defined (Burkill, 1966). Chang and Kadir (1997), Beniwal (1987) and Agustina (1994) reported that there are 15 species of *Aquilaria*. On the other hand, Ding Hou (1960) indicated that only 12 species belong to genus *Aquilaria*. Some of the species were reported taxonomically similar or variant to other species e.g., *Aquilaria agallocha* is variant of *A. malacensis* (Sidiyasa *et al.*, 1986; Chang and Kadir, 1997). Of the 12 species of *Aquilaria* spp. six indicated occur in Indonesia (*Aquilaria malaccensis, A. microcarpa, A. hirta, A. beccariana, A. cumingiana* and *A. filaria*) (Ding Hou, 1960).

Geographical distribution

The species of *Aquilaria* are distributed in a wide range area covering most of East Asia including India, Pakistan, Myanmar, Viet Nam, Lao DPR, Thailand, Kampuchea, Southern China, Malaysia, the Philippines and Indonesia (Ding Hou, 1960; Burkill, 1966; Baruah *et al.*, 1982; Sidiyasa, 1986; Whitmore, 1972; Chakrabarty *et al.*, 1994, Chang and Kadir, 1997; Soehartono and Mardiastuti, 1997).

In Indonesia the six species are distributed almost throughout the country except in the region of Jawa and Lesser Sunda Island (Table 1) (Ding Hou, 1960; Wiriadinata, 1995).

Table 1. Distribution of *Aquilaria* spp. in Indonesia

No.	Name of Species	Geographical distribution
1	*Aquilaria malaccensis* LAMK	Sumatera and Kalimantan
2	*Aquilaria microcarpa* BAILL	Sumatera and Kaimantan
3	*Aquilaria filaria* (OKEN) MERR	Maluku and Irian Jaya
4	*Aquilaria hirta* RIDL	Sumatera
5	*Aquilaria beccariana* VAN TIEGH	Sumatera and Kalimantan
6	*Aquilaria cumingiana* (DECNE) RIDL	East Kalimantan and Maluku

Source: Ding Hou (1960); Wiriadinata (1995)

Characteristics and habitat

Following are the general characteristics of the six species occur ing in Indonesia, adopted from Ding Hou (Sidiyasa (1986); Burkill (1966); CIFOR (1996); Soehartono *et al.* (1997).

Aquilaria malaccensis Lamk.
Tree up to 40 m tall with diameter up to 60 cm. Bark smooth and whitish; branchlets slender, pale l pubescent, glabrescent. Leaves shinning on both surfaces, elliptic-oblong to oblong-lanceolate, 7½ -12 cm b 5½ cm. **Inflorescenes** terminal, axillary or supra axillary. **Flowers** green or dirty-yellow, campanulate, long, scattered puberulous outside. **Fruits** obovoid or obovoid-oblong, rounded at the apex, cuneate to the ba by 2½ cm usually compressed. **Seeds** proper ovoid, including the beak 10-6 mm, densely covered with red The trees occur in secondary to primary tropical forest up to 270 m.

Aquilaria microcrapa Bail.
Tree up to 40 m tall with diameter up to 80 cm. Bark grey, superficially fissured; branchlets light l puberulous, glabrescent. **Leaves** elliptic-oblong to obovate-oblong or oblanceolate, 4½ -10 by 1½ - 4 **Inflorescenes** axillarry or supra-axillary, terminal. **Flowers** white, light yellow or yellow, 5 mm long. subcordate, slightly compressed, 8-12 (-16) by 10-12(-15)mm, 1-(2) seeded; persistent floral tube sometimes on one side. **Seeds** ovoid, 6 by 4mm, densely brownish pubescent; caruncle-like appendage 2 mm long. Th occur in lowland tropical forest up to 200m.

Aquilaria filaria (Oken) Merr.
Tree up to 17 m.tall with diameter up to 50 cm. Young branchlets light brown, pubescent and glabrescent. l oblong, elliptic-oblong to lanceolate, rarely oblanceolate-oblong, 10-20 by 3-5½ cm. **Inflorescenes** axilla extra -axellary, rarely cauliforous. **Flowers** yellowish -green or white, infundibular, 5-6½ mm long.
Fruits ellipsoid to obovoid or subglobose, slightly compressed, rugose, 1¼ -1½ by 1¼ cm, sparsely hairy, **Seeds** deltoid, including the appendage, ¾ by ¼ cm, plano-convex, black.. The trees occur in lowland tropica up to 130 m.

Aquilaria hirta Ridl.
Tree up to 14 m tall with whitish and rather smooth bark. **Leaves** elliptic-oblong, ovate-oblong, 6½ -14 by 2 cm. **Inflorescenes** sessile or up to 10 mm peduncled, pubescent, 5-14 flowered; bract small. **Flowers** white yellowup to 2 cm pedicelled, pubescent. **Fruits** protruding from the floral tube, oblanceolate, abruptly acut apex, attenuate to the base, including the stipe 3½ -5 by 1 cm, densely golden puberulous; pericarp cori **Seeds** ovoid, 10 by 6 mm, puberulous, glabrescent. The trees occur in hill slopes of the tropical forest from l up to 300 m.

Aquilaria beccariana Van Tiegh
Tree up to 20 m tall with diameter up to 60 cm. The bark is grey and smooth. Leaves oblong, oblong- lancec elliptic-oblong, rarely elliptic, (7-)11-27 by (3-) 6-81/2 cm. **Inflorescenes** axillary or extra-axillary, branch up to 11/2 cm peduncled, short-paniculiform, pubescent 3-7 mm. **Flowers** 7-12 mm long, yellowish, gree yellowish-white. **Fruits** protruding from the top of the floral tube, ellipsoid or obovoid, 2-31/2 by13/4 cm,

puberulous and glabrescent. **Seeds** black, ovoid, 10 by 5 mm long. The trees occur in secondary and primary tropical forest, sometimes in swamp, from lowland up to 800 m.

Aquilaria cumingiana (Deone.) Ridl.
Srub or **small tree** up to 5 m tall. Bark ashy grey, mottled and smooth. **Leaves** elliptic-oblong or ovate-oblong , rarely obovate-oblong, 14-18 by 51/2-81/2 cm. **Inflorescenes** simple or sometimes branched, few to many flowered. **Flowers** whitish, 13-16 mm long. **Fruits** globose, slightly obovoid, or ellipsoid, 13/4 by 11/3 cm. **Seeds** broad-ovoid, plano-convex, 1 by ¾ cm. The tree occur in primary tropical forest at low and medium altitude.

Population

As indicated in the previous section *Aquilaria* spp. occur spread out in natural forest in Indonesia. However, the population distribution is patchy across the forest habitat making it difficult to estimate the actual population per unit area at species level (Ding Hou, 1960; Whitmore,1972; Burkill, 1966; WWF, 1994; Soehartono *et al.*, 1997). The assessment from the Indonesian National Forest Inventory (NFI) has revealed the following estimates (Table 2).

Table 2. Population estimate for *Aquilaria* spp. according to NFI

No	Island	Number of Individual ha^{-1}
1	Sumatera	1.87
2	Kalimantan	3.37
3	Irian Jaya	4.33

Source: Soehartono *et al.*, 1997

The NFI project does not cover the island of Jawa. The NFI data available does not also show any indication of the species occurrence within the island of Maluku. Possibly, because the current population of the species is low, it is missed from the NFI samples. For comparison La Frankie (1994) reported that the estimated population of *A. malaccensis* in lowland forest Malaysia is 2.5 per ha. It was also reported that in northern tropical forest in India the density of *A. agallocha*, variant of *A. malaccensis*, is 0.73-0.77 % (Beniwal, 1987; Chakrabarty *et al.*, 1994).

The basic point from the figures above is to estimate the volume of agarwood available in the wild. It was estimated that the tree may produce resin (agar) at the aged of 20 years or above (Beniwal, 1987; Chakrabarty *et al.*, 1994; Chang and Kadir, 1997). Yet, as not all the trees of *Aquilaria* spp appear to be infected (Sadgopal, 1960) it leads to a very complicated estimation in providing a consensus picture of natural stock of agarwood. Much works still need to be done in order to find the acceptable figure of standing stock of agarwood in tropical forests of Indonesia.

Production
Traditionally, harvesting and trading in gaharu have been carried out for many decades by the local people in Kalimantan and Sumatera (Burkill, 1966), trading with Chinese and Arab people who visit the areas. Now, as the country becomes one of the principal exporters of tropical timber and other forest products, the trade of gaharu is quantitatively significant. The export volume of gaharu fluctuates, yet in the last three years the export volume has reached the level of attention due to its high number (Departemen Perdagangan, 1995; Departemen Kehutanan, 1996).

At a national level, compared to timber, the economic share from export gaharu is not significant (Departemen Kehutanan/FAO, 1990) even the product has not been recognised in the minor forest product from Indonesia (Menon, 1989). However, in reality the economic potential of this product has substantial inputs into the livelihood of very large numbers of local people in major islands like Sumatera, Kalimantan and Irian Jaya (Departemen Perdagangan, 1995; Wiriadinata, 1995; Sidiyasa and Suharti, 1987; WWF, 1994; Soehartono and Mardiastuti, 1997).

Following is the figure of Indonesian export of gaharu between 1975 - 1995.

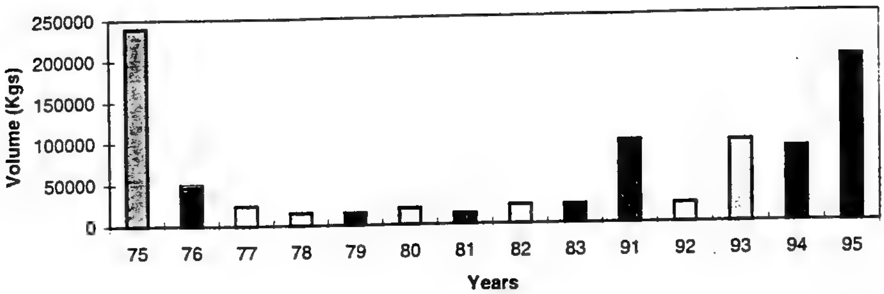

Figure 1. Export of Gaharu from Indonesia between 1975-1995
Source: Adopted from Sidiyasa and Suharti (1986) and Departemen Kehutanan (1996).

The major source of gaharu from Indonesia are East Sumatera (Riau) and Northern Sumatera (Aceh), Kalir and Irian Jaya (Departemen Perdagangan, 1995; Departemen Kehutanan, 1996).

Quality and prices

Species noted to produce high quality gaharu are *A. agallocha, A. crasna, A. baillonii and A grandiflora* (E 1966; Sidiyasa and Suharti, 1987; Chang and Kadir, 1997). The species occuring in Indonesia which know variant of *A. agallocha* is *A. malaccensis* (Sidiyasa *et al.*, 1986)

Regardless of international quality, the gaharu traders in Indonesia have their own grade which sometimes slightly between regions. Yet, in principle the traders set the grade according to substantial resin content higher quality corresponds to better price, although, in reality price always relates to market demand.

Generally, the traders in Indonesia have classified the products into six different grades. The prices ranges b US $ 2-7 for the lowest quality to US $400-600 for the best quality (Oetomo, 1995; Soehartono and Mard 1997). However, for the purpose of practical reasons in control and taxes, the government only recognis kinds of gaharu grade namely kemedangan and gaharu (Departemen Kehutanan, 1996).

Permits and control

Gaharu products are classified as forest products, hence, officially harvest and transport of the products wit out of country is controlled by the Ministry of Forestry and its regional offices. Before November 1994 gaharu products were listed under CITES (Convention on International Trade in Endangered Species of Wil and Fauna) Appendix II all permits relating to gaharu were regulated by the Forestry Regional Offices.

As Indonesia is a party to CITES, since early 1995 when the CITES regulations came into effect, all regul harvest and transport of gaharu have been reorganised according to CITES procedures. The Indonesian S Institutes (LIPI) as the National Scientific Authority to CITES, was appointed as single authority which esta the national quota for annual harvest of gaharu from natural habitat. The quota then is distributed to the R Offices with potential to produce gaharu.

The Regional Offices which have quotas will redistribute the quota to registered gaharu traders located u own authority. The corresponding traders are expected to arrange the given quota with their own collector domestic transport of gaharu is under the authority of Regional Offices.

Export permitting is undertaken by the Directorate General of Forest Protection and Nature Conservation (PH the National Management Authority to CITES (Soehartono and Mardiastuti, 1996). This office is located in the capital city, and for the security reasons the office does not delegate the permit authority to its own Regional Offices.

Problems
The recent development of gaharu trade due to high demand and commercial value causes several major problems such as excessive and illegal harvest, lack of documented information on population and standing stock, enforcement and trafficking.

A. Excessive and Illegal Harvest vs Enforcement: The wild populations of *Aquilaria* spp., regardless the content of gaharu, are practically open access to anyone who harvests the resource. The open competition for resources makes it difficult to control. The authority, except within the strict nature reserves, has no power to control the individual trees of *Aquilaria* spp. within natural forest. With the recent high demand and better price of gaharu, the rate of extraction of the resources has become alarming (WWF, 1994).

The fact that the country has a large geographical area with more than 60 % occupied by forest and limited support to control the entire forest resources makes it very difficult to enforce the existing forest regulations (Ministry of Forestry/FAO, 1990). This situation has created a dilemma. In one hand, the authority has tried hard to accelerate the so called non-timber forest product (gaharu) and to enhance opportunities and abilities for local people to gain benefits from forest resources in a sustainable manner. On the other hand, the limited control of utilisation and lack of co-operation with the traders has escalated illegal harvest.

The traders, quite naturally always look for the largest personal profit. For them, the lack of resources normally, in the short run, could be an advantage especially when the demand and price is high leading to high profit per unit. Ultimately when the resources run out, the traders can easily switch to other businesses.

The traders also know ways of by-passing regulations. The authority has limited access and facilities to control the distribution of gaharu quotas between traders and collectors. The local people who have easier access to the resources and do not have any connection with registered traders usually ignore the quotas system as they may not even understand what the quota is.

Some of the collectors also believe that gaharu does not necessarily occur in standing tree of *Aquilaria* spp. but also can be formed in the felled trees which originally did not contain gaharu. This practices creates even more rapid felling of the species as some of the collectors may log any *Aquilaria* trees regardless the content of gaharu. The lack of information and research on *Aquilaria* spp. population within the natural forest are worsening the situation. Finally, the business of gaharu at regional levels becomes confusing and practically out of control.

B. CITES and its implications: CITES only listed one species of *Aquilaria* (*A. malaccensis*) whereas in reality gaharu products originate from many different trees of species of *Aquilaria* spp. (Burkill, 1966; Jalaluddin, 1977; Sidiyasa, 1986; Chang and Kadir, 1997). The authority has no ability yet to identify to species level the gaharu products which normally are in the form of chips and powder. In practice, therefore, all gaharu products, regardless of the species must comply with CITES procedures and regulations (Soehartono and Mardiastuti, 1996), when they are exported.

Many traders when they deal with high value gaharu (grade super) which normally is carried out in small units (1-2 kg) try to escape the government taxes as the products are small and easy to hide. They try to do similar things when they export the products. They tends to avoid CITES procedures as they reluctant to declare the goods and prepare CITES document in several CITES check points before it leaves the country.

Plantations
Not all the gaharu traders in Indonesia are dishonest. Some of them have foreseen the future of trading gaharu by establishing *Aquilaria* spp. plantations. There are at least four plantations known in the county (Riau-east Sumatera, West Kalimantan, Lombok and Bogor-West Jawa). These plantations, except the one in West Kalimantan, belong to private gaharu traders. The area of each private plantation is not large ranging from 10 to 15 ha with the average age of plantation at 8-9 years.

The plantation in West Kalimantan belongs to the Forest Services of the province. It was established in 1988 f purpose of gaharu research (Soehartono and Mardiastuti, 1977). Currently research on gaharu has been going the area under taken by BIOTROP (the Institute of Tropical Biology) located in Bogor . Although, the p plantation areas are small compared to the entire production of gaharu in the country, the activities within the are encouraging and should be appreciated.

The owners with the help of government and privates researchers have tried different method in inoculating types of fungi into the *Aquilaria* spp. trees with expectation of having instant and good quality gaharu.

Concluding remarks

The business of gaharu in Indonesia has substantial importance in particular for local communities. The c development of the trade although there are problems has positive aspects as indicated by the ongoing res activities relating to gaharu and plantation development. More research in species distribution, natural popu and fungi inoculation are encouraged whereas improvement of enforcement activities are required.

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Defining the conservation status of endemic trees of Peninsular Malaysia – the progress and problems.

Lillian Chua

Assessment of the conservation status of trees of Malaysia by staff at FRIM has focussed on the endemics of Peninsular Malaysia, based on a list of species published in 1990 (Ng *et al.* 1990). It was noted that a similar list of endemic tree species is not yet available for Sabah and Sarawak. The species assessments have been undertaken as a contribution to the *Conservation and sustainable management of trees* project, following the standard data collection form provided by WCMC.

Tree diversity in Peninsular Malaysia is as follows (modified after Ng *et al.* 1990)

100 families
532 tree genera
2830 tree species
720 endemic tree species (25.4%) (this is probably lower once information about plant distribution particularly from Sumatra and Borneo becomes available)

The original number of endemic species in 1990 was 746, but this is now reduced to 720 species because of taxonomic work. Examples of families with a high percentage of endemic tree species are:

Family	**% of endemism**
Aquifoliaceae	(66%)
Araliaceae	(54%)
Theaceae	(57%)
Saxifragaceae	(44%)
Proteaceae	(42%)
Annonaceae	(40%)
Tiliaceae	(41%)
Elaeocarpaceae	(37%)
Myrtaceae	(36%)
Rubiaceae	(33%)
Rutaceae	(33%)
Guttiferae	(30%)
Melastomataceae	(30%)
Euphorbiaceae	(30%)

Recently work has been undertaken on the status of the montane tree flora for those families which are particularly important in Peninsular Malaysia.

To provide information for the *Conservation and sustainable management of trees* project, the application of the 1994 IUCN threat categories and criteria were considered by botanists at FRIM and various problems were encountered. These relate to the difficulties in estimating actual numbers for tree species; the lack of taxonomic research for some of the large and more difficult genera or families and the lack of biological, ecological and phytogeographical data for many tree species. In general there is insufficient collection of herbarium material and unfortunately certain forest habitats and species which have no present commercial value are given low priority for research. In some cases very detailed information is available on tree species composition and abundance but this is only for isolated forest research plots. Nevertheless an approach was agreed for the application of the categories and criteria based on limited information and the interim results are given in the table below. Certain assumptions were made in the use of the categories based on knowledge of the habitat and presumed degree of forest protection.

After carrying out this work it is recommended that several modifications should be made to the present IUCN threat categories. New sets of definitions should be developed, tailored to the biological characteristics of plant families; and phytogeographical patterns should be taken into account. Information available on herbarium specimens should be utilised in application of the categories. Furthermore it would be valuable to explore in greater dep relationship between severely fragmented habitats and decline in species diversity in species populations.

Malaysia is addressing the conservation of forest species in the following ways: the establishment of re programmes; general documentation of biological diversity, specific attention to critical habitats such as peat s mangrove, lowland and hill dipterocarp and montane forests and to specific species; modification of the resent categories acording to the country's needs; identification of hotspot areas; promoting the role of sustainable management and the conservation of biodiversity.

Number of species categorised according to the 1994 IUCN Red List categoreis (based on current limit (preliminary listing).

Family	CR	EN	VU	LR:cd
Aquifoliaceae	0	1	3	5
Araliaceae	0	0	3	8
Theaceae	0	0	12	6
Annonaceae	4	1	8	7
Elaeocarpaceae	0	1	3	7
Myrtaceae	0	3	10	20
Guttiferae	0	0	3	7
Rutaceae	1	2	3	4

Conservation status of trees of the Philippines
Domingo Madulid

One of the most important forest products in the Philippines is timber derived from numerous hardwood species in primary forests around the country. Records show that almost the entire archipelago was originally covered by thick and lush natural forests of various types from sea level to the summit of the highest mountains. This rich natural resource, however, was subjected to human pressure as population gradually increased. A great percentage of the forests were soon exploited and its valuable timber indiscriminately felled and harvested resulting to depletion of its natural population and endangerment of several tree species.

Of the more than 8,000 species of flowering plants in the Philippines more than 3,000 species are trees. Many of these tree species are endemic and found mostly in primary forests. A number of these species are presently threatened in various degrees and need protection to ensure their survival.

There are several reasons why many species of Philippine trees are currently threatened. Forest degradation, fragmentation and destruction are the more common factors that bring about species decline. Logging and slash and burn agriculture (kaingin) cause widescale devastation of the natural forests where most of the endemic tree species are found. Clearing of forests to give way to urbanization and infrastructure development such as roads, bridges and dams account for the other causes of species endangerment. Natural causes of endangerment of tree species include volcanic eruption, drought, flood and soil erosion.

An initial step towards formulating conservation measures for threatened trees in the Philippines is the development of an information base from available sources. Data about the taxonomy, local names, biology, ecology, distribution, uses and other pertinent information of these trees is placed in a computerized data base for easy storage and retrieval of information. Important and useful data to be collected by botanists and foresters is the conservation status of individual tree species following the 1994 IUCN threat categories. This data base will serve as a vital reference from which necessary action and management planning can be undertaken by the concerned government agencies and other institutions involved in biodiversity conservation.

Gathering relevant information and assessing the conservation status of each tree species in the Philippines is a delicate and rather difficult task requiring adequate knowledge of various aspects of the plant such as its taxonomy, past and present distribution, population structure and dynamics biology. Research on conservation status is best done by experienced or professional staff but even then their knowledge of particular species may be limited or require verification in the field.

A number of Philippine tree species are now very rare that it is very difficult to find them in their original habitat. Often the description and notes of their habitat and distribution are based only on one or two specimens. Attempts to recollect these trees in their original place of collection have not proved successful and it is very likely that a number of these tree species are extinct. Many others are now threatened with extinction and it is a matter of a few years that these will also succumb unless immediate conservation action is undertaken. It is imperative and urgent that the concerned public and private organizations and individuals should make a concerted effort towards saving the endangered Philippine trees. There are several options still open for those who want to face this challenge. What is important is for everyone concerned to start now before it is too late.

Conservation status of the trees of Australia
John Benson

Australia contains about 25 000 vascular plant species growing in vegetation formations including alpine herbfields, open eucalypt forests, eucalypt woodlands and savanna, cool temperate, subtropical and tropical rainforest, semi-arid shrublands, and both temperate and arid grasslands to arid in temperate to tropical zones of the hemisphere. Several genera dominate many plant communities. These include 700 species of *Eucalyptus*, 900 species of *Acacia* and 2000 species of Poaceae. While a large proportion of the 25 000 species are woody shrubs or trees numbers of different life forms are not available.

