Map 1. Provinces of the Socialist Republic of Vietnam

31. Quang Tri  32. Thua Thien Hue  33. Da Nang  34. Quang Nam  35. Quang Ngai  36. Kon Tum
61. Tra Vinh  62. Soc Trang  63. Bac Lieu  64. Ca Mau
Vietnam Conifers: 
Conservation Status Review 2004

Nguyen Tien Hiep¹, Phan Ke Loc¹, Nguyen Duc To Luu², Philip Ian Thomas³, Aljos Farjon⁴, Leonid Averyanov⁵ and Jacinto Regalado Jr.⁶

In co-operation with
Paul Mathew⁷, Sara Oldfield⁸, Sheelagh O’Reilly⁷, Thomas Osborn⁹ and Steven Swan⁷

Supported by

Darwin Initiative for the Survival of Species

European Union Programme on Tropical Forests and Other Forests in Developing Countries

¹ Institute of Ecology and Biological Resources; 2 Central Forest Seed Company; 3 Royal Botanic Garden Edinburgh; 4 Royal Botanic Gardens, Kew; 5 Komarov Botanical Institute; 6 Missouri Botanical Garden; 7 Fauna & Flora International; 8 Global Trees Campaign; 9 Independent Consultant.
The designation of geographical entities in this document, and the presentation of the material, does not imply any expression on the part of the authors, contributors, or Fauna & Flora International, concerning the legal status of any country, territory or area, its authorities or the delineation of its frontiers and boundaries.

The opinions of the individual authors and contributors do not necessarily reflect the opinion of Fauna & Flora International.

The authors, contributors and Fauna & Flora International take no responsibility for any misrepresentation of material that may result from the translation of this document into any other language.

Published by
Fauna & Flora International, Vietnam Programme

Copyright
© 2004 Fauna & Flora International

Reproduction of any part of this publication for educational, conservation and other non-profit purposes is authorised without prior permission from the copyright holder, provided that the source is fully acknowledged.

Reproduction for resale or other commercial purposes is prohibited without prior written permission from the copyright holder.

Suggested citation

ISBN
1 903703 16 6

Cover illustration
Fokienia in Che Tao Forest, Mu Cang Chai District, Yen Bai Province © Jeremy Holden/FFI

Cover design and Layout
Kimdo Design

Back Cover
1. Amentotaxus yunnanensis © Phan K. Loc
2. Keteleeria davidiana © L. Averyanov
3. Xanthocyparis vietnamensis © L. Averyanov
4. Fokienia hodginsii © L. Averyanov
5. Cephalotaxus mannii © L. Averyanov
6. Podocarpus neriifolius © L. Averyanov
7. Nageia fleuryi © L. Averyanov
8. Cupressus sp. © Nguyen D. To Luu
9. Pseudotsuga sinensis © L. Averyanov
10. Pinus kwangtungensis © L. Averyanov
11. Calocedrus macrolepis © Phan K. Loc

Available from
Fauna & Flora International, Vietnam Programme
IPO Box 78
340 Nghi Tam
Hanoi
VIETNAM
Tel: +84 (0)4 7194117; Fax: +84 (0)4 719 4119
E-mail: hlsp_project@hn.vnn.vn
vietnam@ffi.org.vn
## Contents

**Foreword** ................................................................................................................. ix  
**Conventions Used** ................................................................................................. xi  
**Abbreviations & Acronyms** ................................................................................... xiii  
**Acknowledgements** ............................................................................................... xv  
**Executive Summary** ............................................................................................... xvii  

### Part 1 – An Introduction to Vietnamese Conifers ........................................ 1  
1.1 Vietnamese conifers in a global context ............................................................. 4  
1.2 Evolutionary aspects of Vietnamese conifers ...................................................... 6  
1.3 Distribution and ecology of conifers in Vietnam ................................................. 6  
1.4 Value of conifers in Vietnam ............................................................................... 8  

### Part 2 – Conservation of Vietnamese Conifers ............................................. 11  
2.1 Introduction ........................................................................................................ 13  
2.2 Existing policy and legal framework for conifer conservation in Vietnam .......... 13  
2.3 Conservation importance .................................................................................. 16  
2.4 Threats to conifers in Vietnam ......................................................................... 18  
2.5 General recommendations ............................................................................. 20  

### Part 3 - Profiles of Vietnamese Conifer Species .......................................... 31  

- **CEPHALOTAXACEAE** .............................................................................................. 47  
  - Cephalotaxus mannii ............................................................................................. 47  
  - Descriptive diagram ......................................................................................... 47  
  - Distribution map for Vietnam ......................................................................... 48  

- **CUPRESSACEAE** ................................................................................................... 49  
  - Calocedrus macrolepis ....................................................................................... 49  
  - Descriptive diagram ......................................................................................... 49  
  - Distribution map for Vietnam ......................................................................... 50  
  - Calocedrus rupestris ............................................................................................ 51  
  - Descriptive diagram ......................................................................................... 51  
  - Distribution map for Vietnam ......................................................................... 52  
  - Cunninghamia konishii ....................................................................................... 53  
  - Descriptive diagram ......................................................................................... 53  
  - Distribution map for Vietnam ......................................................................... 54  
  - Cupressus sp. ...................................................................................................... 55  
  - Descriptive diagram ......................................................................................... 55
Distribution map for Vietnam ................................................................. 56

Fokienia hodginsii .................................................................................................................. 57
Descriptive diagram ............................................................................................................. 57
Distribution map for Vietnam ............................................................................................. 58

Glyptostrobus pensilis ............................................................................................................. 60
Descriptive diagram ............................................................................................................. 60
Distribution map for Vietnam ............................................................................................. 61

Taiwania cryptomerioides ..................................................................................................... 63
Descriptive diagram ............................................................................................................. 63
Distribution map for Vietnam ............................................................................................. 64

Xanthocyparis vietnamensis .................................................................................................. 65
Descriptive diagram ............................................................................................................. 65
Distribution map for Vietnam ............................................................................................. 66

PINACEAE ............................................................................................................................. 67
Abies delavayi subsp. fansipanensis ..................................................................................... 67
Descriptive diagram ............................................................................................................. 67
Distribution map for Vietnam ............................................................................................. 68

Keteleeria davidiana ............................................................................................................. 69
Descriptive diagram ............................................................................................................. 69
Distribution map for Vietnam ............................................................................................. 70

Keteleeria evelyniana .......................................................................................................... 71
Descriptive diagram ............................................................................................................. 71
Distribution map for Vietnam ............................................................................................. 72

Pinus dalatensis ..................................................................................................................... 73
Descriptive diagram ............................................................................................................. 73
Distribution map for Vietnam ............................................................................................. 74

Pinus kesiya .......................................................................................................................... 75
Descriptive diagram ............................................................................................................. 75
Distribution map for Vietnam ............................................................................................. 76

Pinus krempfii ....................................................................................................................... 77
Descriptive diagram ............................................................................................................. 77
Distribution map for Vietnam ............................................................................................. 78

Pinus kwangtungensis ......................................................................................................... 79
Descriptive diagram ............................................................................................................. 79
Distribution map for Vietnam ............................................................................................. 80
Contents

Pinus latteri ............................................................................................................................... 81
Descriptive diagram ............................................................................................................... 81
Distribution map for Vietnam ............................................................................................ 82

Pinus wangii ............................................................................................................................ 83

Pseudotsuga sinensis .............................................................................................................. 84
Descriptive diagram .............................................................................................................. 84
Distribution map for Vietnam ............................................................................................ 85

Tsuga chinensis ....................................................................................................................... 86
Descriptive diagram .............................................................................................................. 86
Distribution map for Vietnam ............................................................................................ 87

Tsuga dumosa ........................................................................................................................ 88
Descriptive diagram .............................................................................................................. 88
Distribution map for Vietnam ............................................................................................ 89

PODOCARPACEAE ............................................................................................................... 90
Dacrycarpus imbricatus ......................................................................................................... 90
Descriptive diagram .............................................................................................................. 90
Distribution map for Vietnam ............................................................................................ 91

Dacrydium elatum ................................................................................................................ 92
Descriptive diagram .............................................................................................................. 92
Distribution map for Vietnam ............................................................................................ 93

Nageia fleuryi ......................................................................................................................... 94
Descriptive diagram .............................................................................................................. 95
Distribution map for Vietnam ............................................................................................ 95

Nageia wallichiana ............................................................................................................... 96
Descriptive diagram .............................................................................................................. 96
Distribution map for Vietnam ............................................................................................ 97

Podocarpus neriifolius ........................................................................................................... 98
Descriptive diagram .............................................................................................................. 98
Distribution map for Vietnam ............................................................................................ 99

Podocarpus pilgeri ................................................................................................................ 100
Descriptive diagram ............................................................................................................ 100
Distribution map for Vietnam .......................................................................................... 101

TAXACEAE .......................................................................................................................... 102
Amentotaxus argotaenia ....................................................................................................... 102
Amentotaxus hatuyenensis ............................................................................................... 104
Descriptive diagram .......................................................................................................... 104
Distribution map for Vietnam .......................................................................................... 105

Amentotaxus poilanei ........................................................................................................ 106
Descriptive diagram .......................................................................................................... 106
Distribution map for Vietnam .......................................................................................... 106

Amentotaxus yunnanensis ............................................................................................... 108
Descriptive diagram .......................................................................................................... 108
Distribution map for Vietnam .......................................................................................... 109

Taxus chinensis ................................................................................................................... 110
Descriptive diagram .......................................................................................................... 110
Distribution map for Vietnam .......................................................................................... 111

Taxus wallichiana ............................................................................................................. 112
Descriptive diagram .......................................................................................................... 112
Distribution map for Vietnam .......................................................................................... 113

References ....................................................................................................................... 114

Annexes

1 2001 (version 3.1) criteria for Critically Endangered, Endangered and Vulnerable categories of the IUCN Red List of Threatened Species ............................................................................. 120

List of Boxes

Box 1 Indigenous Vietnamese conifer species and their existing and revised threat statuses at global and national levels ...................................................... xxiv
Box 2 Protected conifer species of Vietnam following national Decrees 18 and 48, together with proposed global and national conservation statuses................................................................. 15

List Of Maps

Map 1 Provinces of the Socialist Republic of Vietnam............................. inside front cover
Map 2 Major distributions zones of Vietnamese conifers................................. 6

List of Plates

Plate I Amentotaxus spp., Calocedrus macrolepis and Calocedrus rupestris........ 33
Plate II  Cephalotaxus manii ................................................................. 34
Plate III  Cunninghamia konishii and Cupressus sp. .......................... 35
Plate IV  Dacrycarpus imbricatus and Dacrydium elatum .................. 36
Plate V   Fokienia hodginsii .............................................................. 37
Plate VI   Keteleeria davidiana and Nageia fleuryi ............................ 38
Plate VII  Nageia wallichiana .......................................................... 39
Plate VIII Pinus dalatensis ................................................................ 40
Plate IX   Pinus krempfii and Pinus kwangtungensis ......................... 41
Plate X   Podocarpus neriifolius and Podocarpus pilgeri ................. 42
Plate XI   Pseudotsuga sinensis ......................................................... 43
Plate XII  Taiwania cryptomerioides, Taxus chinensis and Taxus wallichiana ...... 44
Plate XIII Tsuga chinensis and Xanthocyparis vietnamensis ............. 45

List of Tables

Table 1  10 Priority Species for Conservation Action ...................... xix
Table 2  Vietnamese conifer flora in a global context ....................... 5
Table 3  Contributions the 2004 Vietnam Conifer Conservation Status
        Review makes to the Global Plant Strategy for Plant Conservation
        of the Convention on Biological Diversity .................................. 16
Table 4  Simplified overview of thresholds for the IUCN Red List Criteria ..... 120
Foreword

The conifers are a natural (monophyletic) group of plants with around 630 species and with disproportionately high ecological and economical value. They occur on all continents except Antarctica (where they are known from the fossil record) and in nearly all major forest biomes, several of which are dominated by conifers. Although many species are widespread with millions or even trillions of individual trees, at least 25% of all species are threatened with extinction. New species and even new genera are still being discovered from time to time in remote areas, adding to the list of rare and threatened conifers. Conifers play a major role in forestry; the majority of sawn timbers in the world’s economy come from conifers. In horticulture and amenity planting conifers play a similarly important role, with many new cultivars being generated and registered each year.

The threats to the survival of conifers as species are manifold, but a few major facts and trends can be highlighted. As is true for many other taxonomic groups, the number of species tends to increase from the cool temperate zones towards the tropics. For conifers, this means that the ‘hotspots’ are either in subtropical or in tropical zones, largely confined to mountainous regions. Many of these areas coincide with high density of human population, exploitation of natural resources such as timber, and potentially irreversible alterations of ecosystems on which these conifers depend. Habitat loss or degradation is the most frequently recurring factor in assessments of threat to conifers, if they are not threatened downright by their very limited number of living individuals, as many species are. Exploitation for valuable wood is a second important factor. Unlike the large scale exploitation of some northern conifers, which if well managed at least have the potential to regrow (renewable resource), many subtropical and tropical species are scarce to begin with, grow slowly and thrive in relatively undisturbed forests only. Their harvest on a large scale is unsustainable, but is becoming more pressing as demand and access to international markets increase year on year.

In 1999, the Conifer Specialist Group of IUCN/SSC published its Status Survey and Conservation Action Plan (Farjon & Page, 1999). It contains an assessment of the global situation for conifers, including a Global Red List, as well as general recommendations for conservation. In addition, several regional reports or conifer action plans were published in it. The Conifer Action Plan formulated several recommendations. The first is, to continue with the evaluation of the conservation status of conifers. Not all species were assessed and several were still ‘data deficient’. The present report is an important contribution to that aim, because now all Vietnamese conifers have been evaluated, both on a national and on a global scale. Vietnam did not count as a conifer hotspot in the Conifer Action Plan of 1999, but this current work has changed that. Vietnam is now recognised as one of 10 conifer hotspots in the world. Another recommendation was to integrate *in situ* and *ex situ* conservation. The work outlined in this book demonstrates, that Vietnam is now in the forefront of this integrated effort to conserve its conifers.

At the time of compiling the Conifer Action Plan, I remember that one of the things the IUCN most wanted us to do was to persuade people and organisations in the conifer hotspots to compile and engage in regional action plans for conifers. The contributions in the Conifer Action Plan were the result. It was not easy. Most contributions represent first
beginnings, and are far from complete. For many major hotspot areas we could not get the people, few as they are in the membership of the Conifer Specialist Group, to start a regional report. It is therefore doubly encouraging to see this book on the conifers of Vietnam and their conservation coming to fruition. It is a very substantial step towards a complete, functioning Status Survey and Conservation Action Plan for the Conifers of Vietnam. Here, too, Vietnam suddenly finds itself in the forefront of conifer conservation developments. I very much hope that it will eventually lead to successful conservation in the wild of Vietnam’s remarkable diversity of conifers.

Aljos Farjon FLS

Chairman, IUCN/SSC Conifer Specialist Group,
Conifer taxonomist,
Royal Botanic Gardens, Kew, England
Conventions Used

Climate
All climatic data presented follows the Bioclimatic Diagrams of Vietnam (Nguyen Khanh Van et al., 2000).

Vegetation types
Altitudinally zoned forest types follow the International Classification and Mapping of Vegetation (UNESCO, 1973), with modified altitudinal ranges as accepted by the National Atlas of Vietnam (Nguyen Van Chien, (ed.) 1997):

0 to 600-700 m amsl – lowland forest;
600-700 to 1500-1600 m amsl – submontane forest;
1500-1600 to 2600 m amsl – montane forest,
2600 to 3143 m amsl (the highest peak of Vietnam - Mt. Fan Si Pan) – subalpine forest.

Taxonomy
Conifer taxonomy follows the World Checklist and Bibliography of Conifers, 2nd edition (Farjon, 2001) with modifications from the Conifers of Vietnam (Nguyen Duc To Luu & Thomas, 2004). Notes on specific taxonomic issues are presented under relevant species profile in Part III.
Citation of species authorities follows Authors of Plant Names (Brummitt & Powell, (eds.) 1992).

Conservation status
Global conservation status - follows the IUCN Red List of Threatened Species (IUCN, 2004), which (except for Amentotaxus hatuyenensis, A. poilanei and Xanthocyparis vietnamensis, which have been assessed using IUCN 2001 criteria) presents assessments from version 2.3 of the red list, based on IUCN (1994) criteria. The global conservation status of a number of Vietnamese conifer species has been recently reassessed by the IUCN-SSC Conifer Specialist Group (CSG) (Farjon et al., 2004b) using IUCN (2001) criteria. These revisions should be considered as provisional yet legitimate proposals to the IUCN (2004) Red List of Threatened Species. Throughout this review, these proposed global assessments are presented in square brackets [ ].


Proposed national conservation status – new CSG assessments, using IUCN (2001) criteria are presented in this report.

Vietnamese Provincial Names – follow those shown in Map 1.
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAP</td>
<td>Biodiversity Action Plan</td>
</tr>
<tr>
<td>c.</td>
<td>circa</td>
</tr>
<tr>
<td>CBD</td>
<td>Convention on Biological Diversity</td>
</tr>
<tr>
<td>CEH</td>
<td>Centre for Ecology and Hydrology</td>
</tr>
<tr>
<td>CFSC</td>
<td>Central Forest Seed Company</td>
</tr>
<tr>
<td>CITI</td>
<td>Convention on International Trade in Endangered Species of Wild Fauna and Flora</td>
</tr>
<tr>
<td>CRES</td>
<td>Centre for Natural Resources and Environmental Studies</td>
</tr>
<tr>
<td>CSG</td>
<td>Conifer Specialist Group</td>
</tr>
<tr>
<td>DANIDA</td>
<td>Danish International Development Agency</td>
</tr>
<tr>
<td>dbh</td>
<td>diameter at breast height</td>
</tr>
<tr>
<td>DEFRA</td>
<td>UK Government Department for Environment, Food and Rural Affairs</td>
</tr>
<tr>
<td>DFSC</td>
<td>DANIDA Forest Seed Centre</td>
</tr>
<tr>
<td>EIA</td>
<td>Environmental Impact Assessment</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
</tr>
<tr>
<td>FDD</td>
<td>Forest Development Department</td>
</tr>
<tr>
<td>FFI</td>
<td>Fauna &amp; Flora International</td>
</tr>
<tr>
<td>FIPI</td>
<td>Forest Inventory and Planning Institute</td>
</tr>
<tr>
<td>FPD</td>
<td>Forest Protection Department</td>
</tr>
<tr>
<td>FSIV</td>
<td>Forest Science Institute of Vietnam</td>
</tr>
<tr>
<td>GoV</td>
<td>Government of Vietnam</td>
</tr>
<tr>
<td>GSPC</td>
<td>Global Strategy for Plant Conservation of the CBD</td>
</tr>
<tr>
<td>GTC</td>
<td>Global Trees Campaign</td>
</tr>
<tr>
<td>IEBR</td>
<td>Institute of Ecology and Biological Resources of the Vietnam Academy of Science and Technology</td>
</tr>
<tr>
<td>IUCN</td>
<td>The World Conservation Union</td>
</tr>
<tr>
<td>IUCN-SSC</td>
<td>Species Survival Commission of the IUCN</td>
</tr>
<tr>
<td>KBI</td>
<td>Komorov Botanical Institute of the Russian Academy of Sciences</td>
</tr>
<tr>
<td>m amsl</td>
<td>metres above mean sea level</td>
</tr>
<tr>
<td>MARD</td>
<td>Ministry of Agriculture and Rural Development</td>
</tr>
<tr>
<td>MBG</td>
<td>Missouri Botanical Garden</td>
</tr>
<tr>
<td>NP</td>
<td>National Park</td>
</tr>
<tr>
<td>NR</td>
<td>Nature Reserve</td>
</tr>
<tr>
<td>NTFP</td>
<td>Non-Timber Forest Product</td>
</tr>
<tr>
<td>ODA</td>
<td>Overseas Development Assistance</td>
</tr>
<tr>
<td>RBGE</td>
<td>Royal Botanic Garden Edinburgh</td>
</tr>
<tr>
<td>Rbgk</td>
<td>Royal Botanic Gardens, Kew</td>
</tr>
<tr>
<td>SFE</td>
<td>State Forest Enterprise</td>
</tr>
<tr>
<td>sp.</td>
<td>Species (singular)</td>
</tr>
<tr>
<td>spp.</td>
<td>Species (plural)</td>
</tr>
<tr>
<td>subsp.</td>
<td>Subspecies</td>
</tr>
<tr>
<td>SUF</td>
<td>Special-use Forest</td>
</tr>
<tr>
<td>UK</td>
<td>United Kingdom of Great Britain and Northern Ireland</td>
</tr>
</tbody>
</table>
IUCN Conservation Status Categories

<table>
<thead>
<tr>
<th>Code</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>EW</td>
<td>Extinct in the Wild</td>
</tr>
<tr>
<td>CR</td>
<td>Critically Endangered</td>
</tr>
<tr>
<td>EN</td>
<td>Endangered</td>
</tr>
<tr>
<td>VU</td>
<td>Vulnerable</td>
</tr>
<tr>
<td>DD</td>
<td>Data Deficient</td>
</tr>
<tr>
<td>NT</td>
<td>Near Threatened</td>
</tr>
<tr>
<td>LC</td>
<td>Least Concern</td>
</tr>
<tr>
<td>NE</td>
<td>Not Evaluated</td>
</tr>
</tbody>
</table>

[ ] Indicates proposed revisions to the IUCN (2004) Red List of Threatened Species based on recent assessments made by the IUCN-SSC CSG using IUCN (2001) criteria (Farjon et al., 2004b).

Species Distribution Map Legend

- Record with voucher specimen
- Record without voucher specimen
Acknowledgements

This review represents the outcome of extensive collaboration by scientists, research institutions, government agencies and donor funded biodiversity conservation projects from the European Union (EU), Russia, the United Kingdom (UK), the United States of America (USA) and Vietnam. These scientists, their institutions, government agencies and projects gratefully acknowledge funding from:

- The Darwin Initiative of the Department of Environment, Fisheries and Agriculture (DEFRA, United Kingdom) which provided funding for two projects which facilitated cooperation in the production of this publication:
  - The first was the project ‘Preservation, rehabilitation and utilisation of Vietnamese montane forests (162/10/017)’. That led to the production of the manual ‘Conifers of Vietnam’ produced by the Ministry of Agriculture and Rural Development (MARD, Vietnam), the Darwin Initiative of the Department of Environment, Fisheries and Agriculture (DEFRA, United Kingdom), the Royal Botanic Garden Edinburgh (RBGE), the Centre for Ecology and Hydrology (CEH, Scotland) and the Central Forest Seed Company (CFSC). The team acknowledges the extensive use of that publication as a basis for this Conservation Status Review.
  - The second was the project ‘Community based conservation of Hoang Lien Mountain Ecosystem, Vietnam’ (162/10/011) undertaken by FFI Vietnam with Lao Cai Forest Protection Department and the Global Trees Campaign of FFI. This facilitated fieldwork in Van Ban District, Lao Cai Province in relation to *Taiwania* and work on *Fokienia* in the Hoang Lien Mountains of north-western Vietnam.

- Information on *ex situ* conservation and assessment of *Pinus lateri* is also compiled from results of Vietnam Tree Seed Project supported by DANIDA.

- Data on conifers gathered from many years of fieldwork and herbarium studies that are presented in this review by Leonid Averyanov, Nguyen Tien Hiep, Phan Ke Loc, and Jacinto Regalado, Jr. were supported by grants from the US National Science Foundation (grant #DEB-9870231), US National Geographic Society (grants #5094-93, 5803-96, 6383-98, 6300-98, 6733-00), American Orchid Society, San Diego County Orchid Society Conservation Committee, Henry Luce Foundation, John D. and Catherine T. MacArthur Foundation (grant #03-75920), International Cooperative Biodiversity Group (NIH grant #1-UO1-TW01015-01), Fauna & Flora International Vietnam Programme, and the Basic Research Program in Natural Science of Vietnam (grants # 6.110.01, 6.128.04).

- The European Union funding for the project ‘Community-based conservation of the Hoang Lien Son Mountain Ecosystem’ (Contract No. AIDCO/B7-6200/01/34/TF) managed by FFI Vietnam in conjunction with the Forest Protection Departments of Lao Cai, Son La and Yen Bai Provinces as well as the Hoang Lien NP which has provided the platform for the production of this publication.
The co-ordination of this work would not have been possible across continents, time zones as well as professional disciplines without the invaluable input of the Global Trees Campaign managed by FFI from Cambridge, UK. This input has been supported by British American Tobacco both for field work in Lao Cai Province and for the production and translation of this review. The production team are extremely grateful to Aljos Farjon, Chairman of the World Conservation Union – Species Survival Commission (IUCN-SSC) Conifer Specialist Group (CSG) and Conifer taxonomist at the Royal Botanic Gardens, Kew for the additional taxonomic discussion and foreword of this review.

Lastly, but by no means least much of the extensive field work necessary for the collection of data for this Conifer Status Review would not have been possible without the support of Provincial and District authorities in Vietnam and the invaluable assistance and warm welcome teams have received from local people throughout the country. The interest shown by local people in the fieldwork gives a strong indication that the inclusion of these people in the management of the long-term conservation of conifers in Vietnam will lead to successful outcomes for many trees.
1. Mature *Taiwania cryptomerioides* in Van Ban District, Lao Cai Province. Copyright Nguyen An Toan /FFI

2-5. Mapping of *Taiwania* in Van Ban District, Lao Cai Province. Copyright Nguyen An Toan /FFI
Executive Summary

Conservation Status Of Vietnamese Conifers

- Over 40 % (14/33) of Vietnam’s indigenous conifer species are listed as globally threatened.
- Nearly 90 % (29/33) of the species that constitute Vietnam’s conifer flora have been assessed as threatened at the national level.
- Box 1 summarises existing and proposed conservation statuses of all Vietnam’s indigenous conifer species.
- Vietnam qualifies as one of the top 10 global conifer conservation ‘hotspots’, as defined by the IUCN Conifer Conservation Action Plan.
- Only two conifer taxa in Vietnam are currently not listed as threatened or near-threatened due to uncertainties of taxonomic identity; one, Cupressus sp., may already be extinct in the wild before its specific identity has been determined.
- Table 1 gives a list of 10 priority species for conservation action.

Table 1  10 Priority Species of Vietnamese Conifer for Conservation Action

<table>
<thead>
<tr>
<th>Species</th>
<th>Conservation Status</th>
<th>Justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glyptostrobus pensilis</td>
<td>DD [EN] CR</td>
<td>Monotypic genus with high scientific importance – remaining populations have a very high probability of extinction due to small size and vulnerability of habitats and lack of regeneration.</td>
</tr>
<tr>
<td>Taiwania cryptomerioides</td>
<td>VU CR</td>
<td>Monotypic genus with high scientific importance; critical state of only known stand; high timber value with potential use in montane forestry</td>
</tr>
<tr>
<td>Xanthocyparis vietnamensis</td>
<td>CR CR</td>
<td>Endemic with high scientific importance</td>
</tr>
<tr>
<td>Fokienia hodginsii</td>
<td>NT EN</td>
<td>Monotypic genus with high economic, cultural and scientific value; over-exploitation may cause it to become critically endangered</td>
</tr>
<tr>
<td>Cunninghamia konishii</td>
<td>VU EN</td>
<td>High timber value with potential use in montane forestry</td>
</tr>
<tr>
<td>Pinus latteri</td>
<td>NT EN</td>
<td>High forestry and NTFP value</td>
</tr>
<tr>
<td>Cupressus sp.</td>
<td>NE DD</td>
<td>High timber and NTFP value; has potential for localised sustainable use for income generation for local people through incense production</td>
</tr>
<tr>
<td>Calocedrus macrolepis</td>
<td>VU EN</td>
<td>Highly threatened by overexploitation for their valuable timber and NTFPs</td>
</tr>
<tr>
<td>Calocedrus rupestris</td>
<td>NE [EN] EN</td>
<td>Highly threatened by overexploitation for their valuable timber and NTFPs</td>
</tr>
<tr>
<td>Pinus krempfii</td>
<td>VU VU</td>
<td>Internationally renowned endemic species with high scientific value</td>
</tr>
</tbody>
</table>

Notes: Global conservation status follows IUCN (2004), with provisional revisions in square brackets [ ] following Farjon et al. (2004b).
Background

- The purpose of this review is to assist botanists, conservationists, natural resource managers, decision and policy makers, and potential funding agencies in focusing efforts and resources for the protection and sustainable use of conifers in Vietnam.

- In response to limited and scattered information, this document reviews all accessible data on the conservation status of conifers indigenous to Vietnam.

- In a wider strategic context, this review uses conifers as ‘flagship species’ for the protection of forest biodiversity in Vietnam.

- The review is organised into three parts: Part 1 – An Introduction to Vietnamese Conifers; Part 2 – Conservation of Vietnamese Conifers; and Part 3 – Profiles of Vietnamese Conifer Species.

- This review is the result of an international collaboration between world and national authorities on botany and conservation.

- This publication is an addition to the existing series of Vietnamese conservation status reviews already produced by Fauna & Flora International and its partners for: gibbons, leaf monkeys and elephants.

Introduction To Vietnamese Conifers

- 33 species of conifer are recognised as indigenous to Vietnam.

- In recent years, the Vietnamese coniferous flora has been expanded by a number of new records for the country together with discoveries of a number of new species for science.

- The biogeography of the Vietnamese coniferous fauna is characterised by three distinct elements: ancient relictual taxa in the climatic refugia of the country’s mountainous areas; endemic species, representing approximately one quarter of the flora; and tropical podocarps, with their origins in the southern hemisphere.

- Conifers in Vietnam are distributed in four main, upland, areas: 1) the north-west; 2) the Hoang Lien Mountains; 3) limestone mountains of north and north-east Vietnam; 4) the Central Highlands (see Map 2 for details).

- A number of values of Vietnamese conifers are identified and briefly introduced, including ecological, commercial, subsistence and cultural. The conservation value of Vietnamese conifers is discussed in more detail in section 2.3.
Conservation Of Vietnamese Conifers

• The conservation of Vietnamese Conifers is discussed in the context of national and international policy and legal frameworks.


• The substantial and varied threats to the conifers of Vietnam are presented and include: unsustainable levels of commercial and subsistence logging, non-timber product exploitation, fire, agricultural encroachment, infrastructure development, hybridisation with introduced exotic species, together with genetic and reproductive problems inherent to small, fragmented populations of ecologically stressed trees.

Recommendations

• The review highlights the threats faced by Vietnamese conifers and provides generic (section 2.3) and specific recommendations (Part 3) to remove or significantly reduce these threats.

• Conservation actions should be guided by status assessment-based prioritisation of conifer species in Vietnam presented in this review (see Table 1).

• Recommendations for Research and Information Management:
  i. Conduct further surveys in order to ascertain comprehensive distributions for taxa, population sizes and continually assess conservation status;
  ii. Establish a national conifer specialist group for regular monitoring of conifer conservation status in Vietnam;
  iii. Develop training modules on collection of specimens for identification by specialists for Forest Protection Department staff at province and district level;
  iv. Disseminate recent research findings on location and management of conifers in Vietnam through particular use of computer information technologies;
  v. Resolve issues of conifer taxonomy through collaboration between national conifer specialist group and international experts;
  vi. Conduct further ecological research of the 10 species for priority action (see Table 1) to support both in- and ex situ conservation interventions.
• **Recommendations for Capacity Building and Awareness Raising**
  
  i. **Develop a technical training programme** and materials for staff of relevant government agencies at all levels on conifer specimen collection, identification and conservation;
  
  ii. **Develop awareness-raising programmes** targeting stakeholders at different levels within government agencies;
  
  iii. **Raise awareness of conifer conservation issues**, using appropriate media, among local communities living near (and using) important populations of threatened species;
  
  iv. Promote active involvement of local communities in conifer conservation projects.

