Teresa Mulliken and Petra Crofton

Review of the Status, Harvest, Trade and Management of Seven Asian CITES-listed Medicinal and Aromatic Plant Species

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Teresa Mulliken
Petra Crofton

Cover picture: Himalayan yew *(Taxus wallichiana),* Valley of Flowers National Park, Nanda Devi Biosphere Reserve. Photo: SAMIR SINHA (TRAFFIC India) 2006.

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INTRODUCTION

Wild plant species form the foundation of healthcare practices throughout much of Asia. This is particularly true in the case of traditional medicine practices, including codified systems such as traditional Chinese medicine, Ayurveyda, Siddha, Unani and Tibetan medicines, and more localised healthcare traditions. Asia's wild plants also form a critical component of 'modern' healthcare practices. Compounds such as reserpine from Snakeroot *Rauvolfia serpentina* and paclitaxel from Himalayan Yew *Taxus wallichiana* have important pharmaceutical uses in Europe, North America and more widely. Some medicinal species are also in demand for their aromatic properties, the use of the oil of Jatamansi *Nardostachys grandiflora*, for example, appearing in written texts dating back over a thousand years. Still others, including Red Sanders *Pterocarpus santalinus*, are also valued for their timber.

Wild plant species also form an important component of livelihood strategies in Asia, with wild collection of medicinal and aromatic plants providing a critical source of income in many areas. This is particularly true in areas such as the high alpine regions of the Himalayas, where agricultural outputs are low and there are few other opportunities for income generation.

The combined and in many cases increasing demand for Asia's medicinal plants and the consequent increase in the rate of collection are having a negative impact on the wild populations of many species, to the point that some species are now considered to be threatened with extinction. National governments throughout the region have responded by establishing various systems of collection and trade controls to bring wild collection within sustainable levels. Governments, non-governmental organizations and in some cases the private sector have also begun investing in cultivation of certain species to meet demand. In order to help ensure that international trade was both sustainable and in accordance with national legislation, member countries of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) have also established international trade controls for some Asian medicinal species.

Earlier reviews of the status, wild collection and trade of a number of CITES-listed medicinal plant species, including those mentioned above, found that implementation of collection and trade controls was generally low, and in some cases nearly non-existent. Not surprisingly, there were also indications of continuing declines in wild populations despite these regulatory efforts. In order to support efforts to improve the management and conservation of medicinal plant species in trade, in 2004, the German Federal Agency for Nature Conservation (Bundesamt für Naturschutz, BfN) contracted TRAFFIC to undertake a study of the status, use, trade and trade controls for seven Asian species. Four of the seven, Elephant's Foot *Dioscorea deltoidea*, *Pterocarpus santalinus*, *Rauvolfia serpentina* and *Taxus wallichiana*, had already been reviewed by BfN as a contribution to the CITES Significant Trade Review process (SCHIPPMANN 2001). A further two, the Himalayan species *Nardostachys grandiflora* and Kutki *Picrorhiza kurrooa*, were previously reviewed by TRAFFIC under contract to the CITES Secretariat, also as part of the CITES Significant Trade Review Process (MULLIKEN 2000). That study also reviewed the trade in *Neopicrorhiza scrophulariiflora*, closely related and similar to *Picrorhiza kurrooa* and also referred to and traded as Kutki. The seventh, Desert Cistanche *Cistanche deserticola*, was listed in CITES Appendix II in 2000 and has not been the subject of a previous review.

The present study was led by TRAFFIC, working with the Species Programme of IUCN – The World Conservation Union. Research support was provided by TRAFFIC offices in East Asia and Southeast Asia, IUCN offices in Nepal and Pakistan, and independent consultants. Members of the IUCN/SSC Medicinal Plant Specialist Group and other experts generously contributed information. The text of MULLIKEN (2000) and SCHIPPMANN (2001) was used as the starting point for the study, with researchers seeking to augment and update this information through a combination of literature reviews and web-based information searches, expert interviews and compilation and analysis of CITES annual report and Customs data.