The rare or threatened Australian plant list (ROTAP) has been developed through five editions over 22 years (1974, 1979, 1981, 1988, 1995). The last four editions have been produced by the CSIRO but future maintenance of the list lies with the Federal Government's agency Environment Australia. The history of ROTAP is summarised in the introduction chapter of Briggs and Leigh (1995). The 1995 ROTAP list includes subspecies and varieties but uses modified pre-1994 IUCN codes. A debate is current as to whether to modify the IUCN 1994 codes before applying the categories to plants in Australia.

Cooperation between conservation agencies and herbaria in each state and territory of Australia has been critical in developing the national list. The endangered and vulnerable categories of the national list are protected under the Federal Endangered Species Act. State lists have also been developed and these apply to State laws dealing with threatened species conservation. This is important in Australia because State Governments rather than the Federal Government are vested with most authority for land management and nature conservation. The NSW Threatened Species Conservation Act and the Victorian Flora and Fauna Guarantee Act can list as threatened both species and communities. The New South Wales legislation ties in with planning legislation and critical habitats of threatened species can be delineated in state, regional or local environmental plans. Also, the NSW Act provides for the preparation of threat abatement plans and species recovery plans.

5031 taxa are listed on the 1995 ROTAP list. This is about 20% of the flora of Australia. Using the pre-1994 IUCN categories, 76 taxa are presumed extinct, 301 are endangered, 708 vulnerable, 1570 rare and 2376 poorly known but suspected to be E, V or R. Therefore, over 1000 taxa are in the threatened categories at present (E and V) but it is expected that many in the K category are threatened, particularly those listed as K in Western Australia. The hotspots for threatened taxa are south-west Western Australia, north coast of New South Wales and Cape York in Queensland. The main threatening processes that have lead to the decline in the flora have been land clearing for agriculture or urban expansion, over-grazing by domestic stock and feral animals (particularly the rabbit), and competition with introduced weedy plant species.

Lyn Meredith of Environment Australia will supply WCMC with a list of Australian trees by November 1997. This list will be a subset of the ROTAP list and the threat categories used will be pre-IUCN (1994), ie X, E, V, R and K. It will contain many rainforest taxa along with a large number of the ubiquitous genus *Eucalyptus*. The definition of tree includes the multi-stemmed mallee eucalypts that mainly occur on sandy soils subject to frequent fire.

Over the last two decades conservation reserve system has quadrupled in Australia to over 6% of the land mass with many other areas protected in other ways. The current National Forest Policy Statement proposes that additional reserves shall be established to protect 15% of the pre-European settlement extent of each forest type. In some regions this implies all remaining forest will be protected. Large areas of remaining old growth forest in public forests have recently been transferred to conservation reserves in the state of New South Wales. Land clearing controls exist in some states but not others. This effects the protection of trees on private land that contain ecosystems that are mostly not well represented in the public land reserve system.

As mentioned above there is some debate in Australia about the suitability of applying the 1994 IUCN categories to plant species. A recent paper by Keith and Burgman (1997) analyses the IUCN codes and suggests some modifications. In summary these are:

- Modify Rule B of IUCN (1994) by decreasing the distributional and habitat occupation thresholds for sessile organisms such as plants. An example being that for the critically endangered category (CE) a species should be contained within a 10 km radius or an area of occupancy of less than 1 ha;

- Add a qualitative assessment of life history as some species have difficulty in regenerating after a po[
loss because of infertility, predation or other factors;
- Add defined thresholds on the number of mature individuals protected in conservation reserves;
- Account for skewed metapopulation structure counting only the larger subpopulations. This lin
importance of small unsustainable subpopulations. Add a rule that accounts for the number of subpop
that make up 90% of the total population of a species. For example, 1 = CE, 5 = E, 10 = V.

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State of knowledge of tree species in Papua New Guinea
David Frodin

Background

New Guinea as a whole, along with the Solomon Islands and including Papua New Guinea, is marked by a relatively late formal historical development, although coastal contacts began in the 16th century (Souter, 1963). Serious biological exploration thus began relatively late when compared with many other parts of the world, although a sketchy knowledge of coastal areas had been obtained from 1700 through 1850. Rugged topography, disease and highly fragmented indigenous linguistic and social organisation impeded outside penetration when serious interest in New Guinea finally developed; primary geographical and biological exploration, initiated in 1871, was effectively completed only in the 1950s. A more intensive secondary phase of biological study, particularly in Papua New Guinea, was manifest from 1946 through the 1980s, generating a large literature including summary treatises such as *New Guinea Vegetation* (Paijmans, 1976), *Biogeography and Ecology of New Guinea* (Gressitt, 1982), and vegetation maps including Robbins (1974) and CSIRO (1975). Since then, there has been a general decline in new research work and particularly in botanical exploration in Papua New Guinea (Conn, 1994) with at present perhaps relatively more productive activity in Irian Jaya.

General floras

Until 1978, general coverage of the flora was largely in the form of collection reports and regional revisions, or in works of larger scope such as *Flora Malesiana* (1948-) and generic and family revisions covering the Malesian region. Around 1970 or so, the Division of Botany of the Department of Forests in Papua New Guinea, then under the direction of John Womersley, initiated work towards a descriptive flora. Since 1978 this has appeared as *Handbooks of the Flora of Papua New Guinea* under a succession of editors, most recently Barry Conn for the third volume (1995). Coverage was also extended to Irian Jaya and the Solomon Islands as far as available material in the Division of Botany herbarium permitted. It is, however, very far from complete and its continuation is by no means certain, given a current near-absence of effective support from Papua New Guinea.

Several partial floras and enumerations of varying quality also exist. The best of these, though of limited scope, is *Flora of Motupore Island* (1996) by H. G. Fortune Hopkins and J. Menzies. It is also the only floristic work covering any part of the distinctive flora of the monsoon belt of southeastern Papua New Guinea. Useful for the north coast is *An Annotated Checklist of the Flora of Kairiru Island* (1989) by O. William Borrell and, for New Ireland and northeastern New Britain, *Flora of the Bismarck Archipelago for Naturalists* (1984) by P. G. Peekel. Both these latter works are well-illustrated. Some families have also been treated in separate works, notably *A Manual of the Grasses of Papua and New Guinea* (1969) by E. E. Henty, *A Manual of New Guinea Legumes* (1979) by B. Verdcourt and *A Survey of Lowland Orchids of Papua New Guinea* (1992) by P. O'Byrne.

Certain floras of wider scope cover Papua New Guinea. The chief of these is *Flora Malesiana*, initiated in 1948 and now covering some 20% of the flora of Indonesia, Malaysia, the Philippines, East Timor and Papua New Guinea, now thought to contain nearly 40 000 species. Series I covers seed plants except orchids; series II, pteridophytes. A separate series *Orchid Monographs* incorporates revisions of Malesian orchid genera. Many separate papers on individual genera and families of vascular plants have also been published; as far as possible, these are indexed annually in *Flora Malesiana Bulletin*.

Tree species

Collection of tree species has featured in all botanical exploration from the beginning, but with the relatively slow development of forestry activities no attempts were made to document the tree flora in its own right until the 1920s. In this respect Papua New Guinea lagged far behind what are now the Philippines, Indonesia and Malaysia. A first survey of forest resources was conducted in the Territory of Papua a few years after its transfer to Australia, but the resulting report, *The Timber Trees of Papua* (1908) by G. Burnett, was deeply flawed in its use purely of vernacular names for the species. Following the mandate of former German New Guinea in 1921, the Commonwealth of Australia charged Charles E. Lane-Poole to undertake a new survey. His report, *The Forest Resources of the Territories of Papua and New Guinea* (1925), included a botanical section based on his collections as well as general sections on vegetation, forests and forest resources. A separate forest service was established in the Mandated

Territory of New Guinea only in 1938; collections of tree species were initiated by one of its two officers. Ja McAdam, but work was suspended in 1942 with the outbreak of World War II in the Pacific.

In 1944, a Forestry Battalion was formed in the A.I.F. and McAdam placed in charge. Lectures on forest bota prepared by Cyril T. White, Queensland Government Botanist, for the troops; in 1961 these were revised Henty and published as *Forest Botany Lectures* with the aim of providing a text for students at the new I School in Bulolo. They comprise the first dendrology for Papua New Guinea. In the early 1960s J.J. Havel, a at the School (later College), composed an illustrated dendrology focussing on the most important speci appeared in 1975 in two parts as *Forest Botany*. R.J. Johns, a later lecturer at the College, revised and expan as *Common Forest Trees of Papua New Guinea* (12 parts and index, 1975-77; parts 1-3 revised 1983). This the most complete national dendrology. Also in the postwar period, a new Department of Forests was establis the Territory of Papua and New Guinea under McAdam; its Division of Botany was formed in Lae in 1946 un Womersley. Inheriting the collections of the A.I.F. from 1944-45, it steadily built up a substantial herbariu one of the larger in greater Southeast Asia. By the 1960s resources were considered sufficient to undertake a work on forest trees; the result was *Manual of the Forest Trees of Papua and New Guinea* (1964-69). This, h was left substantially incomplete with efforts being transferred to the already-mentioned *Handbooks*. The I has since published next to nothing *per se* on forest trees; a compendium initiated by J.R. Croft in the 19 continued through 1984 under the title *Timber Tree Species: scientific names and synonyms arranged alphab and cross-referenced* remains unpublished (Saulei 1996: 33).

A need for increased development of the economy of Papua New Guinea induced Australia to expand exploit the forest resource from the mid-1960s. The Division of Utilisation in the Department of Forests and its Products Research Centre accordingly produced *Properties and uses of Papua and New Guinea Timbers* under the authorship of P.J. Eddowes. This was revised in 1977 as *Commercial Timbers of Papua New* (Eddowes, 1978); the author has a further revision in preparation, planned to cover some 500 species. This la sadly to date failed to attract the support needed for its completion and publication; a leading local industry labelled it 'too academic for industry purposes'! (P.J. Eddowes, personal communication).

The main outside work also covering Papua New Guinea trees is *PROSEA Series 5*. This will comprise one on major commercial species (Soerianegara & Lemmens 1993) and two on minor commercial species (Le Soerianegara & Wong 1995; second volume in preparation as of writing). These volumes have been produce the sponsorship of the PROSEA Foundation, an organisation formed in 1986 with the aim of develo information system, a series of publications and outreach programs on economic plants in greater Southeast main centres are in Indonesia and the Netherlands, and several country offices established; one of these is i New Guinea (at the P.N.G. University of Technology, Lae).

At the present time, there is no critical and effective dendrology for Papua New Guinea and little prospect without substantial outside support. In the absence of such a work prospects for improved knowledge of the s individual principal tree species are slight. The situation is even less satisfactory for 'lesser' species of littl commercial value.

Exploitation

Forest exploitation in Papua New Guinea has existed since the late nineteenth century, although generally on small scale until the 1950s. Guides to key commercial species have appeared have appeared since 1957 wi *forests and forest conditions in the Territories of Papua and New Guinea* by J.S. Womersley and J.B. McAd published by the Department of Forests. With some notable exceptions development of the industry re relatively slow, however, until the 1960s when, as already noted, a more proactive policy towards exploitatio into effect. In 1973 the Department produced an attractive publicity booklet, *New Horizons: Forestry in Pap Guinea* (Brisbane: Jacaranda Press). This covered the major 'timber areas' based on type and accessibi included synopses, with colour illustrations, of quality timbers. In 1978, as already noted, a relatively de guide to commercial species was published (Eddowes, 1978).

Principal hardwoods (cf. Eddowes 1978) include amberoi, *Pterocymbium beccarii* (Sterculiaceae); PNG ba *Endospermum* spp. including *E. myrmecophilum* (Euphorbiaceae); Wau Beech, *Elmerrillia tsiampacca* (forr *papuana*; Magnoliaceae); calophyllum, *Calophyllum* spp. including *C. soulattri* (Guttiferae); pencil

Palaquium spp. including *P. supfianum* (Sapotaceae); white cheesewood or milky pine, *Alstonia scholaris* (Apocynaceae); erima, *Octomeles sumatrana* (Tetrameleaceae); water gum, *Syzygium* spp. including *S. effusum* (Myrtaceae); light and heavy hopea, *Hopea* spp. (Dipterocarpaceae); kamarere, *Eucalyptus deglupta* (Myrtaceae); kwila, *Intsia bijuga* and *I. palembanica* (Leguminosae); labula, *Neolamarckia cadamba* or *Anthocephalus chinensis* (Rubiaceae; the correct name remains a matter for study and possible formal nomenclatural action); PNG mersawa, *Anisoptera thurifera* (Dipterocarpaceae); PNG chestnut-oak, *Castanopsis acuminatissima* (Fagaceae); PNG oak, *Lithocarpus* spp. including *L. celebicus* (Fagaceae); planchonella, *Pouteria* spp. (formerly *Planchonella*; Sapotaceae); PNG rosewood, *Pterocarpus indicus* (Leguminosae); taun, *Pometia pinnata* (including *P. tomentosa*; Sapinaceae); spondias, *Spondias novoguineensis* (Anacardiaceae); brown, pale brown, red-brown, pale yellow, and yellow-brown terminalia, *Terminalia* spp. (Combretaceae), PNG vitex, *Vitex cofassus* (Labiatae), and PNG walnut, *Dracontomelum dao* (Anacardiaceae). In addition, many conifer species are exploited, notably hoop (*Araucaria cunninghamii*) and klinkii pine (*A. hunsteinii*) along with various podocarps (notably from the rimu genus, *Dacrydium*), and there has been considerable interest in ebony (*Diospyros* spp.). In the Highlands, beech (*Nothofagus* spp.) has been much sought after as the best general-purpose timber, with corresponding depletion in more accessible areas. [This list covers both 'export' and 'domestic' species. For alternative lists, see Table 9.1 in Sekhran & Miller (1994).]

The emphasis of the Department of Forests (in the 1970s and 1980s the Office of Forests of the Department of Agriculture, Stock and Fisheries and from the early 1990s, the Forest Authority) has remained largely directed towards exploitation. Forest legislation was in the 1970s amended to facilitate access to the resource within the constraints of customary ownership of most forest lands, a right embodied in the Organic Law. Numerous Timber Rights Purchases (based on landowner-State agreements) and Local Forest Area Agreements (based on landowner-contractor negotiations) have been made, concessions granted and projects set up. The nature of exploitation for export shifted from a mixture of logs, sawn timber and processed wood products to one based largely on logs and chips, to some extent at least through a great expansion at the lowest levels (by 1993 logs accounted for over 99% of forest sector exports). In the 1980s the acqusition of rights became tainted by increasing corruption; concessions also came to be viewed as partly or wholly lacking in promised benefits. Logging operations in particular became increasingly destructive. Indeed, the industry was called 'out of control' (Sekhran & Miller 1994: 156). A Comission of Enquiry was accordingly held in the latter part of the 1980s; its full report is *Report of the Commission of Enquiry into Aspects of the Forest Industry in Papua New Guinea* by T. E. Barnett (Ombudsman Commission of P.N.G., 1989, unpublished; 20 vols.). A summary has been published in Barnett (1990).

The government response to the Enquiry took the form firstly of a Tropical Forest Action Plan; this was in 1991 broadened to form a National Forestry and Conservation Action Program (NFCAP) (Sekhran & Miller 1994: 156-158). Reforms were instituted including the transformation of the Department of Forests into a statutory Forest Authority committed in theory to sustainable forest management. These were reinforced in 1994 under a World Bank/IMF economic adjustment package. With continuing government instability, a need for revenue, and industry pressure, however, there are signs that these steps have been less than truly effective. The NFCAP was in the first instance only implemented for an initial three-year term. More significantly, the question of retroactive application of the reforms to existing concessions had not been resolved by the mid-1990s. There were also signs that incentives and awareness campaigns were failing in the face of many obstacles (Sekhran & Miller 1994: 369-70). Of individual timber projects, the Gogol Project near Madang became particularly notorious and the Vanimo Project in the northwest was long in gestation. Supervision of projects and concessions has been a particular problem. In the last decade, the industry has to a substantial extent come under the control of a Malaysian company, Rimbunan Hijau (which owns one of the two daily newspapers in Port Moresby; the other is owned by Rupert Murdoch's News International). My former student Simon Saulei in 1988 – at the time of the Enquiry – labelled the whole the result of an 'incohesive' forest policy; there is little sign of change since.

With respect to forest research, in the late 1980s a single Forest Research Institute was created which incorporated the Division of Botany and other formerly scattered research units. The Institute was physically and technically developed with assistance from the Japanese International Cooperation Agency (JICA); provision in the Lae building was made for cooperative researchers from that country. Its research and publication record has, however, been relatively slight and it has suffered from several changes in directorship in the 10 years since its formation. The role of the cooperative researchers moreover remains unclear. As with other forestry research organisations, there is much interest in provenances and in fast-growing plantation species; the influence in particular of Australia was a great emphasis on eucalypts. Relatively little 'small-scale' work has been pursued; any 'village forestry' largely fell to regional offices (pursued more in the Highlands than anywhere else; the 'Planim Yar' (*Casuarina oligo* *Gymnostoma papuanum*) programme of the late forest officer John Levien in the mid-20th century b outstanding example of the use of native species). Research into trees of lesser commercial importance as other forest products has been relatively limited, although in the latter sector there is at least some effort bein in the study of rattans (mostly *Calamus* spp.) With respect to the Division of Botany, hardly any new collect pursued after 1984; moreover, little material was incorporated into the herbarium for nearly a decade personal observations, 1992 and 1993; Conn, 1994). Publications have also been few.

It has been left largely to the two major universities, as well as researchers from outside the country, to st impact of the increased forestry activities on local communities. Several studies are listed by Saulei (1996 have also been discussions from time to time on forest policy, forward planning, and reforestation, notabl wake of the above-mentioned judicial inquiry, but to date there seems to be little in the way of developments. As in some other countries, instability and unfavorable working conditions may be forcing p join the private sector or to leave the country. The universities and research institutions, necessary to an in understanding of the biological and human diversity of Papua New Guinea and its resources, remain ess underfunded and serious publishing has correspondingly declined.

Biodiversity and Conservation

A first conservation assessment for the plants of Papua New Guinea appeared in 1974 in *Conservation o* *Plant Communities in Australia and Papua New Guinea* by R.L. Specht, E.M. Roe and V.H. Boughton (1 *Australian Journal of Botany*, Supplement 7). Two chapters on Papua New Guinea discussed current and p impacts but concluded that for most species information on actual rarity or threats was largely deficien attention was drawn to orchids, but nothing of note on trees. In the same year, with the advent of self-gover Papua New Guinea a Department of Environment and Conservation (DEC) was formed. This continues to fu yet, in the absence of reforms in relation to inherited practices, without sufficient related institutional a resources desirable to make it more effective (no central national scientific research organisation was ever and nothing comparable to the Institute of Ecology and Biological Resources in Vietnam exists). Until th conservation in Papua New Guinea remained largely an academic pursuit although DEC gradually incre activities and influence, in the latter part of the 1970s acquiring responsibility for wildlife from the Depart Agriculture, Stock and Fisheries. The main collections of contributions are in Lamb and Gressitt (19 Morauta, Pernetta and Heaney (1982).

The Barnett judicial inquiry and the impacts of increased forest exploitation on local communities resulte emergence of a real 'grass roots' awareness of conservation of the environment and resources. An intera minds in the United States of America around this time gave rise to a symposium in June 1991, published lat year as *Conservation and Environment in Papua New Guinea: Establishing Research Priorities* and edite Pearl, B. Beehler, A. Allison and M. Taylor (Pearl et al., 1991). In the same year the PNG government app the U.S. Agency for International Development (AID) for technical assistance with respect to DEC. T implemented through AID's Biodiversity Support Program. Available biodiversity data were assessed by exp plants by R.J. Johns) and a national workshop conducted in 1992 at the Christensen Research Institute Madang. The following year the reports, results and recommendations appeared as *Papua New Guinea Cons* *Needs Assessment* under the aegis of DEC (Alcorn & Beehler, 1993). Of particular significance was the rec of the essential role of landowners in conservation strategies. Among short-term developments stemming f review as well as the already-mentioned NFCAP was the formation within DEC of a Conservation Resourc with support from the Global Environment Facility (GEF) (Sekhran & Miller 1994: 158). In addition a Bio Country Study was commissioned by the United Nations Environment Program (UNEP) in the wak Convention on Biological Diversity, Papua New Guinea having been one of the first countries to ratify appeared in late 1994 as *Papua New Guinea Country Study on Biological Diversity* (Sekhran & Miller 1994) only effectively placed on general release in early 1996.

Noble aims, however, are one thing. The translation of these aims into practical steps, including the prepa books and other tools for tree identification and information, the assessment of tree species in the field, formation and implementation of plans of action will all require funds and political will. To date, there is r little sign that positive steps are being taken. The country is faced with the continuing Bougainville crisis (un since 1989), the related Sandline mercenary affair of 1997, current negative economic growth, urban c difficult working conditions, problematic relationships with Australia (which continues heavily to exploit the country, its companies taking out in profit five times what is returned in grant-in-aid), the strength of the exploitation 'lobby' (the government reportedly seeks to 'complete' the harvest of the lowland forests by 2005), the already-mentioned negative attitudes in some quarters to research and higher education (as evidenced by the lack of concrete suppport for a revision of the Eddowes book), and political instability resulting from a weak structure of government and sense of higher nationhood; all these would seem to militate against much progress at least in the short term. With respect to plants, there has been no real 'meeting of minds' or moves towards development of a 'Red Data Book'. Indeed, relatively little attention was paid to botany in the above-mentioned *Country Study*; among its 'resource people' there was no one with a serious knowledge of the vascular flora. Given also the low current exploration rate and the serious research and documentation backlog (Conn 1994), my overall conclusion with respect to tree status and conservation must be one of 'data deficency'. Enough is known, however, about certain timber species to make some decisions regarding threats including the application of categories; these have been incorporated into the assessments made during this Conference.

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Tree conservation as related to the Palmae

Dennis V. Johnson

General Introduction

This brief account is an attempt to describe some of the complexity found within the Palm family and how that complexity is being dealt with in following the guidelines for *the Conservation and sustainable management of trees* project. Application of the new IUCN Red List Categories to palms is also considered as related to the palm species selected for inclusion in the Project database.