• **Recommendations for National Policy and Legislation Development**
  
  i. **Update national legislation** in line with revised conservation statuses presented in this review;
  
  ii. **Develop new legislation** prohibiting large-scale commercial logging, and tightly controlling local subsistence logging, of threatened conifer species;
  
  iii. **Conduct research into the national and international trade of conifer timbers** in order to provide recommendations for inclusion in relevant national and international legislation, including CITES.

• **Recommendations for National Legislation Implementation and Enforcement**
  
  i. Through co-ordination of Provincial People’s Committees, **ensure effective co-operation between relevant government agencies** to prioritise and integrate forest protection across all sectors;
  
  ii. **Enforce forest protection laws** through relevant state agencies staffed by adequately informed, trained, motivated and appropriately paid staff;
  
  iii. Check transportation of illegally processed and unprocessed conifer products at guard posts on protected and special-use forest access points;
  
  iv. **Patrol and monitor areas of high importance** for conifer conservation, either by regular Forest Protection Department (FPD) staff, and/or local community-based monitoring groups as extensions of FPD operations.

• **Recommendations for Protected Area Development and Management**
  
  i. **Develop new protected areas**, including state-run and collaboratively managed special-use forests, together with community managed areas, for priority conifer species with restricted distributions;
  
  ii. **Build capacity of protected area staff** in general adaptive management planning for sites with important populations of priority species;

• **Recommendations for State Forest Enterprise Restructuring and Management**
  
  i. **Mainstream conifer conservation** into restructuring of State Forest Enterprises (SFE).
• **Recommendations for Sustainable Use**
  
i. **Study the economics of different types of plantation programmes** to assess which species are suitable for sustainable use and how benefits should be shared among investing stakeholders;

  ii. **Develop timber certification schemes** with identified producers and processors;

  iii. **Assess new, and develop existing markets for** sustainable use of non-timber conifer products in relation to market value and input into local livelihoods.

  iv. **Link** development of conifers for sustainable use to **valid land allocation** to local communities and households.

• **Recommendations for integrating rural livelihood development with conifer conservation**
  
i. **Develop silvicultural practices for community-managed sites** that integrate conifer conservation, watershed management and rural livelihood development;

  ii. **Conduct participatory socio-economic research** in areas where threats to conifers are particularly high to highlight issues regarding demographics, poverty, education, traditional cultural practices, land use patterns, crop structures, forest dependence and conifer use where appropriate;

  iii. **Mainstream conifer conservation** into rural development projects where appropriate;

  iv. **Conduct**, and act on the recommendations provided by, **Environmental Impact Assessments for infrastructure development** in areas where conifer conservation is an identified priority.

  v. **Facilitate the development of small-medium sized processing/craft enterprises** in remoter areas that can utilise the products from well managed, and if necessary certified, plantations under local sustainable management regimes.

• **Recommendations for Ex situ Propagation**
  
i. **Promote research on vegetative and reproductive silviculture and propagation** for conifer species that display limited natural regeneration;

  ii. **Assess potential of cultivated conifers** for new timber, non-timber and ornamental tree markets.

• **Recommendation for Living Gene Banks**
  
i. **Identify, and strictly protect, indigenous tree seed sources**, particularly for conifers with possible commercial potential, as part of both in- and ex situ conservation programmes.
**Box 1  Indigenous Vietnamese conifer species and their existing and revised conservation statuses at global and national levels**

<table>
<thead>
<tr>
<th>FAMILY/SPECIES</th>
<th>CONSERVATION STATUS</th>
<th>GLOBAL</th>
<th>EXISTING NATIONAL</th>
<th>PROPOSED NATIONAL</th>
<th>SPECIES PROFILE/PLATE (page no.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CEPHALOTAXACEAE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cephalotaxus mannii</td>
<td>VULNERABLE A1d</td>
<td>RARE²</td>
<td>VULNERABLE A2cd B1ab(i-v), B2ab(i-v), C1</td>
<td>47 / 34</td>
<td></td>
</tr>
<tr>
<td><strong>CUPRESSACEAE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calocedrus macrolepis</td>
<td>VULNERABLE B1+2b</td>
<td>ENDANGERED</td>
<td>ENDANGERED A2acd, A3cd, B2ab(i-v) C2a(i)</td>
<td>49 / 33</td>
<td></td>
</tr>
<tr>
<td>Calocedrus rupestris</td>
<td>NOT EVALUATED [ENDANGERED A2cd, C1]</td>
<td>NOT EVALUATED</td>
<td>ENDANGERED A2cd, C1</td>
<td>51 / 33</td>
<td></td>
</tr>
<tr>
<td>Cunninghamia konishii</td>
<td>VULNERABLE A1c</td>
<td>RARE²</td>
<td>ENDANGERED A2c, B2ab(i-v)</td>
<td>53 / 35</td>
<td></td>
</tr>
<tr>
<td>Capressus sp.</td>
<td>NOT EVALUATED</td>
<td>RARE²</td>
<td>DATA DEFICIENT</td>
<td>55 / 35</td>
<td></td>
</tr>
<tr>
<td>Fokienia hodginsii</td>
<td>NEAR-THREATENED</td>
<td>INSUFFICIENTLY KNOWN</td>
<td>ENDANGERED A2cd</td>
<td>57 / 37</td>
<td></td>
</tr>
<tr>
<td>Glyptostrobus pensilis</td>
<td>DATA DEFICIENT [ENDANGERED B1ab(i-iv), B2ab (i-iv), D]</td>
<td>ENDANGERED</td>
<td>CRITICALLY ENDANGERED A2c, B1ab(i-v), B2ab(i-v) C1</td>
<td>60 / NA</td>
<td></td>
</tr>
<tr>
<td>Taiwania cryptomerioides</td>
<td>VULNERABLE A1d</td>
<td>NOT EVALUATED</td>
<td>CRITICALLY ENDANGERED A2c, B1ab(i-v), B2ab(i-v), C2a(ii)</td>
<td>63 / 44</td>
<td></td>
</tr>
<tr>
<td>Xanthocyparis vietnamensis</td>
<td>CRITICALLY ENDANGERED B2ab(v) [CRITICALLY ENDANGERED B1ab(ii-v), 2ab(ii-v)]</td>
<td>NOT EVALUATED</td>
<td>CRITICALLY ENDANGERED B1ab(ii-v), 2ab(ii-v)</td>
<td>65 / 45</td>
<td></td>
</tr>
<tr>
<td><strong>PINACEAE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abies delavayi</td>
<td>LEAST CONCERN</td>
<td>RARE</td>
<td>VULNERABLE D1</td>
<td>67 / NA</td>
<td></td>
</tr>
<tr>
<td>Keteleeria davidiana</td>
<td>LEAST CONCERN</td>
<td>ENDANGERED</td>
<td>ENDANGERED A2cd, B1ab(iii), B2ab(ii), D</td>
<td>69 / 38</td>
<td></td>
</tr>
<tr>
<td>Keteleeria evelyniana</td>
<td>LEAST CONCERN</td>
<td>VULNERABLE</td>
<td>VULNERABLE A2cd</td>
<td>71 / NA</td>
<td></td>
</tr>
<tr>
<td>Pinus dalatensis</td>
<td>VULNERABLE B1+2c</td>
<td>RARE</td>
<td>VULNERABLE B1ab(ii-iv), 2ab(iii-v)</td>
<td>73 / 40</td>
<td></td>
</tr>
<tr>
<td>Pinus kesiya</td>
<td>NOT EVALUATED</td>
<td>NOT EVALUATED</td>
<td>LEAST CONCERN</td>
<td>75 / NA</td>
<td></td>
</tr>
</tbody>
</table>
## Conservation Status of Vietnamese Conifers

### Executive Summary

The Vietnam Conifer Conservation Status Review 2004, and the actions proposed therein, makes international policy and legal frameworks.

### Family/Species Global Existing National Proposed National Species Profile/Plate (Page no.)

<table>
<thead>
<tr>
<th>Family/Species</th>
<th>Global</th>
<th>Existing National</th>
<th>Proposed National</th>
<th>Species Profile/Plate (page no.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pinus krempfi</td>
<td>VULNERABLE B1+2c [VULNERABLE B1ab(i-iii), 2ab(i-iii)]</td>
<td>RARE</td>
<td>VULNERABLE B1ab(i-iii), 2ab(i-iii)</td>
<td>77 / 41</td>
</tr>
<tr>
<td>Pinus kwangtungensis</td>
<td>NEAR-THREATENED³</td>
<td>VULNERABLE</td>
<td>VULNERABLE A2acd, C1</td>
<td>79 / 41</td>
</tr>
<tr>
<td>Pinus latteri</td>
<td>NEAR-THREATENED</td>
<td>NOT EVALUATED</td>
<td>ENDANGERED A2cd</td>
<td>81 / NA</td>
</tr>
<tr>
<td>Pinus wangii</td>
<td>ENDANGERED B1+2bd</td>
<td>NOT EVALUATED</td>
<td>DATA DEFICIENT</td>
<td>83 / NA</td>
</tr>
<tr>
<td>Pseudotsuga sinensis</td>
<td>VULNERABLE B1+2c</td>
<td>NOT EVALUATED</td>
<td>VULNERABLE A2acd</td>
<td>84 / 43</td>
</tr>
<tr>
<td>Tsuga chinensis</td>
<td>LEAST CONCERN</td>
<td>NOT EVALUATED</td>
<td>ENDANGERED C1</td>
<td>86 / 45</td>
</tr>
<tr>
<td>Tsuga dumosa</td>
<td>LEAST CONCERN</td>
<td>RARE</td>
<td>VULNERABLE A3c, B1ab(iii), B2ab(iii), D2</td>
<td>88 / NA</td>
</tr>
<tr>
<td><strong>Podocarpaceae</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dacrycarpus imbricatus</td>
<td>LEAST CONCERN</td>
<td>NOT EVALUATED</td>
<td>VULNERABLE A2cd</td>
<td>90 / 36</td>
</tr>
<tr>
<td>Dacrydium elatum</td>
<td>LEAST CONCERN</td>
<td>NOT EVALUATED</td>
<td>VULNERABLE A2cd</td>
<td>92 / 36</td>
</tr>
<tr>
<td>Nageia fleuryi</td>
<td>DATA DEFICIENT</td>
<td>VULNERABLE</td>
<td>VULNERABLE A2ac, B1ab(iii,v), B2ab(iii,v), C1, C2a(i)</td>
<td>94 / 36</td>
</tr>
<tr>
<td>Nageia wallichiana</td>
<td>LEAST CONCERN</td>
<td>VULNERABLE</td>
<td>VULNERABLE A2ac, B1ab(iii,v), B2ab(iii,v), C1, C2a(i)</td>
<td>96 / 39</td>
</tr>
<tr>
<td>Podocarpus nerifolius</td>
<td>LEAST CONCERN</td>
<td>NOT EVALUATED</td>
<td>LEAST CONCERN</td>
<td>98 / 42</td>
</tr>
<tr>
<td>Podocarpus pilgeri</td>
<td>NOT EVALUATED</td>
<td>RARE</td>
<td>VULNERABLE A2ac</td>
<td>100 / 42</td>
</tr>
<tr>
<td><strong>Taxaceae</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amentotaxus argotaenia</td>
<td>VULNERABLE A1c</td>
<td>RARE</td>
<td>VULNERABLE A2c, B1ab(i-v)</td>
<td>102 / 33</td>
</tr>
<tr>
<td>Amentotaxus hatuyenensis</td>
<td>ENDANGERED A2c</td>
<td>RARE</td>
<td>ENDANGERED B1ab(iii)</td>
<td>104 / 33</td>
</tr>
<tr>
<td>FAMILY/SPECIES</td>
<td>GLOBAL</td>
<td>EXISTING NATIONAL</td>
<td>PROPOSED NATIONAL</td>
<td>SPECIES PROFILE/PLATE (page no.)</td>
</tr>
<tr>
<td>------------------------</td>
<td>-------------</td>
<td>-------------------</td>
<td>-------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>Amentotaxus poilanei</td>
<td>VULNERABLE</td>
<td>THREATENED</td>
<td>VULNERABLE</td>
<td>106 / 33</td>
</tr>
<tr>
<td></td>
<td>A2c</td>
<td></td>
<td>D1</td>
<td></td>
</tr>
<tr>
<td>Amentotaxus yunnanensis</td>
<td>ENDANGERED</td>
<td>THREATENED</td>
<td>VULNERABLE</td>
<td>108 / 33</td>
</tr>
<tr>
<td></td>
<td>A1c</td>
<td></td>
<td>B1ab(i-v)</td>
<td></td>
</tr>
<tr>
<td>Taxus chinensis</td>
<td>NOT EVALUATED [LEAST CONCERN]</td>
<td>RARE</td>
<td>VULNERABLE</td>
<td>110 / 44</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>A2ac, B2a(i-v),b(i-v).</td>
<td></td>
</tr>
<tr>
<td>Taxus wallichiana</td>
<td>DATA DEFICIENT [LEAST CONCERN]</td>
<td>RARE</td>
<td>ENDANGERED</td>
<td>112 / 44</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C1</td>
<td></td>
</tr>
</tbody>
</table>

Notes
Taxonomic issues: 1. assessed as Cephalotaxus hainanensis; 2. assessed as Cupressus funebris; 3. assessed as Pinus fenzeliana.

Global conservation status: follows IUCN (2004), which, (except for Amentotaxus hatuyenensis, A. poilanei and Xanthocyparis vietnamensis, which have been assessed using IUCN 2001 criteria), provides conservation statuses based on IUCN (1994) criteria. Statuses presented in square brackets [ ] are recent revisions made by the IUCN-SSC Conifer Specialist Group (CSG) (Farjon et al., 2004b) using IUCN (2001) criteria (See Annex 1). As such, these reassessments should be considered as legitimate, yet provisional, proposals to the IUCN (2004) Red List of Threatened Species.

Existing national conservation status: follows Vietnam Red Data Book for plants (Anon., 1996). Vietnamese threat status categories approximate to those of IUCN as follows – ‘Endangered’ = Critically Endangered and Endangered; ‘Vulnerable’ = Vulnerable; ‘Rare’ = no IUCN equivalent; ‘Threatened’ = Near-threatened; ‘Insufficiently Known’ = Data Deficient. Note that existing Vietnamese conservation status assessments do not use IUCN conservation status assessment criteria.

Proposed national conservation statuses: comprise comprehensive re-assessments made during the compilation of this report for species indigenous to Vietnam using IUCN (2001) criteria (see Annex 1).

NA = not available
An Introduction to Vietnamese Conifers
1. HMong people constructing house using planks made from 
   Fokienia. Copyright: Jeremy Holden /FFI

2. Newly cut and planked Taiwania. Copyright: Nguyen An Toan /FFI

3. Villagers in Phinh Ngai examining Taiwania seedlings on arrival in 
   village by horse. Copyright: Nguyen An Toan /FFI

4. Taiwania seedlings boxed up for transport by horse to Phinh Ngai 
   village. Copyright: Nguyen An Toan /FFI
Part 1: An Introduction to Vietnamese Conifers

In countries such as Vietnam there is often a scarcity of information available to scientists and biodiversity conservation managers about the status of important species and ecosystems. FFI Vietnam has in cooperation with a range of partners taken up the challenge of collating, synthesising and publishing a number of ‘Conservation Status Reviews’ for Vietnam. To date published reviews include Gibbons (Geissmann et al., 2000), Leaf Monkeys (Nadler et al., 2003) and now Conifers in Vietnam. The status review of Elephants in Vietnam is in preparation.

FFI Vietnam, with its project partners in Lao Cai, Son La and Yen Bai Forest Protection Departments have, through the funding from the EU for the Community-based conservation of the Hoang Lien Son Mountain Ecosystem project, a remit to improve the dissemination of knowledge for biodiversity conservation. One of the project’s main goals is to develop approaches to livelihood development that assist in poverty reduction and biodiversity conservation within appropriate cultural frameworks. Conifers in the mountains of Vietnam are important ecologically, culturally and economically. However, the knowledge necessary for the development of effective in situ conservation, both inside and outside formal protected areas is limited. In addition the potential for ex situ conservation approaches to assist local livelihood development has barely been explored. The HLSP therefore has been able to provide a platform to enable the production of this conservation status review for Vietnam’s conifers. The provision of good quality information is the key to the development of effective management strategies for conifer management. This review also highlights that the possible threats posed by inappropriate local use (often caused by poverty as well as lack of knowledge) as well as unsustainable and often illegal use by a range of commercial agencies can, if properly managed be used to advantage. The possible long-term economic benefits of valuable indigenous tree cultivation are highlighted, as well as the need to retain, and expand the native populations as important seed sources and genetic material for the future. In addition the cultural importance of many conifers in the lives of ethnic minorities, as well as the majority population in Vietnam, make conservation of these beautiful trees an important duty for Vietnam.

As indicated in the Foreword by Aljos Farjon, Chairman, IUCN/SSC Conifer Specialist Group, Vietnam is a global conservation hotspot for conifer species. In total 33 indigenous conifer species occur within the country. Twenty-two of these are globally threatened and eight other species are threatened at a national level. This report highlights the unique and valuable conifer species that occur in Vietnam and sets out the priority actions required for conservation of the globally and nationally threatened taxa. Part 1 of this report provides an overview of Vietnamese conifers, with a discussion on their taxonomy, distribution and values. Conservation of the threatened species is discussed in Part 2. The conservation actions proposed will help to ensure the long term survival of the species and their habitats and will contribute to the livelihoods of rural people who utilise these important trees in a variety of ways. In Part 3, profiles are given for each of Vietnam’s native conifers that are of conservation importance.
Information presented in this report draws on the expertise of, and recent studies undertaken by, many organisations and individuals. It has involved the collaboration of scientific and conservation staff from the Vietnamese Institute of Ecology and Biological Resources (IEBR); the Vietnam Central Forest Seed Company (CFSC); the Komarov Botanical Institute of the Russian Academy of Sciences (KBI), the Royal Botanic Gardens, Kew (RBGK); The Royal Botanic Garden Edinburgh (RBGE) and its International Conifer Conservation Programme; Missouri Botanical Garden (MBG); IUCN-SSC Conifer Specialist Group (CSG); Fauna and Flora International Vietnam Conservation Support Programme including the Hoang Lien Son Project and the Global Trees Campaign (GTC).

The conservation actions proposed in this report will contribute to the implementation of Vietnam’s national biodiversity policy and to major international conservation agreements to which Vietnam is signatory – including the Convention on Biological Diversity (CBD) and the Convention on International Trade in Endangered Species (CITES). In particular, they will help Vietnam to fulfil its requirements under the Convention on Biological Diversity with regard to the conservation of forest resources and plant species.

Vietnam has recognised that appropriate forest land management can contribute to biodiversity conservation and to attempts to reduce poverty and develop sustainable livelihoods for people living in remote rural areas. In order to achieve this Vietnam needs to develop partnerships to achieve sustainable forest management. These partnerships, such as those developed for this publication, need to include local, national and international experts, Governments, international donors as well as local communities and commercial interests (private as well as State owned).

The conifers of Vietnam are national and global flagships for the conservation of forest and tree biodiversity. The organisations involved in producing this report are committed to supporting their long-term conservation.

1.1 Vietnamese conifers in a global context

The World Checklist and Bibliography of Conifers (Farjon, 2001) recognises a worldwide total of 630 species from 69 genera, of which 28 species are noted to occur in Vietnam. More recent work (Nguyen Duc To Luu & Thomas, 2004; Nguyen Tien Hiep et al., 2004) lists 29-33 indigenous species from 19 genera in Vietnam. Globally, this represents 5% of the world’s known species and nearly one third of known genera. Table 2 presents an updated comparison of global and Vietnamese conifer floras. In collating all available information on Vietnamese conifers, this review confirms 32 species to be indigenous to the country, with a thirty third species, Pinus wangii provisionally included in the nation’s flora. Box 1 (page xxiv) lists all 33 species and provides a summary of their existing and revised conservation statuses (at both global and national level) that are a result of this review.
### Table 2  Vietnamese conifer flora in a global context

<table>
<thead>
<tr>
<th>FAMILY</th>
<th>GLOBAL CONIFER FLORA</th>
<th>VIETNAMESE CONIFER FLORA</th>
<th>Endemic species</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Genera</td>
<td>Species</td>
<td>Genera</td>
</tr>
<tr>
<td>Araucariaceae</td>
<td>3</td>
<td>41</td>
<td>0</td>
</tr>
<tr>
<td>Cephalotaxaceae</td>
<td>1</td>
<td>5-11</td>
<td>1</td>
</tr>
<tr>
<td>Cupressaceae</td>
<td>30</td>
<td>135</td>
<td>7</td>
</tr>
<tr>
<td>Phyllocladaceae</td>
<td>1</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Pinaceae</td>
<td>11</td>
<td>225</td>
<td>5</td>
</tr>
<tr>
<td>Podocarpaceae</td>
<td>18</td>
<td>190</td>
<td>4</td>
</tr>
<tr>
<td>Sciadopityaceae</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Taxaceae</td>
<td>5</td>
<td>23</td>
<td>2</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>70</td>
<td>624-630</td>
<td>19</td>
</tr>
</tbody>
</table>

**Notes**

Vietnamese endemic species: 1. a new species of undescribed, and potentially endemic species of pine, which is not included in this review, has recently been found in Vietnam (Nguyen Tien Hiep et al., 2004); 2. there is some uncertainty about the number of species of Podocarpaceae in northern Vietnam – there may be up to three undescribed species, which may also be endemic.

The global significance of Vietnamese conifers is indicated in several ways. New discoveries in recent years have added interesting conifers to the Flora of Vietnam: *Pinus kwangtungensis* (Phan Ke Loc, 1984), *Amentotaxus hatuyenensis* (Nguyen Tien Hiep & Vidal, 1996), *Pseudotsuga sinensis* and *Tsuga chinensis* (Nguyen Tien Hiep et al., 2000), *Keteleeria davidiana* (Phan Ke Loc et al., 2002), *Calocedrus rupestris* (Averyanov et al., in press). In 1999 a cupressaceous conifer of unknown affinity was found in Ha Giang Province. This was subsequently described as a new genus and species *Xanthocyparis vietnamensis* (Farjon et al., 2002). In 2001 a small population totalling around 100 trees of the monotypic genus *Taiwania cryptomerioides* was found in Lao Cai Province (Nguyen Tien Hiep et al., 2002). Previously this genus was only known from natural forest stands in Taiwan, Yunnan and north-east Myanmar. Although known in Vietnam by French botanists since 1955, the two small populations of *Glyptostrobus pensilis*, totalling less than 250 trees, in Dac Lac Province may be one of the few remaining natural stands of this monotypic genus, which is also known from (mostly planted) stands in southern China. *Glyptostrobus* is known from the fossil record since the Cretaceous and had a wide distribution across the Northern Hemisphere. Extensive populations of *Cunninghamia konishii* (Phan Ke Loc & Nguyen Tien Hiep, 1999), another ancient genus with only two species, have been found in Thanh Hoa and Nghe An Provinces and the adjoining areas of Laos. Four out of the six known species of *Amentotaxus* are found in Vietnam - two of these are localised endemics (*A. poilanei* and *A. hatuyenensis*) and the main populations of the other two species are also in Vietnam (*A. argotaenia* and *A. yunnanensis*). One of the most interesting species of pine, *Pinus krempfii*, is also a localised endemic with a restricted distribution in the southern part of the Central Highlands (Farjon et al., 2004a). *Pinus dalatensis* may also be endemic to Vietnam; reports from adjoining areas of Laos (Greijmans, 2003) have not been verified from specimens. Several species with wider distributions outside Vietnam are either at the northern or southern edge of their range or are represented by disjunct populations.
1.2 Evolutionary aspects of Vietnamese conifers

The significance of Vietnamese conifers has been determined by the relative geological and climatic stability of the South East Asian landmass over the last several million years coupled with its present diverse topography and associated wide range of habitats. Europe, North America and many parts of Asia have been directly affected by extensive glaciations, geological upheavals (e.g. the formation of the Himalayas) and associated climatic changes, particularly over the last million years. Overall, the climate became drier and cooler, and many conifers that were adapted to warm, moist climates became extinct. However some were able to migrate to more suitable areas such as south-west China and Vietnam. Cunninghamia, Glyptostrobus, Taiwania and Amentotaxus are all examples of genera that were previously much more widely dispersed. Vietnam’s longitudinal range (8°-24°), from close to the equator to the subtropics, coupled with the altitudinal range of its major mountain systems meant suitable habitats persisted and such species could survive. The climatic changes across the northern hemisphere affected different groups of conifers in different ways. Some became extinct or migrated into areas that still had a suitable climate, while others evolved and were able to occupy different habitats in different climates. Vietnamese pines provide examples of both strategies. Pinus krempfii is thought to be an ancient relictual species without any close relatives while P. kesiya is more recently evolved and has a range from north-east India to the Philippines. Vietnam’s proximity to the tropics also meant that bird dispersed conifers from the southern family Podocarpaceae were able to migrate northwards. The Vietnamese conifer flora contains an unusual mix of conifers from both the southern and northern hemisphere (Nguyen Duc To Luu & Thomas, 2004).

1.3 Distribution and ecology of conifers in Vietnam

Vietnamese conifers are found in four main areas (see Map 2):

1/ North and north-east Vietnam:
(to the east of the Red River) the upper ridges usually composed of highly eroded solid crystalline white limestone karst communities (500-1600 m amsl), especially in Ha Giang, Tuyen Quang, Bac Can and Cao Bang Provinces, contain the richest conifer assemblages (up to 9-10 species) in Vietnam. In these harsh environments, with little soil, rapid drainage and periods of drought, the conifers are able to out-compete angiosperms and form the dominant vegetation on the upper ridges. The climate is monsoon tropical with rather cold and dry winters and summer rains. Several species are only found in this area e.g. Xanthocyparis vietnamensis,
Tsuga chinensis, Pseudotsuga sinensis, Keteleeria davidiana, Cupressus sp. and Amentotaxus hatuyenensis. Conifers such as Pinus kwangtungensis, Taxus chinensis, Calocedrus rupestris and Amentotaxus argotaenia have been found also on isolated mountains to the west of the Red River, away from the main limestone area in north and north-east Vietnam (e.g. Yen Chau, Moc Chau, Hang Kia – Pa Co and Pu Luong). Members of the Pinaceae, generally species that have their main distribution in China, are the most frequent in north and northeast Vietnam, although Amentotaxus yunnanensis and Podocarpus pilgeri can be locally common. Nageia fleuryi has a scattered distribution throughout the limestone areas and rocky islands. Populations of almost all species are always small and scattered.

2/ Hoang Lien Son massif (primarily Lao Cai and Yen Bai Provinces):
composed of granite and other silicate rocks. The climate is generally very wet and cool, with rainfall throughout the year. The natural forests of this area tend to be dominated by northern temperate angiosperm families such as Fagaceae and Lauraceae. Fokienia hodginsii is the most widespread conifer, forming large stands. Abies delavayi subsp. fansipanensis is endemic to Mt Fan Si Pan (3143 m asl) while Tsuga dumosa, a mainly Himalayan species, occurs in small populations above 2400 m asl. A single population of Taiwania cryptomerioides has been found in Van Ban District – it may have been more widespread in the past.

3/ North-west (Dien Bien, Lai Chau, Son La, Hoa Binh, Thanh Hoa, Nghe An, Ha Tinh and Quang Binh Provinces):
In this part of Vietnam, altitudes tend to be lower than in the Hoang Lien, and the climate is generally drier. On the silicate derived soils the most widespread conifer is Keteleeria evelyniana, although in the more mountainous and wetter parts such as in Nghe An near the Laos border, Fokienia hodginsii and Cunninghamia konishii can be found. The conifer species composition on limestone area of this region is poorer and less diverse in comparison with the one of the north and north-east. Calocedrus is also relatively widely distributed in Son La towards the Laos border and Pinus latteri occurs in scattered populations.

4/ Central Highlands:
composed of only granite and other silicate rocks. This is the second most diverse area for conifers in Vietnam, especially on the Lam Vien plateau around Da Lat. The conifers are strongly associated with changes in local climate. At lower altitudes (600-1600 m asl) and with lower rainfall, Pinus kesiya and P. latteri are more widespread with Keteleeria evelyniana, Calocedrus macrolepis, Cephalotaxus mannii and Taxus wallichiana more rare and restricted to moister sites. At higher altitudes (1600+ m asl) Fokienia hodginsii, Pinus dalatensis, P. krempfii and Dacrydium elatum can be found. Amentotaxus poilanei, the most southern member of its genus, is restricted to the northern part of the Central Highlands while Glyptostrobus pensilis is only found in two small populations in Dac Lac Province.

Conifers with tropical origins such as Nageia wallichiana, Podocarpus neriifolius and Dacrycarpus imbricatus are distributed throughout the moister, mountainous areas of Vietnam, usually on soils of volcanic origin, but sometimes become less common in the north of the country.
1.4 Value of conifers in Vietnam

Conifers in Vietnam are of great ecological, economic and cultural importance. Ecologically, conifer-dominant forests may define forest types and support a different and varied biodiversity to broadleaved forests. Commercially, conifers are extensively used for their high grade timber and high value non-timber products. And culturally, conifers are often associated with spiritual wellbeing. They often have a significant role for local people whose life largely depends on forest resources. The fate of conifers is always linked to people’s livelihood in remote areas.

Ecological Value:
Conifers represent a group of the most important forest trees in Vietnam. They are often found as dominant or emergent forest components. Large trees play an important role in the formation of special forest habitats. Conifers provide food and shelter for many other plants, birds, mammals, fungi and other organisms in the forest. Podocarps, especially *Dacrycarpus imbricatus*, produce a great quantity of fleshy cones that are important source of food for many forest animals (Nguyen Duc To Luu, unpublished data). Mycorrhizal mushrooms are a striking example of close ecological association of micro-organisms with conifers. Many mushrooms growing in association with pine trees are edible, and are used locally as well as having a great value on international markets (Ingleby et al., 2004).

Conifers display a particular adaptation to habitats where broadleaf trees cannot survive or have fewer advantages in competition. *Fokienia hodginsii*, *Taiwania cryptomerioides*, *Abies delavayi* subsp. *fansipanensis*, *Tsuga dumosa*, *Pinus dalatensis* and *Pinus krempfii* all form special conifer forest types in the high mountains of Vietnam. A variety of conifers such as *Tsuga chinensis*, *Pseudotsuga sinensis*, *Pinus kwangtungensis*, *Xanthocyparis vietnamensis* and *Calocedrus macrolepis* are often the dominant trees on limestone ridges. The highland conifers play a large role in soil conservation and water protection in mountainous areas.

Commercial value:
Throughout their distribution conifers are a major source of timber; their wood is important for local subsistence use, in addition to national and international markets. The national and international markets use conifer timber mainly for the production of handicrafts and high value furniture, though local markets also use conifer timber extensively for construction purposes. *Fokienia hodginsii* is a well-known example of such precious timber in the domestic Vietnamese market, but is also traded abroad to Europe and wealthier Asian territories (Osborn, 2004).