Palm Introduction

Palms in general are most commonly thought of as being trees, but this is a misconception derived from the image of most familiar palm of all: the coconut, *Cocos nucifera*. *Cocos* is but one of about 195 palm genera; its specific epithet, *nucifera*, distinguishes it from 1,500 to 2,000 other valid palm species. In describing palms, there have been a large number of binomials assigned. The WCMC palm database contains about 3,150 recorded names.

Five major growth habits are found within the Palm family. 1) Solitary palms are very common and range in height from as little as 30 cm to as much as 60 m. Stems may be as thin as a pencil or measure 2 m in diameter. 2) Clustering palms with a few up to a dozen or more stems from the same root system are also a common growth form. In general, clustering palms do not reach the height or diameter extremes of solitary species. 3) Aerial branching occurs in a few palm genera, the best example being within the genus *Hyphaene* which is common in Africa. 4) Subterranean branching is found in some palms which do not produce an above-ground trunk. The nipa palm of Asia is perhaps the best known with this growth form. 5) Climbing palms can be either solitary or clustering and can only thrive where other trees are present which they can use for support. Rattans are climbing palms.

The leaf form of a palm represents one of the primary means of description. Basic palm leaf forms are pinnate, palmate, bipinnate and entire. Size can vary from 20 cm to 20 m.

Palm fruits are highly variable in shape and size. Individual seeds may weight as little as 0.23 g to the 20 kg double coconut seed. Palms planted from seed require from 3 to 40 years before reaching sexual maturity. A number of palms are terminal flowering, such as the sago palm.

In terms of habitats, palms also exhibit a remarkable range. Extending from 44° north to 44° south latitudes, palms are found in forest, montane, scrubland, grassland, desert and unusual soil-type habitats.

Palm Conservation Data

The WCMC plants database lists all species of the Palmae, whether threatened or not. For some reason when palm data began to be entered, the decision was taken to include the entire family. This factor has been advantageous to palm conservation. Such is not the case in all plant families in the database.

Palm records in the WCMC database include taxa below the species level. Subspecies, varieties and forms are listed under 38 different genera. Natural hybrids occur in the Palmae but they are not recorded in the database. Palm conservation efforts to date have been focused at the species level.

Selection of CSMT palms.

The two criteria for inclusion of palms in the Project were: 1) species known to be under threat; 2) solitary or clustering palms with stems at least 2 m in height, without regard for stem diameter. It should be pointed out that the first criteria eliminates many palm species for which conservation data are lacking. The result is that geographic areas where knowledge is adequate (e.g. Latin America) are better represented than areas such as Indochina and the island of New Guinea where the majority of the palms fall into the old "unknown" conservation category. As far as the second criteria is concerned, data is sketchy on a number of palm species with regard to height.

Using the two criteria above, a provisional list of 355 palms species, representing 109 genera, were selected Project. The palms included are certainly representative but far from complete, for the reasons indicated Through the cooperation of palm specialists around the world, Project data sheets are being completed for the palms and the old conservation categories being converted to the new.

Problems in Assigning the new IUCN Categories

It is useful to review the 12 definitions on which the new categories are based as they relate to the state of kno of the Palm family.

1 Population. A fundamental problem involves clustering palms. Is a cluster of 8 stems from a sing system 1 palm or 8 palms? If one were to decide to count root systems, in some areas it would be imp because they cannot be distinguished one from another at the surface. Reliable population numbers fo are available in rare instances where only a few palms remain in the wild, such as in the case of endemics where habitat is virtually gone.

2. Subpopulations. It is documented that some palms have a patchy distribution over their range. Desert are a good example. Subpopulations also undoubtedly occur among the numerous forest palms, but d almost nonexistent.

3. Mature individuals. It is not difficult to distinguish mature from immature palms. However, given th period to sexual maturity in many species, it is impossible to estimate population dynamics. Charact terminal flowering palms under this definition is problematic.

4. Generation. Total lack of data for palms.

5. Continuing decline. Without a baseline, decline cannot be even guessed at for palms under threat.

6. Reduction. Total lack of data for palms.

7. Extreme fluctuations. Because of the long time period for palm reproduction, it would require hundreds of years of monitoring to make a determination of the degree of fluctuation.

8. Severely fragmented. The same comments as applied to Subpopulations above.

9. Extent of occurrence. Geographic range of a fair number of palm species is known, but only in th sense. A fundamental problem is that distribution species maps are based primarily on herbarium rec collection locations, which may or may not accurately represent patterns in the wild. The best d available for the most threatened species of palms.

10 Area of occurrence. Not enough detail is available in most cases to be able to approximate are particular species of palm. Some palms have very narrow habitat requirements, occurring, for exam certain soil types which may be infrequent over its geographic range.

11. Location. Highly threatened palms have in some instances been precisely located so that the primary are known. Certain island endemic palms are the best examples.

12. Quantitative analysis. Insufficient data are available for such analysis on threatened palms.

The only solution for overcoming the paucity of palm data needed for the foregoing definitions is to cons singlemost important factor for palms: habitat. Perhaps 90% of all palms species are forest dwelling, and those species cannot survive removal of the forest canopy. Therefore one can infer the conservation status species by an estimate of the pressures which are present, or expected in the near future, on habitat. Admitte is a crude method to carry out an assessment of the conservation status of palm species, but given the current knowledge there is no practical alternative.

IUCN Palm Action Plan

In 1996, the Palm Specialist Group produced an Action Plan which represented the culmination of more than a decade of effort. We now have a better idea of what is and what is not known about the conservation status of palms. Possibly the most useful aspect of the exercise was to identify the major knowledge gaps which exist. That knowledge permitted the development of a list of priority conservation measures to be undertaken.

Three of the major priority action recommendations are as follows. 1) Compile conservation checklists of the Atlantic forest of Brazil, and the island of New Guinea. 2) Design and implement management plans for Endangered palms in Madagascar. 3) Design and implement management plans for Endangered island palms in the Indian and Pacific Oceans.

Information was also gathered for inclusion in the Action Plan about economic palm species since in many instances utilization and conservation are interrelated.

Because the Action Plan was begun before the new red list categories had been published, the old categories were used. The CSMT Project is complementary to one of the next objectives to improve the quality of palm conservation data, that is to replace the old red list categories with the new. Experience gained from completing CSMT data sheets represents an initial step toward applying the new conservation categories to all species of palms.

The work of IUCN/SSC Plant Specialist Groups

Wendy Strahm

Background

IUCN-The World Conservation Union (also known as the International Union for the Conservation of Nature and Natural resources), is one of the largest and longest established international conservation organisations, having been founded in 1948. The unique feature of IUCN is that it brings together a diverse group of organisations involved in conservation (over 800 members from some 125 countries to date), which includes States, government agencies and a diverse range of non-governmental organisations. This provides access and discussion between governmental (States and government agencies) and non-governmental.

Under the umbrella of IUCN are its six commissions: Species Survival, Protected Areas, Environmental Law, Ecosystems Management, Education and Communication, and Environmental Strategy and Planning. Each Commission has its own network and programme, although all are linked through the IUCN Secretariat, which is headquartered in Switzerland, with regional offices in Meso-America, South America, East Africa and Southern Africa, and numerous country offices found mostly in developing countries.

The Species Survival Commission

A year after IUCN was founded, the Species Survival Commission (formally named as such in 1956) came into being, and one of its principal activities was to work on Red Data Books for different groups of plants and animals. However today the Species Survival Commission has greatly diversified, and while still concerned with Red Books and determining threat status of species, it also engaged in a large number of activities aimed to mobilize action by the world conservation community on behalf of species, in particular those threatened with extinction and those of importance to human welfare.

The goals of the Species Survival Commission are:

- To *assess* the conservation status of species worldwide;
- To *identify* conservation priorities for species and their habitats and develop strategies for their conservation;
- To initiate the actions *necessary* for the survival of species;
- To *develop and promote policies* for species conservation;
- To provide an *expert resource network* on the conservation of biodiversity.

The Species Survival Commission today is composed of some 120 'Specialist Groups' of which a quarter are concerned with plants, both with a taxonomic as well as regional focus (see Table 1).

Table 1. IUCN/SSC Plant and related specialist groups

Plant Specialist Groups

African Tree	Japanese Plants
Arabian Plants	Korean Plants
Australasian Plants	Lichen
Bamboo	Macaronesian Island Plants
Brazil Plants	Madagascar Plants
Bryophytes	Medicinal Plants
Bulb	Mediterranean Island Plants
Cactus an Succulent	North American Plants
Carnivorous Plants	NW South American Plants
China Plants	Orchids

Plant Specialist Groups continued

Conifer	Palms
Cycads	Pteridophyte
East African Plants	Southern African Plants
European Plants	South Atlantic Island Plants
Fungi	Temperate South American Plants
Indian Ocean Island Plants	Temperate (broadleaved) Trees
Indian Subcontinent Plants	

Disciplinary

Invasive Species	Re-introductions

The Specialist Groups listed in Table 1 are networks of individuals or organisations that are working toge achieve a common objective which cannot easily be attained by any of the network members working in iso Therefore they must be composed of members that are focused on a clear objective and actively work to imp activities. In the SSC Specialist Groups focus on a number of objectives which include:

- To access species conservation priorities through an Action Planning programme, and deliv recommendations of Action Plans to appropriate agencies and organisations within the global conse community, with particular emphasis on IUCN's members.

- To promote the implementation of species conservation Action Plans by governmental and non-govern conservation agencies, with particular emphasis on IUCN's members.

- To develop policies and guidelines pertaining to the conservation of species and genetic resources and t these to the attention of governments and the conservation community.

- To provide technical advisory services to IUCN and its members and partners on the developme implementation of projects and programmes relating to conservation of species and biological di (including development and screening of project proposals).

- To gather data pertinent to the conservation of species through SSC's volunteer network and to manag data in a standardized, distributed, computerized database.

To achieve these objectives, the network works through its members (largely voluntary although includin staff) and cooperating and partner institutions. For example the last objective is achieved through close collab with the World Conservation Monitoring Centre (WCMC), under the umbrella of the BCIS (Biodi Conservation Information Service) Programme.

Plant activities in the SSC are coordinated by a 'plants officer', a position created in 1993, and the overa programme of the SSC is guided by the 'Plant Conservation Subcommittee', another network of some 18 pro botanists chosen to represent different botanical disciplines and regions, which is currently chaired by Dr Given of New Zealand.

Some recent activities of the SSC

Categories of Threat. The well-known IUCN categories of threat, which is the system developed by Sir Pet in 1963 of calling species either Endangered, Vulnerable, Rare or Not Threatened, has been revised over th by hundreds of conservationist fieldworkers and scientists, and new criteria have been developed (IUCN, 199 new criteria provide a much more objective assessment of which species are most threatened with ext helping conservationists as well as decision-makers to focus limited resources. The goal is to assess all currently listed as threatened with the 1994 IUCN Red List Categories, one of the principal goals of this Wor

Centres of Plant Diversity. This joint IUCN/WWF project aimed to provide a global overview of the main areas in the world of plant diversity, in order to provide priorities which would allow the conservation of the maximum amount of plant diversity. Three volumes, the first on Europe and Africa, the second covering Asia and Australasia, followed by the third on the Americas have been published (IUCN & WWF 1994-7). These volumes provide a blueprint and measuring stick for plant conservation action as well as monitoring to understand if we have been successful. The IUCN/SSC Plant Conservation Subcommittee recommended that all future plant conservation action be directed towards conservation in the important plant sites identified by the CPD project.

IUCN Red List of Threatened Plants. Specialist Groups have a major role to play in the assignment of IUCN Red List or Threatened Species categories for the species within their brief. Globally threatened species (using the old IUCN categories) will shortly be published in the first (Walter and Gillett, in press) attempt to list as many higher plant species known to be threatened at the global scale. The next challenge is to apply the new IUCN Red List categories for species currently listed as threatened.

Action Plans. The activity that has been shown to most unite the Specialist Groups is the development of an 'Action Plan', either for a group of species, or area of concern to the expert group. To date four plant Action Plans have been produced on palms (Johnson *et al.*, 1996), Mediterranean Island Plants (Delanoë *et al.*, 1996), Orchids (IUCN/SSC Orchid SG,1996), and Cacti and Succulent Plants (Oldfield, 1997). Plant Specialist Groups which are currently working on Action Plans include the Bryophyte, Carnivorous Plant, China Plan, Conifer, Cycad, Pteridophyte, and Temperate South American Plants. These Action Plans are distributed to key Governmental and NGO bodies, and Action Plan Implementation is a key activity of the Specialist Groups.

Newsletters. It is often difficult or impossible for Specialist Groups to meet, and other communication means must be found. Six groups are currently producing newsletters, including Cacti and Succulent Plants, Carnivorous Plant, Conifer, Medicinal Plant, Pteridophyte, and Temperate (broadleaved) Tree. In addition, 'Plant Conservation News' (produced by the Plant Conservation Subcommittee) serves to keep the Plant Specialist Group members in touch. This newsletter is sent to all botanically minded members of the SSC, and is published in English, French and Spanish. The Invasive Species SG has also produced its second issue of 'Aliens' which treats many plant-related issues, and the Reintroduction SG produces 'Reintroduction News' which also includes plants.

Meetings. People love to meet, and although this is an expensive and time-consuming activity to organise, it is often essential to develop a programme of activities. Thus far most of the Specialist Groups have been able to meet, often piggy-backing their meetings on other meetings. Workshops where Specialist Groups address and resolve specific species conservation issues are also very useful. Workshops held as part of the 'Conservation & Sustainable Management of Trees' project have served to launch the 'African Tree Specialist Group' and we hope that a similar network for Asian trees may see the light of day, provided a core of members are interesting in developing the network, and an energetic leader is nominated.

Conclusions

The Species Survival Commission of IUCN has been around for a long time but is constantly facing new challenges as the world increasingly recognises the essential need to conserve nature. The Convention on Biological Diversity is an important mechanism, but in order to conserve biological diversity, strong networks of experts who know what biodiversity really is are needed. In order for plants to receive support from decision and policy-makers, strong, clearly focused and well-communicated plant conservation priorities are essential, through Action Plans and other methods. Networks are also important to share conservation experience on what has and has not worked, and in general to support each other in the common goal of ensuring that plants and their habitats are better conserved for the generations to come.

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The Conifer Specialist Group
Aljos Farjon (presentation given by David Frodin)

The Conifer Specialist Group is chaired by Aljos Farjon of the Royal Botanic Gardens, Kew. The Group currently has over 30 members. In recent years geographical representation of expertise within the Group has improved but new members, particularly from Southeast Asia are most welcome. Taxonomic expertise is not essential. People involved in forestry, dendrology, arboriculture or similar disciplines, with an interest in conifers are most welcome to join.

There are currently two themes guiding the work of the Group. The first is the production of an updated world list of threatened conifers. The first edition of the world list was published in 1993 in the journal *Biodiversity and Conservation* entitled A preliminary world list of threatened conifer taxa (Farjon *et al* 1993). The current version, in preparation, incorporates much new information sent in by regional members, for example from Chile, China, Himalayas, Japan, New Caledonia and Taiwan. It also follows the new IUCN categories and criteria. In addition the standard data collection forms developed by WCMC are being annotated while assessing each taxon. This ensures that in addition to applying the IUCN categories a large amount other relevant information is being gathered. Further contributions are welcome, particularly where additional data are available from unpublished sources. In general, much more data could be recorded by botanists for potential use in assessment of conservation status. Herbarium specimen citations record only a proportion of the information. Much more could be added from field observation. It is clear that a great many species are truly threatened , particularly those restricted to forest fragments.

The second theme is the production of an Action Plan for conifers. A text has been drafted for conifers worldwide. This includes a global assessment of threats prepared by Chris Page, former Chair of the SSC Conifer Group. As a component of the Action Plan, the threatened conifer list has been analysed in two ways. Firstly, a priority list of 40 species has been selected for conservation action. Secondly, conifer hot spots ie. areas having both high taxonomic diversity and a high degree of threat have been selected. These are: New Caledonia, Tasmania, California, Caribbean Islands (Cuba and Hispaniola), Borneo, southern South America, Mexico, China, Japan, Taiwan and New Guinea.

There are still problems to be resolved in collecting data and assessing priorities for conifer species conservation. Taxonomic disagreements continue and in some areas, for example, in New Guinea, populations of *Agathis* are being lost before their taxonomic status is understood. This is why the work of the Conifer Specialist Group is so important and new input from experts around the world is welcomed.

Reports from the Working Groups

Four Working Groups were convened to discuss the new IUCN categories and criteria and to apply these to selected groups of tree species. Working Groups 1 and 2 were asked to:

1 Consider the application of the 1994 IUCN Threat Categories to widespread tree species which are of resource importance, and provide general comment

2 Apply the categories and criteria to as many of the species in Working Document 3 as possible on the basis of the information provided and knowledge within the group.

The results of the evaluations for widespread species given by Working Groups 1 and 2 are provided in Annex 6 to this report.

Working Group 3 was asked to consider the application of the 1994 IUCN Threat Categories to Viet Namese Species, and to undertake evaluations where possible. Working Group 4 consisted of palm experts who discussed the application of the IUCN categories and criteria to Southeast Asian palm species.

Working Group 1:
Professor Babu, Vongxay Manivong, Fuh-Juinn Pan, Yong Shik Kim, Weibang Sun (rapporteur), Claire Williams.

The group discussed at length the problems of applying the IUCN categories and criteria to widespread species for which data may be lacking or only available for certain countries. For some of the species included in Working Document 3 it was very difficult to apply the new categories. However, taking into account four additional factors, the categories were applied to 48 species. The additional factors were: extent of distribution; nature and magnitude of threat; extent of utilisation; and regeneration potential.

Working Group 1 assessed 11 species as Endangered; 12 as Vulnerable; 7 as Low Risk; and 18 as Data Deficient.

Working Group 2:
Domingo Madulid, Lillian Chua, Tonny Soehartono, David Frodin (rapporteur), John Benson, Wendy Strahm.

The group spent most of its time working through the draft species profiles in Working Document 3 and discussing the application of the IUCN categories and criteria to these species. General issues were discussed and noted as they became apparent. Species confined to South Asia and/or Sri Lanka were not considered as they were largely outside the competence of the group.

The lack of good information relating to the majority of the species, either throughout their range or in individual countries, was stressed. This made the application of the threat categories difficult. Members of the group offered to look into the situation for certain species and the assignment of a threat category was deferred in these cases. It was also noted that, to some extent, the criteria for application of a category were sometimes difficult or even inappropriate. For forest trees, it was emphasised that loss of habitat (or its degradation) was paramount, along with unsustainable removal (logging/gathering). Taxonomy was another important issue; with many studies of the trees of Southeast Asia largely herbarium based, how does this information translate to the field situation? It was suggested that additional species should be added to the list for evaluation and that in future evaluation documents family names would be useful.

Working Group 3:

The main task of this group was to discuss the evaluation of Viet Namese tree species using the new IUCN categories and criteria. The group agreed there are problems with the use of the new system because it is based on quantitative data which is not generally available at species level. In the past Viet Namese field studies have concentrated on species composition rather than autecolological information. There is a need to collect more information to apply the new IUCN threat categorisation system and to form a group of botanists with a range of different experiences.

The group reviewed the draft list of tree species of Vietnam provided as a printout from the project database group noted that the composition of this list of 1400 species was unbalanced with, for example, 158 speci *Shorea* included and 93 species of Myristicaceae, whereas many other species were missing form the list. I noted that only six species of Fagaceae were included and an additional list of endangered species for this family provided by the group. Taxonomic inconsistencies were also noted together with certain species included as which are, in fact, climbers or herbs. Comments were also provided on the draft categories which had already applied to species in the list. The group, for example, disputed the category VU for *Dipterocarpus intricatus* wh considered to be very common in Viet Nam (dominant over an area of 400,000 ha). *Pinus merkusii* is also com and should not be considered VU.

Despite the apparent problems with the application of the new categories and criteria, the working group agree they would adopt the categories and apply these over time to the threatened trees of Viet Nam.

Working Group 4:
Dennis Johnson, Domingo Madulid and Johanis Mogea.

The Group discussed the application of the new categories and criteria to arian palm species and filled in some collection forms. Comments on the application of the IUCN categories and criteria are included in Dennis John presentation (see. Page 47)

Conclusions and follow-up activities
Sara Oldfield

1. There are already, in many Asian countries, tremendous efforts to document the conservation status of tree species based on detailed scientific knowledge. The breadth of work on tree conservation in Viet Nam as reported at this meeting has been particularly impressive.

2. These initiatives do, however, in many cases need international support and recognition. In some countries new initiatives need to be developed. The situation in Papua New Guinea is of notable concern.

3. The importance of understanding the conservation biology of individual species, including the scientific importance of relic species, the economic and local values of tree species and their sustainable use is paramount.

4. The work of WCMC and SSC through the *Conservation and sustainable management of trees* project is important in highlighting the conservation status of trees worldwide and promoting greater public attention to the requirements for tree species conservation.

5. The methodology used in this particular project could be developed for use at a national level. In several countries the completed data collection forms for selected tree species of conservation concern have already provided a useful resource. Copies of the database will also be available to data providers, for their own use and reference.

6. It has been an over-riding principle throughout this project that database management should as far as possible be developed to ensure compatibility between different initiatives. We do not wish to see duplication of efforts where these can be avoided.

7. The 1994 IUCN threat categories are an important step forward in evaluating the global conservation status of species. Further consideration and guidance is however needed to ensure their standard application to tree species. The development of a compatible system applicable at a national level is also important.

8. Assessment of the conservation status of widespread but declining species is a demanding task which requires exchange and sharing of scattered information. This is particularly important as the tree species concerned are frequently of general interest, beyond the scientific community, because of their utility.

9. During the meeting concerns have been expressed regarding the threat categories applied to Dipterocarps. Further consideration will be given to the use of the categories for this important family

10. It is clear that there is great potential for the development of a successful working group made up of tree experts from the region. We hope that all participants at the workshop will keep in touch and continue the excellent progress that has been made this week. WCMC and SSC are willing to help facilitate this process in any way we can..

It only remains for me to thank once again all who have been involved in the workshop. I would like to thank all the speakers, and everyone who has provided information , completed data collection forms or has offered to provide information after the meeting. Finally I would like to express thanks again to our Vietnamese hosts and to the Government of the Netherlands for financial support.

ANNEX 1

Third Regional Workshop, Hanoi, Viet Nam
18 - 21 August 1997

Objectives

The objectives of this workshop will be:

- to review existing information on the conservation status of Asian tree species and to collect additional information on species of conservation concern;
- to discuss the development of the *Tree Conservation Information Service* appropriate for national, regional and international needs;
- to plan for the establishment of an SSC Asian Tree Specialist Group.

Agenda

Monday 18 August

Registration

Welcome and opening of the meeting – **The Honourable Vice Minister, Professor Chu Tuan Nha, MoSTE**

Introduction to the project - **Sara Oldfield**
the work of WCMC and SSC
project aims, activities and progress

Development of *Tree Conservation Information Service* - data management issues - **Martin Sneary**

Introduction to the 1994 IUCN categories of threat and overview of their use for trees - **Charlotte Jenkins**

Case studies on the conservation status of tree species and application of the 1994 threat categories

Conifers - **Aljos Farjon** (Presented by David Frodin)

Trees of Peninsular Malaysia - **Lillian Chua**

Conservation status of trees of Yunnan - **Weibang Sun**

Conservation status of trees of Philippines - **Domingo Madulid**

Conservation status of trees of Taiwan – **Fuh Juinn Pan**

Discussion on application of new threat categories to tree species

Tuesday 19 August

Forest and tree species conservation in Viet Nam

Th e role of IEBR in tree conservation and sustainable management – **Prof Cao Van Sung**

Strategy for conservation of forest genetic resources - an important part of biodiversity conservation in Vie Nam - **Dr Nguyen Hoang Nghia**

Forest tree genetic resources conservation activities at the Research Centre for forest tree imporovement – **L Dinh Kha**

Pinus krempfii - evolutionary importance and conservation status - **Claire Williams**

Case studies continued

Conservation status of the trees of Australia - **John Benson**

State of knowledge of tree species in Papua New Guinea - **David Frodin**

Discussion

Working Groups to review the conservation status of widespread and heavily utilised tree species

Wednesday 20 August

Excursion to Ba Vi National Park

Thursday 21 August

Reports from the Working Groups

Conservation and sustainable management of *Aquilaria malaccensis* - **Tonny Soehartono**

The work of IUCN/SSC Plant Specialist Groups - **Wendy Strahm**

The Korean Plant Specialist Group – **Yong Shik Kim**

The Indian Sub-Continent Plant Specialist Group - **Professor Babu**

The Palm Specialist Group - **Dennis Johnson**

Development of an SSC Asian Tree Specialist Group

Conclusions and follow-up activities

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ANNEX 3

Working Document 1

Tree Conservation Information Service
Data management issues
July 1997

This paper outlines the development of the ***Tree Conservation Information Service***, which, through the collaborative efforts of a wide range of individuals and organisations, provides access to high quality information relating to tree species. The service aims to harmonise and enhance the value of the data collected and maintained by the expanding Species Survival Commission (SSC) Trees Network by facilitating its application to the conservation and management of trees at the local, national and international level.

The service will be of value to individuals and to key organisations whose decisions rely on access to accurate information. Access to high quality data and information will enhance capacity at all levels to make informed and well reasoned decisions. Whether determining the best use of local land or negotiating the obligations of an international treaty, authoritative data and information on tree species will inform the process and increase the likelihood that sustainable practices are employed and negative environmental consequences are minimised.

Background

The World Conservation Union (IUCN) has long recognised the importance of information management, integration and distribution. The Union created the Conservation Monitoring Centre in 1979 (later the World Conservation Monitoring Centre (WCMC) in 1988) to help manage and disseminate the wealth of data deriving from the activities of the IUCN Commissions. The importance of sound information management is now being expressed in the development of the Biodiversity Conservation Information System (BCIS). BCIS is a collaborative effort of IUCN commissions, programs and partners, including the IUCN SSC, and WCMC, with the broad objective of *supporting decision making and management practices that affect biodiversity and natural resources through the provision of data and information*. A process is now underway to plan the BCIS in detail, and partner reviews were undertaken during May and June 1996 and presented in a report titled *Partner needs and capability assessment*. The development of the SSC Trees Network and the formation of the Tree Conservation Information Service are complimentary to this ambitious project, and collectively they aim to enhance the conservation of biodiversity through the provision of accurate data and information.

Goal

To provide a reliable and up-to-date information service on the distribution, conservation status, local uses and economic values of tree species worldwide, in order to assist countries in the planning of sustainable forest management and biodiversity conservation, through appropriate international or intergovernmental processes.

Data harmonisation and data quality management

Data are widely distributed amongst individual experts, national, and international organisations. For these data to re their full value, they need to be harmonised and presented in an integrated form. Indeed, whether presenting informa for an action plan, a national survey, or to develop legislation, the supporting data will have greater impact if consistent. For example, when evaluating the status of a species, either regionally, nationally or internationally, essential to ensure that all potential sources have been identified, and that all the material being considered refers to same taxonomic species.

The process of harmonising data can be reduced if data are collected along similar guidelines, and considerations need to be given to the use of existing data standards. The application of appropriate standards facilitates **consolida** and **communication** (exchange of data) and helps to ensure **consistency** within and between datasets.

The following benefit considerably from standards:

- Taxonomy
- Geographic areas (e.g. Biological recording units - BRUs)
- Habitat classifications
- Other standards (e.g. IUCN threat categories)

Although the service will aim to encourage the use of standards, the adoption of existing standards will depen individuals, who will need to assess their suitability for use.

In addition to suggesting collection guidelines and identifying standards, the service aims to promote and mai excellent **data quality management**. Quality management refers to the overall process that governs the quality product from beginning to end. In the case of information the process begins with data collection and ends with application. Quality control checks and quality assurance methods are applied throughout all stages.

There can be no absolute measure of the quality of a dataset. What may be "high quality" data for regional planning be "low quality" for local decision making because of factors such as scale, detail, and error. Datasets may no "100%" accurate, as the data are often based on subjective observation (such as deciding a boundary of a hab incomplete sampling (e.g. field observations), or indirect measurement (e.g. remote sensing). Even if it theoretically possible to collect complete and accurate data, time and cost considerations often make this extre difficult from a practical standpoint. Therefore, datasets will generally contain an element of error and uncerta "Quality" must be considered a measure of "fitness for use" and is therefore relative to the proposed or intended use. is a very important consideration when data are being integrated and used for applications beyond the original purpo data collection.

Quality management requires attention to quality assurance, integrity protection, and to the complete documentati the dataset in terms of its quality, uncertainty, limitations, origin and intended purposes.

Data custodianship

A key to good management of biodiversity data is to ensure that data are always maintained by the organisation placed to ensure quality. "Custodianship" provides a framework under which responsibility for a dataset can be assi and accepted by the most appropriate agency. It provides a mechanism to ensure that each information holdi established, maintained and made available by the agency best able to do so. The responsibilities of custodia encompass data acquisition, management, and documentation, as well as determining under what conditions a da may be accessed and used.

As the Tree Conservation Information Service evolves, and more data are collected throughout the networ custodians, accuracy will be maintained by relying on the individuals best qualified to comment on and maintain doing so at the appropriate level. Indeed, custodianship should be recognised as being at the core of efficient effective information management, and essentially provides a mechanism to ensure that each dataset is establi maintained and made available by the organisation best able to do so.

Licensing Agreements

Custodians may be responsible for management of the various licensing agreements, which can become very complex. Where appropriate, every effort should be made to develop relatively simple generic licences for data access and use within each jurisdiction. "Memorandum of Understanding" and similar high-level mechanisms that would allow the unrestricted flow of information between agencies may need to be negotiated. Successful biodiversity management requires ready access to many datasets from a wide variety of institutions. There should be an absolute minimum of administrative, cost and other impediments to the flow of information, consistent with the protection of copyright, intellectual property and other legitimate custodian rights. Any obstacles to the free flow of information will inevitably inhibit responsible decision making and sound biodiversity management.

The concept of custodianship can be very useful when attempting to build co-operative networks of information systems, whether linkages between the partners are electronic or informal. An important principle of the scheme is that all datasets are, in theory, accessible by all the partners. Designated custodians, however, have responsibility for collection and maintenance of the data and the sole right to update it and perform corrections. Varying conditions may be attached to data on the network. For example, data may be used for government decision-making, public information or research purposes, but not for any commercial purposes, at least without specific permission.

Collaboration

Linking with other organisations is an important aspect of the information service, and will ensure that information collected through the project is compatible with other data gathering initiatives. Two important areas of collaboration have been developed: between WCMC and IPGRI and between WCMC and FAO. These relate to the following projects:

- **REFORGEN** database system, developed by the Forest Resources Division of FAO, is a global database system designed to house information related to the world's forest genetic resources.
- **TREESOURCE**, a global information system on forest genetic resources, represents a collaborative effort between FAO, CIFOR, ICRAF and IPGRI, and has been designed to provide readily, reliable and accessible information on forest genetic resources.

These collaborative links will also minimise replication of effort and promote exchange of data. Furthermore, wherever possible, the information service will adapt to support other initiatives for which the data may have a use.

Capacity Building

The service will not aim to maintain all the information potentially available on tree species. Central to the success of the service will be the development of regional capacity and in the development of the Tree Conservation Information Service, we are discussing with various national agencies their data management capacity and development needs. We would welcome your views on local needs during the course of the workshop, particularly as there is no single way to achieve improvements in the environment through the use of information. In all cases the approach has to be tailored to local conditions. Practically, WCMC can offer advice to agencies and individuals implementing their own priorities for information management. Topics covered, in a broad sense, include information systems development, database development, the role of quality management and its implications, techniques for information production and the role of information for decision support.

WCMC has been very active in supporting the development of in-country information management and is the hub of a network of organisations preparing guidelines and materials for capacity building. Documents developed for the UNEP-supported project *Development of Supporting Materials for Biodiversity Data Management and Exchange* are instructive in providing guidance on the conceptual processes, techniques and tools involved in the management of biodiversity information, and will provide valuable experience for the project.

- ***Guidelines for a National Institutional Survey*** (in the context of the Convention on Biological Diversit provides guidance to countries in the conduct of a survey and assessment of the capacity of existing nati institutions to support biodiversity information management
- ***Framework for Information Management*** - guidelines meant to facilitate the development of capacity information management and exchange as required by the ***Convention on Biological Diversity***
- ***Electronic Resource Inventory*** - represents a compilation of reference directories, guidelines, and standards rel to biodiversity information management

Characteristics of the information service

The Tree Conservation Information Service has been designed to be more than a simple catalogue of data, and air provide benefits to individuals and institutions, at all levels. To serve the needs of this wide audience, the informa service has many different features, and central to its success will be the ability to provide practical solutions to **collection, data storage** and **information dissemination**.

Data collection will benefit from standards. Data storage will require an **operational database**, providing stan database functions such as add, edit and delete, coupled with comprehensive reporting. The use of appropriate loo tables and standards will ensure good data integrity. Dissemination of information will rely upon **presenta** functionality, with a strong emphasis on providing information on a selected topic in a range of forms. The media for will vary, and will certainly take advantage of technologies such as the World Wide Web as well as a desktop b presentation solution for those without Internet access.

The development of the information management system component of the information service involv number of distinct phases:

- User needs analysis
- Functional specification and prototyping
- System design and development
- Implementation
- Operation

This approach, following a recognised path from concept to an operational system, is often referred to as the **Struct Development Life Cycle.** Adopting this methodology helped ensure that the final product was developed appropriate consultation between prospective users and developers, and that the system provides the nece information management infrastructure to support the information service and its future maintenance and expansion.

User Needs Analysis

When building an information service, it is essential to identify clearly the requirements of the people who will be the system, and to identify clearly the information products they require. These will provide clear direction for phases in the development of the service itself, and ensure that the information service fulfils the objective of involved.

To assist with establishing user needs, a tree and timber database questionnaire was prepared and mailed (July, 19 over 500 organisations in the following categories:

- National governmental forestry and conservation departments
- Bilateral and multilateral development agencies
- National and international NGOs
- Research organisations
- Forest product trade organisations
- Individuals

The questionnaire survey had two main aims:

- To collect information on existing databases
- To determine priority user needs for the *Tree Conservation Information Service*

Information on over 50 existing tree and timber databases has been received and is collated into a **meta-database**, which may itself become part of the information service. Where the appropriate consent has been given, details of the individual databases will be added to a larger database network, such as CIESIN (Consortium for International Earth Science Information Network) or UNEP GRID (United Nations Environment Programme Global Resource Information Database) meta-database. Information on priority information requirements has been provided by over 80 potential user organisations and individuals and these are summarised in table 1.

Table 1: ***Priority information requirements***

Information Category	Response rate
Species scientific name	86%
Local uses	86%
Species distribution	85%
Commercial uses	83%
Conservation status *global*	77%
Level of exploitation	76%
Habitat type	74%
General ecology	73%
Management practice	73%
Maps	73%
Conservation status *national*	72%
Protected areas	72%
Indication of species abundance	70%
Conservation information *in situ*	69%
Vernacular name	66%
Growth & regeneration	64%
Species description	64%
National legislation	55%
Conservation information *ex situ*	52%
Species identification	50%
Certified timber sources	50%
Wood properties	43%

The range of information categories being considered lead to a number of possible questions with which the informa service could assist:

- Is the species of conservation concern?
- Has the species been evaluated for the new IUCN threat categories?
- If so, what is the category and criteria by which it was assigned?
- What information is available to support the threat category?
- What is the distribution of the species?
- What are the uses of the species?
- Is the use of a species sustainable?
- What are the current levels of trade of the species?
- What are the types, levels and values of use that are being made of a species?
- Is the species legally protected - regionally, nationally, internationally?
- What are the administrative and legislative structures pertaining to the conservation/sustainable use/manageme tree species in any particular context?
- What are the implications of specified human actions and/or natural phenomena?
- What current actions are being taken to manage tree species, and how effective are they in achieving objectives?
- Which individual or organisation holds, has access to, or can generate the data or information relevant to a spe issue?

In addition to identifying key questions, the objectives of collecting the data were also explored. Information ma required for a range of purposes, such as:

- To support policy development
- To support strategic decisions
- To develop effective legislation (for example, CITES)
- To be able to implement legislation
- To evaluate, compare and thus help determine priorities
- To identify what natural resources currently exist and where
- To identify where resources exist together (especially where in conflict; e.g. minerals and high biodiversity)
- To build scenarios of possible consequences of management actions
- To identify what changes are taking place, why and how fast
- To identify what actions will slow or reverse adverse changes
- To implement conservation measures
- To comply with international obligations

From the range of information categories, and the associated questions, certain data will be required and the follo broad categories of data were considered:

- Taxonomic (scientific names, authority, synonyms, common names)
- Distribution (point records, polygons, inferred)
- Conservation status (criteria and supporting references)
- Local Use
- Economic (trade figures, commercial use, level of exploitation)
- Ecology
- Habitat type
- Threats
- Legal structures
- Source of knowledge and expertise
- Links to other systems (Protected areas, legislation (ELC), land use

Through the views expressed in the questionnaire, discussion at the workshop in December 1995 and follo meetings with a number of organisations, including FAO and IPGRI, and the two SSC specialist Groups, Conifer Temperate and Broadleaved Trees, a **data collection form** (appendix A) was designed.

The data requested in the form can be summarised as follows:

Section 1: **Nomenclature and occurrence**

Section 2: **Conservation status**, including revised global IUCN threat category and criteria, threats and conservation measures

Section 3: **Uses and Ecology**, including habitat type

This form was designed to collect species information from regional and taxonomic experts. Existing details of species name and distribution are provided from the WCMC Plants Database, and the partially completed forms are distributed to experts who are asked to assign the new IUCN red list categories and complete the form with details of species conservation status, uses, habitat and ecology. By providing a framework for data collection these forms greatly assisted the collection of information, facilitated the use of standards and ensured that the information could easily be entered into the database.

Several thousand of these forms have already been completed by members of the SSC Specialist Groups for Conifers and Temperate Broadleaved Trees and by regional experts in Africa, Asia and America.

The data collection form provides a framework for a number of data categories. These have been refined and extended to cover other information categories as the project progressed, and importantly, adapted in response to suggestions from ongoing consultation and collaboration with other organisations. One example of collaboration is illustrated by the Medicinal Plants Specialist Group, who have made some very useful comments on the data collection form and, in particular, how to make the data more relevant to sustainable use issues. It is hoped that this type of liaison will continue throughout the project and act as a trigger for the development of new collaborative initiatives.

Functional specification and prototyping

On the basis of the questionnaire results, and ongoing discussions with other organisations and SSC specialist groups, a functional specification of the desired information system was developed. In addition to this document, a prototype was developed. A prototype promotes an interactive approach to development, and ensures that the proposed functioning system correctly addresses the requirements of the users. The development of a small version of the system, built quickly and inexpensively, allowed discussion of the potential capabilities, and identified, at an early stage, areas requiring refinement.

The prototype database provided the first draft operational database, and was focused on providing standard database functionality for the information being collected through the data collection form. It was developed using Microsoft® Foxpro® 2.6 for Windows™. The decision for using this relational database management system to develop the prototype was based upon the ease and speed of development offered by the product, and did not preclude the use of a different product for the final version. The prototype provided the basis for review and comment from interested parties, and was refined as part of the ongoing development.

During this phase, the following were documented and produced:

- Precise information needs of intended users
- Conceptual and logical data models
- Process and data flow diagrams
- Description of all desired information products
- Inventory of key data holdings and information systems; this will involve the completion of the meta-database
- Functioning prototype

System Design and Development

In the system design phase, the functional requirements resulting from the previous phase were translated system specifications. The descriptions of data and processes became the basis for database structures. and definition of procedures and programs. The inter-relationships of the modules and the transfer of data between were also specified. It was at this phase that final decisions were taken on the overall system architecture hardware and software to be used. With on-going advances in technology, it was important that the database implemented in industrial strength development tools, which would enable suitable upgrade paths as and when technologies become available. The choice of which software tool to use was further influenced by the ability to with other applications, including mapping tools (GIS). In addition, the system is required to run in single-user multi-user environments, and to be designed for the latest generation of Windows based network environm especially Windows '95 and Windows NT. With many users now familiar with Windows-based products database needed to be simple to use and intuitive in operation, as well as conforming to recognised Win standards. In addition, a Windows-style searchable help system was to be developed.

Taking these and other factors into consideration, the decision was taken to implement the system in Micros Visual Basic and Access.

The recommended basic specification is:

- 486 DX4 or higher
- Windows 95, Windows NT 3.5 or higher
- 16 MB RAM

The prototype database developed in the earlier phase provided invaluable guidance for this phase, and was used starting point for the development of the functioning system. During design, although the major effort came fro developers, continued user involvement and input was maintained to ensure that the evolving system reflected co their needs.

The design specification defined the development tasks to be undertaken during the development phase. In this again the major effort was from the developers, with essential input and guidance from users. The output of this was a functioning system, which had been thoroughly tested during development and met the users' requirements.

Implementation and Operation

During these phases, the system was tested in an operational environment to ensure that it provided the ex functionality. Essentially, the functionality of the system was checked against the original user requireme documented in the functional specification. Once approved, the system moved into an operational phase, whic continue for its lifetime. This will involve continual maintenance of the system, which may involve refineme minor modification to adapt to changing requirements.

Information Products

Information products are an essential part of the Tree Conservation Database and a number of standard outpu available:

- list-type reports, offering a range of formats and selection criteria
- fact-sheet type summaries, offering a range of formats and selection criteria
-

An example report is given in Appendix B; species summary and data sources.

To provide flexibility within the database, there is comprehensive user-defined reporting capabilities, and records can be selected using a comprehensive range of criteria, including:

- Higher taxa (family/genus)
- Geographic (region, country, BRU)
- IUCN Threat Category
- Level of endemism
- Habitat
- Threat type
- Use type

Output format

A range of report outputs are offered. This way, information can be readily used in other applications, such as word processors and spreadsheets. In addition to printing directly, reports may be written to file in the following formats:

- ASCII, plain text
- ASCII, tab delimited
- ASCII, comma delimited
- dBase format (dbf)
- Hyper-text (html)
- Rich text format (rtf)

Quality Control

The Tree Conservation Database will hold information from a wide range of experts. The information gathered through the project therefore represents an accurate evaluation of a species, based on available information sources. New data, or differing interpretations, may lead to a revision of the assessment of conservation status. By identifying all data sources, and allowing others to consult the same material, and possibly bring new documents into consideration, the evaluation process is open, and is available for independent scrutiny. This is essential, as the assessments and recommendations are only accurate within the bounds of the data that were available during the data collection phase. Quality control will be an ongoing *ad hoc* process, potentially complimented by more thorough structured reviews.