Besides timber, conifers provide many other important products. *Pinus kesiya* and *P. latteri* are important commercial resin-producing pines, with *P. latteri* the main source of the resin *colophonium* in Vietnam, which is utilised in the paint industry. Cypress wood is also usually highly fragrant. Roots of *Cupressus* sp., *Calocedrus macrolepis* and *Fokienia hodginsii* are used to make refined incense and essential oils that have high value in local (An Van Bay, 2002) and international markets such as Europe and Japan.

Vietnam’s indigenous conifers are also highly valued as ornamental trees. In highland areas they may be planted for street shading, e.g. *Fokienia hodginsii* in Sa Pa, or *Keteleeria*
evelyniana in Da Lat. Species that may be more tolerant of hotter tropical climates, such as Pinus latteri, Podocarpus pilgeri, Taxus wallichiana and Xanthocyparis vietnamensis, may have great potential for development as ornamental (often as precious bonsai) garden and house plants in lowland cities.

Some Vietnamese conifers have applications in commercial medicine. Taxol from Taxus spp. is a well-known example that is used in contemporary medicine for the treatment of cancers. Cephalotaxus mannii is used for both traditional and contemporary medicines in parts of its range outside of Vietnam.

Wild conifer populations in remote areas provide an important genetic resource to reinforce plantation programmes for widely used species such as Pinus latteri and Pinus kesiya throughout Vietnam. Recent surveys in remote parts of Ky Son District in Nghe An Province have identified superior provenances that have the potential to make a major contribution to important reforestation programmes such as the 5 Million Hectare Reforestation Programme (Nguyen Duc To Luu, 2004).

While many Vietnamese conifers provide a current economic benefit, potential benefits are much larger if ecological characteristics are further researched and methods are devised to harvest products more sustainably.

Subsistence value:
In the Hoang Lien Mountains of north-west Vietnam many ethnic minority people traditionally use wood of Fokienia hodginsii for constructing their houses, furniture and for firewood. Cunninghamia konishii is used in a similar way in the areas where it is found. Other species, such as Xanthocyparis vietnamensis, have very durable and insect resistant timber that is used locally to make special coffins.

Vietnamese conifers are also sometimes used as local medicines. For example, the bark of Pseudotsuga sinensis is traditionally used to treat rheumatism and to help women during pregnancy; leaves of Nageia spp. are used by Dao people to cure coughs; and the colophonium resin from Pinus latteri is used in traditional medicine to treat skin diseases (Do Huy Bich et al., 2004).

Cultural value:
Conifers are not only of economic importance for the Vietnamese people, they are also a part of Vietnam’s culture. In many temples, conifers such as Dacrydium elatum and Calocedrus macrolepis are planted as symbols of long life and magic and pine forests are romantic symbols of nobility. Conifers include possibly the oldest, largest and tallest living things in Vietnam – Taiwania trees can attain ages of over 1,500 years (Farjon, 2002), and Cunninghamia konishii trees can grow to nearly 3 m in diameter and 60 m in height (Nguyen Ngoc Chinh & Chu Van Dung, 1997).
Part 2

Conservation of Vietnamese Conifers
1. Forest protection rangers monitoring *Fokienia hodginsii* logging. Copyright: Jeremy Holden /FFI

2. Hmong house roof made from *Fokienia* shingles. Copyright FFI

3. Transportation of *Fokienia* planks for house construction. Copyright: Jeremy Holden /FFI
**Part 2  Conservation of Vietnamese Conifers**

**2.1 Introduction**

Vietnam has developed a policy and legal framework for biodiversity conservation and the long-term conservation of conifer species can be developed in this context. National policies have generally targeted macro issues such as general biodiversity, forest conservation and protected area development. These approaches have, undoubtedly, been of assistance to conifer conservation but it is clearly becoming imperative that both international and national legislation, and national and donor projects, should now target conifers specifically in order to protect an important part of the global biological heritage found in Vietnam. Previously, only limited information on Vietnamese conifers has been available; however the information compiled in this report should help to address the critical situation facing Vietnamese conifers. In designing conservation action it is first necessary to analyse the threats facing individual species. Based on such an analysis, general recommendations for the conservation of Vietnamese conifers are made below. Individual species accounts with conservation recommendations are presented in Part 3 ‘Profiles of Vietnamese Conifer Species.’

**2.2 Existing policy and legal framework for conifer conservation in Vietnam**

During the last 12 years, the Government of Vietnam (GoV) has developed a number of national biodiversity and forestry policies that set out the need for the conservation of rare and threatened species. Several decrees, decisions and instructions have been passed through national legislation aimed at increasing the protection and management of a number of species. Under one of these decrees, Decree 48, there are several conifer species whose exploitation is strictly prohibited and several other conifer species whose exploitation is restricted (see Box 2). A national programme for reforestation has been implemented and guidelines on the management of natural forest have also been developed.

---


2 Prime Ministerial Decision 661/1998/QD-TTg, dated 29/7/1998, on The Target, Task, Policy and Organization for the Implementation of the Project of Planting Five Million New Hectares of Forest. (This programme aims at increasing forest cover of Vietnam to 45 % by 2010. One million hectares of this afforestation programme are assigned as ‘protection forest and special-use forest’ status that include areas for forest regeneration).

3 Prime Minister Decision 08/2001/QD-TTg, dated 11/1/2001, on The Promulgation of Regulation on Management of Special-use Forest, Protection Forest and Production Forest.
Vietnam has been a party to the Convention on Biological Diversity (CBD) since 1994. In 1995 the GoV expressed its commitment to biodiversity conservation through the development of the National Biodiversity Action Plan (BAP). The BAP provided recommendations for: conservation policies and programmes, the improvement of management of protected areas, the identification of priority projects and sites for conservation as well as complementary actions for biodiversity conservation such as ex situ methods, research, monitoring, and education.

In 2002, parties to the CBD agreed to the Global Strategy for Plant Conservation (GSPC), which set 16 ambitious targets for delivery by 2010 (see Table 3). This Vietnam Conifer Conservation Status Review makes its most significant contribution to Target 2: ‘A preliminary assessment of the conservation status of all known plant species at national, regional and international levels’. However, this publication should also serve as an invaluable tool in achieving may other targets of the GSPC, from the development of models for plant conservation and sustainable use, through to capacity building, awareness raising and trade controls. Table 3 summarises how the Vietnam Conifer Conservation Status Review contributes to the targets of the GSPC.

Vietnam is also a party to Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), following its accession to the Convention in 1994. The CITES management authority in Vietnam is the Ministry of Agriculture and Rural Development (MARD), and the Institute of Ecology and Biological Resources (IEBR) and the Centre for Natural Resources and Environmental Studies (CRES), a part of Vietnam National University, Hanoi, serve as the CITES scientific authorities.

In October 2004, the 13th Conference of the Parties to CITES agreed to list Asian yews, Taxus chinensis, T. cuspidata, T. faurie and T. sumatrana and all infraspecific taxa of these species in Appendix II of the Convention. This follows an earlier listing of Taxus wallichiana in Appendix II in 1994, mainly reflecting concern about the unsustainable trade in plant parts and chemical extracts for the pharmaceutical industry. The taxonomy of the Asian Taxus is very complicated and controversial and there are several active research programmes attempting to clarify their taxonomy. The Vietnamese populations of Taxus in both northern and southern Vietnam are too small to be threatened by commercial scale exploitation for Taxol production and there is only a local trade for its timber. However the example of Taxus indicates the problem of how limited information on the scale and effect of international and national trade in many conifer species affects conservation efforts. At present it may be premature to suggest inclusion of other species in the CITES Appendices because of the lack of reliable information. Yet it is clear that trade may well be threatening species that occur in Vietnam, such as Fokienia hodginsii, as recent research has suggested (Osborn 2004).

---

### Box 2  Protected conifer species of Vietnam following national Decrees 18 and 48, together with proposed global and national conservation statuses

<table>
<thead>
<tr>
<th>FAMILY/SPECIES</th>
<th>VIETNAMESE LEGAL STATUS</th>
<th>CONSERVATION STATUS</th>
<th>GLOBAL</th>
<th>NATIONAL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CUPRESSACEAE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Calocedrus macrolepis</em></td>
<td>Group II</td>
<td>VULNERABLE</td>
<td>ENDANGERED</td>
<td></td>
</tr>
<tr>
<td><em>Cunninghamia konishii</em></td>
<td>Group II</td>
<td>VULNERABLE</td>
<td>ENDANGERED</td>
<td></td>
</tr>
<tr>
<td>*Cupressus sp.*¹</td>
<td>Group I</td>
<td>NOT EVALUATED</td>
<td>DATA DEFICIENT</td>
<td></td>
</tr>
<tr>
<td><em>Fokienia hodginsii</em></td>
<td>Group II</td>
<td>NEAR-THREATENED</td>
<td>ENDANGERED</td>
<td></td>
</tr>
<tr>
<td><em>Glyptostrobus pensilis</em></td>
<td>Group I</td>
<td>DATA DEFICIENT [ENDANGERED]</td>
<td>CRITICALLY ENDANGERED</td>
<td></td>
</tr>
<tr>
<td><strong>PINACEAE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Abies delavayi</em>²</td>
<td>Group I</td>
<td>LEAST CONCERN</td>
<td>VULNERABLE</td>
<td></td>
</tr>
<tr>
<td><em>Keteleeria evelyniana</em></td>
<td>Group II</td>
<td>LEAST CONCERN</td>
<td>VULNERABLE</td>
<td></td>
</tr>
<tr>
<td><em>Pinus dalatensis</em></td>
<td>Group II</td>
<td>VULNERABLE</td>
<td>VULNERABLE</td>
<td></td>
</tr>
<tr>
<td><em>Pinus krempfii</em></td>
<td>Group II</td>
<td>VULNERABLE</td>
<td>VULNERABLE</td>
<td></td>
</tr>
<tr>
<td><em>Pinus kwangtungensis</em></td>
<td>Group I</td>
<td>NEAR-THREATENED</td>
<td>VULNERABLE</td>
<td></td>
</tr>
<tr>
<td><strong>TAXACEAE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Taxus wallichiana</em>³</td>
<td>Group I</td>
<td>DATA DEFICIENT [LEAST CONCERN]</td>
<td>ENDANGERED</td>
<td></td>
</tr>
</tbody>
</table>

**Notes**

- Taxonomic issues: ¹listed as *Cupressus torolosa*; ²listed as *Abies fansipanensis*; ³listed as *Taxus baccata* var. *wallichiana*
- Vietnamese legal status: listings follow Decree 48/2002/ND-CP, dated 22.4.2002, on *Amending and supplementing the list of rare and precious flora and fauna and regulations for their management and protection*, Decree 18/1992/HDBT, dated 17.1.1992; group definitions follow article 8 of Decree 18 as follows – Group I - exploitation and use is strictly forbidden. In special circumstances, when plants, live animals, products of forest plant or animal, or seeds are needed to be used for scientific purposes or in regard to international co-operation or relations, permission must be obtained from the Chairman of the Council of Ministers, according to the suggestion of the Minister of Forestry. Group II - exploitation and use is restricted, in concrete terms, as follows: Timber trees may be exploited only at restricted levels according to species, number, and area. The planned quotas for each year must be approved by the Chairman of the Council of Ministers, and written permission must be obtained from the Minister of Forestry. During exploitation, the procedures and technical standards of the Ministry of Forestry must be correctly implemented. Authorised use of Group II-listed wood may be used only for special building projects of the state, in the production of handicrafts, or in high-grade furniture to be used domestically and for export. The export of raw or partially processed wood is forbidden. Conservation status: Global assessments in square brackets [ ] are recent proposed revisions using IUCN (2001) criteria (Farjon *et al.*, 2004a); all non-bracketed statuses follow IUCN (2004). All national statuses are new assessments using IUCN (2001) criteria, and presented for the first time as a result of this review.
2.3 Conservation importance

The IUCN’s global Conifer Action Plan (Farjon & Page, 1999) defined conifer hotspots as areas with high diversity and high numbers of threatened species, i.e. more than 2% of all globally threatened species. It listed nine areas that met that criterion. The IUCN (2004) Red List of Threatened Species currently lists 291 conifer species (nearly half of all the world’s species of conifer) as globally threatened. Fourteen (c. 5% of the world’s total number of threatened species) occur in Vietnam. An additional 13 species are threatened at the national level. It is clear, therefore, that Vietnam qualifies as the tenth global conifer hotspot (Farjon et al., 2004).

Table 3 Contributions the 2004 Vietnam Conifer Conservation Status Review makes to the Global Plant Strategy for Plant Conservation of the Convention on Biological Diversity

<table>
<thead>
<tr>
<th>Global Plant Strategy for Plant Conservation Target</th>
<th>Contribution made by the 2004 Vietnam Conifer Conservation Status Review</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) Understanding and documenting plant diversity</td>
<td></td>
</tr>
<tr>
<td>(1) A widely accessible working list of known plant species, as a step towards a complete world flora</td>
<td>Provides a checklist of all acknowledged species of Vietnamese conifer but undoubtedly not complete. Further work is still required as a priority to verify taxonomy of certain taxa. (Box 1)</td>
</tr>
<tr>
<td>(2) A preliminary assessment of the conservation status of all known plant species, at national, regional and international levels</td>
<td>Constitutes a preliminary assessment of all known Vietnamese conifer species at the national level and has informed conservation status of a number of species at the international level. (Box 1)</td>
</tr>
<tr>
<td>(3) Development of models with protocols for plant conservation and sustainable use, based on research and practical experience</td>
<td>Gives general recommendations for in- and ex situ conservation and sustainable use of conifers (see section 2.5, together with specific recommendations for each species in Part 3).</td>
</tr>
<tr>
<td>(B) Conserving plant diversity</td>
<td></td>
</tr>
<tr>
<td>(4) At least 10% of each of the world’s ecological regions effectively conserved</td>
<td>Conifers are promoted as flagship species for wider area- and landscape-based conservation efforts.</td>
</tr>
<tr>
<td>(5) Protection of 50% of the most important areas for plant diversity assured</td>
<td>As above</td>
</tr>
<tr>
<td>(6) At least 30% of production lands managed consistent with the conservation of plant diversity</td>
<td>Recommendations for integrated ex situ conservation and production of commercial conifer species are made. (Section 2.5.9)</td>
</tr>
<tr>
<td>(7) 60% of the world’s threatened species conserved in situ</td>
<td>Recommendations for in situ conservation for all Vietnamese conifer species are made. (Part 3)</td>
</tr>
<tr>
<td>(8) 60% of threatened plant species in accessible ex situ collections, preferably in the country of origin, and 10% of them included in recovery and restoration programmes</td>
<td>As above</td>
</tr>
<tr>
<td>(9) 70% of the genetic diversity of crops and other major socio-economically valuable plant species conserved, and associated indigenous and local knowledge maintained</td>
<td>Recommendations for conservation of genetic diversity of economically viable conifer species, integrated, where possible, with involvement of local communities are made. (Sections 2.5.8-10)</td>
</tr>
<tr>
<td>(10) Management plans in place for at least 100 major alien species that threaten plants, plant communities and associated habitats and ecosystems</td>
<td>This review highlights the threat to some species of indigenous conifer of hybridization with planted introduced alien species.</td>
</tr>
</tbody>
</table>
Part 2: Conservation of Vietnamese Conifers

<table>
<thead>
<tr>
<th>Global Plant Strategy for Plant Conservation Target</th>
<th>Contribution made by the 2004 Vietnam Conifer Conservation Status Review</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(C) Using plant diversity sustainably</strong></td>
<td></td>
</tr>
<tr>
<td>(11) No species of wild flora endangered by international trade.</td>
<td>Highlights international trade as a serious threat to a number of Vietnamese conifer species, and the need to gather more information before effective action can be taken in halting/regulating this trade.</td>
</tr>
<tr>
<td>(12) 30% of plant-based products derived from sources that are sustainably managed</td>
<td>Recommends investigating potential of sustainably managed non-timber product extraction from Vietnamese conifer species</td>
</tr>
<tr>
<td>(13) The decline of plant resources, and associated indigenous and local knowledge, innovations and practices that support sustainable livelihoods, local food security and health care, halted</td>
<td>Promotes integrated conifer conservation and rural livelihood development for certain species</td>
</tr>
<tr>
<td><strong>(D) Promoting education and awareness about plant diversity</strong></td>
<td></td>
</tr>
<tr>
<td>(14) The importance of plant diversity and the need for its conservation incorporated into communication, educational and public awareness programmes</td>
<td>This review itself is intended to raise awareness of conservationists, decision makers, natural resource managers and funding agencies. It also recommends the development of awareness raising programmes for both government officials and local communities situated near key sites for conifer conservation (Section 2.5.2)</td>
</tr>
<tr>
<td><strong>(E) Building capacity for the conservation of plant diversity</strong></td>
<td></td>
</tr>
<tr>
<td>(15) The number of trained people working with appropriate facilities in plant conservation increased, according to national needs, to achieve the targets of this Strategy</td>
<td>Recommends the development of technical training modules and materials for relevant government agencies (Section 2.5.2)</td>
</tr>
<tr>
<td>(16) Networks for plant conservation activities established or strengthened at national, regional and international levels</td>
<td>Recommends the establishment of a national conifer specialist group to monitor conservation status and inform the international specialist group of the IUCN-SSC (Section 2.5.1)</td>
</tr>
</tbody>
</table>

Globally threatened conifers represent over 40% (14/33 species) of the Vietnamese conifer flora. When nationally threatened species are added, the percentage rises to over 90% (31/33 taxa). One species of cypress, *Cupressus* sp., may already be extinct in the wild, while three others (*Taiwania cryptomerioides, Xanthocyparis vietnamensis* and *Glyptostrobus pensilis*) are regarded as Critically Endangered within Vietnam. Nationally, nine species of Vietnamese conifer are Endangered, and another 17 are regarded as Vulnerable. Only two conifer taxa (*Cupressus* sp. and *Pinus wangii*) in Vietnam are currently not listed as threatened or near-threatened due to uncertainties of taxonomic identity. Box 1 (page xxiv) provides detailed listings of global and national conservation statuses for all known species of indigenous Vietnamese conifer.

The extremely high percentage of threatened species is the result of several factors. Almost all species produce valuable timber or non-timber forest products (NTFPs) such as resin and essential oil. Consequently conifers are highly sought after and many have been over-exploited. Other conifers in Vietnam are either localised endemics or are restricted to...
specialised habitats, especially in the limestone areas. Several other species are more widely distributed outside of Vietnam and the Vietnamese populations represent the extremities of the natural range. Some of these populations represent distinct provenances e.g. *Pinus latteri* and *P. kesiya* (Cooling, 1968). Such species are naturally rare in Vietnam and their limited distribution and small population size makes them more susceptible to the effects of large-scale threats such as deforestation.

With half of all Vietnamese conifer species globally threatened and nearly all species threatened with extinction nationally, it is important to be able to identify those species that are of highest priority for immediate conservation action. The assessment using IUCN categories provides a guide but other factors, such as economic value and scientific importance, also need to be considered. Table 1 (page xix) lists 10 potential priority species for conservation action in Vietnam.

### 2.4 Threats to conifers in Vietnam

Threats to the conifers of Vietnam are substantial and varied. Many species have high commercial value and so are specific targets for logging or exploitation. Populations of other species have become fragmented due to the expansion of agricultural lands at the forests’ expense, or through deliberate or accidental fires. Several conifers have long generation times that are characterised by infrequent seed production or episodic regeneration. Overall the threat to the survival of conifers in Vietnam results from different combinations of these factors. Most threats, other than those due to biological or genetic constraints, have an underlying human cause and the threat to conifers increases with proximity to human habitations. Major threats to individual species are outlined in Part 3 ‘Profiles of Vietnamese Conifer Species’. The general threats to the conifers of Vietnam are identified and listed below.

**Commercial logging**

Commercial logging poses one of the major problems for conifers in Vietnam. Large-scale exploitation has affected many high value species (e.g. *Fokienia hodginsii*, *Cupressus* sp. and *Calocedrus macrolepis*). Timber is logged and transported in large quantities for use in urban areas or for export. Since timber exploitation provides an important income for the provincial and national economy, some timbers are legally harvested for special purposes. Many timbers, however, such as *Fokienia hodginsii*, are also harvested for the illegal timber trade (Osborn, 2004; Swan & O’Reilly, 2004).

**Subsistence logging**

Many conifers are heavily exploited by local people throughout their distributions. In many areas, conifers are the timber of choice for their durability, and weather and pest resistant qualities. Selective logging by local people is threatening narrowly distributed conifers such as *Xanthocyparis vietnamensis*, *Taiwania cryptomerioides*, *Cunninghamia konishii*, *Tsuga chinensis*, *Pseudotsuga sinensis* as well as more widespread conifers such as *Fokienia hodginsii*. Selective logging may also have longer term effects such as genetic depletion.

---

6 Decree 48/2002/ND-CP, dated 22/4/2002, on Amending and Supplementing the List of Rare and Precious Flora and Fauna and Regulations for their Management and Protection (see footnote 1).
Inappropriate Species Choice for replanting schemes
A combination of policy frameworks and cost norms for nursery propagation and replanting schemes has the effect of discriminating against replanting schemes based on slower growing indigenous trees. Combined with a lack of knowledge within the forest sector of innovative silvicultural practices this means that in the northern mountains that *Cunninghamia lanceolata*, as well as other quick growing exotics and native trees, are planted widely. This increases the risk of uncontrolled fires as well as increasing the risk of the spread of non-native trees – even within special use forests (protected areas).

NTFP use
NTFP collection from conifers in Vietnam currently threatens a number of species (e.g. *Pinus latteri*). Nevertheless, use of NTFPs can promote conservation if conducted in association with effective conservation goals. However, many NTFP products are currently gained through destructive harvesting and if left unchecked can be disastrous for species (e.g. the entire natural population of *Cupressus* sp. in Lang Son Province may have been destroyed through the destructive harvesting of the roots for incense production). Furthermore the lack of attention to developing silvicultural practices to support NTFP production reduces the ability of local populations to ‘domesticate’ important trees even on land that has been allocated to households and communes/villages for management.

Agricultural encroachment
Agricultural encroachment also poses a major risk to conifer populations in Vietnam. The threat posed to species by direct over-exploitation is compounded by the conversion of large areas of forest land to agriculture (in order to support a continually expanding population), especially in montane areas between 800 and 1500 m amsl. For example, areas of occurrence of *Pinus latteri* and *Keteleeria evelyniana* have been greatly reduced and fragmented by forest conversion and destruction. The two remaining swamps with *Glyptostrobus pensilis* are surrounded by coffee plantations that are changing the hydrology; this will inevitably lead to the extinction of this species at these sites.

Infrastructure development
Infrastructure development poses an indirect threat to the majority of conifers in Vietnam due to the conifers’ restricted range and tendency to occur in remote areas. Nevertheless, with an expanding population and subsequent increase in agricultural encroachment, previously remote areas are becoming accessible and other potential threats increase. An example includes the potential threat to *Abies delavayi* subsp. *fansipanensis* of road development in the Hoang Lien National Park, Lao Cai Province which may increase levels of tourism and further increase the risk of fire destroying the only known population of this subspecies.

Fire
Fires are highly destructive and pose a serious threat to many of Vietnam’s conifers. Fires are, occasionally, naturally occurring but the majority are man-made and are especially dangerous when used for clearing land for agriculture and for early season grazing. Dry, easterly winds at times of land burning increase the risk to nearby forest areas. Other fire risks occur through forest campfire neglect. Several species have been placed under increased risk of local extinction due, in part, to man-made forest fires. The single
population of *Taiwania cryptomerioides* in Lao Cai Province has been, and continues to be threatened by the use of fire to maintain and increase grazing land. The remaining localities of *Glyptostrobus pensilis* in Dac Lac Province have been severely degraded from the deliberate firing of the swamps by local people hunting snakes (Thomas et al., 2004).

**Fragmented small populations**

Heavy logging, frequent fires and conversion of land for agriculture have isolated Vietnamese conifer populations and reduced their numerical size. Fragmentation increases the likelihood of decline in natural regeneration for any plant population and increases susceptibility to all threats.

**Reproductive biology**

Many conifer species are dioecious, for example *Amentotaxus* species. Female trees of the species rarely produce cones and so successful seed production is observed only with a low frequency. This may be compounded by selective logging, which could be changing the sex ratio of the population. Other species are reliant on episodic regeneration and require open, disturbed areas for regeneration. Seed production may be infrequent in these species. This combination of biological and ecological characters may enhance the level of threat to those species when their habitats are degraded or isolated by deforestation and changes in land use. A lack of knowledge of these issues by managers of protected areas means that appropriate methods for *in situ* conservation are not put in place.

**Genetic problems**

The effects of fragmentation and selective logging may also have an impact at genetic level through the loss of genetic variability. Local provenances are often the best materials for local forest plantation as they are well adapted to local climatic and edaphic conditions and may also have specific properties and uses that differ from other provenances. A good example is the lowland provenance of *Pinus lateri* which is widely used for reforestation in Vietnam. Unlike the highland provenance that is valued for timber, the lowland provenance is grown mainly for resin production. Unfortunately, the lowland provenance already appears to be extinct in the wild (Nguyen Duc To Luu, 2004). Hybridisation can also potentially affect conifer species integrity: for example, *Cunninghamia konishii* readily hybridises with *C. lanceolata* and the two should not be cultivated together.

### 2.5 General recommendations

Specific recommendations for individual conifer species are provided within each species profile in Part 3. However, there are a number of general recommendations for effective conservation of Vietnamese conifers that are discussed below. These recommendations are grouped into 10 thematic areas:

- Research and information management;
- Capacity building and awareness raising;
- National policy and legislation development;
- National legislation implementation and enforcement;
- Protected area development and management;
- State Forest Enterprise restructuring and management;
- Sustainable use;
• Integrated conifer conservation and rural livelihood development;
• *Ex situ* propagation;
• Living gene banks.

### 2.5.1 Research and Information Management

i. **Conduct further surveys in order to ascertain comprehensive distributions for species, population sizes and continually assess conservation status.** Whilst this conservation status review provides a good starting point for developing a coherent conifer conservation programme in Vietnam, the review also clearly highlights that there are still significant gaps in both the quality and quantity of scientific knowledge. Furthermore, the information that does exist is often scattered across a variety of sources, many of which are not widely accessible to the scientific or conservation communities, let alone natural resource managers. Many of these ‘grey literature’ survey reports present poorly documented information on conifer occurrence that is not verified by voucher specimens, where species have often been misidentified. Considering relatively recent discoveries in the conifer flora of Vietnam, it is also very possible that new conifer localities, or even new species, will be discovered. It is essential, therefore, that results from surveys are referred to competent conservation authorities, that survey teams voucher their collections, and that these teams have access to most recent publications on conifers, such as the recently published illustrated field guide to Vietnamese conifers (Nguyen Duc To Luu & Thomas, 2004) and this review. Comprehensive field surveys, yielding accurate scientific information, will contribute to Target 2 of the GSPC – ‘a preliminary assessment of the conservation status of all known plant species, at national, regional and international levels’, which is essential for planning and implementation of effective conservation actions.

ii. **Continue taxonomic research to resolve issues of uncertain taxonomic identity.** Many of the conifer species profiles presented in Part 3 of this review highlight the need for further research into the taxonomy of Vietnamese conifers. Several species’ conservation statuses cannot be ascertained because their taxonomic identity remains uncertain. The potentially extinct in the wild *Cupressus* sp. is a chief example, in addition to a number of possibly new pines and podocarps.

iii. **Conifer ecological research to support effective management planning** of the 10 identified priority conifer species listed in Table 1 (page xix). Ecological research is crucial for developing management strategies for the long-term survival of a number of increasingly rare conifer species. To date, except for direct observation and deductive interpretation made during field surveys, there has been very little research conducted on the ecology of Vietnam conifers. Examples of work to date include seed research conducted on *Pinus latteri* (Nguyen Duc To Luu, unpublished data), and phenology, regeneration and soil requirements of *Dacrydium elatum* (Huynh Van Keo & Le Doan Oanh, 2002). Silviculture trials are also key for the *ex situ* conservation of some species such as *Glyptostrobus pensilis*, since its natural habitats have been irretrievably damaged.

---

7 A number of potentially new species of pine and podocarp have already been discovered in Vietnam (Nguyen Tien Hiep *et al*., 2004), but not yet described (and, therefore, not included in this review), see Table 1.
Knowledge on the seed biology of *Amentotaxus* spp. and *Taiwania cryptomerioides* will help find appropriate management strategies to promote their natural regeneration.

iv. **Conduct further research on the national and international trade of conifer timbers**, e.g. *Fokienia hodginsii*, in order to provide recommendations for inclusion on CITES appendices.

v. **Establish a national conifer specialist group** for the regular monitoring of conservation status at the national level and contributing to re-assessments of global statuses co-ordinated by the CSG of the IUCN-SSC. This group would provide a focal point for data collection and evaluation, maintaining international standard herbarium collections and liaising with other herbaria and specialists around the world.

vi. **Disseminate recent research on location and management of conifers in Vietnam**. Collecting new and reliable data is of limited application if natural resource managers, tasked with protecting Vietnam’s biological diversity cannot access this information. Therefore, in addition to conducting further baseline surveys and taxonomic research, there is a need to develop a programme of dissemination to scientists, universities, conservationists as well as practicing forest land managers at state, commercial and grassroots levels. It is hoped that the wide dissemination of this review, particularly in digital formats (CD ROM, website), will help address the issue of inaccessible existing information.

### 2.5.2 Capacity Building and Awareness Raising

i. **Develop a training programme on technical aspects of conifer conservation**. The technical capacity of FPD staff, especially in remote areas where threatened conifers often occur, is currently limited by the availability of training courses and the level of awareness of the training opportunities available. To date, a number of training projects have been undertaken, targeting FPD technical staff and management, universities and research institutions, e.g. the IEBR-MBG Vietnam Botanical Conservation Programme (plant conservation, including identification), the VTSP (seed propagation techniques, tree improvement, seed sources, conservation and sustainable use of conifers), and FSIV (genetic conservation). Such training has included conifers but not targeted conifers specifically. Specialised training on survey methods and conservation of conifers in Vietnam has only occurred recently through the RBGE-CFSC Preservation, Rehabilitation and Utilisation of Vietnamese Montane Forests project. Outputs of this project included field manuals for conifer identification, propagation and conifer mycorrhizas (Nguyen Duc To Luu & Thomas, 2004; Dick *et al.*, 2004; Ingleby *et al.*, 2004). Except for these manuals, very few extension materials applicable to conifer conservation are available. VSTP have produced various extension materials, such as videos and calendars, based mainly on seed issues. Similarly ODA conservation projects have produced posters and brochures but they focus on general habitat conservation rather than on conifers specifically. Few materials from national projects have been distributed to provincial forestry authorities and protected areas, and there is still no system or incentive to transfer the knowledge contained within these publications to staff at the district and commune levels.
Training and educating provincial and district Forest Protection Department (FPD) staff in practical elements of conifer conservation is essential for *in situ* management of threatened populations. This capacity building, transferring both theoretical knowledge and practical skills, should be extended to all involved parties at all levels (national to commune), from government decision makers and forest rangers to local community participants in conservation efforts. It is essential that such training programmes, and the relevant extension materials, be accessible at the district and commune levels in areas where conifer conservation is an issue. Where necessary, the programme should be tailored to address the conservation situation for individual species. Once trained, local FPDs should embark on programmes to locate and demarcate all major sites, and in the case of severely threatened species, every tree of a threatened conifer species.