Future developments

The evaluation of the conservation status of species and the collation of data are an ongoing process. The database provides a tool by which to achieve this. Areas of potential development include:

- Upgrades to the database and information products in line with feedback from users
- Species mapping facilities
- Inclusion of annual trade data
- Using conservation status to identify potential candidate species for inclusion on the CITES appendices.
- Refinement of the habitat criteria, and linking to forest cover GIS layers
- Re-evaluations of species

Summary

The information management component of the Tree Conservation Information Service will provide practical solutions to **data collection**, **data maintenance** and **information dissemination**. The development of a data collection form and the use of appropriate standards will promote consistency and guide the collection of data. Data storage will be served by an operational database, providing standard database functionality together with a comprehensive set of reporting tools. A prototype database has been developed, and will serve as a focal point for discussion, and will also guide the development phase. Information presentation will involve a number of media, and will certainly involve establish World Wide Web site for the project. Web pages will initially give project information, the list of temperate threat tree species, and links to other related web sites. To serve those without Internet connection, other forms of present will be considered. In addition the Tree Conservation Information Service will aim to make available information o following:

- Comprehensive information on species of conservation concern (including maps)
- Material on sustainable use
- Details of legislation
- Collection methodologies
- Information management guidelines
- Application of the new threat categories

To make a significant contribution to the conservation and sustainable use of tree species, the information servic aim to address the following key points:

- Make information available to individuals and organisations at all levels
- Protect custodians' legitimate interests
- Ensure information is available in a timely manner
- Provide information in a form that is readily understood and easily communicated
- Ensure information is accompanied by an audit trail so all underlying data and intermediate products c scrutinised and independently reviewed
- Aid the development of regional capacity for information management
- Promote data exchange
- Develop collaborative links with other organisations
- Be responsive and flexible

Appendix A - Data Collection Form (reduced in size)

Section 1 - Nomenclature and Occurrence	
Scientific name	
Other scientific name(s) in current use	
Family	
Common names	
Distribution at BRU* level (*Basic Recording Unit)	
Global IUCN threat category	
Uses	
Is the taxonomy above correct?	
Is the distribution complete? If not, in which additional countries or states can the species be found?	
If the species distribution is confined to a particular area? (e.g. a mountain range) Please give the details	

Section 2 – Conservation Status	
Is this species of conservation concern in any part of its range? Please specify where	☐ Yes ☐ No
Revised global IUCN threat category (1994)	☐ EX ☐ EW ☐ CR ☐ EN ☐ VU ☐ LRcd ☐ LRnt ☐ LRlc ☐ DD ☐ NE
Criteria (e.g A.1.(d) etc.)	
Comment Please use this space to sum up the status of the species. Please include any information about the **population size or decline, restricted range, ecological or taxonomic uniqueness, characteristics of regeneration or reproductive strategy**, and any indications of the fragility of the state of the species, especially where **data are insufficient to assign a threat category**	
Threats If multiple threats please indicate order of concern - use 1 for the most serious threat(s)	[ ] Felling [ ] Grazing [ ] Exploitation of plant parts [ ] Fire [ ] Natural Disaster [ ] Pollution [ ] Pests & Diseases [ ] Invasive species [ ] Lack of dispersal/pollination agents [ ] Seed Predation [ ] Poor regeneration for unknown reasons [ ] Mining [ ] Tourism [ ] Industrial development [ ] Agriculture [ ] Forestry [ ] Expansion of human habitation [ ] Decline in soil water content [ ] Other major threat:
Conservation measures Please give the details of any on-going conservation activities, including **legal measures, presence in protected areas, management practices and *ex situ* conservation**, especially where the species is categorised as LRcd	

Section 3 - Uses and Ecology						
Brief species description						
****Uses**	Use	Part	Level	Use	Part	Level
Please enter in the columns provided the appropriate letter and number corresponding to the part used and the level exploitation respectively Unspecified, Entire plant, SeeDling, Gall, STem, Bark, Leaf, Inflorescence, Fruit, Seed, EXudate, Root 1 Major International trade 2 Minor International trade (LKS) 3 National or Local trade 4 Local use only	**EXAMPLE** Medicine Timber Fuel Food Food additive Animal food Invertebrate food Bee plant Vertebrate poison	T,B	2,2	Non-vertebrate poison Gum, resin, oil etc Fibre Gene source Social use Environmental use Ornamental Other (please specify)		
*****Habitat Type** Please tick whichever boxes describe the species natural habitat most appropriately.	☐ Closed forest ☐ Open forest ☐ Scrub ☐ Herbaceous vegetation ☐ Sparsely vegetated	☐ Lowland ☐ Submontane ☐ Montane ☐ Alpine	☐ Broadleaved ☐ Coniferous ☐ Mixed	☐ Cloud forest ☐ Mangrove ☐ Swamp forest ☐ Wetland ☐ Sclerophyllous ☐ Anthropic landscape		
	☐ Temperate ☐ Tropical	☐ Seasonal ☐ Non-seasonal	☐ Moist ☐ Dry			
Please define habitat type further if necessary						
Species associations						
Regeneration guild	☐ Early pioneer ☐ Late secondary ☐ Primary					
Spatial distribution	☐ Abundant ☐ Scattered ☐ Clumped					
Obligative species dependencies						
Dispersal/pollination agents						
Altitudinal range in metres	Min		Max			
Status of the species in cultivation	☐ Plantation grown ☐ Widely cultivated ☐ Small scale ☐ None					
Relevant references Please cite any references used to complete this form						

Please indicate the uses of species only when relevant to human use e.g. only those plants eaten by invertebrates such as silkworms, lac insects etc. should be i as **invertebrate food. **Bee plants** are those which are used for honey production. **Animal food** refers to those plants eaten by domesticated animals. **Environme** refers to shade trees, windbreaks and trees used in erosion control etc. Examples of plants of **social use** are narcotics, contraceptives, plants of ritual significance
***Closed forest consists of trees with interlocking crowns. **Open forest** (woodland) contains trees with crowns not interlocking. **Herbaceous vegetation** is dc by non-woody plants with scattered trees.

Your name	Date

Appendix B1 – example Species Report

Quercus acerifolia
Fagaceae EN
B1+2c, C2b
USA (Arkansas)
Three localities of this species are known, two of them being recently discovered, in open glades and shrubland in central west Arkansas. The populations are small, each numbering less than 500, but stable and contained within a National Forest. Data accumulated by Stoynoff and Hess support the contention that the taxon is a species and not a subspecies of *Q.shumardii*.
Assessor: Unspecified
Refs: 8470, 10353

Quercus albocinta
Fagaceae LR/lc
Mexico (Chihuahua, Sinaloa, Sonora)
Assessor: Unspecified
Refs: 7538, 9653, 11715

Quercus arkansana
Fagaceae VU D2
USA (Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, Texas)
Less than five localities of this woodland species are known to exist. Populations are thought to be declining because of habitat destruction caused by grazing and conversion to farmland.
Assessor: Unspecified

Quercus aucheri
Fagaceae NE
Greece, Turkey
A small tree very similar to Q.coccifera. It grows in the Aegean region on the Greek Islands and in Anatolia in Turkey. Populations are localised and isolated.
Assessor: Unspecified
Refs: 3489, 4863, 7538

Quercus* x *basaseachicensis
Fagaceae EN D1
Mexico (Chihuahua, Durango)
A hybrid of Q.rugosa and Q.depressipes known from 4 sites in Chihuahua and 1 in Durango in submontane woodland or scrub. The populations are isolated and none are believed to be large.
Assessor: Unspecified
Refs: 7538, 9653

Quercus benthamii
Fagaceae VU A1c
Guatemala, Mexico (Chiapas, Oaxaca)
Until the taxonomy of Central American specimens is confirmed the exact range of this species cannot be consolidated but could extend to southern parts of Central America. The rate of destruction of the moist forest habitat in the last few decades qualifies the species as threatened.
Assessor: Unspecified
Refs: 7980, 9653

Quercus brandegeei
Fagaceae EN
B1+2e
Mexico (Baja California)
The species occurs in low density in a xeric habitat in the foothills of the Sierra Lazaro. The area is accessible and subject to grazing pressure. Regeneration has not been observed in recent years.
Assessor: Unspecified
Refs: 7538, 9653, 12945

Quercus brenesii
Fagaceae DD
Costa Rica
A taxonomically doubtful species apparently endemic to the department of Alajuela.
Assessor: Unspecified
Refs: 6678, 7538, 7980

Quercus buckleyi
Fagaceae NE
USA (Oklahoma, Texas)
A tree confined to scrub on Edward's Plateau.
Assessor: Unspecified
Refs: 3786, 7538, 10353

Quercus bumelioides
Fagaceae VU A1c
Costa Rica, Guatemala, Honduras, Nicaragua, Panama
The montane moist forest habitat of this species has suffered serious declines in past decades. The tree can grow to large proportions and has obvious value as a timber tree.
Assessor: Unspecified
Refs: 730, 7538, 11715

Quercus cedrosensis
Fagaceae VU D2
Mexico (Baja California)
A species restricted to a specialised sclerophyllous habitat at lowland to montane altitudes. Cedros Island suffers from overgrazing by goats. More information on the regeneration of this species may qualify it for a status of endangered.
Assessor: Unspecified
Refs: 7538, 8470, 12945

Quercus cerrioides
Fagaceae LR/cd
Spain
The taxonomic status of this localised oak is uncertain. It may be a hybrid. The taxon occurs in dry montane forest in Catalonia, Aragon, Mallorca, La Rioja and Navarra, possibly extending into France. Fire, forest management activities and hybridisation pose threats to the taxon. 21332
Assessor: Unspecified
Refs: 5287, 7222, 7741

Quercus coahuilensis
Fagaceae DD
Mexico (Coahuila)
It is suspected the species will prove to be threatened when the area of occupancy is calculated taking into account the altitudinal ran of the species.
Assessor: Unspecified
Refs: 7538

Appendix B1 – example Data Sources Report

412 Muller, C.H. 1979. *Quercus deliquescens*, a new species from Chihuahua, Mexico. *Phytologia* 42(2): 289-291.

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5988 U.S. Department of the Interior. Fish and Wildlife Service. 1985. Review of plant taxa for listing as endangered or threatened species; notice of review. *Federal Register* 50(188): 39526-39584.

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7538 Govaerts, Rafael. 1994. Checklist of *Quercus* species world wide. (unpublished).

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8470 Nixon, Kevin. 1996. Comments in an email from Allen Coombes to Sara Oldfield concerning the list of threatened *Quercus*.

9653 Nixon, K., W. Hess, A. Coombes, & M. Rodriguez. 1996. Discussions on the status of *Quercus* species in the Americas. Regional workshop for the Conservation and Sustainable Management of Trees project.

10353 Hess, William. 1996. Data collection forms for *Quercus* species

ANNEX 4

Working Document 2

Draft Charlotte Jenkins, WCMC

Guidelines for the application of the 1994 IUCN Red List Categories to trees

These guidelines are for use in conjunction with the red pamphlet *IUCN Red List Categories (1994)*. They are intended to provide practical advice and examples of the application of the categories specifically to tree species. IUCN categories of threat have been in use for over thirty years. The 1994 revision represents the first step to make the categories more quantitative, objective and equable over all taxa (except for microorganisms). As from now, a category can only be assigned to a species if one or more of a choice of five criteria apply.

The revised IUCN categories are being applied to tree species as part of the *Conservation and sustainable management of trees* project being carried out by the World Conservation Monitoring Centre in collaboration with the IUCN Species Survival Commission. Over 15000 tree species have already been evaluated by various experts using different methods and sources, some of which are outlined below. It is the aim of the project that all tree species of global conservation concern will be evaluated by the end of 1997 and it is envisaged that these evaluations will be added to and updated as further information becomes available.

Information sources for evaluating tree species

In order to qualify for a category of threat, evidence is needed to demonstrate that a species is experiencing, to various degrees, one of the following:

Criterion A. Population is seriously declining or is expected to decline at a specified rate
Criterion B. Population is localised, fragmented and declining at an unspecified rate
Criterion C. Population is small and declining, and either fragmented or localised
Criterion D. Population is very small or localised, but stable

Information on species conservation status and threats, although more commonly available than in the past, remains scarce and patchy for many countries. Taxonomists, or their published floras and taxonomic revisions, provide essential baseline data on taxonomy, nomenclature, species distribution, habitat type and sometimes additional information. In many cases this is the sole source of information on rare and restricted-range species.

It is possible, by examining the geographical and altitudinal ranges, the location and habitat of species, to make preliminary evaluations of their status. The numbers of collections in herbaria and the date they were made can help to indicate the rarity of the species. Species which are known from less than five specified locations can technically qualify for a threat category, **VU D2**. Frequently, species which are rarely collected are overlooked or from areas or habitats that are rarely visited. It is up to the assessor to judge whether this is likely to be the case. It is important to record these poorly known species even though they may, ultimately be downgraded.

Relevant data may also be obtained from forest inventorying and mapping. Rarely do restricted-range and uncommon species appear in these datasets but these data can indirectly indicate population declines because of habitat loss. An excerpt from Will Hawthorne's report in appendix 2 gives an example of this type of evaluation.

GIS (Geographical Information System) is a powerful tool to store and analyse species distribution information in a standard way. Where species' point localities can be stored in a GIS, data can be very successfully manipulated to assess whether their **AOO** (Area of Occupancy) or **EOO** (Extent of Occurrence) are within the limits set by the B criterion and also by the criterion for **VU D2**. David DuPuy and Jonathan Hughes have evaluated a subset of Madagascan Legumes in this way.

It is important, initially, to note:

- The categories only apply at a global level to the entire species population.
- The categories can be applied to any taxonomic level, including infra-specific taxa, microspecies and natural hybrids.
- It is not expected that all the criteria will be appropriate for any one species. Different criteria apply to different species according to the biology and habit of the taxon.
- Exact population figures or species ranges are not essential to apply categories. It is possible to infer or project into the future the effects of current and potential threats. The situation known in a major part of range may also be extrapolated to assess the overall status of the species if it is unknown elsewhere. Population declines can also be estimated from habitat loss or levels of trade.
- It is essential that the criterion and subcriterion applied are recorded with the category of threat (e.g. VU A1c,d). Lower risk species should be recorded as LRcd, LRnt or LRlc.
- The B criterion should only be used when two of the subcriteria are fulfilled.
- The category "Rare" from the previous version of the IUCN categories of threat no longer exists. Species which are naturally rare can only be assigned a category of threat by having less than 5 localities (**VU D2**) or by showing signs of some population decline or loss of habitat.
- The most serious category applicable should be assigned to the taxon.

The definitions interpreted for tree species

1. **Mature individuals** ("number of individuals known, estimated or inferred to be capable of reproduction"). The capability of reproduction in tree species varies widely and vaguely according to age/size class of individuals (e.g. *Bailonella toxisperma* first flowers at 50-70 years and doesn't fruit until roughly twenty years later, conversely *Sequoiadendron giganteum* may produce seed at less than 20 years of age and continue to do so for 3000 years). We suggest 80% of individuals in any age/class should be capable of fruiting in order to call them "mature". If little is known about age at fruiting, mature individuals should be counted as those of a typical size; e.g. canopy species should be canopy height etc. In addition, individuals should be reproductively effective. Individuals which are unable to regenerate or those hampered by their isolation or by inbalanced sex ratios may be discounted from population estimates. Clones of apomictic and vegetatively reproducing species count as individuals.

2. **Generation time** ("average age of parents in the population"). The only practicable calculation for generation time is to simply use the age of species at maturity (see above). Where there is no information we suggest the following estimations: 50 years for most tree species, 10-20 for pioneer species or small trees, 100 years or more for slow-growing trees.

3. **Population** ("the total number of mature individuals"). These estimates should include only mature individuals. For most non-pioneer species population estimates should be a fraction of the total population number.

4. **Continuing decline** ("a recent, current or projected future decline...liable to continue unless remedial measures are taken"). Declines could be regarded in the context of the species generation time. If dramatic declines in the past have since halted for the duration of a generation then it does not seem appropriate to say the species is suffering from continuing declines, unless, of course, there are strong prospects that further declines will take place in the next generation. If the establishment of Forest Reserves or National Parks is helping to prevent declines but is not a safeguard against future declines it is quite appropriate to assign a category of threat.

4. **Extreme fluctuations** ("in a number of taxa where population size or distribution area varies widely, rapidly and frequently, typically with a variation greater than one order of magnitude"). Tree species are unlikely to experience extreme fluctuations. Therefore in order to qualify a species as threatened according to the B criterion the population must be fragmented or in ten or fewer locations and also declining or likely to decline.

5. **Extent of occurrence (EOO)** ("the area contained within the shortest continuous imaginary boundary which...encompasses all the known, inferred or projected sites of present occurrence of a taxon, excluding cases of vagrancy"). In tropical regions, if the total population or the sum of disjunct subpopulations takes up the equivalent of approximately 2 degree square then this should qualify the species as having an **EOO** less than 20,000km². In more temperate latitudes around 2.5 degree squares can be occupied. **Endangered** and **Critically endangered** species should be assessed at a finer scale, perhaps on a 1:1,000,000 map using grid squares of 50km x 50km. Good examples of disjunct subpopulations occur where a species is distributed in upland vegetation on separate mountains or where species occur on separate islands. More difficult to discern as a disjunct distribution is where a species occurs in a number of isolated forest patches. If gene flow is impossible between them then they should be considered as disjunct.

6. **Area of occupancy (AOO)** ("smallest area essential at any stage to the survival of existing populations"). This is intended to be a more accurate figure for the area to which species are confined. The estimate should take into account the habitat requirements of the species, whether this is a specific canopy height, species composition or microclimatic condition. **AOO** should be measured on a scale roughly ten times finer than that used to measure **EOO**. For more endangered species grids of 5 X 5 km and maps of 1:100,000 would be useful.

7. **Subpopulation** ("distinct groups in the population between which there is little exchange...one successful migrant..per year"). In the case of tree species we may define a subpopulation as an isolated population which experiences insignificant seed or pollen migration from other populations within a generation time.

8. **Extinct in the wild** ("exhaustive surveys in known and/or expected habitat...throughout its historic range have failed to record an individual..over a time frame appropriate to the taxon's life cycle and life form"). There is no suitable time frame in which to judge a tree species to be extinct, especially where few exhaustive surveys have been carried out to recover it. We suggest if its habitat has disappeared or the site has been visited by botanists then the species can be considered as Extinct. If the area is restricted then at least **VU D2** is appropriate. Where the species is taxonomically poorly determined then the species status should be considered **Data Deficient**.

The criteria applied to tree species

Criterion A

This criterion is useful in applying the categories to species which **are not localised but whose habitat or population has been heavily exploited or degraded** or which are **regenerating poorly** and also for species which are **sparsely distributed and declining.**

How to make estimates of population decline in the last 100+ years. Three generations of a tree species may span a millennium. Population declines are rarely supported by direct evidence but are more commonly inferred from habitat loss and in most cases the changes in habitat or population declines which have occurred over the course of the twentieth century are the most appropriate to take into account.

Should species which are widespread but have experienced a general decline of 20% because of habitat destruction be Vulnerable? Many tropical forest species have experienced a 20% decline in their natural habitat over the past 3 generations. Some of these species, however, do have a wide ecological tolerance (e.g. *Baikaea plurijuga*). The most likely candidates for this criterion are those which are strictly confined to declining habitat types and not able to regenerate outside of them, or species which are specifically and heavily exploited. A ceiling on the acceptable extent of the species range may be incorporated into criterion A.

Where species are regenerating poorly. If regeneration is known to be poor then the A criterion could be applied by using projected decline. Will individuals replace themselves in the next three generations? If the species is long living or its regeneration depends on stochastic events it will be hard and not advisable to projec a decline. Alternatively, criteria C or D may apply here.

Where species have experienced a genetic decline. In many cases tree species have suffered a tremendous genetic decline or loss of fitness in the population where the larger and fitter individuals have been harvested. I this is a significant proportion (20% or more) of the mature population then the taxon can be registered as threatened under criterion A.

Criterion B

This criterion is useful in order to assign categories to threatened species which are **regionally endemic o confined to a particular location or habitat**. Much of the necessary discussion concerning these criteria can be found under the definitions for **AOO, EOO, Extreme fluctuations** and **Continuing** decline. Incidentally, it i expected that many threatened tropical tree species will be assigned under this criterion.

Criteria C & D

These criteria can only be used where **population numbers or locations, from which the species is known are small or highly restricted**. It is also possible to assign these criteria **to species which are rare and no regenerating.**

Where species are known only from type localities or less than five locations. A species can technically b assigned a category of **Vulnerable D2** on this information alone. If there are doubts as to whether the populatio still exists a more serious threat category should be assigned by assuming a decline and that the extent o occurrence is small, **EN B1+2c, CR B1+2c**, or the population size is less than 10,000 mature individuals, **EN C1, C2a or b or CR C1, C2a or b.** The assessor may alternatively choose to assume the species is mor widespread than evidence suggests and assign a category of **Lower Risk** or **DD**.

Where species are not regenerating. It is embedded in the definition of "mature individuals" that individual should be effective at reproducing. Individuals which produce offspring which are not viable should not b counted in the population estimate. Therefore population estimates may be made by taking reasonable estimate of the proportion of the population which are reproducing effectively, the population density and the area o occupancy.

Where species are sparsely distributed. Where population density is low or populations do not occur in easil recognisable clumps, from which AOO can be estimated, the only way to denote the species as threatened i through estimating population declines (criterion A) or population sizes (criteria C or D).

Criterion E

Few population viability assessments (PVA) have been carried out for tree species. We would be pleased to hea of any.

Category Lower Risk, conservation dependent (LRcd)

When should presence in protected areas be used as a means for applying LRcd? In some cases, if protecte area boundaries were to be taken away the tree species inside would rapidly be wiped out and, where the ensuin declines in species population are significant, the species would register as threatened. If the current status of th species does not qualify as threatened, **LRcd** is the appropriate category to use in these cases. The effectivenes of protected areas in preventing declines in species populations is sometimes questionable or unknown. In thes cases, species should be allocated a category of **LRnt. All species which can satisfy the criteria for a threa category should be assigned one whether protected or not.**

Category Lower Risk, near threatened (LRnt)

This category should contain species which narrowly miss the criteria for threatened species. It is also useful for species which appear not to suffer from serious threats but would quickly qualify as threatened if unforeseen pests, exploitation or habitat loss were to occur.

Category Lower Risk, least concern (LRlc)

This is the appropriate categorisation for the species recorded as "not threatened" under the old red list category system.

Category Data Deficient (DD)

This category is useful to apply to species which are taxonomically dubious. As long as the name is published, however, a threat category can be applied. It must be emphasized that data are largely deficient for a wholly accurate evaluation of the status of most tree species. Species which are obviously threatened but to an unknown degree can still be given one of the threat categories. The evaluations are not permanent and should be updated where new information indicates a change in category is appropriate. **DD** is most useful as a last measure.

Case Studies

The examples of species evaluations below are provided by regional and taxonomic experts. They are intended to help illustrate how assessments for tree species may be based on limited information. The IUCN Species Survival Commission will be insisting on the documentation of each species evaluation in the future. The supporting comments here are an important step towards this aim and are stored, along with the IUCN category, in the *Tree Conservation Information Service.*

Species for which there is limited information

Engelhardtia mendalomensis – **VU D2** is an uncommon tree which is known only from the type specimen collected in primary mixed dipterocarp forest in the Mendalom Forest Reserve, Sarawak.

Cynometra filifera - **CR A2, B1 & 2(a-e)** is locally dominant in a patch of Tanzanian forest of about 0.25ha. It is only known elsewhere from a forest, 40km away, which has not been visited for 40 years and is believed no longer to exist.

Nectandra herrerae - **EN B1+2c** was discovered near the train station of Aguas Calientes in Machu Picchu Historical Sanctuary in Peru. The area is heavily visited by tourists on foot and by train. The town is rapidly expanding and there is frequent burning of the forests in surrounding areas.

Nothaphoebe javanica – **CR C2b, D1** is known from a single specimen collected in Mt. Payung in Ujong Kulon National Park, Java. It is not known whether the species is now extinct.

Quercus uxoris - **VU A1c** occurs in Colima, Guerrero and Jalisco. Population declines are not documented but the species occurrence in an area which has experienced dramatic forest destruction qualifies the species as at least vulnerable.

Extinct species

Thuja sutchuenensis - **EX** was collected from a site, where it was possibly planted, near a temple in Sichuan in 1892. No-one has collected a wild specimen since, despite botanical visits to the area.

Chrysophyllum januariense - **EX** was once collected in Rio de Janeiro in the Laranjeiras forest, which has since been cleared.

A species displaying poor regeneration

Heritiera longipetiolata - **VU C1** consists of about 1000 trees on Guam, several hundred on Tinian and less than 100 on Saipan. Lack of regeneration on Guam is the major problem there. This may be caused by seed or seedling predation by ungulates or crabs. Habitat loss is a minor problem currently and the species status is not especially fragile. If the lack of regeneration is found to be a significant problem this species could easily qualify for a category of **EN**.

Mountain top or isolated species

Quercus X macdonaldii - **VU D2** is restricted to a few scrubby localities in Santa Rosa, Santa Catalina and Santa Cruz Islands. Control of grazing and the removal of sheep has helped oak regeneration on Santa Cruz Island.

Rhododendron protistum var. *giganteum* – **VU D2** is known from a population of several dozen trees restricted to an area of submontane evergreen broadleaved forest in the Gaoligong Mts. in south-west Yunnan. The designation of the area as a nature reserve is believed to help in protecting this flamboyant variety.

Widespread timber species

Amburana acreana - **VU A1d+2d** formerly abundant in terra firme forest, this species has been heavily exploited for its wood which is used for making luxury furniture. In Rondônia the number of sawmills, which process principally *A.acreana*, has increased 8 fold between 1975 and 1982.

Entandrophragma cylindricum - **VU A1cd** is a major source of African mahogany. It is scattered in semi-deciduous forest and heavily exploited throughout tropical Africa. Genetic erosion has occurred because of the serious depletion of mature individuals from many populations. Compared to other *Entandrophragma* species this tree can occur in drier habitats, including abandoned fields, but it does not respond well after burning and growth rates are amongst the slowest in the genus. Protected populations and felling limits exist in various countries.

Pseudotsuga sinensis var. sinensis – **VU A1cd** is widespread in southern China and Taiwan, but scattered as isolated individuals or in small stands. It provides an important timber, which is extensively extracted where accessible. Populations remain primarily on mountain ridges in mixed submontane forest.

Lower Risk near threatened species

Agathis vitiensis - **LRnt** is a timber species endemic to Fiji. It is found in low densities but is relatively unthreatened. If logging activities intensify in the area then the status of this species will become a concern.

Micropholis gnaphaloclados - **LRnt** is a tree of submontane cerrado, caatinga and rocky outcrops. It ranges from Pernambuco to Mato Grosso in Brazil but the populations appear to be highly fragmented.

Bretschneidera sinensis – **LRnt** is uncommon and thought to be getting rarer over its range throughout south-east China extending into Lai Chau in Viet Nam and Taibei in Taiwan. The Vietnamese populations are considered to be threatened. It occurs in low to middle elevation forest in ravines and by streams.

Lower Risk least concern taxa

Dacrycarpus expansus - **LRlc** is locally common or in pure or co-dominant stands in disturbed areas and on the edge of tree fern grassland in Irian Jaya and Papua New Guinea.

Lower Risk conservation dependent taxon

Pinus balfouriana ssp. balfouriana - **LRcd** is known from a few isolated subalpine populations on the Klamath Mts. within USDA National Forest lands. The trees are extremely slow growing and populations may be susceptible to fire and overgrazing by wildlife. Old trees are protected from being cut or damaged.

Geissanthus vanderwerfii - **LRcd** is endemic to the south-central Andes of Ecuador where it occurs in open elfin forest or scrub above 2200m. It is currently not believed to be threatened. It forms a conspicuous element of cloud forest and a sizeable population occurs in a remote national park.

Prunus kinabaluensis – **LRcd** is known from Mt. Kinabalu in Sabah, but has also recently been discovered on Luzon Island in the Philippines. The species occurs in Mt. Kinabalu National Park and is well protected.

Data Deficient species

Monodora junodii var macrantha - **DD** is endemic to northern Mozambique, where war and its aftermath has prevented any kind of field work. The taxonomy, extent of the species range and current status needs to be confirmed.

Solanum betaceum - **DD.** The native range of the tamarillo tree is not resolved. It is thought by some to be extinct. Putative wild populations are small, occurring in restricted areas in Argentina and Bolivia. It is widely cultivated in the Andes, Europe, Africa and New Zealand. Wild representatives are important for the genetic improvement and understanding of cultivated forms.

Abies chengii – **DD**. Populations in the wild remain unknown. The species was described from a specimen in cultivation at Hilliers, U.K. Repeated attempts to discover the wild population have failed.

Appendix 1 Key to the application of red list categories to tree species

1

Can the species population or habitat be said to experience declines to any degree, in the past, present or future?	**Go to 2**
Is the species population and habitat in a completely stable state?	**Go to 6**

2

Has or will the global population experience declines of 20% or more because of poor regeneration, exploitation, habitat degradation or loss, or any other reason?[1] (N.B.Geographically confined or small populations may also qualify for other criteria, continue to 3.)	
20% habitat/species declines	**Assign VU A1 or 2(a-e)**
50% habitat/species declines	**EN A1 or 2(a-e)**
80% habitat/species declines	**CR A1 or 2(a-e)**
Is the global population decline unqualified or less than 20%?	**Go to 3**

3

Is the global population known or likely to contain less than 10,000 mature individuals? (N.B. Geographically confined species may also qualify the B criterion, continue to 5.)	**Go to 4**
Is the global population unknown or likely to contain more than 10,000 mature individuals?	**Go to 5**

[1] It is assumed that three generations is greater than 10 years and is at least 100 years

4

Is the global population experiencing declines of 10% or more and does it contain no more than 10,000 mature individuals?	Assign **VU C1**
or 2500 mature individuals + 20% decline?	**EN C1**
or 250 mature individuals + 25% decline?	**CR C1**
Is the global population fragmented and containing no more than 10,000 mature individuals + subpopulations of less than 1000 mature individuals?	Assign **VU C2a**
or 2500 mature individuals + subpopulations of less than 250 mature individuals?	**EN C2a**
or 250 mature individuals + subpopulations of less than 50 mature individuals?	**CR C2a**
Is the species only known from one population containing no more than10,000 mature individuals?	Assign **VU C2b**
or 2500 mature individuals?	**EN C2b**
or 250 mature individuals?	**CR C2b**
Is the species none of the above?	**Go to 5**

5

Does the species exend over a range less than 20,000km² and can it be assumed that the species is known from less than ten locations or its distribution is fragmented?[2]	
Extent of Occurrence 20,000km²	Assign **VU B1&2(a-e)**
Extent of Occurrence 5000km², fragmented or 5 or less locations	**EN B1&2(a-e)**
Extent of Occurrence 100km², fragmented or just 1 location	**CR B1&2(a-e)**
Does the species extend over a range greater than 20,000km² or can the assumptions above not be made?	**Go to 7**

[2] If an accurate measure of the actual species **Area of Occupancy** (AOO) can be made refer to the IUCN red list categories booklet.

6

Is the global population known or likely to contain less than 1000 mature individuals in the wild? Less than 1000 mature individuals	**Assign VU D1**
Less than 250 mature individuals	**EN D1**
Less than 50 mature individuals	**CR D1**
Is the global population unknown or likely to be more than 1000 mature indivduals in the wild?	**Go to 7**

7

Is the species only known from less than five localities or from an area less than 100km²?	**Go to 8**
Is the species known from more than five localities?	**Go to 9**

8

Technically it is correct for these species to be assigned a threat category. It is sometimes likely that individuals of the species are overlooked in the field and should be found to be more widespread. The decision whether to take this to be the case or not is up to the assessor.	**Assign VU D2**
It may be worthwhile to reconsider whether species can be presumed to be declining and either confined to less than 20,000km² or to less than 10,000 mature individuals.	**Return to 1**

9

Does the species narrowly miss qualifying one of the above criteria or will it become threatened should circumstances worsen or change for the worse?	**Go to 10**
Is the species unlikely to qualify as threatened unless under very unusual circumstances?	**Assign LRlc**

10

Is a significant proportion of the population contained within a protected area so that, in the future, the species will be cushioned from fulfilling a category of threat?	**Assign LR cd**
Does the species occur outside protected areas?	**Assign LR nt**

Appendix 2 An excerpt from "Conservation priorities amongst Ghana's forest trees. An assessment of the IUCN red-list guidelines, and a comparison with Ghana's own star-rating

Population numbers are next to impossible to estimate for continental tree species in the tropics. Ghana has carried out one of the most extensive surveys of its forests in Africa and yet it is impossible to collect sufficient details about rare species to validate a population estimate. The approach taken by William Hawthorne in assessing the status of tree species in Ghana involves estimating the likely EOO from the distribution of the species habitat and assuming its rate of destruction in the last few decades from published figures. The following is an extract from the working document prepared by William Hawthorne for the project's technical conference in Wageningen in November 1995.

Forest Types are those defined by Hall and Swaine (1981):
WE Wet Evergreen, **ME** Moist Evergreen

Wet forest species: General trends
[In Ghana] the decline in forest quality and quantity has been less dramatic here [in wet forests] than in drier forests, yet the statistics are rarely presented in a way which allows this to be quantified.

The greatest number of globally rare species in Ghana are wetter evergreen forest species, apparently restricted to these forests by a wetter climate/base-poor soil there, although there is also much speculation about their status as 'refugees' in or near Pleistocene refugia there (see summary discussion and references in Hawthorne, 1995). A sketch of enclaves of Wetter (evergreen) Guinean forest is shown in Parren and de Graaf, 1995. A species restricted to this vegetation in Ghana has a maximum EOO of about 2000 km^2, but the internal variation is substantial and no rare species are found throughout. Many such species favour swamps or riverside forest, for instance. Much of this vegetation type in Ivory Coast is deforested. The total area in the Ghana and Ivory Coast Block is probably < 3000 km^2. A species restricted to this area would qualify as at least endangered (B1,B2), without further consideration. Most species occur outside this block, however, either in the Liberian block of WE forest or in the ME zone in Ghana and elsewhere. In Liberia and Sierra Leone, the remnant WE type zone is larger, possibly about 15000-20000 km^2 (from maps in Parren and de Graaf, 1995).

Some species are restricted to the WE zone, others extend various degrees into the drier ME zone. In Ghana the area of ME zone forest is about 2.5 times the WE area, but is more widely disturbed. Assuming the same trend for the Liberian block, we can estimate an effective ME area of the order of perhaps 30,000 km^2. Combined with the WE area, this sets a maximum area on Upper Guinean wetter-forest species.

White (1983) includes both WE and ME type forest in his mapping unit 1a ("hygrophilous coastal evergreen Guineo-Congolian rain forest"). The extent of this mapping unit in Lower Guinea is about twice the extent of that of Upper Guinea. Most Guinea-wide species (i.e. species in both Upper and Lower Guinea) have been filtered out from consideration; those that remain for consideration here are those like *Afrostyrax lepidophyllus* which seem restricted within these zones, so these total areas of Guinean Wet forest are much broader than the EOO (esp.AOO) of these species[3]

Although the area of this type of forest is limited, it seems that forest loss has not been as bad in such areas (especially the WE type) as in drier areas, because of negligible loss due to fire, lower densities of timber than in semideciduous forests and rather infertile (heavily leached) soils, although mining in the ME belt of Ghana has accounted for significant losses e.g. around Tarkwa. Cocoa farming has not been as great a factor in the WE zone as it as in the ME zone. Mining is a potential threat for deforestation in Ghana, with recent quarrying in Neung and Cape Three Points, and there has been significant forest loss on unreserved land in the WE zone (and in Western Region generally) since Ahn's (1959) summary of land-use patterns. Deforestation of Subri Forest Reserve and elsewhere due to industrial plantation is, being moderately optimistic, unlikely to expand much further.

[3] Note that attempts to model AOO using known distribution and the environmental associations of such species would in most cases lead to a gross overestimate of AOO.

Wet Forest species: Specific cases
It is hard to place with confidence any WE species as critically endangered, in spite of the limited range of many of them. Some potential contenders, like *Trichoscypha chevalieri* (found only a few times ever, in a limited total range) come very close, but our picture of this species' situation is a little too hazy to commit it to this alarming status. Instead, I propose to put the majority of such (locally and globally) rare, systematically declining WE species in the Endangered category, preferably with a hair-trigger, set to upgrade their status to critical if any more negative factors arise. Alternatively, any future records e.g. in Lower Guinea are liable to render the species merely Vulnerable. For species with a wider distribution, only *Monocyclanthus vignei* (from two main areas) attains endangered status. The others must therefore be defined as Vulnerable.

Wet forest species: tentative conclusions:

VULNERABLE (VU-B1&2C & A1c)

Tapura ivorensis
Drypetes afzelii (EN?)
Sapium aubrevillei
Cassipourea hiotou
Cola umbratilis
Placodiscus bancoensis
(P. bracteosus?)
Spathandra barteri
Trichilia ornithothera
Xylopia elliotii
Croton aubrevillei
Desmostachys vogelii
Amanoa bracteosa
Anthonotha vignei
Berlinia occidentalis
Cryptosepalum tetraphyllum
Dactyladenia dinklagei
Deinbollia molliuscula
Didelotia idae
Gilbertiodendron bilineatum
Gilbertiodendron splendidum
Isolona deightonii
Neostenanthera hamata
Ouratea amplectens
Pausinystalia lane-poolei
Pavetta mollissima
Phyllanthus profusus
Piptostigma fugax
Placodiscus oblongifolius
Rhaptopetalum beguei
Schumanniophytum
Synsepalum aubrevillei
Trichoscypha albiflora
T. beguei
T. cavalliensis
Afrostyrax lepidophyllus
Allexis cauliflora
Dasylepis assinesis
Amanoa strobilaceae
Citropsis gabunensis
Crotonogyne manniana
Didelotia unifoliolata
Gluema ivorensis
Oricia suaveolens
Pellegriniodendron diphyllum
Piptostigma fugax
Pseudagrostistachys africana
Trichoscypha atropurpurea
Warneckea memecyloides

ENDANGERED (B1 & 2c)

Chrysophyllum azaguieanum
Dactyladenia hirsuta
Hemadradenia chevalieri
Hymenostegia gracilipes
Sericanthe toupetou
Trichoscypha chevalieri
Monocyclanthus vignei
Neolemonierra clitandrifolia This large tree probably a very long generation time. Its habit extends to Uplan[d] evergreen forest, which has declined more than the lowland variants.

The following species are perhaps of less concern than the above: LRcd 'Conservation dependent' (in Forest reserves), might be more appropriate.

Crudia gabonensis Probably well-buffered in lower Guinea.
T. oba
Raphia Palma-pinus Guinea-wide Swamp species often outside forest.
Uapaca paludosa
Xylopia rubescens
Magnistipula zenkeri
Anisophyllea meniaudii
Dichaetanthera africana Although rare in Ghana a pioneer of wet forest
Ehretia trachyphylla Pioneer-ish and well into ME zone
Ficus tesselata
(*Homalium dewevrei & longistylum*) Complicated taxonomy/variation pattern and distribution area. These appear to be widespread. ?Data Deficient.

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ANNEX 5

Working Document 5

Conservation and Sustainable Management of Trees

Regional Workshop

Hanoi, Viet Nam
From 18-21 August 1997

Sustainable use and the conservation of tree species

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Abstract: The concept of sustainable use of natural resources is now widely accepted as an important policy objective at both national and international levels. Although sustainability has been defined in a variety of ways, the concept implicitly includes the conservation of species and ecosystems which are subjected to human use. Particular attention is currently focussing on how sustainable management of forests may be defined and assessed, reflecting concern about the high rates of forest depletion in many areas. However, current approaches to assessing sustainable forest management fail to assess the impact of use on the conservation status of individual tree species. To address this, new approaches to assessing sustainability need to be developed. It is suggested that the potential for sustainable use of different tree species may be assessed by reference to their key biological characteristics, such as aspects of their reproductive biology and seedling regeneration requirements. Different uses of trees also vary in their intrinsic likelihood of sustainability; harvesting of timber, for example, is intrinsically less likely to be sustainable than harvesting of fruits or exudates, because of its greater impact on the growth and survival of the individual tree. Such assessments would help identify those species which are currently threatened with extinction as a result of overexploitation, or which may be particularly vulnerable to unsustainable use in the future. Greater appreciation of the impact of use on the conservation status of tree species would also assist in the development of appropriate conservation action for the species concerned.

Resumen:

Introduction

The concept of sustainability became the focus of international attention largely as a result of the Brundtland Report (WCED 1987), which defined sustainable development as 'meeting the requirements of present generations without compromising the ability of future generations to meet their own needs'. This statement has subsequently provided the foundation for numerous national and international development policy initiatives, despite some confusion over the what the term 'sustainability' means precisely (Dixon and Fallon 1989). The second World Conservation Strategy, for example, highlights the difference between 'sustainable development' and 'sustainable use' - the former relating to the improvement in quality of human life within the carrying capacity of supporting ecosystems, the latter referring specifically to the use of natural resources within their capacity for renewal (Holdgate 1996). In a sense, the concept of sustainability links development activities with conservation objectives, by requiring that species and ecosystems which are subjected to human use be effectively conserved (Cassells 1995).

In the context of forestry, the concept of sustainability became the focus of international attention following the statement of Forest Principles and Chapter 11 of Agenda 21, which were formulated at the 1992 UN Conference on Environment and Development (UNCED). The Forest Principles aim to 'contribute to the management, conservation and sustainable development of forests' and note the need for setting relevant standards for forest use (Upton and Bass 1995). Sustainability concepts have in fact been recognized for at least 200 years by foresters (Wiersum 1995). Traditionally, the concept was equated with the principle of sustained yield of timber; in recent years the concept has broadened to include environmental and socio-economic aspects (Wiersum 1995; Cassells 1995). A number of authors have recently attempted to define sustainable forest management in a variety of ways (for example, see Botkin and Talbot, 1992; Gale and Cordray 1991; Poore 1993, ITTO 1992, DBB 1994, Heuveldop 1994). Most authors agree that sustainability may be considered to comprise three main components: environmental, social and economic (Upton and Bass 1995). Environmental sustainability requires that an ecosystem be able to support healthy organisms, whilst maintaining its productivity, adaptability and capability for renewal; social sustainability requires that an activity does not stretch a community beyond it's tolerance for change; and economic sustainability requires that some form of equivalent capital (such as a natural resource) is handed down from one generation to the next (Upton and Bass 1995).

With the objective of sustainable use of forest resources now included in a number of national and international policy initiatives, attention is focussing how the sustainability of forest management activities may be assessed in practice. This has led to the development of a wide variety of different criteria and indicators of sustainable forest management. This paper highlights how these current initiatives fail to address the impact of use on the conservation status of individual tree species. Trees have in recent years been the focus of increasing conservation concern, as reflected in the recent attempts to list a number of species on Appendix II of CITES (ref). Large numbers of tree species as now considered to be threatened with extinction, according to IUCN Red List categories. - cite conifers as an example. To a large extent, this increasing concern reflects the current high rates of deforestation in many areas (Sharma 1992). Although deforestation is caused by a variety of factors, which vary with the region concerned

(Sharma 1992), human use is globally one of the most important. This is a consequence of the fact that very many socially and economically important products are derived directly from trees.

To assess the relationship between sustainable use and conservation of tree species, this paper first examines the current initiatives assessing sustainable forest management, and the limitations of these approaches for assessing the impact of use on the conservation of tree species. It is suggested that a new approach is required in order to be able to assess the sustainability of the use of different tree species. Three different aspects are considered separately: the potential for sustainable use, based upon the biological characteristics of a species; the intrinsic likelihood of a particular use being sustainable, based upon the part of the plant harvested; and the impact of use on the conservation status of a species. The links between these different approaches are highlighted, and suggestions are made as to how more meaningful assessments of sustainable use may be developed in future.

Assessing sustainable forest management

Since the need to formulate criteria to characterise sustainable forestry was recognised by international policy statements such as Agenda 21, a large number of initiatives have been developed. For example, the International Tropical Timber Organization (ITTO) published a definition of sustainable forest management in 1992 along with a provisional list of criteria and indicators of sustainability (ITTO 1992). The aim was to provide a framework within which producer countries would be able to generate their own national and local standards. A detailed set of criteria was also developed by the 'Montreal Process', an international working group focussing on sustainable management of temperate and boreal forests (Montreal Process 1995). Again, the aim of this initative was to provide a basis for national policies and international cooperation. A set of Principles and Criteria for 'responsible' forest management (check) has also been produced by The Forest Stewardship Council (FSC), an independent non-governmental organization established to provide consumers with reliable information about the source of forest products. These Principles are again designed to provide a framework for the development of national and local management standards (FSC 1994), and to provide a basis for timber certification initiatives. The FSC Principles are increasingly being seen as an international standard to which other initiatives should conform.

Other initiatives which have been developed focus at the level of the forest management unit. For example, the Responsible Forestry Standards produced by the Soil Association were designed to enable forestry operations to be assessed objectively by inspectors in the field, providing a basis for timber certification. The Standards include a list of indicators which is one of the most comprehensive currently available (SA 1994). Similarly, the Rainforest Alliance, a non-profit organization aiming to conserve tropical rain forests, has produced a set of generic guidelines to provide a basis for field assessments as part of the timber certification process, and to provide a 'minimum acceptable measure for assessing the sustainability of logging operations' (RA 1993). The criteria developed by these organizations are more specific than the general statements developed by international policy initiatives such as those described earlier.

The wide variety of organizations involved in developing criteria and indicators of sustainability, with their contrasting backgrounds and objectives, has resulted in a high diversity of different approaches. There is rather little consensus about what the key criteria and indicators of sustainable forest management actually are. For example, in a comparison of nine different initiatives, Upton and Bass (1995) noted pronounced variation in emphasis and breadth of scope, despite their similar broad objectives. In general, the emphasis to date has very much been on timber species rather than non-timber forest products, and social aspects have received relatively little attention. However, 'conservation of biodiversity' is one of the few aspects which seems to be common to all approaches (Upton and Bass 1995). There is a current trend towards convergence of the different criteria which have been proposed; this process is being encouraged by the FAO and by the Centre for International Forestry Research (CIFOR), who aim to produce a regionally adaptable set of criteria and indicators through a programme of field evaluation (Prabhu 1994a,b Prabhu 1995).

Sustainable management versus sustainable use

Although sustainable forest management is clearly a laudable objective, there is no guarantee that sustainable management will successfully conserve tree species which they contain. The emphasis of current initatives is on the assessment of forests as a productive ecosystem, rather than tree species *per se*. Management of any forest generally focuses on a limited range of economically valuable species. Harvesting of these preferred species may have a negative impact on non-harvested species as a result of habitat disturbance during logging. It is arguable that those species which occur at low density and which may therefore be under greatest threat of extinction, are likely to suffer most from management activities directed at other species. In addition, it should not be assumed that all species sourced from a forest certified as 'sustainably managed' will necessarily themselves be sustainably harvested. For example, management of peat swamp forests in Sarawak is currently achieving a sustainable yield in terms of total timber volume. However, the most valuable timber species in this forest type (Ramin, *Gonystylus bancana*) is being heavily overcut (ITTO 1990).