**ii. Develop awareness raising programmes on the importance of conifer conservation for relevant government agency stakeholders.** Again, such programmes should operate at all levels of administration, and also be developed in conjunction with the technical training programmes suggested above. Awareness (and capacity building) also needs to be imparted to those local authorities, from FPD rangers to protected areas managers, to SFE staff that currently implement government forestry programmes (such as Programme 661), that communities are an important stakeholder in conifer conservation actions. Conservation is most successful when it receives good collaboration from all stakeholders: consumers, natural resource managers, policy makers, conservationists and scientists, funding agencies and especially local people. Collaboration with authorities in other countries could also help raise awareness on conifers in border areas, e.g. *Cunninghamia konishii* on the Vietnam – Laos border.

**iii. Build capacity in general management planning and conifer conservation specifically, for management authorities of protected and non-protected areas** supporting globally important populations of threatened conifers. Many protected areas have limited management plans based on original investment plans. The need to adapt and change management plans in relation to increased scientific knowledge is currently a slow process in Vietnam, leading to unresponsive authorities - especially when faced with changing threats such as increases in illegal logging. A wide range of capacity building measures are required to facilitate effective management of protected areas as well as for sites supporting populations of threatened conifers that are not within designated special-use forests.

**iv. Raise awareness, through appropriate media, of local communities to the importance of conifer conservation,** particularly where local use poses the major threat to the threatened conifer population. Conservation problems for conifers occur mostly in remote areas where there are significantly low standards of living, including high poverty and low formal education levels. Awareness raising for local people is therefore essential for conifer conservation. Locating these awareness programmes within management activity planning, including monitoring, that brings benefits to local people should be the ideal. Such integrated awareness raising programmes should also develop linkages with GoV poverty reduction programmes.
Communicating and raising awareness among local people is essential for *in situ* conservation, a need that is recognised in Target 14 of the GSCP. Despite protected areas and ODA projects both conducting a number of generalised awareness raising programmes for local communities, the large size of protected areas and the lack of proper training methods and strategies often reduces the effectiveness of these programmes. In addition, in the remoter areas, ethnic minority communities are often not addressed using appropriate media, such as use of oral material and posters rather than written documents in the national language. It is also clear that despite the importance of women’s knowledge in relation to forest land management in many forest-dependant communities, they are usually excluded from discussions of protected area management. This is often a result of cultural constraints as well as the fact that ethnic minority women in remote areas are rarely fluent in the national language. Forest Protection Departments are dominated by men and their ability to communicate with ethnic minority women is often limited.

### 2.5.3 National policy and legislation development

**i. Revise national laws and regulations regarding the conservation and use of threatened conifers**, based on up-to-date information gathered from recent field surveys and taxonomic research on conifers in Vietnam. Existing national legislation, notably Decrees 18 and 48, which lists species of rare and precious Vietnamese flora and fauna, protected by national law, must now be considered inaccurate in light of the recent discoveries regarding conifers in Vietnam. New information gathered over the last two years suggests that highly threatened conifers, such as *Xanthocyparis vietnamensis* and *Taiwania cryptomerioides* must be included on the Group I list (strict no use) of Decrees 18/48. Other conifer species, such as *Cephalotaxus mannii*, should be reassessed in light of new evidence and consideration be given for inclusion to Group II (restricted use). The taxonomy used by these laws should also be revised to be consistent with recent information.

**ii. Develop new legislation prohibiting all large-scale commercial logging of any conifer species** in Vietnam (by any agency, private or state-run), especially for *Fokienia hodginsi*, *Calocedrus rupestris* and *Calocedrus macrolepis*. The same legislation should also tightly control and minimise small-scale logging for subsistence use, especially for species with narrow ranges of distribution such as *Tsuga chinensis*, *Pseudotsuga sinensis* and *Cunninghamia konishii*. Existing national legislation (Decrees 18/48) still allow the use and exploitation of ‘protected’ conifers species listed in Group II under ‘special circumstances’ and with relevant permission. These ‘special circumstances’ include use in government buildings, handicrafts and furniture making for the domestic and export market. It is clear, however, that such restrictions are too weak and unenforceable to the extent that relatively widespread conifers, such as *Fokienia hodginsi*, are under intense logging pressure throughout their distribution. A moratorium on the exploitation of all populations of naturally occurring conifer species should be considered until assessments have been conducted on the levels of sustained exploitation each species can tolerate.
2.5.4 National legislation implementation and enforcement

i. Provincial People’s Committees should co-ordinate effective co-operation between relevant provincial agencies to ensure that forest protection is a priority.

ii. Authorities charged with upholding the law must enforce legislation. Despite the GoV Decision 8\(^8\) banning the exploitation of natural forests in 2001, levels of law enforcement remain highly varied; especially where previous licenses for exploitation exist or where land has been assigned to SFEs for management. It is also clear that the list of protected species (Decrees 18 & 48 –see Box 2 and section 2.5.3 above) is also being disregarded in essence as indicated by the large-scale exploitation of *Fokienia hodginsii* by licenses granted to SFEs and other commercial companies by provincial authorities. In addition to this legal, yet unsustainable, harvest, illegal exploitation of timber, including conifers, from natural forest and protected areas still occurs throughout Vietnam. Enforcement of forest protection laws on the ground is hampered by low capacity, remote locations and the limited risk that forest crime perpetrators will be apprehended. Often it is more profitable for local businesses to disregard the law and pay fines/bribes, especially when timber prices are high. Local people also often use forest products for house construction, with or without relevant permission, as they have little alternative. In order to achieve effective law enforcement, relevant agencies need to be fully conversant in all pertinent forest protection legislation and trained in its implementation.

iii. Strict and regular checking of any and all potential forest law violators at guard posts on forest access routes, particularly in the case of protected areas, should be a priority action for law enforcement.

iv. Conduct regular monitoring patrols of areas of high conifer conservation importance. Such actions will require education and training for both forest rangers and their supervising authorities. When not on patrol ranger teams should be engaged in conservation awareness raising activities with local communities. These patrol teams could be comprised of FPD rangers and/or local community members, operating as an intelligence extension of FPD, particularly in remote mountainous areas where threatened conifers tend to occur in Vietnam. The development of trained and salaried ‘Community-based Monitoring Groups’, as part of a protected area management structure, also provides local incentives for forest protection.

---

\(^8\) Prime Ministerial Decision 8/2001/QĐ/TTg, dated 11/1/2001, on Promulgating Management Regulations of Natural Special-use, Protection and Production Forests.
2.5.5 Protected area development and management

i. Develop new protected areas for important populations of threatened conifers. Despite the rapid expansion of the protected area system in Vietnam, a number of threatened conifer species are still poorly represented, or absent, in the protected area network (Phan Ke Loc & Nguyen Tien Hiep, 1997). Developing new protected areas, can involve long and costly processes, but should be expedited for areas with conifer species of restricted distribution, such as Nui Voi - Duc Trong, Lam Dong Province for *Taxus wallichiana*, or Van Ban District, Lao Cai Province for *Taiwania cryptomerioides*. However, gazetting a new protected area affords no protection per se if the strict no logging regulation for special-use forests is not enforced (see section 2.5.4 above). New ‘protected areas’ for conifers need not necessarily be special-use forests, species that could sustain some limited harvest, such as *Taxus wallichiana* in Lam Dong Province and *Pinus kwangtungensis* in Son La and Cao Bang Provinces, could benefit from in situ protection in areas of critical watershed protection forest, which allows for limited logging. Protected area development for conifers contributes towards Target 7 of the GSCP – ‘*60 % of the world’s threatened species should be conserved in situ*’.

ii. Explore opportunities for community and collaboratively managed protected areas. Vietnam is currently in a process of developing new community forestry models and legislation, in line with the CBD decision on protected areas, which includes Community Conservation Areas. In remote locations, where local people’s livelihoods are dependant upon forest resources to some degree, community forestry could be the most effective means of achieving protection for important tree species in the short-term. In return for strict protection of the conifer forest area, support from relevant agencies (both GoV and ODA) could develop remaining forest land for indigenous tree and fodder cultivation through the use of appropriate agroforestry models.

iii. Focus further inventory surveys in existing and proposed protected areas in order to evaluate the comprehensiveness of the network in terms of conifer conservation. General floristic surveys should target conifers as focal species. Recent changes in protected area system, and new discoveries of conifer species in Vietnam, also require an update of Phan Ke Loc & Nguyen Tien Hiep’s (1997) review of threatened conifer occurrence in protected areas, which would help target surveys of poorly known areas.

iv. Use threatened conifers as flagship species for conservation of wider habitats within protected areas. Most protected area projects focus on both species and habitat conservation, yet the potential of conifers, as charismatic flagships for conservation, has rarely been exploited. One notable exception is *Taiwania cryptomerioides*, which is currently providing justification for protected area development in the Hoang Lien Mountains.

---

9 Efforts are currently underway to expand the system of special-use forests (SUF) to meet a national target of two million hectares by 2010 (Anon., 2003; Tordoff et al., 2004).
2.5.6 State Forest Enterprise restructuring and management

i. **Ensure conifer (as flagship species) conservation is a priority consideration in restructuring SFEs as significant contributors to national forest protection and biodiversity conservation.** In many cases, threats to existing populations of conifers come from legal operations conducted by SFEs. SFEs are under pressure to reform but this is a very slow and irregular process. Restructured SFEs could support conifer conservation through both *in* and *ex situ* approaches. Management and restructuring of commercially non-viable SFEs that support important populations of threatened conifer should be supported from the highest levels in exploring alternative mechanisms for conserving these populations. SFE restructuring for conservation gains could include formal protected area status, commune/village protection forest for biodiversity conservation or other novel methods suitable to the local conditions.

2.5.7 Sustainable use

i. **Assess possibilities of sustainably using threatened conifer species.** The economics, at both large-scale commercial, and small-scale craft enterprises, of different types of plantation programmes need to be studied. However, sustainable use of conifers usually has limitations due to long generation times.

ii. **Explore opportunities for certifying conifer timber suppliers as sustainably managed.** Possible commercial wood-processing companies need to be identified and action programmes to link cultivation of certified wood sources to commercial enterprises, e.g. through ‘contract growing’ opportunities, need to be developed.

iii. **Assess market value and harvesting sustainability of potential NTFPs from conifers.** Where currently sustainable, efforts should be made for trial production and marketing.

2.5.8 Integrated conifer conservation and rural livelihood development

i. **Development of good, integrated, silvicultural practices for land under household or commune/village management which links biodiversity conservation, watershed management and livelihood development.** Many threats to conifers, such as subsistence felling, agricultural land encroachment, fires, NTFP exploitation, etc., occur as a result of local people’s needs. Many forest-dependent communities are poor and suffer from regular periods of hunger. Whilst pioneer slash and burn cultivation is often blamed for forest destruction, in most areas of Vietnam this agricultural practice has ceased, although practices of uncontrolled burning of fallow fields can still destroy large areas of primary forest inadvertently. Halting the conversion of forested land should be facilitated through appropriate long-term land allocation and technical support to develop good forest land management practices.

which support watershed protection, biodiversity conservation and livelihood development. However, recognition of the need to develop appropriate technical models and support for their dissemination is required. Agricultural and forestry extension services in the remotest areas are usually under-resourced and have little knowledge about agroforestry practices, use of indigenous trees and appropriate silvicultural techniques for use on household and commune/village forest land. In some areas, strong local knowledge exists which could facilitate this process. At all times livelihood development linked to conifer conservation should include the allocation of valid, and long term, land use certificates so that tenure arrangements are clear to all stakeholders. This must include households, commune/villages as well as larger commercially viable enterprises. Exploring the use of the provision of recent ‘benefit sharing’ legislation for forest land in relation to protection forest and conifer conservation could highlight opportunities for local communities.

ii. **Explore opportunities for directly engaging local community members in conifer conservation activities.** For example, employing local people to monitor remote sites where key populations of threatened conifer occur. Other possibilities for direct and active community involvement in conifer conservation include: stewardship programmes, ecotourism ventures, fire control, developing plantations, authorised seed collection etc.

iii. **Conduct participatory socio-economic research in areas where threats to conifers are high.** Such research should highlight issues regarding demographics, poverty, education, traditional cultural practices, land use patterns, crop structures, forest dependence and conifer use where appropriate. By use of participatory methods, local people can help define appropriate strategies for livelihood development as well as conservation management.

iv. **Livelihood development approaches in key locations should take into account biodiversity issues.** Through appropriate integration of development activities from GoV and ODA projects at the district level, targeted interventions in remote villages/communes can be linked to conservation measures. This can bring together biodiversity conservation objectives and local interests (social, cultural and economic).

v. **Conduct EIAs, in a transparent manner, when infrastructure development is proposed in areas where conifer conservation is an identified priority.** Appropriate mitigation strategies should be put in place to minimise the impact on the conifer population under consideration.

vi. **Facilitate the development of small-medium sized processing/craft enterprises in remoter areas that can utilise the products from well managed, and if necessary certified, plantations and possibly natural forest that is under local sustainable management regimes.**

---

2.5.9 Ex situ propagation

i. **Research on silviculture and propagation, both vegetative and reproductive, for 'difficult' conifer species should be promoted.** *Ex situ* conservation areas for indigenous trees have also been established for some important conifers include *Taxus wallichiana* and *Keteleeria evelyniana*. Small plantations (1 ha) of *Cupressus* sp. and *Xanthocyparis vietnamensis* have also been established from cuttings. Effective propagation can provide material (including cuttings and seedlings) for replanting programmes. These plantations could help to connect and restore original distributions of species and make their population size large enough to be able to regenerate naturally. However this later aim depends on the use of appropriate provenances. These plantations can also serve as awareness raising tools for local people and other agencies. Seed propagation and replanting are important measures for small fragmented populations of *Xanthocyparis vietnamensis*, *Glyptostrobus pensilis*, *Taiwania cryptomerioides* and *Cupressus* sp. Seed and vegetative propagation research has been conducted by CFSC and FSIV to establish propagation methods for some Vietnamese conifers (Nguyen Duc To Luu, unpublished data; Dick *et al.*, 2004; Than Van Canh, 2002; Tran Minh Tuan, 2002; Nguyen Hoang Nghia, 2000; Huynh Van Keo *et al.*, 1999). The current work contributes to the GSPC Target 8, that 60% of threatened plant species should be in accessible *ex situ* collections, preferably in the country of origin (see Table 3, page 16).

While several conifers have potential for forest plantation, only *Pinus latteri* and *P. kesiya* are found in production plantations at present. Difficult silvicultural requirements and the long rotation for production prevent the sustainable use of many conifers especially where fast growing exotic species provide inputs for the wood-based processing industry including pulp/paper and chip. Development of the furniture industry, and other craft industries requiring good quality timber however may make a reassessment of the long term viability of using key indigenous species appropriate. The possible closure of trade in timber from Laos and Cambodia into Vietnam’s timber trade would also accelerate the need to develop ‘home-grown’ plantations of valuable trees in order to protect those specimens that still exist in the wild and within protected areas. Also the development of mixed forest land plantations for indigenous trees has not been explored in Vietnam. The linking of cultivation of short and long rotation timber/NTFP species plantation is limited thus restricting the options available to land holders. Other products from conifers, such as high value NTFPs, should be utilised for the sake of conifer conservation and sustainable use. Intercropping conifer plantations with faster-growing economic broadleaf trees or agricultural crops could also provide benefits.

Propagation and plantation are also important for sustainable utilisation of species. A good practise has been demonstrated with *Fokienia hodginsii* in Van Ban District, Lao Cai Province and Ky Son District, Nghe An Province where logging companies have to establish new plantations of the species using part of their turnover from timber logs. Plantations can help to reduce exploitation pressure on natural populations and conserve species in the *ex situ* context. However the regulation of this process is critical as at present there is a ‘gap’ between the current trade requirements and the
development of the plantations themselves. Illegal logging from within protected areas and natural forest is hard to control, and once the timber has been cut identifying the source is likely to prove impossible with the resources available to the FPD in Vietnam.

ii. **Assess market potential for ornamental use of cultivated trees** of some species, e.g. *Nageia* spp., *Amentotaxus argotaenia*, *Fokienia hodginsii*.

### 2.5.10 Living Gene Banks

i. **Identify, and strictly protect, indigenous tree seed sources for conifers with possible commercial potential.** Gene banks provide a mechanism to conserve genetic variation within species. Such variation is useful in helping to prevent genetic bottlenecks and eventual extinction. Genetic variation can also be used to maximize potential utilization value of a species. The land where these trees exist could, if not already within an approved protected area, be assigned to local people for protection in return for inputs to livelihood development. This approach may be the only viable approach where remaining populations are in remote and inaccessible areas. Different sites should be chosen for the conservation of genetic variation for species with wide distributions e.g. *Fokienia hodginsii*, *Dacrycarpus imbricatus*, *Pinus latteri*, *P. kesiya*, *Dacrydium elatum*, *Cephalotaxus mannii*, *Nageia* spp. The selected sites can then also be registered as seed sources for *ex situ* programmes. Various initiatives are currently underway in Vietnam to undertake *ex situ* conservation activities for conifers. Attempts to survey and register major seed sources for indigenous trees of Vietnam are carried out by Central Forest Seed Company (CFSC) and the DANIDA-supported Vietnam Tree Seed Project (VTSP). To date, three conifers have been registered - *Pinus latteri*, *P. kesiya* and *Fokienia hodginsii*. Under Vietnamese law registered seed sources can receive better attention and support from authorities for protection and development.
1. *Fokienia hodginsii*’s crown and trunk /Copyright Leonid Averyanov
2. *Xanthocyparis vietnamensis*
3. *Amentotaxus yunnanensis*
Amentotaxus species.
1. *A. poilanei* cone-bearing branchlet and very young seed cones (specimen VH 802, Kon Tum, Ngoc Linh, photo by Averyanov); 2. *A. hatuyenensis* cone-bearing branchlet and young pollen cones (specimen DKH 4970, Ha Giang, Quan Ba, Can Ty, photo by Averyanov); 3. *A. yunnanensis* sterile branchlets with leaves adaxial and abaxial (Bac Can, Cho Don, Ban Thi, photo by Averyanov); 4. *A. yunnanensis* seed-bearing branchlet and ripe seeds (specimen WP 626, Ha Giang, Yen Minh, Lao Va Chai, photo by Phan Ke Loc).

*Calocedrus macrolepis.*
Left: branchlet with seed cones (Cuc Phuong NP, photo by Phan Ke Loc),
Right: branchlet with pollen cones (Cuc Phuong NP, photo by Averyanov)

*Calocedrus rupestris* (new sp.).

Seed cones (specimen HAL 5441, Bac Can, Na Ri, Liem Thuy, photo by Phan Ke Loc).
Cephalotaxus mannii.
1. Trunk of tree (photo by Averyanov, Pu Luong NR, Thanh Hoa, Ba Thuoc, Thanh Son); 2. Seedling (specimen HLF 3133, photo by Phan Ke Loc, Pu Huong NR, Nghe An, Con Cuong, Binh Chuan); 3. Cone-bearing branchlet and pollen cones (specimen P-10618, photo by Phan Ke Loc, Hoa Binh, Mai Chau, Pa Co); 4. Ripe seeds (photo by Averyanov, Pu Luong NR, Thanh Hoa, Ba Thuoc, Thanh Son).
Plate III

*Cunninghamia konishii*:

*Cupressus* sp.:
1. Tree c. more than 40 years old, cultivated at Van Linh, Chi Lang, Lang Son; 2. Ripe seed cones from this tree (photos by Nguyen Duc To Luu).
**Plate IV**

*Dacrycarpus imbricatus.*
1 and 2. Seed-bearing branchlets and seeds (photos by Averyanov from Pu Luong NR, Thanh Hoa, Ba Thuoc, Co Lung); 3. Tree (photo by Phan Ke Loc from Chu Mom Ray NP, Kon Tum).

*Dacrydium elatum.*
1 and 2. Tree crown and trunk (Bi Doup NR, Lam Dong); 3. Young foliage (Na Hang NR, Tuyen Quang, specimen HAL 1703); 4. Seed-bearing branchlets and young seeds (Nui Chua NP, Ninh Thuan, specimen 5412). (All photos by Averyanov).
*Fokienia hodginsii.*

1 and 2. Tree crown and trunk (Lao Cai, Van Ban, Khanh Yen Ha); 3. Young foliage (Hoa Binh, Mai Chau, Hang Kia); 4 and 5. Young seed cones (Lao Cai, Van Ban, Khanh Yen Ha); 6. Mature seed cone (Bac Can, Cho Don, Ban Thi). (All photos by Averyanov).
Keteleeria davidiana. Seed cones (photo by Averyanov from Bac Can, Na Ri, Kim Hy NR).

Nageia fleuryi.
1. Seed-bearing branchlet and young seeds, (specimen HAL 1494), Ha Giang, Quan Ba, Thai An; 2 and 3. Mature seeds, Cuc Phuong NP. (Photos by Averyanov).
Nageia wallichiana. 1 and 3. Tree and branchlet with young seeds (Quang Ninh, Van Don, Quan Lan, Quan Hai, photos by Nguyen Duc To Luu, specimen P-10704); 2. Sapling (Pu Huong NR, Nghe An, specimen HLF 3099, photo by Phan Ke Loc); 4. Branchlet with seeds (Kon Tum, Kon Plong, Hieu, photo by Averyanov, specimen P-10263).
*Pinus dalatensis.*
1. Emergent trees in forest canopy, Kon Tum, Kon Plong, Hieu (photo by Averyanov); 2. Single tree (Bi Doup NR, Lam Dong, photo by Phan Ke Loc); 3 and 4. Branchlet with seed cones (Kon Tum, Kon Plong, Hieu (photo by Averyanov, specimen P-10205).
Pinus krempfii.
1. Tree crown (Bi Doup NR, Lam Dong); 2. Tree trunk (Bi Doup NR, Lam Dong, Lac Duong, Cong Troi); 3. Seed cones (photos 1 and 3 by Averyanov, photo 2 by Phan Ke Loc).

Pinus kwangtungensis. 1. Habitat and 2. Emergent crown in forest canopy (Hoa Binh, Mai Chau, Pa Co); 3. Seedling hardly seen in nature (Cao Bang, Trung Khanh, Ngoc Khe); 4. Young female cones (Ha Giang, Quan Ba, Thai An); 5. Branchlets with mature seed cones (Hoa Binh, Mai Chau, Pa Co); 6. Seed cones (Thanh Hoa, Ba Thuoc, Co Lung). (All photos by Averyanov).
*Podocarpus neriifolius.*
1. Foliage (Cao Bang, Trung Khanh, Ngoc Khe); 2. Ripe seeds (Cao Bang, Tra Linh, Thang Heng); 3. Branchlet with young seeds (Ha Giang, Quan Ba, Thai An, specimen HAL 1451); 4. *Podocarpus pilgeri* pollen cones, (specimen HAL 1504, Ha Giang, Quan Ba, Thai An). (All photos by Averyanov).
Pseudotsuga sinensis.
1. Habitat and 2. Forest stand of *P. sinensis* in Bac Can, Na Ri, Kim Hy; 3. Pollen cones (Ha Giang, Quan Ba, Bat Dai Son NR); 4. Young seed cones and old pollen cones (Ha Giang, Meo Vac, Lu Lu Thang); 5. Unripe seed cone (Bac Can, Na Ri, Kim Hy NR); 6 and 7. Ripe seed cones (Cao Bang, Trung Khanh, Ngoc Khe). (All photos by Averyanov).
Taiwania cryptomerioides.

Taxus chinensis.
1. Branchlets with young pollen cones (Hoa Binh, Mai Chau, Hang Kia, photo by Averyanov). Taxus wallichiana. 2. Base of trunk (Lam Dong, Don Duong, Ho Tien); 3. Branchlets with ripe seeds (Lam Dong, Da Lat, Xuan Tho). (Photos by Nguyen Duc To Luu).
**Tsuga chinensis:**
1. Tree crown (photo from Nguyen Duc To Luu & Thomas, 2004); 2. Branchlet with open seed cones (Cao Bang, Nguyen Binh, Yen Lac); 3. Branchlet with young and mature cones and leaf buds (HAL 1448, Ha Giang, Quan Ba, Thai An). (Photos 2 and 3 by Averyanov).

**Xanthocyparis vietnamensis:**
1. Habitat; 2. Tree crown (HAL 1430); 3. Branch with two different foliage types; 4. Branchlet with unopen seed cones; 5. Branchlet with open seed cones. (All photos from Ha Giang, Quan Ba, Bat Dai Son NR by Averyanov).
CEPHALOTAXACEAE

Cephalotaxus mannii Hook. f.  Plate II

Dinh tùng, Phi ba mủi (Vietnamese), Plum Yew (English), hai nan cu fei (Chinese).

Synonymy: Cephalotaxus hainanensis H.L. Li, Cephalotaxus griffithii Hook.f.

In some references this tree is referred to as C. oliveri Mast. Other references also record C. fortunei and C. drupacea from Vietnam. There is only one species from this small genus in Vietnam - C. mannii.

Conservation status

<table>
<thead>
<tr>
<th>Global</th>
<th>VULNERABLE A1d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing national</td>
<td>RARE</td>
</tr>
<tr>
<td>Proposed national</td>
<td>VULNERABLE A2cd B1ab(i-v), B2ab(i-v), C1</td>
</tr>
</tbody>
</table>

Globally this species is considered Vulnerable (A1d) due to the range-wide reduction of forests, and throughout its range, Cephalotaxus mannii is restricted to small populations in which the largest trees are often targeted for their timber. This global status has not yet been evaluated under the new IUCN (2001) criteria. In Vietnam it has been considered a Rare species (Anon., 1996). The CSG gives this conifer a Vulnerable national status based on population reductions due to widespread conversion of its prime habitat, severe fragmentation and continuing decline in area, extent and quality of habitat.

Description

A moderately shade tolerant, small, upright tree with a straight bole and narrow crown up to 20 - 30 metres tall and 0.5 – 1.1 m dbh. It is found scattered in small groups from 500-2000 m amsl in primary closed evergreen tropical seasonal broad-leaved submontane forests on both limestone and silicate derived soils (mean annual temperature 13-21°C, rainfall above 1500 mm). Often associated with Nageia wallichiana, Taxus wallichiana,

Cephalotaxus mannii Hook. f.

1. Sterile branchlet.
2. Leaf abaxial view.
3. Cone-bearing branchlet and pollen cones.
4. Seed-bearing branchlet and ripe seeds.

(1-2 drawn from DKH 7294, 3- from P 10618 and 4- from HAL 4292 by Pham Van Quang).
Podocarpus neriifolius and Dacrycarpus imbricatus on silicate derived soils of mountains in central and southern Vietnam, and Pseudotsuga sinensis, Pinus kwangtungensis, Nageia fleuryi, Podocarpus pilgeri, Fokienia hodginsii, Taxus chinensis and Amentotaxus spp. on limestone mountains in northern Vietnam. Natural regeneration is frequent.

**Distribution**
Within Vietnam it is definitely known from in Lao Cai, Ha Giang, Son La, Cao Bang, Hoa Binh, Ha Tay, Thanh Hoa, Nghe An, Thua Thien-Hue, Kon Tum, Gia Lai, Lam Dong. Reports from Thai Nguyen, Ha Tinh, Quang Binh, Quang Tri, Dac Lac, Khanh Hoa and Ninh Thuan need to be confirmed. Outside of Vietnam this species is distributed across north-east India, Laos, northern Myanmar, northern Thailand and southern China.

**Uses**
Produces high quality insect and termite resistant timber that is used for quality furniture, fine crafts and tool handles. The seed has medicinal qualities and in Hainan the bark is used to treat fever (Tripp, 1995). An alkaloid (Homoharringtonine) isolated from the Chinese C. harringtonia has shown efficacy against various leukaemia’s (Fu Li-kuo & Jin Jian-ming, 1992). The possibility of growing this species for anti-cancer drug production should be investigated further. This species also has good potential for ornamental use as the young trees are shade tolerant and have a good form, while mature trees have interesting bark patterns.

**Threats**
This species has been exploited for its timber and medicinal properties throughout its global range. Collecting the bark is fatal to the tree and this type of harvesting is unsustainable. Within Vietnam it is principally threatened by forest fragmentation and conversion of habitat to agricultural use in submontane, lowland and some montane forests in non-limestone regions. Where it occurs in the interface between agriculture and montane forest, the forest is liable to degradation. For this species, adequately administered reserves that contain large areas of undisturbed forest may be the only long-term solution.

**Protected Area status**
This species has been recorded in small populations from several national parks and nature reserves including Ba Vi NP, Bach Ma NP, Pu Luong proposed NR, Pu Huong NR, Chu Mom Ray NP and most of the protected areas around Bi Doup in Lam Dong. Reports from Tam Dao NP need to be confirmed. The largest populations in Lam Dong (c. 100 trees) occur on the slopes of Nui Voi – Duc Trong, an area that is now classed as watershed protection forest (Thomas, Gardner & Nguyen Duc To Luu, 2002).

**Recommended conservation action**
This species should be included in Group IIA of the List of Rare and Precious Flora and Fauna for limited use, which will promote conservation of the species outside of protected areas, mainly in protection forests. The wide distribution of the species gives it a high potential for establishment of ex situ gene conservation areas in all provenances using seeds or cuttings. Good populations such as in Nui Voi – Duc Trong – Lam Dong and Pu Huong NR should be declared and protected as National Seed Sources.
**CUPRESSACEAE**

**Calocedrus macrolepis** Kurz

Bách xanh, Tùng hương, Po mu già, Trắc bách đếp núi (Vietnamese), cui bai (Chinese).

Synonymy: *Libocedrus macrolepis* (Kurz) Benth. & Hook.

**Conservation status**

<table>
<thead>
<tr>
<th>Conservation status</th>
<th>Global</th>
<th>Existing national</th>
<th>Proposed national</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VULNERABLE B1+2b</td>
<td>ENDANGERED</td>
<td>ENDANGERED A2acd, A3cd, B2ab(i-v), C2a(i)</td>
</tr>
</tbody>
</table>

Despite its extensive distribution in northern South East Asia, this species is listed as Vulnerable (B1 + 2b). In Vietnam, its conservation status has changed over the years from Endangered (Anon., 1996) to ‘conservation dependent’ (Phan Ke Loc & Nguyen Tien Hiep, 1997) or Endangered with a population of less than 250 mature individuals (criterion D – see Annex 1) (Nguyen Hoang Nghia, 2000). Recent survey work in southern Vietnam recorded more populations so that it no longer meets the D criterion for Endangered. However, the recognition of the northern and southern populations as different taxa, coupled with the restricted distribution, past overexploitation and continuing problems with illegal logging in the south, means that nationally *C. macrolepis* can be assessed as Endangered A2acd, A3cd, B2ab(i-v) C2a(i). The global listing for *C. macrolepis* needs to be reassessed.

**Description**

Straight-boled tree up to 20 – 25 m in height, with a diameter of 0.6 – 0.8 m. Branches early and broad crowned. Found in small groups in primary closed evergreen tropical seasonal mixed submontane forests (mean annual temperature 15-20°C, rainfall over 1500 mm) from 800 – 1500 m amsl on silicate derived soils. In some areas it is associated with *Dacrycarpus imbricatus, Dacrydium elatum* and *Keteleeria evelyniana*. Seedling regeneration may occasionally be abundant (Thomas, Gardner & Nguyen Duc To Luu, 2002). Seedlings are light demanding and mainly found in gaps. Shaded seedlings generally die within 5 years.
Distribution
In Vietnam this species has been recorded from both limestone areas in the north and non-limestone areas in the south. Populations in southern Vietnam (Dac Lac, Lam Dong, Khanh Hoa, Ninh Thuan) show strong morphological resemblance to those outside of Vietnam. Those from the limestone areas in the north (Son La, Ha Giang, Cao Bang, Bac Can, Hoa Binh and Nghe An) show differences in their vegetative morphology which suggest either a response to the more severe environment or the presence of a different species. A lack of fertile specimens has inhibited further research. Recent studies on fertile specimens collected in Bac Can Province has led to the description of a new species - *Calocedrus rupestris* (Averyanov et al., in press). The majority of other populations in the limestone areas of northern Vietnam are now thought to represent this species. There may also be populations that represent naturalised trees. Outside Vietnam *C. macrolepis* occurs in north-east Myanmar, Thailand, Laos and south-east China.