Current initatives aimed at assessing sustainability tend to focus on forests which are under some form of formal management. For example, many of the criteria listed by the Soil Association (SA 1994) refer to the existence of forest management plans and appropriate institutional support. Such a focus ignores the many individual trees which grow in forests which are not formally managed but are used intensively by local people. Many individual trees grow outside forests altogether, in hedgerows on farms, as scattered individuals in rangeland, or in small patches of woodland. Many such isolated or non-forest trees may be intensively used without being included in any formal forest management. Such a situation even applies to some valuable timber species which are traded internationally, such as many African savannah species. It is possible therefore that the emphasis on sustainable forest management will lead to significant areas of tree use, which may be highly relevant to the conservation status of these species being entirely ignored.

Another problem with current approaches is the issue of scale. Assessments of forest management at the scale of the management unit, or even at the national scale, are inappropriate for assessing the impact of use on individual species. Many tree species have broad distributional ranges; assessments of use across the full range of a species is required for the impact on conservation status of the species to be fully evaluated.

These difficulties indicate that assessing the sustainability of forest management does not provide an adequate framework for assessing the conservation status of individual tree species. Alternative approaches therefore need to be developed. Rather than forest management, use of individual species provides a more appropriate focus. Sustainable use of a tree species might be broadly defined as one which does not impact adversely on the conservation status of that species. The different components of sustainable use are described in the following section.

Components of sustainable use

Sustained yield

Sustained yield may be defined as maintaining a regular and continuing supply of forest products without impairing the capacity of the land to support production (after Matthews 1989). The key objective is the achievement of an appropriate ('normal') distribution of size classes of trees within the area under management (Smith 1986). Although management for sustained yield is a traditional objective in forestry, it may conflict with other components of sustainability. For example, large ancient trees of primary (or 'old growth') forests may often be felled to produce a size structure appropriate for sustained yield (Smith 1986; Parry et al. 1983), despite their high ecological value. Sustained yield concepts have also been criticized for failing to take account of natural ecological processes in forest ecosystems, leading to ecologically inappropriate management (Mladenoff and Pastor 1993). Although some authors have suggested that sustained yield (resulting in a continuous flow of forest products) is an essential component of sustainable use (ITTO 1992), it is arguable whether this is in fact the case (Newton 1996).

Maintenance of regenerative capacity

In order for the use of a particular tree species to be sustainable, the species must retain sufficient genetic variation to be able to adapt to changing environmental conditions, and the processes enabling this adaptation to occur must be maintained. In addition, sufficient numbers of individuals must also be maintained to avoid extinction. This requires that key regenerative processes, such as pollination, seed development and dispersal, seedling establishment and growth, should be maintained.

Maintenance of biodiversity

Sustainable use of a tree species will require that populations of other species are also maintained. Organisms that depend on trees may face three problems as a consequence of tree uses: (i) fewer trees, (ii) a different spatial distribution of trees and (iii) different patterns of fruit and leaf production (Johns 1992). Those species which are obligately associated with particular tree species, such as some pollinating insects and avian seed dispersers, are more likely to be adversely affected by the use of their 'host' tree species, than other organisms.

Maintenance of ecological services

Trees provide a number of ecological services, including (after Sharma 1992) regulation of runoff and groundwater flow, maintenance of soil fertility, and regulation of local and regional climate. Sustainable use may be defined as maintaining the quantity or quality of services being provided, or in the capacity to provide such services in the future. This principally involves the maintenance of canopy structure and vegetation cover, and the adoption of appropriate harvesting techniques which minimize soil disturbance and compaction.

Social and cultural impacts

The concept of social sustainability reflects the ability of a society to withstand shocks or stresses brought about by a change in conditions (Barbier *et al.* 1994). Sustainable use of a tree species should therefore maintain the coherence of local communities, and the processes and institutions which enable them to persist. A key aspect of social sustainability is the well-being of the social group concerned (Wollenberg 1995), including cultural heritage and identity, justice, safety and health. Recently, the sustainability concept has also been applied to the maintenance of cultural diversity (Colfer 1995, Carley and Christie 1992). Social and cultural impacts of tree use are especially pronounced where species have particular cultural or spiritual importance, such as the shrine forests associated with Buddhist temples (Cernea 1992).

Institutional mechanisms

The term 'institution' refers to the rules and conventions of society that facilitate coordination among people regarding their behaviour (Barbier *et al.* 1994). The role of institutions in the sustainable use of trees may be considered from two perspectives: the structure and activity of the institutions themselves, and the policies which they formulate and implement. Institutional failures account for many of the basic causes of unsustainable resource use, and may result conflict between stakeholders, uncoordinated decision-making, and weak or ineffective government control mechanisms (Upton and Bass 1995). Policies are required which address the main problems affecting forest trees, and provide incentives for sustainable use (Upton and Bass 1995)

Economic sustainability

Upton and Bass (1995) defined economic viable forestry operations as those which are sufficiently profitable to enable stability of operation, but not at the expense of the forest resource, the ecosystem or the affected communities. Essentially, the activities of current generations should not result in future generations being economically worse off (Barbier et al. 1994). Trees may be viewed as economic assets; how these assets are valued is central to defining whether or not a particular use is economically sustainable (Barbier *et al.* 1994). Failure to properly value forest resources results in timber being traded at artificially low prices (Repetto and Gillis 1988) and an undervaluation of forest land by governments. Another key component of economically sustainable use is the provision of appropriate financial incentives which encourage investment in responsible forestry practices (Upton and Bass 1995).

The potential for sustainable use of tree species

Peters (1994) made the important observation that tree species differ in their potential for sustainable use, as a result of their contrasting biological characteristics. This variation in potential provides an alternative basis for assessment of sustainability, which avoids many of the limitations associated with assessing forest management.

The biological characteristics which determine the ability of a species to withstand use are those which enable the species to tolerate or to recover after harvesting. The key characteristics, therefore, are those which determine the regeneration capacity of the species, including reproductive biology and regeneration characteristics. Differences between species in such characteristics can be used to classified them according to their potential for sustainable use (see Table 1, adapted from Peters 1994).

For example, those species with relatively regular and copious production of flowers and fruits, and with relatively abundant pollinators and seed dispersers, will be more likely to be able to maintain populations through natural regeneration. Such species may be considered to have a relatively high potential for sustainable use (Table 1). In contrast, those species with highly specific pollinators, seed dispersers or requirements for seedling establishment, may be much less able to maintain population size. Natural regeneration of such species may be irregular or highly sporadic, leading to populations with few young individuals, or a high proportion of individuals within a narrow range of age classes. Such species will be much less able to maintain population size if individuals are removed by harvesting; such species may therefore be considered to have a relatively low potential for sustainable use (Table 1). The same applies to species which occur at low density, particularly with uneven or 'clumped' distributions (Peter 1994).

This analysis focuses solely on the biological aspects of sustainability, with no reference to cultural, economic or institutional aspects. This has the advantage of considering only objective biological criteria, which determine the response of a species to use, and which therefore underpin other other components of sustainabiltiy. However, cultural and economic characteristics of a species could potentially be included into such a scheme, by considering their relative value. Use of a species with a high cultural value, for example, would arguably have a lower potential for sustainability because of the magnitude of the effects of use on local communities.

The potential for sustainability of different uses

The different uses of a tree may also be considered to vary in their intrinsic likelihood of sustainability, as noted by Peters (1994). The impact that a particular use has on a tree will depend on the part of the tree used, and the method of harvesting. This may be assessed by reference to the different components of sustainability outlined earlier (see Table 2).

Whereas removal of exudates, flowers or fruit has minimal impact on growth or survival of an individual tree, removal of the stem is likely to be far more detrimental, and would therefore have a much lower likelihood of being sustainable. Harvesting of fruits or exudates are also likely to be less damaging to the environment purely because the volume of the product, and therefore the potential for soil compaction, will tend to be lower. Cunningham (1991), for example, notes that removal of bark or roots has a more damaging effect on both habitat and species populations than harvesting of leaves or fruits. However, harvesting of flowers or fruits could have a relatively large impact on regenerative processes (Hall and Bawa 1993). As most organisms dependent on particular tree species are associated with fruits or flowers, as dispersers or pollinators, harvesting of these parts would also be expected to be relatively deleterious to associated species. The relative cultural value of different plant parts will obviously differ from species to species, although in general roots and branches perhaps have less cultural importance than other parts of the tree. Similarly, forest products with economic value are generally derived from fruits, exudates or stem wood; very few economically important products are derived from tree flowers or roots.

The overall intrinsic likelihood of sustainability (indicated in the final column on Table 2) is based on a combined assessment of the different components of sustainability. The use of tree stems (e.g. for timber) appears to have a relatively low intrinsic likelihood of being sustainable, as a consequence of its high impact on growth and survival of the tree, as well as its reproductive ability, and on ecological services. Similarly, the relatively high cultural and economic value of fruits, together with their importance for other organisms and the reproductive ability of the tree itself, would reduce the intrinsic likelihood of their use being sustainable. In comparison, the impacts of the use of other plant parts are relatively slight, and may therefore be expected to have a higher chance of being sustainable.

This analysis is necessarily tentative, as the impacts of different types of harvesting on individual trees have received very little research attention (Clay 1992). However, the results compare closely with those of Peters (1994), who also concluded that harvesting of the stem has a relatively low potential for sustainability. Peters (1994) also considered fruit to be either of medium or high potential for sustainable management, depending on the species, pointing that species producing a relatively high yield may be expected to have a higher potential for sustainable use. In contrast to the present analysis, Peters (1994) also considered bark and roots to be of low potential for sustainable use, perhaps reflecting his consideration of non-timber products in general rather than only tree species, and his consideration of only ecological aspects of sustainability. Harvesting of sufficient roots to severely affect the survival of a mature tree must be comparatively rare, although it clearly can occur (Cunningham 1991).

Clearly it is not simply which part of the tree is used but how it is harvested that will determine the impact of use. For example, although trees may be able to recover from harvesting of exudates or fruit, if the trees are felled during harvesting the impact will obviously be far greater. The analysis presented (Table 2) is therefore very much a generalization, assuming the adoption of the lowest impact method of harvesting available. Another key point is the growth stage of the plant used. The removal of leaves or roots, for example, would have a significantly larger impact if juveniles rather than adults were harvested (Hall and Bawa 1993).

Towards a methodology for assessing the sustainable use of tree species

As noted above, species may be classified into categories of low, moderate or high potential for sustainable use, according to their intrinsic biological characteristics Peters (1994) suggested that this classification could be achieved by calculation of a simple index of 'sustainability potential' derived by assigning a numerical value to each characteristic, and summing to provide an overall score. However, this approach assumes that all characteristics included in the classification have equal weighting. A more conservative approach would be to classify a species with a low potential for sustainable use on any single biological characteristic, as of 'Low potential' overall. This would ensure that species with a particularly vulnerable part of its life-cycle would be recognized as being particularly susceptible to use.

It is also important to differentiate between classifying the potential of sustainability of species and the uses to which they are put. Peters (1994) combined different uses with the biological characteristics of the species, to provide an overall assessment of the potential for sustainable management. This approach fails to recognize the overriding importance of the type of use that the tree is put to. For example, species being harvested for timber will always be in greater danger of unsustainable use, regardless of their biological characteristics. The key aspect of use is the ability of the species to recover following harvesting. The impacts of different uses on a species may therefore best be assessed by consideration of the biological characteristics of the species which determine its ability to tolerate use. For example, the ability of a species to regrow bark after removal will clearly determine the sustainability of bark harvesting; the ability of a stem to resprout will influence the ability of a species to tolerate branch removal.

Impact of use on conservation status

IUCN Categories of threat

A framework for assessing the impact of use on the conservation status of tree species already exists in the form of the IUCN Red List categories of threat (IUCN 1994). These are designed to provide an assessment of the likelihood of extinction of a taxon under current circumstances. Species are evaluated according to a series of criteria, relating to trends in population size extent of occurrence. Recent revisions of the criteria have sought to improve the objectivity of the classification process (Mace and Lande 1991).

Clearly, use of a tree species may affect its likelihood of extinction. For the use of a tree species to be sustainable, the likelihood of extinction should not be increased. The impact of use is addressed explicitly in the IUCN criteria relating to population reduction, which lists 'actual or potential levels of exploitation' as a possible cause of decline (IUCN 1994). Use of a tree species may also result in a decline in the area of occupancy and the number of mature individuals of the species; a decline in the extent of occurrence of the species and / or quality of its habitat; or an increase in population fragmentation. Each of these is included in the criteria on which the Red List categories are based (IUCN 1994).

Classification of a taxon as 'Vulnerable' requires an estimated reduction of at least 20% of mature individuals within 3 generations, either inferred from the past or suspected to be met in the future. Since 1850, the forests of N Africa and the Middle East declined by 60%; those of S Asia by 43%; those of tropical Africa by 20% and those of Latin America by 19% (Rowe et al. 1992). Given the long generation time of most trees, it is probable that very many tree species in these areas would qualify as Vulnerable on this basis. To what extent such declines are the result of unsustainable use is not clear. To assess whether the use of a species is increasing its threat of extinction, explicit reference is required to the impacts of use during the process of assessing species according to the Red List criteria.

CITES

The Convention on International Trade in Endangered Species (CITES) provides a framework for the prevention of trade in endangered species, and for regulation of trade in other species of concern. New criteria for listing species on the respective Appendices were adopted in 1994 to provide a more objective basis for classification. The criteria were developed along similar lines to the revised IUCN criteria for categorizing species on the Red List (IUCN 1994). The three main biological criteria are population size, area of geographic distribution and population decline.

The criteria for listing on Appendix II, which requires strict regulation of international trade, includes the following: 'it is known, inferred or projected that harvesting of specimens from the wild for international trade has, or may have, a detrimental impact on the species by exceeding over an extended period the level that can be continued in perpetuity' (Rosser and Haywood 1996). This is essentially a definition of sustainability. The phrase 'an extended period' is obviously critical to this criterion. Annex 5 to the Resolution of conference 9.24 states that the length of the period 'will depend upon ... whether the number of specimens removed from the wild is consistent with a sustainable harvesting programme'.

Since the concept of sustainable use is enshrined within the concept of 'detrimental impact', any species being harvested above sustainable thresholds for international trade would qualify for listing on Appendix II of CITES. As few forests are currently being managed on a sustainable basis (Poore 1989), it could be argued that a large number of timber species being traded internationally qualify for listing on Appendix II under these criteria. The recent attempts to list some tropical timber species on Appendix II of CITES have been highly controversial. However, the fact is that many timber species currently being traded internationally have undergone massive reductions in population size in the last few decades. As noted earlier, many tree species qualify as at least Vulnerable under the revised Red List criteria, and therefore arguably meet the criteria for listing on the CITES Appendices, if they are traded internationally.

Genetic erosion and threat

The possible occurrence of genetic erosion has recently been one of the main conservation concerns relating to tree species (Rodan et al. 1992). Forest trees generally display considerable genetic variation within and between populations (NRC 1991). Depletion of intraspecific genetic variation ('genetic erosion') is therefore likely to occur as a result of deforestation, as genetically distinctive populations and individuals are lost. However, little quantitative evidence is available to indicate whether genetic erosion has taken place, largely because few baseline data are available (Ledig 1992). The best examples are perhaps provided by the wild populations of tropical tree crops, many of which have demonstrably suffered since the onset of domestication (Smith et al. 1992). Genetic erosion may also result from forest fragmentation and the interruption of gene flow, which may result in the loss of variation through genetic drift (Ledig 1992), although again, this process has rarely been quantified in trees.

Whether or not use of a species will cause genetic erosion will largely depend on the genetic structure and age distribution of the population, as well as system of use adopted. Ledig (1992) highlighted the importance of harvesting intensity: impacts of logging on genetic variation are likely to be higher the greater the proportion of trees removed, particularly if only the poorest formed trees are left after logging. In the cases where very few trees are recorded in the smaller size classes, removal of the largest trees could have a very severe effect on total genetic variation of a population. In such circumstances, it is conceivable that a single harvest could cause significant genetic erosion, particularly in individual populations which are genetically distinctive (Newton et al. 1996). Logging may also increase the incidence of inbreeding, by reducing the density of reproductively mature individuals (Ledig 1992). This could have implications for the evolutionary viability of an individual population.

If the use of a species results in genetic erosion, then this will increase the threat of extinction of that species. However, intra-specific genetic variation is not explicitly addressed by the IUCN Red List categories in their current form (IUCN 1994). No attempt is made to consider genetically distinct populations, genotypes or individual genes. As mentioned earlier, it is not only the existing genetic variation that is important for long-term viability of a species, but also the processes involved in maintaining that variation (such as gene flow). These processes are also not included in the criteria explicitly, although a reduction in population size or extent of occurrence, which are included in the criteria, take account of these processes to some extent. The IUCN criteria could perhaps be amended in future to include intra-specific genetic variation, although assessing genetic erosion presents a number of technical difficulties, demonstrated by the lack of quantitative data currently available

Conclusions

As the conservation of biological diversity will not be achieved solely by designation of protected areas (Cassells 1995), the development of land use systems which are compatible with conservation objectives is of paramount importance. Sustainability concepts can potentially provide a tool by which this may be achieved, providing a link between development and conservation objectives. The challenge is to realize this potential, by developing a concept of sustainability which can meaningfully be applied to assess the impact of human activities (Wiersum 1995).

Existing approaches to assessing the sustainability of forest management fail to address the impact of use on the conservation status of individual tree species. Alternative approaches to assessing sustainability therefore need to be developed. One approach is to consider the potential for sustainable use of different species, based upon their biological characteristics. Those species better able to maintain population size, as a result of these characteristics, could be considered to have a higher potential for sustainable use. The different uses of trees may also be considered to vary in their intrinsic likelihood of sustainability, based upon the part of the tree used, and its impact on growth and reproductive processes.

Analysis of the potential for sustainable use would be highly complementary to the assessment of threat of extinction using the IUCN Red List criteria. In particular, sustainability assessments would help identify species which are not currently considered threatened with extinction ('Lower risk' according to the IUCN Red List criteria), but may become so in the future as a consequence of overexploitation. Those tree species which are already threatened with extinction (in that they fulfill the criteria for inclusion on the IUCN Red List) primarily as a result of unsustainable use may also be identified with greater precision, by highlighting the extent to which use of a species is responsible for its decline. Assessment of the potential for sustainable use would also be of value when considering tree species for listing on CITES Appendices. Greater appreciation of the impact of use on the conservation status of tree species would also highlight the fact that large numbers of tree species are of increasing conservation, largely because of unsustainable land use practices.

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Table 1. The potential for sustainable use of different tree species, based on their biological characteristics (adapted from Peters, 1994)

	Low	Moderate	High
Reproductive characteristics:			
Flower number, size	Few, large	Intermediate	Many, small
Fruit number, size	Few, large	Intermediate	Many, small
Reproductive phenology	Irregular, supra-annual	Regular, supra-annual	Regular, annual
Pollination system	Biotic, with specialized vector	Biotic, with generalist vector	Abiotic
Pollinator abundance	Low (bats, hummingbirds)	Moderate (beetles, moths)	High (small insects)
Sprouting ability	None	Low	High
Regeneration processes:			
Seed dispersal	Biotic, with specialized vector	Biotic, with generalist vector	Abiotic
Disperser abundance	Low (large birds, primates)	Moderate (small mammals)	High (small birds)
Seed germination	Low viability; recalcitrant	Intermediate	High viability; orthodox
Shade tolerance	Pioneer	Intermediate	Shade tolerant
Regeneration niche	Narrow; specialised	Intermediate	Broad; generalist
Population structure:			
Size-class distribution	Type III curve (low representation in more than one size class)	Type II curve (low representation of reproductive adults)	Type I curve (reverse J; exponential decay)
Tree density	Low (0-5 adults ha^{-1})	Moderate (5-10 adults ha^{-1})	High (>10 adults ha^{-1})
Spatial distribution	Scattered	Clumped	Evenly distributed

Table 2 The impact of tree use on different components of sustainability, and the overall intrinsic likelihood of sustainability

Anatomical part of tree	Impact of use on growth and survival of the tree	Impact of use on environment	Impact of use on the tree's reproductive processes	Impact of use on other organisms	Relative cultural value	Relative economic value	Intrinsic likelihood of sustainability
Stem	***	***	***	***	**	***	*
Branches	**	**	**	**	*	**	**
Roots	***	***	**	**	*	*	**
Leaves	**	**	**	**	**	**	***
Fruit	*	*	***	***	***	***	**
Bark	***	*	**	*	***	**	**
Flowers	*	*	***	***	**	*	***
Exudates	*	*	*	*	***	***	***

Key: * low , ** moderate , *** high.
These assessments refer to the use of specific tree species in their natural environments, and not to trees in general

ANNEX 6

Results of Working Group Evaluations

Species	Distribution	IUCN Conservation Category		
		Group 1	Group 2	Consensus
Acer laurinum	Myanmar, possibly Thailand, China (Hainan), Malaysia, Java, Borneo, Sumatra, Celebes and Lesser Sunda Islands, Philippines.	DD	DD	DD
Afzelia rhomboidea	Eastern Sumatra, northern Borneo and Philippines.	VU A1d	VU A1cd	VU A1cd
Ailanthus integrifolia ssp. *integrifolia*	Found in the Bismarks and the Solomons in Melanesia and in Malesia on all the islands except Java and the Lesser Sunda Islands.	LR	LR:lc	LR:lc
Alstonia pneumatophora	Peninsular Malaysia, Sumatra, Sulawesi, Borneo.		LR:lc	LR:lc
Aquilaria malaccensis	Found in north-east India (Arunachal Pradesh, Assam, Meghalaya, Manipur, Tripura, West Bengal, Mizoram, Nagaland, Sikkim), Bhutan, Myanmar, Bangladesh, Thailand, Malaysia, Indonesia (Sumatra and Borneo), Philippines, Laos and Viet Nam.	CR (based on India)	VU A1cd	VU A1cd
Cantleya corniculatum	Sumatra, Sabah, Sarawak, Peninsular Malaysia, Ria, Lingga Archipelago and Bangka.	VU	VU A1cd	VU A1cd
Chloroxylon swietenia	India and Sri Lanka	VU A1c		VU A1c
Cinnamomum parthenoxylon	China, India, Indonesia, Thailand and Viet Nam	DD	DD	DD
Dalbergia cochinchinensis	This species is found in Cambodia, Thailand, Laos and Viet Nam.	VU A1c+d		VU A1c+d
Dalbergia latifolia	This species is found in Nepal, Java and western and north-eastern India, in the states of Kerala, Karnataka and Tamil Nadu. It also occurs in Madhya Pradesh and Andhra Pradesh and sporadically in northern India.	VU	Deferred	VU criteria to be confirmed
Dehaasia cuneata	Thailand, Indonesia and Peninsular Malaysia	DD	DD	DD
Diospyros celebica	This species is endemic to Sulawesi. It is found mainly in the central and northern regions, with very few trees	CR	Deferred	Deferred