Uses
This species produces valuable, straight grained, finely textured timber that is resistant to termites and insects, and easy to work. It is used for construction, cabinet work, office furniture and fine crafts. It is also used for incense and essential oil, and the young trees are highly ornamental and suitable for cultivation in montane areas.

Threats
The major threat is overexploitation for its valuable timber throughout its range. In southern Vietnam it is also threatened by forest fragmentation, forest fire and conversion of its habitat to agricultural use.

Protected Area status
Small populations are located within protected areas around Bi Doup in Lam Dong and Phuoc Binh in Ninh Thuan. Trees in Ba Vi National Park may be naturalised (Averyanov et al., in press).

Current conservation measures
The species is included in Group IIA of the List of Rare and Precious Flora and Fauna, therefore exploitation is limited by the law. In Lam Dong, propagation programmes have been undertaken by the Western Highland Forest Enterprise and the Vietnam Tree Seed Project to provide planting materials for enrichment plantings and for the establishment of living gene banks.

Recommended conservation action
The main populations are located outside protected areas but still in protection forests such as in Thuong Da Nhim (Lam Dong), Tan Tien (Ninh Thuan), Khanh Son (Khanh Hoa). Since the exploitation of species is limited by the law, conservation awareness should be raised in such protective areas. All logging should be prohibited in all areas where this species is found. Cultivation in plantations could provide an important renewable resource for incense and essential oil and use of material from these sites should be promoted.
**Calocedrus rupestris** Aver., H.T. Nguyen & L.K. Phan (*ined.*)

Bách xanh dà (Vietnamese).

### Conservation status

<table>
<thead>
<tr>
<th>Global status</th>
<th>NOT EVALUATED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing national status</td>
<td>NOT EVALUATED</td>
</tr>
<tr>
<td>Proposed national assessment</td>
<td>ENDANGERED A2cd, C1</td>
</tr>
</tbody>
</table>

As the data on this species has not been formally published, only a provisional assessment can be made. In northern Vietnam almost all populations of *Calocedrus* have been heavily exploited. Its narrow habitat range, limited distribution, the small fragmented population sizes and extensive recent exploitation mean that it can be assessed as EN (A2cd, C1). This infers a reduction in population size of more than 50% over the last 3 generations accompanied by a decline in the area of occupancy and quality of habitat due to actual level of exploitation (A2cd). The total national population size can be estimated at less than 2500 mature individuals (i.e. trees that are reproducing – saplings and young trees are excluded) and there is likely to be a continuing decline of a further 20% within the next two generations given the continuing illegal logging and its lack of representation in protected areas.

### Description

Tree up to 25 m tall, trunk to 1 m dbh, evergreen, monoecious, with broadly rounded crown. Bark with numerous large resin ducts. Timber light yellow, odourless. Branchlets arranged in a plane, spreading and ascending, flattened, prominently jointed. It is distinguished from *C. macrolepis* by the obtuse to broadly obtuse leaf apex, small sub-sessile 4-scaled broadly ovate seed cones 4–5 (-6) x 2.5–3 (-3.5) mm with very short stalk 0.5–1 (-1.5) mm long having 6–8 (-12) obtuse scales and fertile seed scales with incurved roundish apex having rough, more or
less flat surface without any mucro. This species is found as a co-dominant in floristically very rich relict primary closed tropical seasonal coniferous submontane forests with *Keteleeria davidiana*, *Pinus kwangtungensis* and *Pseudotsuga sinensis*, on tops of rocky limestone hills composed of highly eroded solid crystalline white limestone at elevation 650–700 m amsl (mean annual temperature is about 20°C, annual rainfall over 1500 mm). Very few seedlings of *Calocedrus rupestris* are observed.

**Distribution**
The type locality is near the village of Na Bo, 21°56'44"N, 106°05'09"E, at elevation 650-700 m amsl, Liem Thuy Commune, Na Ri District, in the southeastern most part of Bac Can Province, bordering with Thai Nguyen and Lang Son Provinces. This conifer is found in fragments of primary coniferous forests situated in the large limestone areas of northern Vietnam where many interesting conifers such as *Xanthocyaris vietnamensis*, *Pseudotsuga sinensis*, *Tsuga chinensis*, *Taxus chinensis*, *Keteleeria davidiana* as well as many other higher vascular plants were found. The majority of populations of "*Calocedrus macrolepis*" found on limestone mountains in Son La, Ha Giang, Cao Bang and Hoa Binh probably belong to this new, as yet unpublished taxon. Reports of *Calocedrus* from Nghe An have not been verified.

**Uses**
Similar to *Calocedrus macrolepis*, it produces valuable, straight grained, finely textured timber that is aromatic, resistant to termites and insects, and is easy to work. It is used for construction, cabinet work, office furniture and fine crafts and for incense.

**Threats**
The major threats are forest fragmentation, forest fire and overexploitation for timber and resin. There are less than 100 mature individuals at the type locality. During May-June 2004, it was noted that more than 80% of seed cones of *Calocedrus rupestris* were parasitised by insects. If this is a regular occurrence then natural regeneration may be inhibited (Averyanov et al., in press).

**Protected Area status:**
The type locality where this species is found is not yet protected. *Calocedrus* occurs within the Bat Dai Son NR and Hang Kia-Pa Co NR. These populations are small and there are few large trees. *Calocedrus* was widespread in parts of Son La but the majority of the large trees have been logged.

**Current conservation measures**
None are implemented at present.

**Recommended conservation action**
The type locality should be assessed for inclusion in protected area system. This species should be added to the List of Rare and Precious Flora and Fauna and all logging should be stopped. Trials should be undertaken to establish a similar *ex situ* programme as there is for *Calocedrus macrolepis* in southern Vietnam.
**Cunninghamia konishii** Hayata

Sa móc dâu, Sa móc Quê Phong, Ngọc am (Vietnamese).

**Conservation status**

<table>
<thead>
<tr>
<th>Existing global status</th>
<th>VULNERABLE A1c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing national status</td>
<td>RARE</td>
</tr>
<tr>
<td>Proposed national assessment</td>
<td>ENDANGERED A2c, B2ab (i-v)</td>
</tr>
</tbody>
</table>

Globally this species is listed as Vulnerable A1c. In Vietnam, due to the small size of the populations, their restriction to a few areas in three provinces and the extent of deforestation resulting from shifting cultivation in those areas, it meets the Endangered status following the IUCN (2001) criteria.

**Description**

Closely related to *C. lanceolata*, this is an upright tree with pyramidal habit, reaching up to 50 m high with a dbh to 2.5 or more metres. It is found scattered in small groves in primary closed evergreen tropical seasonal mixed submontane and montane forests (mean annual temperature 13-19°C, rainfall above 1500 mm) on granite and some other silicate derived soils from 960 - 2000 m amsl. Associated conifers include *Fokienia hodginsii*, *Nageia wallichiana* and *Dacrycarpus imbricatus*. Natural regeneration has not been observed in Pu Huong NR or at Pu Mat NP in Ky Son, Nghe An. In other areas regeneration seems to be confined to landslips or freshly burnt areas and apparently requires gaps.
**Distribution**
In Vietnam it is found in Ha Giang (Tay Con Linh), Thanh Hoa (Xuan Lien) and Nghe An (Pu Hoat, Pu Huong, Pu Mat, Ky Son). This species has also been recorded from adjoining areas of Laos (Province - Houa Phan) and from Taiwan.

**Uses**
Accessible stands have been heavily exploited by State Forest Enterprises in the recent past; currently it is used locally for house construction and making coffins as the wood is resistant to rot, termites and is easily worked. It is relatively fast growing and has potential for forest plantation.

**Threats**
Heavy exploitation and limited distribution are the main threats. A secondary threat is related to the introduction of foreign provenances of the closely related *C. lanceolata* for plantation work. These taxa are known to hybridise readily; if this happens then the genetic integrity of the remaining wild populations in Vietnam and in Laos would be at risk.

**Protected Area status**
Populations are recorded from Xuan Lien, Pu Huong, Pu Hoat and Pu Mat, Tay Con Linh protected areas.

**Current conservation measures**
This species is included in Group IIA of the List of Rare and Precious Flora and Fauna for limited exploitation. In Nghe An, a research project is underway to determine the full extent of its distribution within the province and to study its biology and ecology (Tran Van Duong, 2001). Attempts at establishing conservation plantations in Ky Son have had limited success; a major problem is the collection of seed and selection of suitable sites for plantation.

**Recommended conservation action**
Local logging activities have to be stopped by raising the awareness of the people and state agencies and by providing on-site protection. Local people, and relevant authorities, also need to be informed about the problems of introducing *C. lanceolata* from areas outside of Nghe An for their own use. Collaboration with Laotian foresters is an important measure since most populations are located in areas that cross the national borders. The species has high potential for timber plantation as one of the largest trees in Vietnam. Silviculture trials should be established in suitable sites by collecting seeds from different sources. Seeds and seedlings can be imported from Laos for plantation but *C. lanceolata* should not be interplanted with the species.
**Cupressus sp.**

Hoàng dàn (Vietnamese).

Older references for Vietnamese conifers identify *Cupressus* trees found in Lang Son and north-east Vietnam as *C. torulosa* D. Don (Nguyen Tien Hiep & Vidal, 1996; Vu Van Dung, 1996). This species is naturally restricted to the Himalayas. An introduced species *C. lusitanica* is widely planted in tropical countries and some specimens in Vietnamese herbaria appear to refer to this species (Farjon, 2002). Natural and many cultivated trees currently found in Lang Son do not appear to belong to *C. torulosa*. *C. tonkinensis* Silba was described in 1994, based on specimens collected from the Lang Son area around 1919 and others collected in Guangxi about the same time (Silba, 1994). Genetic and morphological comparison of material collected from natural and cultivated trees of known wild origin in north-east Vietnam strongly suggest that they are a distinct taxon which is closely related to *C. funebris* (Nguyen Duc To Luu & Thomas, 2004; Thomas et al., in prep.). Records of *Cupressus funebris* from Ha Giang (Le Tran Chan et al., 2000) need to be confirmed. This species has a long history of cultivation in China, especially near temples and its natural distribution is uncertain (Farjon, in press). Its occurrence in northern Vietnam may be the result of naturalisation.

**Conservation status**

<table>
<thead>
<tr>
<th>Global status</th>
<th>NOT EVALUATED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing national status</td>
<td>RARE</td>
</tr>
<tr>
<td>Proposed national assessment</td>
<td>DATA DEFICIENT</td>
</tr>
</tbody>
</table>

If this taxon is correctly identified and it turns out to be indigenous, then it should be listed either as Critically Endangered or as Extinct in the wild for Vietnam. Until then it should be regarded as Data Deficient, until identity is confirmed.

**Description**

This description is based on recently planted trees collected from Lang Son (Van Linh) and surrounding karst ridges areas. Upright single stemmed tree with broad pendulous crown up to 8 m with dbh to 0.4 m. It was found sparsely distributed on limestone ridges from 550 – 1000 m amsl. May have been associated with *Nageia, Pseudotsuga sinensis* and other limestone conifers. Natural regeneration absent.
**Distribution**

In Vietnam, the last known natural tree of *Cupressus* sp. in Huu Lien NR in Lang Son was destroyed by a fire in January 2004 (Thomas & Nguyen Duc To Luu, 2004b). Records from Na Hang in Tuyen Quang represent *Dacrydium elatum*. Reports from Dong Van in Ha Giang (Le Tran Chan et al., 2000) need further verification. Its status in China also needs verification. The distribution of *C. funebris* in Vietnam, as well as its distribution in China need to be clarified before it can be regarded as indigenous in Vietnam.

**Uses**

The timber has a straight, fine textured grain that is resistant to termites and insects. It is aromatic, especially the roots, and does not deform or split after seasoning. Used for cabinet work, office furniture, high quality crafts and statues. It is also used for incense sticks and essential oil extracted from wood and roots can be used in medicine, perfumes manufacture, soaps and other cosmetics. It is also planted as an elegant ornamental tree with attractive juvenile foliage and mature shape.

**Protected Area status**

Huu Lien NR was established to protect the remaining trees (as well as many other threatened species) in 1986. Illegal logging and fire have eliminated this species from the reserve (Thomas & Nguyen Duc To Luu, 2004b).

**Current conservation measures**

This species has been the focus of extensive ex situ conservation and utilisation programs. A small stand of less than 20 trees has been established within Huu Lien NR. The Central Forest Seed Company and its associated State Forest Enterprise have undertaken propagation trials based on a collection of 40 clones established as a living gene bank to support future plantation work.

**Recommended conservation action**

Further research to establish the species identity is ongoing. Verification of previous reports for localities in Tay Con Linh and Ha Giang is also important. FPD, FDD and FIPI staff should be asked to report any new finds. Replanting and plantation programmes using propagated materials can be aimed at production of incense and essential oil. Recent market surveys (An Van Bay, 2003) have indicated that there is a substantial demand for *Cupressus*. Further trials to establish plantations should be undertaken. Genetic fingerprinting of the existing ex situ collections should be undertaken to establish the range of clones currently in cultivation.
**Fokienia hodginsii** (Dunn) A. Henry & H.H. Thomas  
Plate V

Pơ mu, Mỹ vạc, Hồng, Mỹ long lanh (Vietnamese)

**Conservation status**

<table>
<thead>
<tr>
<th>Global status</th>
<th>NEAR-THREATENED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing national status</td>
<td>INSUFFICIENTLY KNOWN</td>
</tr>
<tr>
<td>Proposed national assessment</td>
<td>ENDANGERED A2cd</td>
</tr>
</tbody>
</table>

Its extensive distribution accounts for its current global evaluation as Near-threatened under IUCN (1994) criteria. However, in each country where it occurs, this species has been extensively exploited and populations are becoming more isolated and fragmented. Its global status is currently under review. In Vietnam, this species has been listed as Endangered (Nguyen Duc To Luu & Thomas, 2004) based on the reduction in its habitat and the extent of logging operations. The majority of the remaining mature stands are confined to remote mountainous areas in Lao Cai, Nghe An and Lam Dong Provinces. Licences for felling are still being granted to State Forest Enterprises e.g. in Van Ban District, Lao Cai Province and Muong La District, Son La Province, and illegal logging is also still a problem.

**Description**

An upright, straight boled tree with rounded crown, reaching up to 30 m high with a dbh to 1.5 or more metres. There is only a single species in this genus, which is remarkably variable in its leaf shapes dependent on the maturity of the tree and its foliage. It occurs in nearly pure stands on top ridges of limestone and non-limestone mountains or dispersed as individuals or small groves of trees on slopes and flat areas in primary closed evergreen.
tropical seasonal broad-leaved submontane and montane forests (mean annual temperature 13-20°C, annual rainfall above 1800 mm) dominated by Fagaceae, Lauraceae and Magnoliaceae (Kuznetsov, 2001). In the southern provinces it is associated with Dacrydium elatum, Pinus dalatensis and P. krempfii, in the central and northern provinces it is associated with Cunninghamia konishii, Taiwania cryptomerioides, and Pinus kwangtungensis. In limestone areas of northern Vietnam (Ha Giang, Bac Can and Hoa Binh Provinces) it is found sometimes in pure stands on top ridges of limestone mountains at the elevation of 900-1400 m amsl. It regenerates abundantly, but is shade intolerant and requires gaps.

**Distribution**
Within Vietnam it is found in Dien Bien, Lai Chau, Lao Cai, Son La, Yen Bai, Ha Giang, Bac Can, Phu Tho, Hoa Binh, Nghe An, Ha Tinh, Thua Thien-Hue, Kon Tum, Gia Lai, Dac Lac, Lam Dong, Ninh Thuan and Khanh Hoa. Reports from Tuyen Quang need to be verified. Outside of Vietnam it is found across much of southern China and in Laos. In both of these countries the extent of the remaining stands are unknown, making it difficult to estimate the extent of the global populations represented in Vietnam.

**Uses**
It produces high quality timber that is used for house building (including roofing shingles), for furniture and handicrafts. It is also a source of valuable essential oil. Seeds have been reported to have medicinal properties (Perry, 1980).

**Threats**
The timber is highly valued and consequently it has been intensively exploited. Large trees are becoming rare due to selective felling. Large quotas are still being licensed for cutting in some provinces. The ecology of the species is not well known. If it is dependent on episodal disturbance events followed by large-scale regeneration (the fact that it does here and there occur in groves seems to confirm this), then selective cutting is likely to favour angiosperms, which by quickly filling the gaps will prevent the more light demanding conifers from successfully regenerating. Smaller existing trees are likely to be felled in a next quorum harvest, once they are bigger. This scenario, if correct, would effectively remove Fokienia even from forests that would be otherwise protected (Farjon, 2002).

**Current conservation measures**
Fokienia hodginsii is listed in the List of Rare and Precious Flora and Fauna in Group IIA for limited exploitation. Surveys for volume and area of the species have been done by FIPPI (Phung Tu Boi, 1996) in 9 provinces. Two natural stands in Ky Son, Nghe An Province and Van Ban, Lao Cai Province have been registered as National Seed Sources. In some areas, (Ky Son, Nghe An, Van Ban, Lao Cai), large trial plantations are being established with some success but there is a gap between trade related demand and wood availability from plantations in the short term.

**Recommended conservation action**
It is recommended that strict reserves, e.g. within the Hoang Lien Mountain Ecosystem and
its forest protection areas, be created in which the various distribution patterns, age classes (including “over mature” or senescent phases if possible) are represented. Simultaneously, regeneration of *Fokienia* (whether or not this occurs) in exploited forest should be monitored.

Osborn (2004) conducted a general status survey on *Fokienia* for FFI and made the following recommendations:

- Continue reviewing published information that has benefit for the implementation of the management plan.
- Clarifying the legal position regarding the harvesting and trade of *Fokienia* in Vietnam. Continual monitoring of the legal situation is also important
- Assessing trade statistics, where possible, of *Fokienia* through logging companies and/or processing companies. This may involve the sub-contracting of consultants or researchers outside of Vietnam.
- Conducting detailed research into the ecology and regeneration strategy of *Fokienia* using the Hoang Lien National Park and/or Van Ban District, Lao Cai Province as pilot studies. A pilot study for *Fokienia* found on limestone parent rock should also be conducted.
- Conducting (or contracting) research into the association between *Fokienia* and the Beautiful Nuthatch *Sitta formosa*. Positive association would have an impact on the conservation of both taxa and potentially provide further resources of funding. Research would have to be undertaken in suitable areas particularly where the ranges of both species overlap.
- Assessing the volume of *Fokienia* (standing) wood through the use of remote sensing and ground truthing techniques.
- Reviewing all data (where possible) of provincial authorities with regards *Fokienia* distribution, density and harvesting quotas.
- Based on the site specific results devise a plan for the management of *Fokienia* for the whole of Vietnam.
- Assess the use of plantation strategies with regards timber trade and the effects of such strategies on both in situ and ex situ conservation of *Fokienia*.
- Assess the use of *Fokienia* by different ethnic groups for subsistence and cultural purposes.

In addition full protection for *Fokienia* should be given in watershed protection areas – including revoking of current licences for State Forest Enterprises to harvest from natural forest areas. *Ex situ* gene conservation areas of all provenances should be established. Silvicultural trials for domestication should be undertaken both for large scale commercial production and for local requirements for ethnic minorities and for furniture/craft based small/medium size enterprise development.
**Glyptostrobus pensilis** (Staunt.) K. Koch

Thông nước, Thuỷ tùng (Vietnamese), Water Pine (English), shui song (Chinese).

**Conservation status**

<table>
<thead>
<tr>
<th>Global status</th>
<th>DATA DEFICIENT [ENDANGERED B1ab(i,iv), B2ab(i,iv), D]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing national status</td>
<td>ENDANGERED</td>
</tr>
<tr>
<td>Proposed national assessment</td>
<td>CRITICALLY ENDANGERED A2c, B1ab(i-v), B2ab(i-v), C1</td>
</tr>
</tbody>
</table>

Globally, this species is listed as Data Deficient due to uncertainty about the natural status of the Chinese populations. Recently, and partly as a result of the clarification of its status in Vietnam it has been assessed as Endangered following criteria B1ab(i, iv) and B2ab(i, iv), D under the IUCN (2001) criteria (Farjon et al., 2004b). In Vietnam, *Glyptostrobus* should be listed as Critically Endangered under categories A2c, B1ab(i-v), B2ab(i-v) and C1 (see Annex 1 for explanation of IUCN, 2001 criteria). The extent of occurrence and the area of occupancy are considerably less than 100 km² and 10 km² respectively. The two extant populations remaining in Vietnam can be regarded as severely fragmented and, based on the current observed health of the trees in both populations and the types of threats described above, there will be a continuing decline in the area, extent and quality of habitat. The overall Vietnamese population contains less than 250 mature individuals and, with the level of damage caused by recent fires and the likelihood that they will reoccur, a further decline of 25 % within the next generation would be a reasonable estimate.

**Description**

An upright tree with a pyramidal crown becoming broader with age, smallest branches usually deciduous, reaching up to 20 m high with a dbh to 1 m. Pneumatophores often
found around the partly buttressed base of the tree. It is found in closed evergreen swamp forests dominated by *Syzygium, Dipterocarpus obtusifolius* and *Elaeocarpus* (mean annual temperature 22-24°C, annual rainfall 1300-1800 mm) on a basalt substrate from 550 – 750 m amsl. No other conifers are indigenous to this area. Natural regeneration has not been reported.

**Distribution**

In Vietnam it is only known from Dac Lac (Ea H'leo, Krong Nang). It may have been more widespread in the past, at least in Gia Lai and Lam Dong. Most records from south-east China refer to cultivated or naturalised trees but there may be several areas in which original populations or remnants of populations also occur. This situation makes it currently very difficult to evaluate the IUCN status of this species on a global scale. Reports of its occurrence in Khammouan province in Laos are based on verbal reports by visiting Vietnamese foresters (Thomas *et al.*, 2004d).

**Uses**

Previously used for construction and craftwork. In China, timber from naturally fallen trees is used for boat building and bridge construction as it is water resistant. It has a very attractive habit and is suitable for planting near water. In China it is often planted on flood banks for stabilisation (Fu Li-kuo *et al.*, 1999d).

**Threats**

In Vietnam, *Glyptostrobus* is confined to two small nature reserves surrounded by coffee plantations. Its extent of occurrence and area of occupancy are considerably less than 100 km$^2$ and 10 km$^2$ respectively. The estimated total population contains less than 250 mature individuals. Both populations are declining and face considerable threats from fires and habitat changes, primarily conversion to agriculture.

**Protected Area status**

The largest population, (c. 220 trees) is located in a small 50 ha reserve at Earal while the second, (c. 34 individuals) is within a larger reserve (100 ha) at Trap Kso.

**Current conservation measures**

*Glyptostrobus* is listed in Group I of the ‘Rare and Precious Flora and Fauna of Vietnam’ (Council of Ministers Decree 18/1992/HDBT)$^{12}$. Under this legislation reserves and management plans had to be established. Exploitation and use are forbidden. Further legal protection was given under Law on Environmental Protection$^{13}$ that was aimed at regulating developments in the surrounding areas. The Dac Lac Provincial People’s Committee declared reserves for both populations in 1994. Management boards and management plans along with guard stations and fences were established (Tordoff *et al.*, 2004).

---

12 See footnote 1.
**Recommended conservation action**

The area covered by the reserves and the size of the populations within them is too small to guard against stochastic events such as fire over the longer term. Due to the extensive clearance of the surrounding areas there is no possibility of linking the reserves to other suitable areas. Despite these problems, the efforts at *in situ* conservation should be maintained, not least because the swamp community (particularly at Earal) may represent assemblages that no longer occur anywhere else. A full survey of both reserves is needed before this potential benefit can be assessed.

The critical state of the remaining trees makes some form of *ex situ* conservation essential. The Forest Science Institute of Vietnam has been attempting to establish an *ex situ* collection for a number of years. Seed collections have been made repeatedly but no germination has been recorded. Attempts at vegetative propagation by FSIV have also been largely unsuccessful, probably due to the senescent state of most of the trees and the consequent lack of suitable propagating material. A limited number of clones have been successfully rooted and are being grown on at the FSIV research centre in Dalat. If these clones can be established, then other techniques could be used to produce material for *ex situ* work. At the RBGE the use of cone induction techniques have successfully produced viable seed from this species. Tissue culture is another potential option (Thomas *et al.*, 2004d).
Taiwania cryptomerioides Hayata

Bách tán Đài Loan (Vietnamese), Taiwan shan (Chinese), Chaz Kauz (Cha Cau) (H’mong).

Synonymy: Taiwania flousiana Gaussen.

Conservation status

<table>
<thead>
<tr>
<th>Global status</th>
<th>VULNERABLE A1d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing national status</td>
<td>NOT EVALUATED</td>
</tr>
<tr>
<td>Proposed national assessment</td>
<td>CRITICALLY ENDANGERED A2c, B1ab (i-v), B2ab (i-v), C2a(ii)</td>
</tr>
</tbody>
</table>

Globally this species was listed as Vulnerable; however, the size of the single Vietnamese population is currently estimated to be around only 130 trees within an area of less than 3 km$^2$. It is therefore classified as Critically Endangered at the national level using IUCN (2001) criteria.

Description
An emergent, single stemmed tree, broadly pyramidal or with few large horizontal branches and pendulous branchlets in upper crown. It reaches up to 40 m high with a dbh to 1.2 m. It is found on granite derived soils from 1800 – 2100 m amsl and in areas with mean annual temperature about 13°C with the mean temperature of the hottest month less than 17°C, annual rainfall over 3000 mm with no dry months. Found associated with Fokienia hodginsii. Natural regeneration episodic, thought to be limited by frequent fires.

Distribution
A single, small disjunct population in Vietnam has recently been found in Lao Cai (Van Ban). It was evaluated and assessed as indigenous following field studies by several of the authors of this report (Nguyen Tien Hiep et al., 2002; Farjon et al., 2004a). Outside of Vietnam it is found in Myanmar and China (Yunnan and Taiwan). The isolation of the Vietnamese trees means that they represent a distinct population.
**Uses**

This tree produces very high quality timber for construction (including roofing shingles), furniture and coffins (Fu Li-kuo & Jin Jian-ming, 1992). It is also a very ornamental tree suitable for montane areas and is known to contain compounds with anti-cancer and insecticidal properties (Kan He et al., 1997). The species has considerable cultural significance in China due to its longevity and stature. It could potentially be the tallest tree in Vietnam and have similar flagship value.

**Threats**

This species is extensively exploited for its valuable timber in Myanmar, Yunnan and Taiwan. The Vietnamese population has suffered from felling in the past (possibly by the SFE as well as local people) and regeneration is restricted by the continued use of fires in the area following clearance (whether through a natural fire or from harvesting over 40 years ago) for grazing purposes. Naturally this species is thought to require fire to regenerate, but the frequency and intensity of artificial fires in the Van Ban area allows woody angiosperms, scrub and grass to take over. As a result, most of the remaining trees are restricted to rocky areas that are not subject to burning. Due to the extremely fragmented forest remnants in which it occurs (c. 90% of forest within the area of occurrence has been destroyed) any further fires will now directly threaten the remaining trees (Farjon et al., 2004a).

**Protected Area status**

Currently the population is not within a protected area; however, Lao Cai Forest Protection Department and Flora & Fauna International (Vietnam) are currently working on a community based conservation project in an attempt to ensure its *in situ* conservation.

**Current conservation measures**

Seed collection aimed at providing material for restoration work as well as seed banking and utilisation trials has been undertaken by the Central Forest Seed Company as part of its project with the International Conifer Conservation Programme (Thomas & Nguyen Duc To Luu, 2004a). It is planned to return over 250 seedlings to near the site in early 2005 with local community cooperation. Work is under way to mark individual trees and assess the level of regeneration.

**Recommended conservation action**

This species should be included in Group IA of the List of Rare and Precious Flora and Fauna and Vietnam Red Data Book for full protection. The site of the trees should be established as a nature reserve with strong local community involvement in this remote area. Fire breaks should be installed around remaining populations. Awareness raising and community development programs should be implemented, especially for people in Phinh Ngai and Lung Cung villages, Nam Co Commune, Yen Bai Province who live closest to the remaining trees. Seed collection and production of planting materials should serve for on-site replanting and restoration work in order to reconnect metapopulations. Reforestation work will require the appropriate involvement of Van Ban State Forest Enterprise as the trees are currently on land assigned for their management. Research into possible genetic variation between all populations would be useful for understanding the evolutionary history of the species. National and international collaboration therefore is important in conservation of the species.
**Xanthocyparis vietnamensis** Farjon & Hiep  
Bách vàng (Vietnamese), Golden Cypress (English).

### Conservation status

| Global status | CRITICALLY ENDANGERED B2ab (v)  
[BCRITICALLY ENDANGERED B1ab(ii-v), 2ab(ii-v)] |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing national status</td>
<td>NOT EVALUATED</td>
</tr>
<tr>
<td>Proposed national assessment</td>
<td>CRITICALLY ENDANGERED B1ab(ii-v), 2ab(ii-v)</td>
</tr>
</tbody>
</table>

This species is listed as Critically Endangered due to its restricted occurrence, limited habitat, and the effects of selective logging and forest fire. The most recent survey recorded a total of 561 trees scattered over three communes, only 290 of which were mature trees (To Van Thao et al., 2004).

**Description**

Tree with pyramidal habit when young, broad, flattened crown when mature, reaching up to 15 m high with a dbh to 0.8 m. One of the striking morphological features of *Xanthocyparis vietnamensis* is the occurrence of two distinct types of leaves on many mature trees. It has both branches with juvenile leaves and those with mature, scale-like leaves. Only the latter type bears either male or female cones. It is found in the second layer of the primary closed evergreen tropical seasonal coniferous *Pseudotsuga sinensis* submontane forests on top ridge of highly eroded solid crystalline white limestone mountains (mean annual temperature 14-18°C, annual rainfall 2000 - 2400 mm). Found scattered associated
with Nageia fleuryi, Podocarpus pilgeri, Calocedrus rupestris, Taxus chinensis and Amentotaxus sp. Natural regeneration is rare; saplings contribute about 10-15\% of total number of trees (To Van Thao et al., 2004).

**Distribution**
Very narrow local endemic to Bat Dai Son limestone massif, Quan Ba District in Ha Giang Province.

**Uses**
Locally valued for its fragrant, durable timber.

**Threats**
The already small population is primarily threatened by forest fragmentation and by selective logging (Farjon et al., 2004a). Regeneration is variable; recent seed collections from specific localities and subsequent germination trails have not been successful (Nguyen Duc To Luu, 2004; unpublished data).

**Protected Area status**
All of the population lies within the Provincial Protected Area of Bat Dai Son. Local logging remains a problem.

**Current conservation measures**
Vegetative propagation trials have been successfully undertaken by the Central Forest Seed Company with 30 clones. Seed trials are ongoing (To Van Thao et al., 2004; Nguyen Duc To Luu, 2004, unpublished data) and replanting programmes are also being undertaken by Institute of Ecology and Biological Resources in the Bat Dai Son Provincial Protected Area.

**Recommended conservation action**
This species should be fully protected by law by inclusion in Group IA of the List of Rare and Precious Flora and Fauna and Vietnam Red Data Book. Awareness-raising, especially in Thanh Van Commune where most of the illegal logging occurs (To Van Thao et al., 2004), is important for effective conservation. Seed study and propagation work should be promoted to providing planting material for restoration. On-site replanting is necessary to increase population size to ensure increased regeneration in the future.
PINACEAE

Abies delavayi Franch.
subsp. fansipanensis (Q.P. Xiang) Rushforth

Vân sam Fan Si Pan (Vietnamese).

This tree has previously been known as Abies delavayi var. nukiangensis in major references such as Vietnam Red Data Book (Anon., 1996) and the Flore du Cambodge, du Laos et du Viet Nam (Nguyen Tien Hiep & Vidal, 1996). It was redescribed as a new species (Xiang Qiao-ping, 1997) on the basis of cone characters and then reduced to a subspecies by Rushforth (1999).

Conservation status

<table>
<thead>
<tr>
<th>Global status</th>
<th>LEAST CONCERN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing national status</td>
<td>RARE</td>
</tr>
<tr>
<td>Proposed national assessment</td>
<td>VULNERABLE D1</td>
</tr>
</tbody>
</table>

Globally the threat status of this subspecies has not been evaluated. Based on the new IUCN (2001) criteria, the national assessment for this subspecies should be changed to Vulnerable, due to its small population size, limited distribution and vulnerability to forest fires. In Vietnam it is listed in Group I (i.e. strict no use by law) of the List of Rare and Precious Species.

Description

An upright tree, 15-20 m tall with a dbh to 1m that grows on the high slopes and ridges of Mt Fan Si Pan from 2600 – 3000 m amsl in primary closed evergreen tropical seasonal mixed subalpine forest. Mean annual temperatures 8.8-10.8°C at an elevation of 2170 m amsl and annual rainfall of 2,500 mm - 3,500 mm are extrapolated from data gathered at
Hoang Lien Son station (Nguyen Khanh Van et al., 2000). This subspecies can be found partly in bamboo-dominated vegetation and is locally dominant on granite derived soils where it is associated with *Tsuga dumosa*. Seed is shed annually but seedlings are not shade tolerant and it requires some disturbance for establishment.

**Distribution**
This subspecies is endemic to Mt Fan Si Pan in Lao Cai Province. *Abies delavayi* is widespread in south-western China and extends into the Himalayan areas of Myanmar and north-eastern India.

**Uses**
Due to the small size of the population that is situated far from villages, it is not used economically in Vietnam. In China *Abies delavayi* timber is used for construction and tannin is extracted from the bark.

**Threats**
The entire known population is situated on the tallest mountain in Vietnam and within the Hoang Lien National Park. Plans to build a ‘road’ to the summit of Mt Fan Si Pan could present a threat to this species. Other threats include fire and the lack of natural regeneration. Cutting of trees on the mountain, both for trekking tourists and for possible local use threaten this tree. However, remoteness at present causes difficult access of at least the highest occurring trees. The same species (different subspecies) is fairly heavily exploited in similar mountains in Yunnan, China. Risks may increase in the near future unless specific protection in the form of a logging ban and some form of enforcement are implemented.

**Protected Area status**
The only known population lies within Hoang Lien National Park.

**Current conservation measures**
No *ex situ* conservation programmes involve this taxon.

**Recommended conservation action**
Since the threats for the species are real e.g. growth in tourism on Mt. Fan Si Pan and may increase in the future, regular monitoring of the threats is essential for conservation. This should enable preventative measures to be taken as those threats become evident.
**Keteleeria davidiana** (Bertrand) Beissn.  
Plate VI

Du sam núi đá (Vietnamese), tie jian shan (Chinese).

**Conservation status**

<table>
<thead>
<tr>
<th>Global status</th>
<th>LEAST CONCERN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing national status</td>
<td>ENDANGERED</td>
</tr>
<tr>
<td>Proposed national assessment</td>
<td>ENDANGERED A2cd, B1ab(iii), B2ab(ii), D</td>
</tr>
</tbody>
</table>

This species of pine is widely distributed in southern China and therefore is not considered threatened globally. Within Vietnam, the two small populations that have been discovered could represent disjunct outlying populations. Recent distribution maps for the Chinese populations indicate the nearest Chinese populations are more than 100 km away (Ying Tsun-shen *et al.*, 2003) making it unlikely that there is currently any genetic exchange between them. Field observations by Vietnamese botanists indicate that there were intervening populations in the recent past so that the now isolated Vietnamese localities were once part of a more continuous population. This makes it difficult to assess the significance of isolation of the Vietnamese localities and to apply the IUCN categories. The recent Regional Guidelines (IUCN, 2003) state that “provided that the regional population to be assessed is isolated from conspecific populations outside the region, the IUCN Red List Criteria (IUCN, 2001) can be used without modification within any geographically defined area”. If this is done then the Vietnamese population would be assessed as Endangered on the basis of their size (criterion D) alone. They also meet the criteria for A2cd, B1ab(iii), B2ab(ii).

**Description**

A large tree, 20-25 m tall, 0.6-0.8 m dbh (or more) with a flat semi-hemisphere shape. It is found in small groups of 3-5 trees intercalated in closed evergreen tropical seasonal submontane forests dominated by *Pseudotsuga sinensis* and restricted to the upper ridges of highly eroded solid crystalline white limestone mountains at the elevation of 550-700 m.
amsl, (mean annual temperature c. 20°C, annual rainfall above 1500 mm). Mainly associated with *Pseudotsuga sinensis*, rarely with *Calocedrus rupestris* and *Pinus kwangtungensis*. Natural regeneration occasional, saplings very rare.

**Distribution**
Known only from two small populations in two adjacent very restricted localities in Na Ri district of Bac Can Province. Outside Vietnam it is found in central and south China.

**Uses**
This species produces valuable, straight grained, finely textured, yellowish, smoothly veined timber that is resistant to termites and insects. The wood is easy to work with and is popular for house building, especially for making furniture or walls.

**Threats**
Forest fragmentation and restricted populations, forest fire and overexploitation for timber. There are less than 100 mature individuals left.

**Protected Area status**
One of two localities where this species is found is in Kim Hy NR.

**Current conservation measures**
None are implemented at present.

**Recommended conservation action**
The two localities in Na Ri District of Bac Can Province represent the only occurrence of this species in Vietnam. These sites should be given as much protection from logging and fire as possible. Seed collections should be made and seed either stored or used to support a local replanting programme if that is feasible. The support and participation of the local community are essential.
Keteleeria evelyniana Mast.

Du sam núi đất, Ngo tùng (Vietnamese).

Synonymy: K. roulettii (A. Chev.) Flous

**Conservation status**

<table>
<thead>
<tr>
<th>Global status</th>
<th>LEAST CONCERN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing national status</td>
<td>VULNERABLE</td>
</tr>
<tr>
<td>Proposed national assessment</td>
<td>VULNERABLE A2cd</td>
</tr>
</tbody>
</table>

Globally, this species is not currently listed as threatened due to its wider distribution in Laos and China. In Vietnam, however, it has been listed as Vulnerable (Anon., 1996). Deployment of IUCN (2001) criteria would support this assessment qualifying it under criteria A2cd: a continuing population size reduction of at least 30 % over the last three generations due to persistent habitat loss and direct exploitation (see threats section below).

**Description**

An upright, single stemmed tree with an irregular branching habit, older trees with a broad crown, reaching up to 30 m high with a dbh to 1.5 m. It is found in warm primary and secondary closed evergreen tropical seasonal mixed or coniferous submontane forests with Fagaceae, Lauraceae and Pinus kesiya (in some areas) on neutral soils (mean annual temperature 18-22°C, annual rainfall above 1500 mm), from 1000-1600 m amsl (occasionally 500-2000 m amsl). Found associated with Fokienia hodginsii, Calocedrus macrolepis (c. 900 m amsl), Nageia wallichiana, Dacrycarpus imbricatus, Podocarpus...
neriifolius, Cephalotaxus mannii and Pinus latteri. Natural regeneration is abundant, though seedlings are intolerant of heavy shade and maybe be dependent on regular fires.

**Distribution**
In Vietnam, it is found in Dien Bien, Son La, Hoa Binh, Nghe An, Ha Tinh, Thua Thien-Hue, Kon Tum, Dac Lac, Lam Dong, Khanh Hoa and Ninh Thuan. It also occurs in Laos and is quite widespread in southern China, although it is often difficult to determine which Chinese populations are within primary unaltered forests and which have been managed. Although the Vietnamese populations are likely to represent only a small part of the global population, they may represent distinct provenances.

**Uses**
*K. evelyniana* produces a yellow-white timber that is insect resistant and is useful for construction and household furniture making. This species can be used in plantations as it grows relatively quickly.

**Threats**
In many areas of Vietnam, it has been overexploited for timber by local people and large parts of its natural habitat have been converted to agriculture.

**Protected Area status**
Some stands are protected within protected areas such as Bach Ma NP in Thua Thien-Hue Province, Ngoc Linh NR in Kon Tum Province, Bi Doup NR in the Central Highlands.

**Current conservation measures**
This species is included in Group IIA of the List of Rare and Precious Flora and Fauna. The CFSC has initiated a programme for the establishment of seed orchards in Lam Dong, Lai Chau and Lang Son. Seed collection and field trials and monitoring of natural regeneration are also being undertaken in Son La by FSIV.

**Recommended conservation action**
Exploitation of the species is limited by GoV policy so in theory, this tree is safeguarded in protected forests. However, raising awareness for local people and relevant government agencies is an essential conservation action as the main threat is local logging. Establishment of *ex situ* gene conservation areas should be expanded to include the full range of available provenances. Silviculture trials should be further promoted to provide useful data for plantation efforts for commercial and local uses.
**Pinus dalatensis** Ferré

Thông Đà Lạt (Vietnamese).

**Conservation status**

<table>
<thead>
<tr>
<th>Global status</th>
<th>VULNERABLE B1 + 2c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing national status</td>
<td>RARE</td>
</tr>
<tr>
<td>Proposed national assessment</td>
<td>VULNERABLE B1ab (iii,v), 2ab(iii,v)</td>
</tr>
</tbody>
</table>

Globally and nationally this species is currently listed as Vulnerable (B1 + 2c). It is known from fewer than 10 distinct locations and there has been a continuing decline in the extent and quality of its habitat. The majority of the populations are limited to less than 100 mature trees in each.

**Description**

A straight-trunked tree with wide spreading crown, reaching up to 25 m high (sometimes taller) with a dbh to 1.2 m. It is found as an emergent over primary closed evergreen tropical seasonal coniferous or mixed submontane and montane forests on flat mountain ridges as well as on foothills near streams, on heavy clay and yellow ferralic soils with a distinct humus layer (mean annual temperature 16–21°C, annual rainfall above 1800 mm) 1000 – 2600 m amsl. Found associated with *Pinus krempfii*, *Fokienia hodginsii* and *Dacrydium elatum* in the southernmost part of the Central Highlands, and in small patches within *Fagaceae* and *Lauraceae* dominated forests in central Vietnam. Natural regeneration involves the rapid growth of young trees until they reach the canopy, broad crowns then

---

*Pinus dalatensis* Ferré

1. Cone-bearing branchlet and seed cones.
2. Leaf fascicle.
4. Leaf distal portion, abaxial view.

(Drawn from VH 5354 by Pham Van Quang).
develop. Seedlings are shade intolerant. This species may require periodic fire to provide clearings for regeneration. Trees may live for several hundred years. The cones, foliage and shoots show a wide range of variation within and between populations, for which reason the species has recently been divided into var. *dalatensis* Businsky, var. *bidoupensis* Businsky and subsp. *procera* Businsky (Businsky, 1999).

**Distribution**
This is local endemic in the southern part of Truong Son (Annamite Mountain) range of Vietnam and Laos. In Vietnam it is known from Thua Thien-Hue (Phu Loc), Kon Tum (Ngoc Linh, Kon Plong), Gia Lai (Kon Ka Kinh NR), Dac Lac (Chu Yang Sinh and other massifs), Lam Dong, (Bi Doup mountain), Ninh Thuan (Phuoc Binh). Its precise distribution in Laos is uncertain (Griejmans, 2002).

**Uses**
The rarity of this species means that it has not been used as a timber tree although its wood has similar properties to that of *Pinus kesiya*. This species could have a high ornamental value in montane areas. Similar five-needle pines imported from China are considered as good material for bonsai.

**Threats**
In the past, logging of the associated *Fokienia* has also involved felling of *P. dalatensis*. Current threats include the destruction of surrounding forests through the continuation of shifting cultivation and the replacement of forests with fire adapted *Pinus kesiya* dominated forests.

**Protected Area status**
The main populations in Kon Tum, Dac Lac, Lam Dong and Ninh Thuan are all within recently declared national parks and nature reserves.

**Recommended conservation action**
Regular monitoring of forest fires and local logging is the primary course of action for conservation of this species. Understanding the response of this tree to forest fire is important to ensure suitable regeneration. Genetic variation in species seems to be high, so *ex situ* gene conservation areas should be set up for the species. However, appropriate sites should be well chosen since this pine may require specific growing conditions, including the presence of mycorrhiza.
**Pinus kesiya** Royle

Thông ba lá (Vietnamese), Khasya Pine (English).

Synonymy: *Pinus insularis* Endl., *P. langbianensis* A. Chev.

**Conservation status**

<table>
<thead>
<tr>
<th>Status</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global status</td>
<td>NOT EVALUATED</td>
</tr>
<tr>
<td>Existing national status</td>
<td>NOT EVALUATED</td>
</tr>
<tr>
<td>Proposed national assessment</td>
<td>LEAST CONCERN</td>
</tr>
</tbody>
</table>

Due to its widespread distribution across South East Asia including Vietnam, this pine is not listed as threatened. This may change depending on the assessment of the remaining natural populations.

**Description**

A tall, single stemmed tree with a thin, umbrella shaped crown, reaching up to 35 m high with a dbh to 1 m. It is usually found in pure stands, sometimes with broad-leaved species as understory on infertile red and yellow podzolic soils with pH around 4.5 (mean annual temperature 14-20°C, annual rainfall above 1500 mm) from 1300 – 2300 m amsl (occasionally down to 800m). Found associated with *Pinus lateri* and *Keteleeria evelyniana* on foothills. Heavy seed crops are produced each year and seedlings establish in disturbed areas. Trees are resistant to fires after 15 years.
**Distribution**
In Vietnam (including managed forests) it is found in Ha Giang, Kon Tum, Gia Lai, Dac Lac, Lam Dong, Khanh Hoa, Ninh Thuan and Dong Nai. It has also been reported from Dien Bien, Lao Cai, Yen Bai and Dac Nong. The major forests are in Lam Dong, Kon Tum, Ha Giang. Outside Vietnam it is widespread from north-east India, Myanmar throughout southern China to the Philippines.

**Uses**
One of the most common pines used for plantations in highland areas, natural forests have been heavily managed to maximise timber production. Plantations are generally established by using the best local source for seed.

**Threats**
Globally, this species is not currently regarded as threatened. Within Vietnam, there is some uncertainty about the extent of the remaining natural forests and the extent to which local provenances have been used for replanting. Most of the forests on the Da Lat plateau are managed for timber, watershed protection and erosion control. These forests tend to be even-aged which may have consequences for their re-establishment due to changes in the occurrence of important mycorrhiza associated with young trees as the age of the forest increases (Ingleby et al., 2004).

**Protected Area status**
Some original stands are protected in national parks on the Langbian Plateau

**Current conservation measures**
Due to the economic value of this species, seed orchards have been established for gene conservation and tree improvement.

**Recommended conservation action**
The species is widely used in timber plantations and the Vietnamese populations have been recognised as distinct provenances (Hansen et al., 2003). Therefore, it is important to conserve the genetic variation in different provenances for future tree improvement. Selected sources can be chosen for this purpose. A comprehensive survey of the status of the remaining natural forests needs to be carried out.
**Pinus krempfii** Lecomte

Thông lá dết (Vietnamese), Krempf’s pine (English).

Synonymy: Ducampopinus krempfii (Lecomte) A. Chev.

**Conservation status**

<table>
<thead>
<tr>
<th></th>
<th>Global status</th>
<th>Existing national status</th>
<th>Proposed national assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VULNERABLE B1+2c</td>
<td>[VULNERABLE B1ab (i-iii), 2ab(i-iii)]</td>
<td>VULNERABLE B1ab (i-iii), 2ab(i-iii)</td>
</tr>
</tbody>
</table>

*Pinus krempfii* has been listed globally as Vulnerable. There are fewer than 10 distinct populations in a total area of occupancy that is less than 2,000 km², and there has been a continuing decline in the area, extent and quality of its habitat (Farjon *et al.*, 2004a).

**Description**

A tall emergent tree, broad domed with a single straight, buttressed stem. Tree reaches up to 30 m high with a dbh to 2 m. It is found in primary closed evergreen tropical seasonal mixed and coniferous submontane and montane forests (mean annual temperature 14-20°C, rainfall above 1500 mm) on moist silicate derived soils with well-developed humus layers from 1500 - 1800 (occasionally 1200-2000) m amsl. Found associated with *Fokienia hodginsii*, *Pinus dalatensis* and *Dacrydium elatum*. Very little is known about its ecology.

**Distribution**

This species is a localised endemic in the southern Truong Son Range, in areas such as the Hon Vong Phu, Chu Yang Sinh and Bi Doup Massifs in Dac Lac, Lam Dong, Khanh Hoa and Ninh Thuan Provinces.
Uses
Its timber is thought to have similar qualities to *Pinus kesiya*, but its rarity means that it is not a major source of timber. It has high scientific value due to its unique characters.

Threats
The recent decline of this species has been attributed to the effects of the American War in the 1960s and the clearance of land for agriculture in the following decades. Its limited distribution and the inaccessibility of much of its habitat mean that there has been little direct exploitation (Farjon *et al.*, 2004a).

Protected Area status
Most populations are within recently established nature reserves around the Bi Doup massif (Farjon *et al.*, 2004a).

Current conservation measures
This species is listed in Group IIA of the List of Rare and Precious Flora and Fauna for limited use. Attempts on domestication of the species by FSIV have not been successful as it appears to have very specific conditions for growing.

Recommended conservation action
Although most populations are in protected areas it is important that management plans for these sites reflect the status of knowledge concerning ecology and regeneration potential. It is also important to learn the cultivation requirements and study aspects of its biology through the establishment of *ex situ* collections in montane areas. Research into its ecology, population dynamics and genetic diversity is needed to build on the preliminary work done by Texas A&M University (Williams, 1999).
**Pinus kwangtungensis** Chun ex Tsiang Plate IX

Thông Pà Cò (Vietnamese), Guangdong wuzhen song (Chinese).

Note: There is considerable debate about the status of this species. Some taxonomists regard *P. kwangtungensis* as a synonym of *Pinus fenzeliana* Hand.-Mazz. The Son La populations have also been identified as *Pinus wangii* Hu & W.C. Cheng, originally described from southern Yunnan. Other taxonomists treat the Vietnamese populations as a completely different species (*Pinus eremitana* Businsky, 2004).

**Conservation status**

<table>
<thead>
<tr>
<th>Global status</th>
<th>NEAR-THREATENED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing national status</td>
<td>VULNERABLE</td>
</tr>
<tr>
<td>Proposed national assessment</td>
<td>VULNERABLE A2acd, C1</td>
</tr>
</tbody>
</table>

In the global red listings *P. kwangtungensis* is considered to be a synonym of *P. fenzeliana*, which is listed as Near-threatened. In Vietnam, *P. kwangtungensis* has been considered as a distinct species that was evaluated as Vulnerable (Anon., 1996) and Endangered (Nguyen Duc To Luu & Thomas, 2004) due to its small, fragmented populations, restricted habitat and persistent localised logging. Under the new criteria, and as a result of more extensive fieldwork since its previous assessment, the national conservation status of this pine should now be changed to Vulnerable A2acd, C1, i.e. a population size of < 10,000 mature trees that has been reduced by at least 30 % over the last three generations due to habitat loss and direct exploitation (see threats section below), and is expected to continue to decline by at least 10 % over the next three generations due to continued illegal logging for locally valued timber.

**Description**

Generally a single stemmed tree with a broad crown, up to 20 m high and a dbh to 0.7 m. Restricted to top ridges of highly eroded solid crystalline white limestone mountains (mean annual temperature 14-20°C, rainfall above 1200 mm) on limestone soils from 900-1400 m amsl (occasionally 600-1600 m amsl), forming pure stands of primary closed evergreen
tropical seasonal coniferous submontane forests of *Pseudotsuga sinensis*, *Fokienia hodginsii* and *Xanthocyparis vietnamensis*. It is associated with scattered trees of *Podocarpus pilgeri*, *Nageia fleuryi*, *Cephalotaxus mannii* and *Taxus chinensis*. Natural regeneration is very rare and seedlings are intolerant of shade.

**Distribution**

Vietnam: Ha Giang, Cao Bang, Bac Can, Son La, Hoa Binh and Thanh Hoa. Improved knowledge of the distribution of *P. kwangtungensis* suggests that there may be two areas that could be defined as subpopulations – localities in Ha Giang, Cao Bang and adjoining provinces, and secondly, localities around Son La, Hoa Binh and Thanh Hoa Provinces. Within each of these areas the scattered distribution along ridges may allow sufficient gene flow for each locality to be considered part of a larger meta-population.

Outside of Vietnam it is found in southern China.

**Uses**

Selectively logged on a local scale, timber is used for local house construction; resin is used as a glue. Potentially a bonsai species.

**Threats**

Local logging and increased forest fire resulting from changes in land-use are threats to this species due to its limited habitat, distribution and its low natural regeneration.

**Protected Area status**

Only two populations are known to occur within nature reserves (Kim Hy NR and Hang Kia - Pa Co NR), though other populations are in areas that have been proposed (Thang Heng, Pu Luong). All the remaining populations require the enforcement of the regulations relating to strict protection from illegal logging and therefore sale of the wood.

**Current conservation measures**

This species is included in Group IA of the List of Rare and Precious Flora and Fauna.

**Recommended conservation action**

Although the species is strictly protected by the Decree 48/2002/ND-CP, efforts should be focused on conservation of the species both inside and outside of protected areas. Important populations in Son La, Ha Giang, Cao Bang should be protected from local logging and man-made fires. Raising awareness among state agencies as well as increasing community involvement in conservation and possible domestication is therefore crucial for conservation.

Populations within Vietnam represent the southern range of this species. Those in Son La are disjunct from those in the northern provinces and the adjoining Chinese provinces and are therefore worth conserving from a genetic point of view. One way that this can be achieved is through seed collection and storage, with some seeds being used to establish trial plantations in different areas. Seed research therefore is the first step since the species seems to have difficult seed physiology for storage and germination. Studies on reproductive biology can also guide *in situ* restoration work since the species regenerates poorly in natural habitats.

---

14 see footnote 1.
**Pinus latteri** Manson

Thông nhự (Vietnamese), Thông hai lá (Vietnamese)

**Note:** In Vietnam, the majority of taxonomic accounts, including the recent *Flore du Cambodge, du Laos et du Vietnam* (Nguyen Tien Hiep & Vidal, 1996) along with forestry manuals refer to the Vietnamese populations as *P. merkusii*. However, the recent World Checklist of Conifers (Farjon, 2001) restricts the distribution of *Pinus merkusii* to the Philippines and Indonesia; populations in mainland South East Asia, including those in Vietnam are referred to as *Pinus latteri* Manson. This taxonomic treatment is also used in the recent Flora of China account of *Pinaceae* (Fu Li-kuo et al., 1999a).

**Conservation status**

<table>
<thead>
<tr>
<th>Global status</th>
<th>NEAR-THREATENED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing national status</td>
<td>NOT EVALUATED</td>
</tr>
<tr>
<td>Proposed national assessment</td>
<td>ENDANGERED A2cd</td>
</tr>
</tbody>
</table>

This pine is currently listed as Near-threatened. This assessment is currently under review due to increasing concerns about the decline and fragmentation in other parts of its range as well as within Vietnam (DFSC, 2000). Recent surveys have found that the native populations in Vietnam now have total areas less than 1,000 km$^2$ in less than 10 locations. The high rates of land conversion and timber and resin exploitation pose a significant threat to natural populations (Nguyen Duc To Luu, 2004). This species should be listed as Endangered nationally. In view of this national assessment, it is desirable to re-assess the global status of *Pinus latteri*, as similar conditions may prevail in much of its range.

**Description**

A tall, single stemmed tree, clean boled with irregular branches forming light canopy. It reaches up to 30 m high with a dbh to 0.6-0.8 or more metres. It is found either in pure stands with sparse understory or with broad-leaved trees e.g. *Dipterocarpus obtusifolius* in periodically inundated areas in the rainy season (mean annual temperature 19-23°C, annual rainfall above 1300 mm) on infertile red and yellow feralite soils with pH around 4.5, from 600-1200 m amsl. Found associated with *Pinus kesiya* on foothill and lower part of slopes at higher altitudes. Natural regeneration is light demanding and able to colonise bare ground.
Distribution
Within Vietnam natural forests of *Pinus latteri* can now only be found at high altitudes in Kon Tum, Gia Lai, Dac Lac, Dac Nong, Lam Dong, Khanh Hoa, Ninh Thuan and Nghe An. The largest native population is in Lam Dong. Highland populations in Moc Chau and Yen Chau, Son La Province are heavily exploited for timber and plantations in the areas are set up using material derived from lowland provenances. Outside of these areas natural forests have either been replaced by managed forests or by plantation. In the past there possibly were natural forests in lowland areas such as Quang Ninh, Bac Giang, Thanh Hoa, Nghe An, Ha Tinh, Quang Binh and Thua Thien-Hue. Lowland populations are distinct from those in the highlands, especially in the length of reproductive cycle (13-15 months for highland provenances and 17-19 months for lowland provenances) (Nguyen Duc To Luu, unpublished data). Outside Vietnam it occurs in southern China, Myanmar, Cambodia, Laos and Thailand.

Uses
This species is the most widely used indigenous plantation tree. It produces valuable resin for industry. Natural populations are also exploited for timber. The best timber provenance is thought to be in Ky Son, Nghe An Province. The largest native population in Lam Dong is not a good provenance for timber. Plantations are established using the nearest local source, whether it is a plantation or a natural forest. This species produces high quality resin after 15 years and is used for afforestation and erosion control programmes.

Threats
Populations of *P. latteri* in Nghe An and Kon Tum are threatened by local logging, sometimes at a considerable scale. Resin extraction is killing many natural populations due to destructive (burning) methods used by local people. Fires are common in the dry pine forests. Areas of natural occurrence of the species are targets for agriculture conversion. Conversion to agricultural land has already deleted all native populations in the lowlands. In Lam Dong, coffee plantations have replaced many natural stands. Natural regeneration in some areas such as in Kon Plong, Kon Tum Province is erratic due to irregular cone production and competition with broadleaf species at high altitudes (> 1,000 m amsl). The use of unsuitable lowland provenances in highland sites (e.g. Son La) is likely to lead to the loss of locally adapted genotypes through hybridisation.

Protected Area status
Very few original stands are protected in natural reserves, such as in Phuoc Binh NR.

Current conservation measures
Due to the economic value of this species seed orchards and provenance trials have been established in Lam Dong and in Quang Binh since the 1980s to conserve its genetic variation.

Recommended conservation action
Logging in areas such as Nghe An and Kon Tum need to be regulated and core areas identified and protected as National Seed Sources.
**Pinus wangii** Hu & W.C. Cheng

Thông năm lá Thưa Lưu (Vietnamese).

**Conservation status**

<table>
<thead>
<tr>
<th>Global status</th>
<th>ENDANGERED B1+2bd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing national status</td>
<td>NOT EVALUATED</td>
</tr>
<tr>
<td>Proposed national assessment</td>
<td>DATA DEFICIENT</td>
</tr>
</tbody>
</table>

**Description**

This five-needle pine was originally described in 1948 from near Malipo in Yunnan, not far from the border with Ha Giang Province, Vietnam. It has many characters in common with both *Pinus kwangtungensis* and *P. fenzeliana*, the principal differences are the length of the needles, size of the cones (slightly shorter and smaller than *P. kwangtungensis* or *P. fenzeliana*) and the colour and degree of pubescence of the first year shoots. Currently, its distribution in China remains confined to 2 populations in Xichou and Malipo counties. Both of these areas consist mainly of limestone karst. There is some debate as to whether this species occurs in Vietnam. Specimens from Mai Chau, Son La have been determined as *P. wangii* rather than *P. kwangtungensis* by the authors of the Flora of China account of Pinaceae (Fu Li-kuo *et al.*, 1999a). The most recent world checklist of conifers (Farjon, 2001) also uses the name *P. wangii* for the trees at Mai Chau. However, 5-needle pines growing on limestone karst in Ha Giang, Cao Bang and other parts of northern Vietnam that are much closer geographically to Yunnan have been identified as either *P. fenzeliana* or *P. kwangtungensis*. Until *Pinus wangii* is more extensively studied, its status in Vietnam remains unclear.
**Pseudotsuga sinensis** Dode

Thiệt sam giả (Vietnamese), Duanye huangshan (Chinese).


**Conservation status**

<table>
<thead>
<tr>
<th>Global status</th>
<th>VULNERABLE B1+2c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing national status</td>
<td>NOT EVALUATED</td>
</tr>
<tr>
<td>Proposed national assessment</td>
<td>VULNERABLE A2acd</td>
</tr>
</tbody>
</table>

The Chinese populations of *Pseudotsuga sinensis* are currently listed as Vulnerable (B1 + 2c) due to their limited distribution and changes in the quality and extent of their habitat. In Vietnam the total population size is unknown; at each of the specific localities where it has been found, it is likely that other trees also occur on surrounding ridges and peaks. Under the IUCN (2001) criteria, this species meets the criterion for A2 as it is reasonable to infer that, due to the value of its timber and the frequency of its use by local people then there is likely to have been at least a 30 % reduction in Vietnamese populations over the last three generations and that there has been a decline in the area, extent and quality of its habitat. Further fieldwork may result in an upgrading to the category of Endangered, however, further inventories may also reveal more remote and less exploited populations in areas not yet visited by botanists.

**Description**

An upright tree with a short bole and wide spreading crown, reaching up to 10 - 15, occasionally 18 m high with a dbh to 0.6 or more metres. It is restricted to the top ridges of highly eroded solid crystalline white limestone areas (mean annual temperature 15-21°C,
annual rainfall above 2000 mm), from 900-1400 (occasionally 550-1600) m amsl, usually forming primary closed evergreen tropical seasonal submontane monodominant forests like the ones of *Pinus kwangtungensis* and, but more restricted than that of *Xanthocyparis vietnamensis* and *Fokienia hodginsii*. It is occasionally associated with *Nageia fleuryi*, *Tsuga chinensis*, *Podocarpus pilgeri*, *Amentotaxus yunnanensis* and *Taxus chinensis*. Although seedlings are frequent, saplings are rare.

**Distribution**

In Vietnam it is widely distributed in all limestone areas of Provinces Ha Giang, Cao Bang, Bac Can, Lang Son. Outside of Vietnam it is found also in the adjoining limestone areas of the Chinese provinces of Guangxi and Guizhou. The Vietnamese populations of this species represent a significant part of the global population – they also represent the most southern distribution of this genus in Asia.

**Uses**

This species is selectively logged wherever it occurs, used for local house construction and furniture, and has possibilities for plantation. Some local people (e.g. in Bac Son) use the bark and foliage for medicine as a topical application for treatment of insect stings, rheumatism and during pregnancy.