Species	Distribution	IUCN Conservation Category		
		Group 1	Group 2	Consensus
	remaining in the south.			
Diospyros ebenum	Southern India and Sri Lanka, cultivated in Peninsular Malaysia.	DD	Deferred	Deferred
Diospyros mun	*D. mun* is endemic to Viet Nam. In the northern provinces it is found at Hà Tuyen, Lang Son, Hòa Bình, Hà Tinh, Quang Bình; in the south it occurs at the communes of Cam Thinh Dong and Cam Thinh Tay, district Cam Ranh, province Khánh Hòa.	VU A1cd	Category given by Working Group 3	
Diospyros philippinensis	This species is endemic to the Philippines and Northern Sulawesi.	EN	EN A1c +B1+B2 A-C	EN A1c +B1+B2 A-C
Diospyros pilosanthera	This widespread species is found in Myanmar, Thailand, Cambodia, Viet Nam, Peninsular Malaysia, Indonesia (Sumatra, Java; Borneo, and the Moluccas) and the Philippines.	VU	Lillian Chua to look for info	Deferred
Diospyros rumphii	Sulawesi and the Moluccas.	DD	DD	DD
Durio kutejensis	Borneo (Sabah, Sarawak, Brunei, Kalimantan). Cultivated in other areas of Malesia e.g. Java and E. Kalimantan.	VU	Lillian Chua will look for info.	Deferred
Dyera costulata	Peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra, Borneo and intervening islands	VU	LR:lc	LR:lc
Eusideroxylon zwageri	Sumatra, Bangka, Belitung, Borneo, Sulu Archipelago, Kalimantan, Sabah, Sarawak, Philippines (Palawan).	VU	At least VU A1 cd + A2 cd	VU A1 cd + A2 cd
Homalium foetidum	Sumatra, Peninsular Malaysia, Borneo, the Philippines, Sulawesi, Moluccas, Papua New Guinea and the Bismark Archipelago.	LR:lc	LR:lc	LR:lc
Hydnocarpus sumatrana	Thailand, Sumatra, Sabah, Sarawak, Kalimantan, south/central Java, Philippines.	DD	DD	DD
Intsia bijuga	American Samoa, Australia, Burma, Cambodia, India, Indonesia, Madagascar (at low altitudes in the west), Malaysia, Myanmar, Pacific Islands, Papua New Guinea, Philippines, Seychelles, Tanzania, Thailand, and Viet Nam.	EN (more infor needed)	Lillia Chua to find more info.	Deferred

Species	Distribution	IUCN Conservation Category		
		Group 1	Group 2	Consensus
Jackiopsis ornata	Indonesia, Peninsular Malaysia, Sabah, Sarawak.	DD	Lillian Chua to find more info.	Deferred
Kalappia celebica	Endemic to Sulawesi.	EN	VU D2	VU D2
Koompassia excelsa	Southern Thailand, Peninsular Malaysia, north-eastern Sumatra, Borneo and Palawan.	LR:cd	NE	LR:cd
Koompassia malaccensis	Thailand, Indonesia (Sumatra), the Riau Archipelago, Bangka, Belitung, Borneo Peninsular Malaysia, Sarawak, Sabah	LR:cd	NE	LR:cd
Mangifera decandra	Borneo (Sabah, Sarawak, Brunei, E. Kalimantan) and Sumatra.	LR	Lillian to investigate	Deferred
Mangifera macrocarpa	Peninsular Thailand, Cambodia, Peninsular Malaysia, Sumatra, Sabah, Kalimantan, Western Java and Borneo.	VU A1c	Lillian to find out more	Deferred
Merrillia caloxylon	South Thailand, Peninsular Malaysia, Sabah, Sumatra.	DD	Lillian to find out more info	Deferred
Neobalanocarpus heimii	Indonesia (it may be extinct), Peninsular Malaysia, Thailand (south of Pattani).	CR	VU	Deferred
Ochanostachys amentacea	Sumatra, Sabah, Sarawak, Bangka, Peninsular Malaysia, Borneo and intervening islands. It is probably erroneously reported from the Nicobar and Andaman Islands.	LR:lc (more info needed)	DD	DD
Parinari costata ssp. *costata*	Peninsular Malaysia, Sumatra, Borneo (Sabah, Sarawak, Brunei, Kalimantan), Philippines.	DD	DD	DD
Parinari oblongifolia.	Peninsular Malaysia, Sumatra, Borneo (Sabah, Sarawak, Brunei, Kalimantan).	DD	DD	DD
Pericopsis mooniana	Micronesia, Papua New Guinea, Indonesia (Java, Kalimantan, Sulawesi, southern Sumatra, Moluccas), Eastern Borneo (Sabah, East Kalimantan), Philippines (Mindanao), the Moluccas, Sri Lanka, Peninsular Malaysia, Sabah.	EN)	VU A1 cd	VU A1 cd
Pterocarpus dalbergioides	Andaman Islands. Planted from India to Indonesia and in Madagascar.	DD	Deferred	Deferred
Pterocarpus indicus	Southern Burma, Philippines, Peninsular Malaysia, Indonesia, Sabah, Singapore, India, Myanmar, Thailand, Indochina, the Malay Archipelago, Pacific islands.	EN (in India at least)	LR:lc	VU A1d
Pterocarpus	Laos, Myanmar, Thailand, Viet Nam	DD	DD	DD

Species	Distribution	IUCN Conservation Category		
		Group 1	Group 2	Consensus
macrocarpus				
Pterocarpus santalinus	Occurs mainly in the southern eastern Ghats states of Peninsular India (Andhra Pradesh, Karnataka, Tamil Nadu) and sporadically in other states.	EN		EN B1+2de
Pterocymbium beccarii	Indonesia, Papua New Guinea	DD	DD (Frodin to investigate)	DD
Pterocymbium tinctorium	Indonesia, Philippines, Sabah.	DD	DD	DD
Santalum album	Widely scattered in China, India, Indonesia (Timor, Sumba and Flores and planted in Java and Bali), the Lesser Sunda Islands, the Philippines and Australia. Once the tree was thought to have originated from India, but most botanists now believe that sandalwood was taken from Indonesia to India.	LR (nt) in India	VUA1d	VU A1d
Shorea curtisii	Borneo, Peninsular Malaysia, Sumatra, Thailand, the Riau and Lingga Archipelago.	VU	LR:lc	LR:lc
Sindora beccariana	Borneo, Kalimantan, Sabah, Sarawak	LR:lc	DD	DD
Sindora inermis	Philippines from south Luzon to Mindora and the Sulu Archipelago.	VI A1d	VU A1d	VU A1d
Sindora supa	Philippines (Luzon, Mindoro).	EN	VU A1d	VU A1d
Strombosia javanica	Myanmar, Sumatra, Thailand, Peninsular Malaysia, West Java, Borneo (Sarawak, Brunei and Kalimantan).	DD	DD	DD
Tectona philippinensis	Endemic to Philippines (Mindoro, Luzon and province Batagas).	EN	EN B1+B2 A-C	EN B1+B2 A-C
Toona calantas	Thailand, Indonesia, Philippines.	DD	DD	DD
Vavaea bantamensis	Indonesia	DD	DD	DD
Vitex parviflora	Philippines, Sulawasi, Timor, the Moluccas; possibly also Sabah and Java; planted in Central America.	DD	DD	DD
Wallaceodendron celebicum	Indonesia, Philippines.	DD	DD	DD

ANNEX 7 LIST OF FOREST TREES RECORDED IN VIETNAM

(Appendix 1)

A. GYMNOSPERMAE

CEPHALOTAXACEAE
Cephalotaxus oliveri 1

CUPRESSACEAE
Calocedrus macrolepis 2
(Libocedrus macrolepis)
Cuppressus torulosa 3
Fokienia hodginsii 4

PINACEAE
Ducampopinus krempfii 5
Keteleeria davidiana 6
Pinus dalatensis 7
Pinus kesiya (P. khasya) 8
Pinus kwangtungensis 9
Pinus massoniana 10
Pinus merkusii 11
Tsuga dumosa 12

PODOCARPACEAE
Dacrydium pierrei 13
Podocarpus brevifolius 14
Podocarpus fleuryi 15
Podocarpus imbricatus 16
Podocarpus nagi 17
Podocarpus nerrifolius 18

TAXACEAE
Amentotaxus ynnanensis 19
Taxus chinensis 20

TAXODIACEAE
Cunninghamia konishii 21
Cunninghamia lanceolata 22
Glyptostrobus pensilis 23
(Taxodium sinense)

B. ANGIOSPERMAE

ACERACEAE
Acer decandrum 24
Acer erythranthum 25
Acer flabellatum 26
Acer oliverianum 27
Acer wittsonii 28

ALANGIACEAE
Alangium chinense 29
Alangium kurzii 30
Alangium ridley 31

ANACARDIACEAE
Allospondias lakonensis 32
Anacardium occidentale 33
Buchanania latifolia 34
Choerospondias axillaris 35
Dracontomelon mangiferum 36
Melanorrhea laccifera 37
Rhus succedanea 38
Semecarpus annamensis 39
Semecarpus caudata 40
Spondias pinnata (S.mangifera) 41

ANNONACEAE
Alphonsea hainanensis 42
Alphonsea monogyna 43
Miliusa balansae 44
Mitrephora thorelii 45
Polyanthya cerasoides 46
Polyalthia jucunda 47
Polyalthya laui 48
Polyalthya nemoralis 49
Polyalthya sp. 50
Xylopia vielana 51

APOCYNACEAE

Source. Vu Van Dung (ed.) 1996 Vietnam Forest trees, Agricultural publishing house. Hanoi

LIST OF ENDANGERED FOREST WILD FLORA IN DECISION N° 18/HĐBT

ANNEX 8

(Appendix 2)

Order	Species	Threat category
	Group 1	
1	Calocedrus macrolepis	E
2	Taxus chinensis	E
3	Cephalotaxus fortunei	R
4	Podocarpus neriifolius	R
5	Pinus kwangtugensis	R
6	Pinus dalatensis	V
7	Glyptostrobus pensilis	R
8	Keteleeria calcarea	E
9	Amentotaxus argotenia	E
10	Abies nukiangensis	R
11	Aquilaria crassna	R
12	Cupressus torulosa	E
13	Ducampopinus krempfii	E
	Group 2	
1	Dalbergia oliverrii	V
2	Dalbergia bariaensis	V
4	Dalbergia dongnaiensis	V
5	Afzelia xylocarpa	V
6	Sindora cochinchinensis	K
7	Sindora tonkinensis	V
8	Pterocarpus pedatus	K
9	Pterocarpus cambodianus	K
10	Pterocarpus indicus	K
11	Chukrasia tabularis	K
12	Chukrasia sp	K
13	Chukrasia sp	K
14	Dalbergia cochinchinensis	V
15	Dalbergia annamensis	E
16	Dalbergia combodiana	E
17	Fokienia hodginsii	K
18	Diospyros mun	V
19	Diospyros sp	V
20	Markhamia pierrei	V

Order	Species	Threat category
21	Madhuca pasquieri	K
22	Burretiodendron hsienmu	V
23	Erythrophloeum fordii	
24	Padocarpus fleuryi	V
25	Rauwolfia verticillata	V
26	Morinda offficinalis	K
27	Lilium brownii	
28	Panax vietnamensis	E
29	Amomun longiligulare	
30	Amomum tsaoko	

APPENDIX 3: THE FOREST TREES LISTING IN RED DATA BOOK OF VIET NAM.

ANNEX 9

ORDER	SCIENTIFIC NAME	COMMON NAME	THREAT CATEGORY
	DIVIS. 1. ANGIOSPERMAE		
	CLASS. 1 .DICOTYLEDONES		
1.	Acmena acuminatissima	Thoa	V
2.	Actinodaphne ellipticibacca	Bộp quả bầu dục	T
3.	Adina cordifolia	Gáo	T
4.	Adinandra megaphylla	Sum lá to	T
5.	Aesandra dongnaiensis	Xưng đào	T
6.	Afzelia xylocarpa	Gõ đỏ	V
7.	Alniphyllum eberhardtii	Lá dương đỏ	R
8.	Altingia chinensis	Tẩm	R
9.	Amesiodendron chinense	Trường ngân	T
10.	Annamocarya sinensis	Chò đãi	V
11.	Aquilaria banaensae	Dó bà là	T
12.	Aquilaria crassna	Trầm hương	E
13.	Argusia argentea	Phong ba	R
14.	Aucuba chinensis	Ô rô bà	R
15.	Azima sarmentosa	Gai me	R
16.	Barringtonia asiatica	Bàng vuông	R
17.	Bennettiodendron cordatum	Ben nét tim	R
18.	Bretschneidera sinensis	Chuông đài	T
19.	Buddleja macrostachya	Bọ chó bông to	R
20.	Burretidendron tonkinensis	Nghiến	V
21.	Bursera tonkinensis	Râm	K
22.	Caesalpinia sappan	Tô mộc	T
23.	Camellia fleuryi	Chè sốp	T
24.	Camellia gilbertii	Chè gilbert	T
25.	Camellia pleurocarpa	Chè lá mỏng	T
26.	Carya tonkinensis	Mạy châu	V
27.	Chukrasia tabularis	Lát hoa	K
28.	Cinnadenia paniculata	Kháo xanh	K
29.	Cinnamomum balansae	Vù hương	R
30.	Cinnnamomum parthenoxylon	Re hương	K
31.	Cleidiocarpon laurium	Đen lá rộng	R
32.	Cleistanthus petelotii	Cách hoa petelot	R
33.	Colona poilanei	Chông	R
34.	Craibiodendron scleranthum	Hoa khế	R
35.	Craibiodendron stellatum	Cáp mộc	R
36.	Croton phuquocensis	Ba đâu Phú Quốc	T

ANNEX 10

FOREST TREE SPECIES SUGGESTED FOR GENETIC RESOURCES CONSERVATION

1. Rare and valuable tree species which are endangered or critical endangered:

- *Pinus krempfii* A.Chev.	Pinaceae
- *P. dalatensis* Y de Perre	Pinaceae
- *Glyptostrobus pensilis* K.Koch.	Taxodiaceae
- *Cupressus torulosa* D.Bon	Cupressaceae
- *Taxus wallichiana* Zucc.	Taxaceae
- *Diospyros mun* A.Chev. ex Lecomte	Ebenaceae
- *Abzelia xylocarpa* (Kurz) Craib	Fabaceae
- *Dalbergia cochinchinesis* Pierre.	Fabaceae
- *Pterocarpus macrocarpus* Kurz	Fabaceae

2. Tree species having high economic value which are endangered and presently planted:

- *Fokienia hodginsii* (Dun) Alenry et Thomas.	Cupressaceae
- *Aquilaria crassa* Pierre et Lecomte.	Thymeleaceae
- *Chukrasia tabularis* A.Juss	Meliaceae
- *Erythophloeum fordii* Oliver	Fabaceae

3. Tree species presently used in reforestation programmes:

- *Dipterocarpus alatus* Roxb.	Dipterocarpaceae
- *Anisoptera costata* Korth	Dipterocarpaceae
Hopea ordorata Roxb.	Dipterocarpaceae
- *Parashorea chinensis* Wang tise	Dipterocarpaceae
- *Pinus kesiya* Royle ex Gordon	Pinaceae
- *P. merkusii* Jung et vriese	Pinaceae
- *Styrax tonkinensis* Pierre.	Styracaceae
- *Manglietia glauca* Blume	Magnaliaceae
- *Melaleuca cajuputi* Powell	Myrtaceae

4. Widely planted, exotic tree species:

- *Tectona grandis* L.	Verbenaceae
- *Pinus caribaea* Morelet	Pinaceae
- *P. massoniana* Lambert	Pinaceae
- *Acacia mangium* Willd.	Fabaceae
- *A. auriculiformis* Cunn ex Benth	Fabaceae
- *A. crassicarpa* Cunn ex Benth	Fabaceae
- *A. aulacocarpa*	Fabaceae
- *Eucalyptus urophylla* S.T. Blake	Myrtaceae
- *E. tereticornis*	Myrtaceae
- *E. camaldulensis* Dehnh	Myrtaceae
- *E. microcorys* F. Muell.	Myrtaceae
- *E. grandis*	Myrtaceae
- *E. brassiana* S.T.Blake	Myrtaceae
- *Casuarina equisetifolia* J.Ret J.G. Forester	Casuarinaceae
- *C. junghuhniana*	Casuarinaceae
- *Azadirachta indica* A.Juss	Meliaceae

5. Useful and valuable rattan and bamboo species:

- *Bambusa bambos* (L.) Druce	Poaceae
- *Bambusa spinosa* Roxb.	Poaceae
- *Phylostachys pubescens* Mazel ex Lehail	Poaceae
- *Dendrocalamus membraceus* Munro	Poaceae
- *Chimonobambosa quadrangularis*	Poaceae
- *Calamus platyacanthus* Warb.	Poaceae

ANNEX 11

Priority list of tree species of conservation concern in NW (NE Yunnan)

Tree Species	Distribution	Categories
Ginkgoaceae		
Ginkgo biloba	NE Yunnan	EN
Pinaceae		
Abies ernestii var. salouensis	NW Yunnan	VU
Abies georgei	NE and NE Yunnan	VU
Abies georgei var. simthii	C and NE Yunnan	EN
Pinus griffithii	Gongshan of NW Yunnan	VU
Larix speciosa	W and NW Yunnan	VU
Pseudotsuga forrestii	NW Yunnan	CR
Pseudotsuga sinensis	NE Yunnan	VU
Tsuga forrestii	Deqin, Weixi and Lijiang of NW Yunnan	EN
Taxodiaceae		
Taiwania flousiana	W and NW Yunnan	VU
Cupressaceae-		
Sabina (Juniperus) recurva var. coxii	W and NW Yunnan	VU
Podocarpaceae		
Podocarpus forrestii	?	EW(?)
Cephalotaxaceae		
Cephalotaxus fortunei	C, W and NW Yunnan	VU
Cephalotaxus lanceolata	W Yunnan	EN
Cephalotaxus oliveri	W, C and SE Yunnan	VU
Taxaceae		
Taxus yunnanensis	W, NW Yunnan	EN
Torreya yunanensis	Lijiang, Weixi, Zhongdian of Yunnan	EN
Lauraceae		
Phoebe nanmu	S, SW and W Yunnan	VU
Cinnamomum mairei	Zhaotong, Daguan and Yilian of NE Yunnan	EN
Eupteleaceae		
Euptelea pleiosperma	W and NW Yunnan	EN
Tetracentraceae		
Tetracentron sinense	NW, SW, NE and SE Yunnan	VU
Ranunculaceae		
Paeonia lutea	C, W and NW Yunnan	EN
Berberidaceae		
Mahonia salweenensis	W Yunnan	VU
Mahonia taronensis	W Yunnan	VU
Theaceae		
Camellia yunnanensis	W and NW Yunnan	VU
Gordonia yunnanensis	W and NW Yunnan	EN
Rosaceae		
Malus sikkimensis	Lijiang, Weixi and Deqin of NW Yunnan	EN
Leguminosae		
Cercis yunnanensis	W Yunnan	VU
Acrocarpus fraxinifolius	W and SW Yunnan	VU
Meliaceae		
Toona cilliata	W, S and SE Yunnan	EN
Toona microcarpa.	W, NW and S Yunnan	VU

Tree Species	Distribution	Categories
Hamamelidaceae		
Rhodoleia forrestii	W (NW) Yunnan	VU
Betulaceae		
Corylus chinensis	Deqin, Zhongdian, Weixi and Lijiang of NW Yunnan	VU
Eucommiaceae		
Eucommia ulmoides	NW and NE Yunnan	VU
Sapindaceae		
Delavaya yunnanensis	W, S and SE Yunnan	VU
Hippocastanaceae		
Aesculus lantsangensis	W and SW Yunnan	EN
Anacardiaceae		
Mangifera sylvatica	W and SW Yunnan	VU
Juglandaceae		
Juglans regia	Most parts of Yunnan	LR
Pterocarya delavayi	W and NW Yunnan	VU
Davidiaceae		
Davidia involucrata	NW and NE Yunnan	VU
Eriaceae		
Rhododendron haematodes	W Yunnan (only in Cangshan Mt.)	CR
Rhododendron giganteum	W and NW Yunnan	CR
Rhododendron forrestii	W and NW Yunnan	EN
Rhododendron fictolacteum	W and NW Yunnan	VU
Rhododendron gongshanense	W Yunnan	EN
Rhododendron rex	W, SE and NE Yunnan	VU
Compositae		
Nouelia insignis	NW Yunnan	VU
Nyssaceae		
Nyssa sinensis	NE, S and SE Yunnan	VU
Nyssa shweliensis	W and SW Yunnan	EN
Oleaceae		
Syringa yunnanensis	W and NW Yunnan	VU
Osmanthus delavayi	C, W and NW Yunnan	LR
Rubiaceae		
Emmenopterys henryi	C and NE Yunnan	VU
Palmae		
Trachycarpus princeps	NW Yunnan	CR
Trachycarpus nana	C and W Yunnan	VU
Gramineae		
Qiongzhuea tumidinoda	Daguan, Yongshan, yilian of NE Yunnan	EN
Guttiferae		
Garcinia nujianensis	W Yunnan	EN
Tiliaceae		
Tilia chemoui	W Yunnan	EN
Sterculiaceae		
Firmiana major	C to W Yunnan (?)	EW (?)
Pterospermum kingtungense	W Yunnan	EN
Rosaceae		
Amygdalus (Prunus) mira	NW Yunnan	VU
Cercidiphyllaceae		
Cercidiphyllum japonicum var. sinense	NE Yunnan	EN

Tree Species	Distribution	Categories
Thymelaceae		
Edgeworthia garderi	W Yunnan	EN
Cornaceae		
Cornus monbeigii	Lijiang, Zhongdian and Deqin of NW Yunnan	VU

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IUCN
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UNEP

WWF

The World Conservation Monitoring Centre is a joint-venture between the three partners who developed the *World Conservation Strategy* and its successor *Caring for the Earth:* IUCN-The World Conservation Union, UNEP-United Nations Environment Programme, and WWF-World Wide Fund for Nature.