**Threats**

The majority of the known populations have been subject to illegal logging and many mature trees have been removed. Other threats are forest fire and degradation of its habitat. Some sites show recent regeneration but it is uncertain if the young trees will survive to maturity.

**Protected Area status:**

This species is known to occur in some protected areas (Bat Dai Son NR and Kim Hy NR) as well as in other areas that have been proposed as nature reserves (Thang Heng for example).

**Current conservation measures:**

No specific measures have been implemented for this species

**Recommended conservation action**

This species forms an important component of a highly biodiverse habitat. Measures to protect this species should also benefit many others, especially in areas outside of national parks or nature reserves. Development of appropriate management recommendations that can be included in protected area management plans is an important conservation action to assist *in situ* conservation. As *Pseudotsuga* is highly valued for local construction, trial plantations should be established to try and meet that demand based at the commune level. Research into cultivation and establishment requirements should also be undertaken. Seed collection and research into germination and storage should also be undertaken.
**Tsuga chinensis** (Franch.) Pritz. ex Diels

Thiệt sam núi đá (Vietnamese), tie shan (Chinese), Chinese hemlock (English).

This species is another recent discovery in northern Vietnam. Currently it is only known from a few localities in the karst mountains of Ha Giang and Cao Bang. The Vietnamese populations represent this species most southern distribution.

<table>
<thead>
<tr>
<th>Conservation status</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing global status</td>
<td>LEAST CONCERN</td>
</tr>
<tr>
<td>Existing national status</td>
<td>NOT EVALUATED</td>
</tr>
<tr>
<td>Proposed national assessment</td>
<td>ENDANGERED C1</td>
</tr>
</tbody>
</table>

As with *Pseudotsuga*, the total size and number of populations of *T. chinensis* in Vietnam is uncertain. At each of the localities where *Pseudotsuga* has been found, it is likely that *T. chinensis* also occurs on surrounding ridges and peaks although less frequently and at higher elevations than *Pseudotsuga*. At a national level, the Vietnamese populations probably meet the criteria for Endangered (C1). Further fieldwork may result in the discovery of additional populations in more remote areas, which could lead to a downgrading of its national conservation status.

**Description**

An upright, single-stemmed tree with short bole and wide spreading crown formed from many spreading branches. It reaches up to 15-18 m high with a dbh to 0.6-0.8 or more metres. It is found in primary closed evergreen tropical seasonal coniferous submontane forests. In these forests it is restricted to the higher ridges on highly eroded solid crystalline white limestone mountains. These may be dominated by *Pseudotsuga sinensis* or *Fokienia*

(Drawn from CBL 246 by Bui Xuan Chuong).
hodginsii at lower elevation (1000-1300 m amsl). At the highest elevations (1300-1600 m amsl) it may be co-dominant. The mean annual temperature of its habitat is 15-19°C, annual rainfall above 2000 mm. The species associated are Nageia fleuryi, Podocarpus pilgeri, Amentotaxus spp. and Taxus chinensis.

**Distribution**
In Vietnam, populations of this species are found in a few limestone localities close to each other in Ha Giang and Cao Bang Provinces. Outside Vietnam it is found in central and southern China.

**Uses**
Locally used for house construction and for making furniture.

**Threats**
The majority of the known populations have been subject to illegal logging and many mature trees have been removed. Some sites show recent regeneration but as so little is known about its regenerative capacity, it is uncertain if the young trees will survive to maturity.

**Protected Area status**
This species is known to occur in Bat Dai Son NR

**Current conservation measures**
No specific measures have been implemented thus far.

**Recommended conservation action**
Prevention of illegal logging is essential for the long term conservation of this species. Research into its ecology and biology need to be undertaken to understand its requirements and assess its potential for utilisation. Seeds should be studied in order to improve regeneration.
Tsuga dumosa (D. Don) Eichler
Thiết sam núi đất (Vietnamese).

Conservation status

<table>
<thead>
<tr>
<th>Global status</th>
<th>LEAST CONCERN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing national status</td>
<td>RARE</td>
</tr>
<tr>
<td>Proposed national assessment</td>
<td>VULNERABLE A3c, B1ab(iii), B2 ab(iii) D2</td>
</tr>
</tbody>
</table>

Globally, this species is not considered threatened. At a national level, the Vietnamese populations probably meet the criteria for Vulnerable due to their small size and restricted distribution. Further fieldwork may result in an upgrading to the category of Endangered. The Vietnamese populations represent the most southern distribution of this genus in Asia.

Description
Tall to medium trees reaching heights of up to 40 m (usually 20-25 m) and with dbh up to 1 m. Mainly restricted to the high slopes and ridges of Mt. Fan Si Pan, at an elevation of 2400-2900 m amsl in the primary closed evergreen tropical seasonal mixed subalpine forests (mean annual temperature 13-18°C, annual rainfall 2000 mm - 3500 mm), partly in fire damaged bamboo-dominated vegetation and locally dominant on granite derived soils (Nguyen Tien Hiep & Vidal, 1996; Vu Van Dung, 1996). Associated species include Abies delavayi subsp. fansipanensis, Podocarpus neriifolius and Fokienia hodginsii. Seedlings are occasional, though saplings rare.

Distribution
In Vietnam Tsuga dumosa is restricted to Lao Cai and possibly Yen Bai Provinces. The main population is on Mt Fan Si Pan. Outside of Vietnam it is found in India, Nepal, Bhutan and...
Myanmar. In China it is found in the mountains of south-east Xizang (Tibet), Yunnan and Sichuan.

**Uses**
In many parts of its range, this species is a valuable timber tree used for a range of construction purposes. The small size of the Vietnamese populations limits its use.

**Threats**
The main population is situated on the tallest mountain in Vietnam and within the Hoang Lien NP. Plans to build a ‘road’ to its summit could present a threat as could increased tourist and development related activity on the mountain. Other threats include fire and the lack of natural regeneration. Remoteness at present causes difficult access of at least the highest occurring trees. The same species is fairly heavily exploited throughout its range.

**Protected Area status**
This species is known to occur in Hoang Lien NP as well as in the proposed protected area for Van Ban District, Lao Cai.

**Current conservation measures**
The largest known population of this species is situated on the tallest mountain in Vietnam and within the Hoang Lien NP which includes Fan Si Pan Mountain. Development of tourism and other activities inside the Hoang Lien NP could pose a threat to this species. The same species is heavily exploited in similar mountains in the Himalayas. Unless specific protection in the form of a logging ban and some form of enforcement is implemented, the risk may well increase in the future.

**Recommended conservation action**
Inclusion of conservation measures for this species within any management plan for the Hoang Lien NP is essential. Staff of the Hoang Lien NP, as well as local communities, need to understand the conservation value of this species. Implementation of GoV policy is essential in relation to this species. As the main threat to this species in Vietnam is from selective logging (legal and illegal), it is important that seed collection is undertaken and trial plantations are established. Seed should also be stored. Monitoring of the species is necessary.
PODOCARPACEAE

*Dacrycarpus imbricatus* (Blume) de Laub.  
Plate IV

Thông nàng, Thông lông gà, Bạch tùng (Vietnamese), ji mao song (Chinese).

Synonymy: *Podocarpus imbricatus* Blume

**Conservation status**

<table>
<thead>
<tr>
<th>Global status</th>
<th>LEAST CONCERN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing national status</td>
<td>NOT EVALUATED</td>
</tr>
<tr>
<td>Proposed national assessment</td>
<td>VULNERABLE A2cd</td>
</tr>
</tbody>
</table>

Due to its wide distribution this species is not listed as globally threatened. Nationally it has not been previously evaluated for the Red Data Book of Plants (Anon., 1996), but has been considered to be Vulnerable (A1cd) by Nguyen Duc To Luu & Thomas (2004). Under the new IUCN (2001) criteria, it should be listed as Vulnerable (A2cd) due to the extent of deforestation over the last three generations that continues to occur throughout its range.

**Description**

An upright tree with a long clear bole, emergent with wide, dome shaped crown, lower branches pendulous, reaching up to 35 m high with a dbh to 1 m. It is found as an
emergent in primary closed tropical seasonal mixed lowland and submontane forests on slopes and in valleys (mean annual temperature 16-22°C, annual rainfall usually above 1400 mm) mostly on granite and other silicate derived soils, rarely on limestone, from 300 – 1500 m amsl. Usually associated scattered with *Podocarpus neriifolius*, *Nageia wallichiana*, *Cephalotaxus mannii* and *Dacrydium elatum*. Natural regeneration is abundant in most areas. Seedlings are shade tolerant when young, then light demanding.

**Distribution**
Within Vietnam it is widely distributed from Lao Cai, Son La, Quang Ninh, Bac Giang, Hoa Binh and through Thanh Hoa, Nghe An, Ha Tinh, Quang Tri, Thua Thien-Hue, Da Nang, Quang Nam, Kon Tum, Gia Lai, Lam Dong, Khanh Hoa, and Ninh Thuan. Reports from Tuyen Quang, Ninh Binh, Quang Binh and Dac Lac have not been confirmed. Outside of Vietnam it ranges from Myanmar across South East Asia to Fiji. With such an extensive range outside of Vietnam, and even though many of these countries have experienced significant deforestation, it seems unlikely that more than 20% of the global population is represented in Vietnam.

**Uses**
This species produces fine, light, easily worked timber that may be used for internal construction in houses. The timber is not durable. It can be used for plantations as it grows relatively fast.

**Threats**
In Vietnam, populations tend to be small and localised; much of its habitat in lowland and sub-montane areas has been destroyed through conversion to agriculture. It has also been subject to selective felling.

**Protected Area status**
This species is known from a number of protected areas throughout its range including Hoang Lien NP, Pu Mat NP and in several areas around Bi Doup and in northern Central Highlands (Chu Mom Ray NP, Kon Ka Kinh NR, Kon Cha Rang NR).

**Recommended conservation action**
Where this tree is located in protected areas appropriate law enforcement should take place to ensure the conifer survives in the wild. In addition steps to ensure natural regeneration should be a priority within management planning for these sites. However, good timber quality and relatively fast growth rate make this species potentially suitable for forest plantations, especially in highland areas. Therefore, silviculture trial is the first step for domestication. Widespread distribution makes it worthwhile to establish an *ex situ* conservation stand including materials from all provenances. Fertile and dense populations such as in Kon Ha Nung, Van Ban – Lao Cai, Bach Ma – Thua Thien Hue can be registered and protected as National Seed Sources.
**Dacrydium elatum** (Roxb.) Wall.  
Hoàng dàn già, Hồng tung, Thông đuôi chòn (Vietnamese).

Synonymy: *D. pierrei* Hickel

**Conservation status**

<table>
<thead>
<tr>
<th>Global status</th>
<th>LEAST CONCERN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing national status</td>
<td>NOT EVALUATED</td>
</tr>
<tr>
<td>Proposed national assessment</td>
<td>VULNERABLE A2cd</td>
</tr>
</tbody>
</table>

Globally this species is listed as Least Concern. Within Vietnam, due to extensive decline in the area and quality of its habitat (through shifting cultivation and logging) it should be listed as Vulnerable A2cd on the basis of the extensive deforestation over the last 50 years.

**Description**

An upright tree with a clear bole and ascending branches forming a small dome, reaching up to 30 m high with a dbh to 0.8 m. It is found in primary closed evergreen tropical seasonal mixed mainly submontane, sometimes lowland or montane forests on slopes and ridges (usually mean annual temperature 16-22°C, annual rainfall above 1700 mm) on either granite and other silicate soils or on top ridges of highly eroded solid crystalline white limestone mountains. Found mostly from 700 – 2000 m amsl but it has also been
recorded close to sea level in the southern provinces such as Kien Giang (Phu Quoc island, where annual mean temperature is 26°C, annual rainfall over 3000 mm). Outside of Vietnam, it tends to be restricted to montane areas above 1000 m amsl. In submontane and montane areas it is found associated with Pinus krempfii, Pinus dalatensis, Podocarpus neriifolius, Fokienia hodginsii and Dacrycarpus imbricatus.

**Distribution**
Within Vietnam it is found in Tuyen Quang, Quang Ninh, Ha Tinh, Quang Binh, Thua Thien-Hue, Da Nang, Quang Nam, Kon Tum, Gia Lai, Dac Lac, Lam Dong, Khanh Hoa, Ninh Thuan, Binh Thuan, Dong Nai and Kien Giang. Reports from Lang Son, Nghe An, and Quang Tri have not been verified from specimens. Outside of Vietnam it is also found in China (where it is often known as *D. pierrei* Hickel), Laos, Cambodia, Thailand, Malaysia and Indonesia.

**Uses**
The timber is water resistant and used for boats, bridges and furniture construction. Its resin is used for incense sticks and this genus may be a source of chemicals with insecticidal properties. In some parts of Vietnam this species is used in combination with other species to treat dysentery (Perry, 1980)

**Threats**
Threatened by forest fragmentation, selective logging and conversion of habitat to agricultural use.

**Protected Area status**
This species has been recorded from several established national parks, nature reserves and areas proposed for protection e.g. Na Hang NR, Pu Mat NP, Bach Ma NP, Ba Na NR and Nui Chua NP.

**Current conservation measures**
In Bach Ma there is an active research programme studying its *in situ* regeneration (Zeigler, 2003).

**Recommended conservation action**
Full protection to the species where present within protected areas – including specific inclusion within management plans for these areas. In addition the wide distribution of this species makes it worthwhile to establish an *ex situ* gene conservation areas in all provenances. Studies on species ecology (growth in island areas, reproductive biology) should be conducted in order to understand its distribution.
**Nageia fleuryi** (Hickel) de Laub.         Plate VI

Kim giao núi đá (Vietnamese) changye zhubai (Chinese).

**Synonymy:** *Podocarpus fleuryi* Hickel.

**Note:** in northern Vietnam this species is usually found in limestone karst formations although some populations have also been recorded from coastal localities. Recent field work suggest that there may be another species of *Nageia* present in Vietnam (Phan Ke Loc, pers. com).

**Conservation status**

<table>
<thead>
<tr>
<th>Global status</th>
<th>DATA DEFICIENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing national status</td>
<td>VULNERABLE</td>
</tr>
<tr>
<td>Proposed national assessment</td>
<td>VULNERABLE A2ac, B1ab(iii,v), B2ab (iii,v), C1, C2a(i)</td>
</tr>
</tbody>
</table>

Globally *N. fleuryi* is currently listed as Data Deficient as it has not been evaluated under the 1994 or 2001 IUCN criteria at a global level, but was listed as Vulnerable in the 1997 IUCN Red List of Threatened Plants which used the pre-1994 criteria (Walter & Gillett, 1998). The IUCN Conifer Action Plan (Farjon & Page, 1999) included it in a special list of species that were known to be of conservation concern but had not been evaluated according to the IUCN criteria due to a lack of information about its extent of occurrence, area of occupancy and population sizes. The major part of the global population is likely to be in Vietnam with only a small proportion in either China or Laos. With the amount of new knowledge that has been obtained through the work of the authors of this report a national assessment can now be made. This species is found in a characteristic habitat along with other conifers, consisting of steep upper ridges in karst limestone areas. Assuming that this habitat represents an estimated extent of occurrence of less than 20,000 km$^2$, that the distances between the major localities represent severe fragmentation and that there has been a decline that is likely to continue in the area, extent and quality of the habitat, then the criteria for Vulnerable B1ab(iii, v) are met. *Nageia fleuryi* may also meet the criteria for Vulnerable C1 – population size less than 10,000 mature individuals and estimated decline of at least 10% over the next three generations. Given the value of the timber and the persisting problems with illegal logging a minimum 10% decline may actually be an underestimate. Alternatively it could also be Vulnerable C2a(i) – populations less than 10,000 mature individuals and a continuing decline with no sub-population containing more than 1,000 mature individuals. This would also cover populations that are not on limestone e.g. those in Bai Tu Long NP.

**Description**

An upright dioecious tree with a pyramidal crown, reaching up to 25 m high with a dbh to 0.7 m. It is almost always found in primary closed tropical seasonal upper part of lowland and submontane forests (mean annual temperature 18-22°C, annual rainfall above 1400 mm) on the top ridges of highly eroded solid crystalline white limestone mountains from 500 – 1200 m amsl. This species is mainly found in coniferous forests on the higher ridges of limestone mountains where *Pinus kwangtungensis, Pseudotsuga sinensis* and *Fokienia hodginsii* may be locally dominant and where *Podocarpus pilgeri* and *Taxus chinensis* also occur. Natural regeneration is occasional, saplings rare.
Distribution
In northern Vietnam it has been recorded from Ha Giang, Tuyen Quang, Cao Bang, Bac Can, Ha Tay, Hai Phong, Quang Ninh, Ninh Binh, Thanh Hoa, Nghe An, Quang Binh. Reports from Bac Giang and Vinh Phuc need further verification. Records of *N. fleuryi* from Thua Thien-Hue, Quang Nam, Lam Dong and Ninh Thuan may be the result of confusion with *N. wallichiana*. Outside of Vietnam *N. fleuryi* is known from southern China, and possibly Laos.

Uses
The wood is highly valued for musical instruments, chop sticks, fine crafts and household tools. The leaves may be used as a traditional cure for coughs and the tree is highly ornamental.

Threats
Throughout its range, it occurs as scattered small groups. Its timber is also highly prized.

Protected Area status
Two of the largest known populations occur in Cuc Phuong and Cat Ba National Parks. Another large population is in Bai Tu Long NP. In these areas, *N. fleuryi* is used in restoration and reforestation programmes. Other populations have been recorded from Tam Dao NP, Bach Ma NP, and from areas proposed for protection e.g. Thang Heng, Phong Nha - Ke Bang. Some of these may actually represent *N. wallichiana*.

Current conservation measures
The Central Forest Seed Company has initiated a propagation programme to make seedlings available for reforestation programmes.

Recommended conservation action
Localities in southern Vietnam where *N. fleuryi* has been recorded need to be verified. Further study is needed to investigate possible differences between localities in northern Vietnam that are limestone and those that are not. The interest of Vietnamese ethnic people in ornamental planting of *Nageia* spp. should be encouraged by either supplying seedlings from collected seeds or developing programmes for local people to collect seed and propagate in village/commune nurseries both for use in local replanting and for possible commercial purposes.
**Nageia wallichiana** (C. Presl) O. Kuntze

Kim giao núi đất (Vietnamese).

Synonymy: *Podocarpus wallichianus* C. Presl.

**Conservation status**

<table>
<thead>
<tr>
<th>Global status</th>
<th>LEAST CONCERN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing national status</td>
<td>VULNERABLE</td>
</tr>
<tr>
<td>Proposed national assessment</td>
<td>VULNERABLE A2ac, B1ab(iii,v), B2ab (iii,v) C1, C2a(i)</td>
</tr>
</tbody>
</table>

The wide distribution of *N. wallichiana* means that it is not listed as threatened globally. In Vietnam it faces the same pressures and problems as *N. fleuryi* and was listed by Nguyen Duc To Luu & Thomas (2004) as Endangered (A1cd). Under new IUCN (2001) criteria, and as a result of increased fieldwork since its previous assessment, it should be listed as Vulnerable A2ac, B1ab(iii,v), B2ab (iii,v) C1, C2a(i).

**Description**

An upright dioecious tree with conical crown, reaching up to 30 m high with a dbh to 1 m. It is found in primary closed evergreen tropical seasonal broad-leaved and mixed submontane and montane forests (mean annual temperature 14-23°C, annual rainfall above 1700 mm) on granite and other silicate derived soils from 500 – 2100 m amsl. Occasionally it is found at sea level. Found associated with *Dacrycarpus imbricatus*, *Cephalotaxus mannii*, *Podocarpus neriifolius*, *Taxus wallichiana* (southern Vietnam). Natural regeneration occasional, saplings rare (although rather common in Pu Huong NR).
Distribution
Within Vietnam it is found in Lao Cai, Phu Tho, Vinh Phuc, Thanh Hoa, Nghe An, Ha Tinh, Thua Thien- Hue, Da Nang, Quang Nam, Kon Tum, Gia Lai, Dac Lac, Lam Dong, Ninh Thuan, Binh Thuan and Kien Giang. It has also been reported from Ha Giang, Ninh Binh, Quang Tri and Quang Ngai. Some of these reports may be the result of misidentification. Outside of Vietnam it occurs from India to Papua New Guinea. The proportion of the global population of this species represented in Vietnam is unknown.

Uses
The wood is highly valued for musical instruments, chop sticks, fine crafts and household tools. The leaves may be used as a traditional cure for coughs and the tree is highly ornamental.

Threats
Throughout its range, it occurs as scattered small groups on fertile soils which are targeted for agriculture. Its timber is also highly prized.

Protected Area status
This species has been recorded from various protected areas near Kon Tum, Bi Doup in Lam Dong, Nui Chua NP and in Pu Huong NR.

Current conservation measures
Currently no ex situ programmes are focussed on this species.

Recommended conservation action
See Nageia fleuryi. In addition attention should be paid to why the species appears to regenerate in Pu Huong NR but not at other locations.
**Podocarpus neriifolius** D. Don

Thông tre lá dài (Vietnamese)

**Conservation status**

<table>
<thead>
<tr>
<th>Status</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global status</td>
<td>LEAST CONCERN</td>
</tr>
<tr>
<td>Existing national status</td>
<td>NOT EVALUATED</td>
</tr>
<tr>
<td>Proposed national assessment</td>
<td>LEAST CONCERN</td>
</tr>
</tbody>
</table>

Its wide distribution throughout the montane areas of Vietnam means that it is not considered as threatened within Vietnam (IUCN, 1994; 2001).

**Description**

An upright tree with spreading crown, reaching up to 20-25 m high with a dbh to 0.7 m. Dioecious. It is found scattered in primary and secondary closed evergreen tropical seasonal broad-leaved, mixed and coniferous mostly submontane forests (mean annual temperature 16-23°C, annual rainfall above 1500 mm) mainly on deep fertile silicate and limestone derived soils from 600 – 1500 m amsl. Found associated with almost all conifer species except *Pinus kesiya* and *P. latteri*. Natural regeneration normal, seedlings are shade tolerant.

**Distribution**

Within Vietnam it is the most widely distributed conifer species, found in all forested hills and mountains in Dien Bien, Lao Cai, Son La, Yen Bai, Ha Giang, Tuyen Quang, Cao Bang, Bac Can, Lang Son, Quang Ninh, Vinh Phuc, Ha Tay, Hoa Binh, Ninh Binh, Thanh Hoa, Nghe An, Ha Tinh, Thua Thien-Hue, Da Nang, Kon Tum, Gia Lai, Dac Lac, Lam Dong, Khanh Hoa, Ninh Thuan, Dong Nai, Kien Giang. Reports from Phu Tho, Quang Binh, Quang Tri, Quang Nam, Quang Ngai and Ba Ria-Vung Tau need to be verified. Outside of Vietnam it occurs in Nepal, throughout South East Asia and as far east as Fiji.


**Uses**
The termite and water resistant timber mean that it is valued for construction and other uses such as boat building.

**Threats**
Due to its wide distribution, this species is not regarded as threatened although it is becoming increasingly rare in many parts of its range, mainly due to changes in its habitat.

**Protected Area status**
With such a wide distribution, this species is known to occur in many of the montane protected areas that have been established. In all of these areas it is rare or infrequent. The Nepalese population of this species has been listed in Appendix III of CITES since 1975.

**Current conservation measures**
There are no specific conservation measures for the species at present.

**Recommended conservation action**
Monitoring of the trade in this species should be carried out and linked to reliable estimates of standing volumes. Licences for logging this species should be linked to replanting/regeneration to ensure the long term availability of this timber for local and commercial trade. This species has a potential for forest plantations, thus silviculture trials should be established in highland areas. *Ex situ* gene conservation areas should also be established by seeds or cuttings from different provenances.
**Podocarpus pilgeri** Foxw.  
Thồm tre lá ngán (Vietnamese)

**Note:** *Podocarpus* spp. show a range of variation that is often related to physiological, edaphic or climatic conditions. These variations can lead to problems in identification. In addition, several species (e.g. *P. chinensis*, *P. macrophyllus*) are commonly cultivated and may have naturalised. In older references, taxa such as *P. annamiensis* N.E. Gray, *P. brevifolius* (Stepf) Foxw. and *P. tixieri* Gaussen (Fu Li-kuo et al., 1999b) have also been recorded from Vietnam. It is also possible that there are other, as yet, undescribed species in Vietnam, especially in the limestone areas of north-east Vietnam (Phan Ke Loc, pers. comm.).

**Conservation status**

<table>
<thead>
<tr>
<th>Global status</th>
<th>NOT EVALUATED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing national status</td>
<td>RARE</td>
</tr>
<tr>
<td>Proposed national assessment</td>
<td>VULNERABLE A2ac</td>
</tr>
</tbody>
</table>

**Description**

Dioecious tree reaching from 5 to 12 m high with a dbh less than 0.5 m. Branches are scattered and often in whorls of five. It is found in the 2nd or 3rd layer of the primary closed evergreen tropical seasonal submontane coniferous forests on the top ridges of highly eroded solid crystalline white limestone mountains (mean annual temperature 16-21°C, annual rainfall above 1500 mm) usually from 700-1600 m amsl. Found associated scatteredly with *Pinus kwangtungensis*, *Pseudotsuga sinensis*, *Xanthocyparis vietnamensis*, *Fokienia hodginsii*, *Taxus chinensis*, *Nageia fleuryi* and *Tsuga chinensis*. Sometimes it is found on non-limestone mountains. Natural regeneration localised but frequent.
**Distribution**
Within Vietnam it is found in all submontane karst areas in the north such as Lao Cai, Son La, Ha Giang, Cao Bang, Hoa Binh, as well as in some silicate mountains of Quang Ninh Province. Records from Kien Giang in southern Vietnam based on old herbarium records (Nguyen Tien Hiep & Vidal, 1996) require further verification. Outside of Vietnam it occurs from India to Papua New Guinea.

**Uses**
This species produces hard, water resistant timber that can be used for construction as well as musical instruments. A similar introduced species (*P. chinensis*) is widely used as an ornamental.

**Threats**
The wide distribution in South East Asia means that it is not currently listed as threatened. This species is only occasionally exploited for its timber and its habitat is not suitable for agriculture. However, the small size of individual populations and its restricted habitat means that it can be considered as threatened because of habitat disturbance through the logging of the associated species and forest fires. Seedlings and saplings are occasionally removed for ornamental use.

**Protected Area status**
This species has been recorded from protected areas such as Hang Kia - Pa Co NR and Bat Dai Son NR. Reports from Tam Dao NP have not been confirmed.

**Current conservation measures**
There are no conservation measures for the species at present.

**Recommended conservation action**
Aspect of species ecology on islands should be investigated further. In some sites, taxonomic work may be necessary to distinguish the species from *P. neriifolius* and possibly other podocarps. Ornamental plant growers should not gather the species from wild, but from propagated materials.
TAXACEAE

**Amentotaxus argotaenia** (Hance) Pilg.  Plate I

Dé tùng sóc trắng hep, Sam bông sóc trắng hep (Vietnamese), sui hua shan (Chinese).

**Conservation status**

<table>
<thead>
<tr>
<th>Global status</th>
<th>VULNERABLE A1c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current national status</td>
<td>RARE</td>
</tr>
<tr>
<td>Proposed national assessment</td>
<td>VULNERABLE A2c, B1ab(i-v)</td>
</tr>
</tbody>
</table>

Globally, this species is currently listed as Vulnerable A1c (IUCN, 2004); in Vietnam, it has been listed as Rare (Anon., 1996). Recent survey work has discovered new populations in several areas and consequently its Vietnamese conservation status should be changed to VULNERABLE under criteria A2c due to the extent of deforestation within its range, B1a (an estimated extent of occurrence under 5,000 km² and populations severely fragmented from deforestation in areas between populations) and B1b(i-v) based on the likely ongoing effects of deforestation and habitat degradation.

**Description**

A large, spreading, dioecious tree with ascending branches up to 35-40 m tall, 1.0-1.2 m dbh. It is found between 950 – 1500 m amsl in primary closed evergreen tropical seasonal coniferous submontane forests (mean annual temperature 17-21°C, rainfall over 1700 mm), usually on top ridges of highly eroded solid crystalline white limestone mountains, but also in mixed and broad-leaved submontane forests on non-limestone ones such as sandstone, shale, granite. Seedlings and saplings are shade tolerant. Associated conifers vary, depending on the type of soils (limestone or non-limestone). In Son La and Hoa Binh and other limestone areas it is occasionally associated with *Pinus kwangtungensis*, *Taxus chinensis*, *Nageia fleuryi*, *Podocarpus neriifolius* and *Podocarpus pilgeri*. In other areas with silicate derived soils, such as Pu Luong it may be associated with *Cephalotaxus mannii* and *Amentotaxus yunnanensis* in mixed- or broad-leaved forests.

**Distribution**

Known with certainty from Lao Cai, Son La, Thai Nguyen, Vinh Phuc, Hoa Binh and Thanh Hoa Provinces. Reports from Ha Giang, Tuyen Quang, Phu Tho, Lang Son and Quang Ninh have not been verified. Outside of Vietnam small populations are found scattered across southern China.

**Uses**

The timber is used for tool making, handicrafts and furniture. It also has attractive foliage and can make good bonsai. This genus is potentially useful for anti-cancer treatments (Su Huey-jen *et al.*, 2003) and the seeds have a high oil content.

**Threats**

Forest fragmentation and forest degradation resulting from the conversion of surrounding forests at lower altitudes for agricultural use are the main threats. Timber cutting is rarely a threat. A potential threat could arise if the members of this genus are confirmed to have medicinal properties. Lack of regeneration resulting from infrequent coning may also be a problem; seed predation has been reported as a problem in Chinese populations (Fu Li-kuo & Jin Jian-ming, 1992).
**Protected Area status**
This species is definitely known from Tam Dao NP, Hang Kia - Pa Co NR and Pu Luong NR. In all of these areas, populations are small and need strict protection. Reports from Xuan Son NR have not been verified.

**Current conservation measures**
There are currently no *ex situ* programmes focussed on this species. Some research has been carried out on vegetative propagation techniques and germination by the CFSC.

**Recommended conservation action**
All populations within national parks, nature reserves and proposed protected areas need strict protection. Research on its ecology and reproductive biology needs to be undertaken. Research into its potential medicinal uses and propagation requirements should also be undertaken. This species appears to be the most suitable *Amentotaxus* for ornamental use. Propagation both by seeds and cuttings should be encouraged in order to provide planting materials for potential *ex situ* conservation and possible utilization programmes.
Amentotaxus hatuyenensis N.T. Hiep

Dé từng sóc nâu rồng, Sam bông sóc nâu rồng (Vietnamese).

**Conservation status**

<table>
<thead>
<tr>
<th>Global status</th>
<th>ENDANGERED A2c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing national status</td>
<td>RARE</td>
</tr>
<tr>
<td>Proposed national assessment</td>
<td>ENDANGERED B1ab(iii)</td>
</tr>
</tbody>
</table>

Globally, this species conservation status has been assessed as Endangered A2c (IUCN, 2004), and within Vietnam has been listed as Rare (Anon., 1996), and more recently as Critically Endangered (Nguyen Duc To Luu & Thomas, 2004) due to its restricted distribution, poor natural regeneration and decline of quality of habitat as a result of forest fire, timber and firewood cutting. Under the new IUCN (2001) criteria, it should be listed as Endangered B1ab(iii) nationally on the basis of its known distribution and continuing conservation problems in the areas where it has been recorded – especially outside of Bat Dai Son NR. To qualify for Critically Endangered under these criteria a reduction of \( \geq 80\% \) over three generations, or an extent of occurrence less than 100 km\(^2\) has to be demonstrated; it seems safer in view of new discoveries of closely related species as a result of current inventories to assume that this species will also be found in other locations.

**Description**

This species is very poorly known. It is very similar to *A. yunnanensis*; the main difference being the colour of the stomatal bands (brown rather than white). It occurs in primary closed evergreen tropical seasonal mixed on slopes or on top ridges of submontane forests.

---

![Illustration of Amentotaxus hatuyenensis](DKH 4970 by Nguyen Quang Hung)
with highly eroded solid crystalline white limestone mountains between 1000 and 1500 m amsl, mean annual temperature of ca. 15-18°C, annual rainfall over 1800 mm. Other conifers that may be associated with it include *Pinus kwangtungensis*, *Tsuga chinensis*, *Cephalotaxus mannii*, *Podocarpus neriifolius*, *Nageia fleuryi* and *Podocarpus pilgeri*.

**Distribution**
This species is currently thought to be a local endemic. It has only been recorded from Bat Dai Son NR and three nearly contiguous unprotected areas in Ha Giang.

**Threats**
Forest fragmentation, decline of habitat due to forest fire, poor natural regeneration and longer term effects of the conversion of surrounding habitats for agricultural use are the main threats.

**Protected Area status**
Recorded only from Bat Dai Son NR.

**Current conservation measures**
Currently no *ex situ* programmes are focussed on this species although some research has been carried out on vegetative propagation techniques by the CFSC.

**Recommended conservation action**
Further field survey and taxonomic work should be encouraged in order to gain better knowledge of this species. As its known distribution is sympatric with *A. yunnanensis* conservation efforts should be aimed at both species.
Amentotaxus poilanei (Ferré & Rouane) D.K. Ferguson

Dé tùng Nam, Sam bông Nam (Vietnamese)

Conservation status

<table>
<thead>
<tr>
<th>Global status</th>
<th>VULNERABLE A2c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing national status</td>
<td>THREATENED</td>
</tr>
<tr>
<td>Proposed national assessment</td>
<td>VULNERABLE D1</td>
</tr>
</tbody>
</table>

Species in this genus almost always have a localised distribution; in the case of *A. poilanei* there is only one location known and there is no specific information about decline at that locality. As such, it should be listed nationally as Vulnerable D1 (a total population estimate of < 1,000 mature trees) using the IUCN (2001) criteria.

Description

Tree to 20 metres, occurring at altitudes up to 2300 m amsl. In Ngoc Linh it is found scattered in primary closed evergreen tropical seasonal mixed- or broad-leaved forests, where the mean annual temperature does not exceed 12°C with the highest monthly temperature less than 16°C and the annual rainfall is over 3000 mm with no dry months.

Distribution

This species is only known with certainty from Ngoc Linh Mt in Kon Tum Province. There have been unconfirmed reports from Lo Xo, on the border with Quang Nam and Kon Tum (Tordoff, ed.) 2002.)
Threats
Currently there are no direct threats but forest fragmentation and degradation of habitats resulting from conversion of forests at lower altitudes to agricultural use may pose a threat in the future.

Protected Area status
Found in protected areas around Ngoc Linh.

Current conservation measures
None.

Recommended conservation action
Threats to this species have not reached a high level of concern but monitoring is necessary in order to take corrective actions when any threat becomes real. Information about the population size, area of occupancy and the extent of deforestation or other threats within or near its habitat is lacking and further surveys are needed.
**Amentotaxus yunnanensis** H.L. Li

Dé tung Vân Nam, Thông tre Vân Nam, Sam bông sóc trải rồng (Vietnamese), Yunnan shuhuashan (Chinese).

**Conservation status**

<table>
<thead>
<tr>
<th>Status</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global status</td>
<td>ENDANGERED A1c</td>
</tr>
<tr>
<td>Existing national status</td>
<td>THREATENED</td>
</tr>
<tr>
<td>Proposed national assessment</td>
<td>VULNERABLE B1ab(i-v)</td>
</tr>
</tbody>
</table>

Globally, this species is listed as Endangered A1c. In Vietnam, it has been listed as Threatened (Anon., 1996), however, Nguyen Duc To Luu & Thomas (2004) evaluated this species as Critically Endangered because until recently only one population near Sa Pa was known. New populations have now been discovered in several other provinces; the most significant of these is in Pu Huong NR. At a national level, and under the IUCN (2001) criteria, this species qualifies for Vulnerable B1ab(i-v) status on the following basis – its extent of occurrence is likely to be less than 20,000 km$^2$, with severely fragmented localities due to the extent of deforestation in the intervening areas that are likely to undergo a continued decline in the area, extent and quality of its habitat. Its global status should also be reviewed, with particular emphasis on the situation in China.

**Description**

This is a medium to large spreading, dioecious tree up to 25-30 m tall, dbh to 0.8 m (specimens HAL 4029 & 4216 collected at Pu Luong). Found in the mid-canopy, sometimes emergent in primary closed evergreen tropical seasonal submontane forests (mean annual temperature 17-20$^\circ$C, rainfall above 1500 mm) mostly coniferous on top ridges of highly eroded solid crystalline white limestone mountains, mixed- or broad-leaved forests on silicate derived soils. Found scatteredly associated with *Fokienia hodginsii*, *Podocarpus neriifolius*, *Xanthocyparis vietnamensis*, *Pseudotsuga sinensis*, *Tsuga chinensis*, *Taxus chinensis* and *Dacrydium elatum* on limestone mountains, *Cephalotaxus mannii*, *Amentotaxus argotaenia* on non-limestone mountains. Seedlings and saplings are tolerant of light shading.
**Distribution**
In Vietnam this species is the most widespread member of the genus (Lao Cai, Ha Giang, Tuyen Quang, Bac Can, Thanh Hoa, Nghe An). It is also known from several small populations in the adjoining Chinese provinces of Yunnan and Guizhou (Fu Li-kuo & Jin Jian-ming, 1992; Ying Tsun-shen et al., 2003). Recent discoveries of this species in several provinces indicate that the majority of the global population is in Vietnam rather than China.

**Uses**
Timber is used for tool making, handicrafts, furniture in China. The genus has potential uses for anti-cancer treatments; seed has high oil content (Su Huey-jen et al., 2003). The tree has attractive foliage, sometimes used for bonsai. Seedlings are collected directly from the wild.

**Threats**
Forest fragmentation, selective felling of larger trees, decline of habitat due to forest fires and conversion of habitat in silicate derived soil areas to agricultural use are the principle threats. In 1998 the population in Sa Pa was logged by local people for export to China for medicinal use and for timber (Nguyen Duc To Luu, pers. obsv.).

**Protected Area status**
The population known from Hoang Lien NP on the slopes surrounding Sa Pa was decimated in 1998. Local sources report other populations within the park proper but recent surveys have not located them (Thomas & Nguyen Duc To Luu, 2004a). It is likely to occur in Bat Dai Son in Ha Giang. Small populations have been recorded in nearby unprotected areas (Lao Va Chai -Yen Minh). Others have been recorded from Na Hang NR as well as in Pu Luong proposed NR and Pu Huong NR. Populations are small and need strict protection.

**Current conservation measures**
Currently no ex situ programmes are focussed on this species although some research has been carried out on vegetative propagation techniques by the CFSC.

**Recommended conservation action**
All populations within national parks and nature reserves and proposed protected areas need strict protection. Research on its ecology and reproductive biology needs to be undertaken. Research into its potential medicinal uses and propagation requirements should also be undertaken. Further study of medicinal properties is important to enable utilization of this species. Research into propagation and cultivation requirements could allow this species to be sustainably exploited and thereby help to reduce threats to natural populations. This should be complemented by awareness raising programmes among the local people.
**Taxus chinensis** Pilg.

Thông đỏ (Vietnamese), Yew (English), hong du shan (Chinese).


**Note:** The taxonomy and distribution of *Taxus* in Vietnam is unclear. The World Checklist of Conifers (Farjon, 2001) cites *T. chinensis* (Pilg.) Rehder var. *mairei* (Lemée & Lév.) W.C. Cheng & L.K. Fu as the only representative. The gymnosperm account of the *Flore du Cambodge, du Laos et du Vietnam* (Nguyen Tien Hiep & Vidal, 1996) along with other Vietnamese works record two species: *T. wallichiana* Zucc. from the Da Lat plateau of southern Vietnam and *T. chinensis* (Pilg.) Rehder from the karst limestone areas in northern and north-western Vietnam (Anon., 1996; Vu Van Dung, 1996; Nguyen Duc To Luu & Thomas, 2004). The northern populations are geographically close to south-east and south-west China where *Taxus chinensis* is widespread and their morphology closely resembles that of ‘typical’ *T. chinensis*. The southern populations are disjunct and their correct identification is uncertain and depends on clarification of the taxonomic status of the Himalayan *T. wallichiana*, the south-west Chinese populations of *T. chinensis* var. *mairei* and the Indonesian and Philippines populations of *T. sumatrana*. The uncertainty is further indicated by the inclusion of var. *mairei* as a variety under *T. wallichiana* by the authors of the Flora of China, Vol. 4 (Fu Li-kuo et al., 1999c).

**Conservation status**

<table>
<thead>
<tr>
<th>Global status</th>
<th>NOT EVALUATED [LEAST CONCERN]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing national status</td>
<td>RARE</td>
</tr>
<tr>
<td>Proposed national assessment</td>
<td>VULNERABLE A2ac, B2a(i-v),b(i-v)</td>
</tr>
</tbody>
</table>

Due to its wider distribution in southern China, this species is not listed as globally threatened. In Vietnam, the populations are much smaller in size and many have been logged. At a national level, this species was listed as Rare. Under the new IUCN (2001) categories this should change to Vulnerable A2ac, B2a(i-v),b(i-v).

**Description**

An upright tree with spreading branches (depending on situation), reaching up to 15 m high (occasionally 20m) with a dbh to 1 (occasionally 1.5) m. It is found scattered in

---

*Taxus chinensis* Pilg.

1. Cone-bearing branchlet and very young pollen cones.
2. Leaf, abaxial view.

(Drawn from DKH 7125 by Nguyen Quang Hung.)
primary closed evergreen tropical seasonal coniferous submontane forests on the top ridges of highly eroded solid crystalline white limestone mountains and steep slopes (mean annual temperature 15-20°C, rainfall above 1300 mm) from 900-1500 m amsl. Found in *Pseudotsuga sinensis, Pinus kwangtungensis, Fokienia hodginsii or Xanthocyparis vietnamensis* communities, associated with *Podocarpus pilgeri, Nageia fleuryi* and *Tsuga chinensis*. Natural regeneration is occasional.

**Distribution**
Found in the Provinces Son La, Ha Giang, Tuyen Quang, Cao Bang, Hoa Binh and Thanh Hoa. Outside of Vietnam it is found in southern China.

**Uses**
The timber is red in colour with a fine structure, water resistant and can be used for irrigation paddles. The seeds have medicinal uses and the tree is used as bonsai. A limited amount of research has been undertaken within Vietnam to investigate the pharmaceutical qualities of Vietnamese trees. Important intermediate substances in the production of taxol such as 7-xylosyl-10-deacetylbaccatine III and 10-deacetylbaccatine III have been isolated and characterized from bark and needles of *Taxus chinensis* from Hoa Binh in northern Vietnam (Mai Van Tri et al., 1995). Harvesting can only be sustained from plantations as the natural populations are too small.

**Threats**
Difficult reproductive biology and poor natural regeneration of this species are compounded by threats through logging, forest fragmentation, degradation of habitat and forest fires.

**Protected Area status**
In Hoa Binh small populations have been found within Hang Kia-Pa Co NR. This population is probably contiguous with those in Son La which are in areas that have not been designated as a protected area (Thomas & Nguyen Duc To Luu, 2004c). In Ha Giang, *Taxus chinensis* is known from Bat Dai Son NR, in Tuyen Quang from Na Hang NR. It has also been found in the proposed Pu Luong NR.

**Current conservation measures**
No attempts have been made to domesticate *Taxus* in northern Vietnam on any significant scale. Some research into propagation methods have been carried out by the FSIV (Nguyen Hoang Nghia, 2000). *Taxus chinensis*, and other Asian yew taxa, are included in Appendix II of CITES.

**Recommended conservation action**
This species should be included in Group IIA of the List of Rare and Precious Flora and Fauna in order to provide legislated protection in areas where most populations occur and then this enforced by trained FPD staff. Further taxonomic work is needed to clarify its systematic position (see Part I). *Ex situ* conservation plantation should be established.
**Taxus wallichiana** Zucc.

Thông đỏ lá dài, Thông đỏ Nam (Vietnamese), Himalayan Yew (English), xu mi hong dou shan (Chinese).


**Conservation status**

<table>
<thead>
<tr>
<th></th>
<th>DATA DEFICIENT</th>
<th>[LEAST CONCERN]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Existing national status</td>
<td>RARE</td>
<td></td>
</tr>
<tr>
<td>Proposed national assessment</td>
<td>ENDANGERED C1</td>
<td></td>
</tr>
</tbody>
</table>

Due to its wide distribution outside of Vietnam, this species is not yet listed as globally threatened, even though many populations have been over-exploited. In Vietnam, it has been assessed as Rare (Anon., 1996), Data Deficient or Critically Endangered C2a (Nguyen Hoang Nghia, 2000). The last assessment is based on field surveys undertaken in Lam Dong Province during 1998, which resulted in an estimated total population size was < 250 mature trees with no more than 50 trees in each sub-population. Since then, further fieldwork in Lam Dong Province has been undertaken and a new sub-population consisting of at least 250 trees was found. The total number of mature trees occurring in Vietnam is now estimated to be more than 250, but much less than 2,500, spread over severely fragmented populations. This means that its status for Vietnam should now be Endangered C1 (based on IUCN, 2001 criteria). As all of the populations face a high level of threat, especially from fire in the surrounding forests, this conservation status may need to be upgraded in future. The Lam Dong populations represent the most southern distribution for this genus on the South East Asian mainland. As such they are disjunct and may represent a distinct provenance (Thomas *et al.*, 2002).

**Description**

An upright dioecious tree with spreading branches depending on situation, reaching up to 20 (occasionally 30) m high with a dbh to 1 (occasionally 1.5) m. It is found in small localised populations in primary closed evergreen tropical seasonal mixed or broad-leaved submontane forests (mean annual temperature 15-21°C, annual rainfall above 1500 mm),

*Taxus wallichiana* Zucc.

1. Seed-bearing branchlet and ripe seeds.
2. Leaf, abaxial view.

(Drawn from *DKH 7125* by Nguyen Quang Hung).
on granite and other silicate derived soils from 900 - 1600 m amsl. Associated conifers include Cephalotaxus mannii, Nageia wallichiana, Podocarpus nerifolius, Dacrycarpus imbricatus and Keteleeria evelyniana. Natural regeneration sporadic, seedlings and saplings are very shade tolerant.

**Distribution**

In Vietnam, it is only currently known for certain from Lam Dong (Duc Trong, Xuan Tho, Don Duong, Lac Duong) (Thomas & Nguyen Duc To Luu, 2004c). There are herbarium records dating back to the 1930’s for this species in Khanh Hoa (Nguyen Tien Hiep & Vidal, 1996) but there are no recent reports. Other reports from Ninh Thuan and Dac Lac need further verification. Outside of Vietnam it is found in south-western China and the Himalayas.

**Uses**

A limited amount of research has been undertaken within Vietnam to investigate the pharmaceutical qualities of Vietnamese trees. An analysis of samples from Lam Dong populations showed that it had a higher content of the precursor 10-deacetylbaccatine III than Taxus baccata (Le Thi Xuan, et al., 1996).

**Threats**

Generally threatened by habitat loss, but more specifically from fire in the surrounding forests. Trade in parts and derivatives of the species as a source of taxol is a threat to wild populations in parts of its range outside of Vietnam (Thomas & Nguyen Duc To Luu, 2004c).

**Protected Area status**

In southern Vietnam all Taxus populations are located within areas involving protection functions but not necessarily biodiversity conservation areas. The two main populations at Nui Voi and Ho Tien are within watershed management forests. A third, Xuan Tho is on land controlled by a State Forest Enterprise that is classed as experimental (seed) forest. Only one tree has been recorded from this area although it is highly likely that there are more (Thomas & Nguyen Duc To Luu, 2004c).

**Current conservation measures**

This species is protected by law since it is included in Group IA of the List of Rare and Precious Flora and Fauna. Vegetative propagation and ex situ plantation projects have been conducted by FSIV (Nguyen Hoang Nghia, 2000) and CFSC (Dick et al., 2004). Taxus wallichiana, along with other Asian yew taxa, is included in Appendix II of CITES.

**Recommended conservation action**

The main population in Nui Voi – Duc Trong – Lam Dong should be proposed as a nature reserve (e.g. a Species Habitat Conservation Area) for conifers, especially Taxus wallichiana. As the species is protected by law, awareness of state agencies and the public should be raised at remaining sites for long term protection. The population is also a good site for ecological and seed studies of the species. Further taxonomic work is needed to clarify its taxonomic status.
References


Global Trees Campaign and FFI Vietnam.


Nguyen Duc To Luu (2004). *Results from VTSP research programme into conifers.* Unpublished report for DANIDA and CFSC


Nguyen Hoang Nghia (2000). *Some Threatened Tree Species of Vietnam.* Agricultural
References


Annex 1

2001 (version 3.1) criteria for Critically Endangered, Endangered and Vulnerable categories of the IUCN Red List of Threatened Species

Table 4 Simplified overview of thresholds for the IUCN Red List Criteria

<table>
<thead>
<tr>
<th>Criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critically Endangered</td>
</tr>
<tr>
<td>A1: Reduction in population size</td>
</tr>
<tr>
<td>A2–A4: Reduction in population size</td>
</tr>
<tr>
<td>B1: Small range (extent of occurrence)</td>
</tr>
<tr>
<td>B2: Small range (area of occupancy)</td>
</tr>
<tr>
<td>C: Small and declining population</td>
</tr>
<tr>
<td>D1: Very small population</td>
</tr>
<tr>
<td>D2: Very small range</td>
</tr>
<tr>
<td>E: Quantitative analysis</td>
</tr>
</tbody>
</table>

NA, not applicable.
DOI: 10.1371/journal.pbio.0020383.t001
Reproduced from: Butchart et al. (2004).

Critically Endangered (CR)
A taxon is Critically Endangered when the best available evidence indicates that it meets any of the following criteria (A to E), and it is therefore considered to be facing an extremely high risk of extinction in the wild:

A. Reduction in population size based on any of the following:

1. An observed, estimated, inferred or suspected population size reduction of ≥90% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) any of the following:
   (a) direct observation
   (b) an index of abundance appropriate to the taxon
(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
(d) actual or potential levels of exploitation
(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

2. An observed, estimated, inferred or suspected population size reduction of $\geq 80\%$ over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

3. A population size reduction of $\geq 80\%$, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.

4. An observed, estimated, inferred, projected or suspected population size reduction of $\geq 80\%$ over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:

1. Extent of occurrence estimated to be less than 100 km², and estimates indicating at least two of a-c:
   a. Severely fragmented or known to exist at only a single location.
   b. Continuing decline, observed, inferred or projected, in any of the following:
      (i) extent of occurrence
      (ii) area of occupancy
      (iii) area, extent and/or quality of habitat
      (iv) number of locations or subpopulations
      (v) number of mature individuals.
   c. Extreme fluctuations in any of the following:
      (i) extent of occurrence
      (ii) area of occupancy
      (iii) number of locations or subpopulations
      (iv) number of mature individuals.

2. Area of occupancy estimated to be less than 10 km², and estimates indicating at least two of a-c:
   a. Severely fragmented or known to exist at only a single location.
b. Continuing decline, observed, inferred or projected, in any of the following:
   (i) extent of occurrence
   (ii) area of occupancy
   (iii) area, extent and/or quality of habitat
   (iv) number of locations or subpopulations
   (v) number of mature individuals.

c. Extreme fluctuations in any of the following:
   (i) extent of occurrence
   (ii) area of occupancy
   (iii) number of locations or subpopulations
   (iv) number of mature individuals.

C. Population size estimated to number fewer than 250 mature individuals and either:

   (i) An estimated continuing decline of at least 25 % within three years or one generation, whichever is longer, (up to a maximum of 100 years in the future) OR

1. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a-b):
   (a) Population structure in the form of one of the following:
      (i) no subpopulation estimated to contain more than 50 mature individuals, OR
      (ii) at least 90% of mature individuals in one subpopulation.
   (b) Extreme fluctuations in number of mature individuals.

D. Population size estimated to number fewer than 50 mature individuals.

E. Quantitative analysis showing the probability of extinction in the wild is at least 50 % within 10 years or three generations, whichever is the longer (up to a maximum of 100 years).
Annex 1

Endangered (EN)
A taxon is Endangered when the best available evidence indicates that it meets any of the following criteria (A to E), and it is therefore considered to be facing a very high risk of extinction in the wild:

A. Reduction in population size based on any of the following:

1. An observed, estimated, inferred or suspected population size reduction of ≥70 % over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) any of the following:
   (a) direct observation
   (b) an index of abundance appropriate to the taxon
   (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
   (d) actual or potential levels of exploitation
   (e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

2. An observed, estimated, inferred or suspected population size reduction of ≥50 % over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

3. A population size reduction of ≥50 %, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.

4. An observed, estimated, inferred, projected or suspected population size reduction of ≥50 % over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:

1. Extent of occurrence estimated to be less than 5,000 km², and estimates indicating at least two of a-c:
   a. Severely fragmented or known to exist at no more than five locations.
   b. Continuing decline, observed, inferred or projected, in any of the following:
      (i) extent of occurrence
      (ii) area of occupancy
      (iii) area, extent and/or quality of habitat
      (iv) number of locations or subpopulations
(v) number of mature individuals.

**c. Extreme fluctuations in any of the following:**

(i) extent of occurrence
(ii) area of occupancy
(iii) number of locations or subpopulations
(iv) number of mature individuals.

2. **Area of occupancy estimated to be less than 500 km², and estimates indicating at least two of a-c:**

a. Severely fragmented or known to exist at no more than five locations.
   - Continuing decline, observed, inferred or projected, in any of the following:
     (i) extent of occurrence
     (ii) area of occupancy
     (iii) area, extent and/or quality of habitat
     (iv) number of locations or subpopulations
     (v) number of mature individuals.

b. **Extreme fluctuations in any of the following:**
   (i) extent of occurrence
   (ii) area of occupancy
   (iii) number of locations or subpopulations
   (iv) number of mature individuals.

C. **Population size estimated to number fewer than 2500 mature individuals and either:**

1. An estimated continuing decline of at least 20% within five years or two generations, whichever is longer, (up to a maximum of 100 years in the future) OR

2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a-b):
   (a) Population structure in the form of one of the following:
      (i) no subpopulation estimated to contain more than 250 mature individuals, OR
      (ii) at least 95% of mature individuals in one subpopulation.
   (b) Extreme fluctuations in number of mature individuals.

D. **Population size estimated to number fewer than 250 mature individuals.**

E. **Quantitative analysis showing the probability of extinction in the wild is at least 20% within 20 years or five generations, whichever is the longer (up to a maximum of 100 years).**
**Vulnerable (VU)**
A taxon is Vulnerable when the best available evidence indicates that it meets any of the following criteria (A to E), and it is therefore considered to be facing a high risk of extinction in the wild:

A. Reduction in population size based on any of the following:

1. An observed, estimated, inferred or suspected population size reduction of $\geq 50\%$ over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are: clearly reversible AND understood AND ceased, based on (and specifying) any of the following:
   (a) direct observation
   (b) an index of abundance appropriate to the taxon
   (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
   (d) actual or potential levels of exploitation
   (e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

2. An observed, estimated, inferred or suspected population size reduction of $\geq 30\%$ over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

3. A population size reduction of $\geq 30\%$, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.

4. An observed, estimated, inferred, projected or suspected population size reduction of $\geq 30\%$ over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:

1. Extent of occurrence estimated to be less than 20,000 km², and estimates indicating at least two of a-c:
   a. Severely fragmented or known to exist at no more than 10 locations.
   b. Continuing decline, observed, inferred or projected, in any of the following:
      (i) extent of occurrence
      (ii) area of occupancy
      (iii) area, extent and/or quality of habitat
      (iv) number of locations or subpopulations
      (v) number of mature individuals.
   c. Extreme fluctuations in any of the following:
(i) extent of occurrence
(ii) area of occupancy
(iii) number of locations or subpopulations
(iv) number of mature individuals.

2. Area of occupancy estimated to be less than 2,000 km², and estimates indicating at least two of a-c:
   1. Severely fragmented or known to exist at no more than 10 locations.
      (a) Continuing decline, observed, inferred or projected, in any of the following:
         (ii) extent of occurrence
         (iii) area of occupancy
         (iv) area, extent and/or quality of habitat
         (v) number of locations or subpopulations
         (vi) number of mature individuals.
      (b) Extreme fluctuations in any of the following:
         (i) extent of occurrence
         (ii) area of occupancy
         (iii) number of locations or subpopulations
         (iv) number of mature individuals.

C. Population size estimated to number fewer than 10,000 mature individuals and either:

1. An estimated continuing decline of at least 10% within 10 years or three generations, whichever is longer, (up to a maximum of 100 years in the future) OR

2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a-b):
   (a) Population structure in the form of one of the following:
      (i) no subpopulation estimated to contain more than 1,000 mature individuals, OR
      (ii) all mature individuals are in one subpopulation.
   (b) Extreme fluctuations in number of mature individuals.

D. Population very small or restricted in the form of either of the following:

1. Population size estimated to number fewer than 1,000 mature individuals.

2. Population with a very restricted area of occupancy (typically less than 20 km²) or number of locations (typically five or fewer) such that it is prone to the effects of human activities or stochastic events within a very short time period in an uncertain future, and is thus capable of becoming Critically Endangered or even Extinct in a very short time period.

E. Quantitative analysis showing the probability of extinction in the wild is at least 10% within 100 years.
Information On Organisations Contributing Technical Expertise And Key Funding Agencies For Field Work Support.

The Global Trees Campaign is a joint initiative of Fauna & Flora International (FFI) and the United Nations Environment Programme – World Conservation Monitoring Centre (UNEP-WCMC). The Global Trees Campaign aims to save the world’s most threatened trees and the habitats where they grow through provision of information, conservation action and sustainable use. Promoting and supporting the conservation of Vietnamese conifers is a priority component of the Global Trees Campaign.

Fauna & Flora International (FFI) is the world’s longest established international conservation body, founded 100 years ago. Renowned for its science-based approach, FFI has pioneered sustainable conservation work that tackles problems holistically, providing solutions that simultaneously help wildlife, humans and the environment.

The Darwin Initiative is a UK government initiative that aims to work with local partners in countries rich in biodiversity but poor in resources to achieve the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources. Over the last 10 years the Initiative has funded 5 major projects in Vietnam; three of these have involved conservation in montane areas.

The Forest Protection Department is the government agency under the Ministry of Agriculture and Rural Development that is charged with the responsibility to protect the nations forests. It has a presence throughout the country from national through province and district down to commune and villages. Its main roles are fire protection as well as activities linked to the management of protected areas designated by the National and Provincial Governments.

Central Forest Seed Company is mandated by the Ministry of Agriculture and Rural Development (MARD) as the major tree seed supplier in Vietnam. In its 40 years of existence the Company maintained continuous research for promoting use of indigenous species in forest plantation through effective propagation and quality seed use. The Company is also
involved in different aspects of gene conservation for longterm
tree improvement. Having a practical and national network
of 9 Forest Seed Enterprises in all ecoregions of Vietnam the
Company contributes to formulation of management and
development strategy for forest reproductive materials of
MARD.

**The mission of the Royal Botanic Garden Edinburgh (Scotland)** is to 'explore and explain the world of plants through research, conservation and education'. Over the last 100 years, the RBGE has maintained an extensive programme of botanical taxonomic research and conservation throughout Asia. The RBGE is also a leading centre for research into the diversity and conservation of conifers and has active research programmes in many parts of the world. It is supported by the Scottish Executive Rural Affairs Department (SERAD)

**The International Conifer Conservation Programme**, based at the Royal Botanic Garden Edinburgh, is dedicated to the conservation of the world’s rich heritage of conifers. Vietnamese conifers have been a major focus for the programme through the work of the recent Darwin Initiative ‘Preservation, Rehabilitation and Utilisation of Vietnamese Montane Projects, a collaborative project with the Central Forest Seed Company and the Center for Ecology and Hydrology (Scotland). The ICCP is also active in the IUCN Conifer Specialist Group

**The mission of the Royal Botanic Gardens, Kew (England)** is to 'enable better management of the Earth’s environment by increasing knowledge and understanding of the plant and fungal kingdoms – the basis of life on Earth.' The RBGKEW has undertaken research into plant diversity in many parts of the world for more than 200 years. It has a long tradition, beginning with Maxwell Masters in the late 19th century, of research into the diversity of conifers and has recently made substantial contributions to this with the publication of several monographs by its leading conifer taxonomist Aljos Farjon.

**The Institute of Ecology and Biological Resources (IEBR)** of the Vietnam Academy of Science and Technology in Hanoi was established in 1990. IEBR's objectives are the study of biodiversity in Vietnam, the inventory and scientific evaluation of this diversity for sustainable utilisation and conservation, ecosystem research including remote sensing analysis, and postgraduate training within these disciplines. The IEBR has over 120 scientific staff working in 16 departments and a
biodiversity field station. The Botany Department is actively conducting research on the flora of Vietnam with numerous national and international organisations.

**The Missouri Botanical Garden (MBG)** in Saint Louis is the oldest operating botanical garden in the United States. The MBG seeks to discover and share knowledge about plants and their habitats in order to preserve and enrich life. In Vietnam, the Missouri Botanical Garden has collaborated with the Institute of Ecology and Biological Resources (IEBR) since 1994. The goal of the cooperative MBG-IEBR Vietnam Botanical Conservation Program is to revitalize study of the country's flora and strengthen the capacity to manage the country’s biological resources in a sustainable manner. Website: www.mobot.org

**The Komarov Botanical Institute** of the Russian Academy of Sciences in Saint Petersburg was established in 1931, although the botanic garden dates back to 1714 as the pharmacy garden of Peter the Great. The Institute engages in basic scientific research in systematics, floristics, ecology, geography, phylogeny, paleobotany, plant resources, wild plant introduction, structural and functional botany. The Institute has 21 scientific departments with a staff of more than 500, half of which are scientists. The Institute's museums and collections include the Botanical Museum, Botanical Garden, and the Herbarium which has the second largest collections of plant specimens in the world. Website: http://botguide.spb.ru

**EC Programme on Tropical Forests** and other Forests in Developing Countries budget line is an important instrument for the commission to support innovative pilot activities and strategic studies that address the problems affecting forests and negative environmental trends whilst contributing simultaneously to the overall objective of poverty reduction.

**The Species Survival Commission** is a network of some 7,000 volunteer members from almost every country of the world, all working to stop the loss of plants, animals and their habitats. Members include researchers, government officials, wildlife veterinarians, zoo and botanical institute employees, marine biologists, protected area managers, and experts on plants, birds, mammals, fish, amphibians, reptiles, and invertebrates. SSC seeks to mobilise action by the world conservation community for species conservation, particularly those species threatened with extinction and those of importance for human welfare.
Fauna & Flora International acts to conserve threatened species and ecosystems world-wide, choosing solutions that are sustainable, are based on sound science and take account of human needs.