A summary of the overall findings of this research, based on a comparison of information available for each of the seven species, is presented (MULLIKEN & SCHIPPMANN), followed by detailed assessments for the individual species. The individual species accounts begin with information on the species' taxonomy, description, distribution, status and threats. This is followed by a review of available information on the species' medicinal and other uses, harvest and processing, cultivation, national markets and international trade. Available information on illegal trade is presented, followed by a discussion of national and international trade controls for the species. A brief overall analysis of the situation with regard to the species' status and trade is provided as concluding text, followed by possible next steps that might be taken by governments, particularly within range States, to address concerns identified. A list of country codes and of abbreviations used to describe the origin of trade names are provided as annexes.

It is hoped that this information will be useful to national governments, non-governmental organizations working in the fields of conservation and development, and businesses concerned with the harvest, use and trade of medicinal plants. More importantly, it is hoped that it will support efforts to manage harvest and trade in a way that conserves wild species and ecosystems while meeting the current and future development needs of the people most dependent on them.

METHODS

This study was led by TRAFFIC, working with the Species Programme of IUCN – The World Conservation Union. Significant research support was provided by TRAFFIC offices in East Asia and Southeast Asia, offices of the World Conservation Union (IUCN) in Nepal and Pakistan, and independent consultants. Members of the IUCN/SSC Medicinal Plant Specialist Group and other experts also generously contributed information.

The species assessments build on the results of CITES significant trade reviews undertaken by SCHIPPMANN (2001) for Elephant's Foot *Dioscorea deltoidea*, Red Sanders *Pterocarpus santalinus*, Snakeroot *Rauvolfia serpentina* and Himalayan Yew *Taxus wallichiana*, and MULLIKEN (2000) for Jatamansi *Nardostachys grandiflora* and Kutki *Picrorhiza kurrooa*. The text of SCHIPPMANN (2001) and MULLIKEN (2000) was used as the starting point for the study, with researchers seeking to augment and update this information through a combination of literature reviews and web-based information searches, expert interviews and compilation and analysis of CITES annual report and Customs data. Such text was not available for Desert Cistanche *Cistanche deserticola*, which was listed in CITES Appendix II in 2000 and has not been the subject of a CITES significant trade review.

Text from SCHIPPMANN (2001), MULLIKEN (2000) and, in the case of *C. deserticola*, information available from other sources, was incorporated into a questionnaire designed to facilitate identification of out-of-date or otherwise inaccurate information and information gaps, and to address these. The questionnaires were provided to IUCN and TRAFFIC colleagues leading research within Asia, who used them to solicit input from other experts as well as to guide their own research. This included literature searches and expert consultations within China, India, Nepal and Pakistan, consultation with experts, including government staff, within these countries, consultation with government staff within Myanmar and Thailand, and web-based information searches.

Where the status of species has been reviewed making use of the IUCN Red List Criteria, the categories arrived at as a result of those reviews and the version of the criteria used (1994, 2001) have been noted. It is important to bear in mind that in some cases the reviews do not represent formal Red List assessments, and further, relate to only one part of the global population. Further information on the Red List can be found on www.redlist.org.

Data on international trade reported by CITES Parties (CITES annual report data) were obtained from the UNEP-World Conservation Monitoring Centre, which maintains this information on behalf of the CITES Secretariat. These are presented in the form of "comparative tabulations", which allow comparison of trade reported by exporting/re-exporting Parties with that reported by importing Parties. When considering these data it is important to bear in mind that discrepancies in trade reporting by different countries, for example reporting of the source of specimens in trade, may give the appearance that different shipments are involved when this is not the case. In addition, Parties often report exports based on the date of permit issuance; however, CITES export permits can be valid for up to six months, with the result that they may be issued and reported on in one year by the exporting Party, but not reported on until the following year by the importing Party. A guide to interpretation of CITES annual report data can be found on the UNEP-WCMC website at www.unep-wcmc.org/citestrade/docs/Guide_v.6.0.pdf. A guide to the information contained within the CITES data tables is provided in Annex 2.

Customs data compiled and maintained by national governments are generally not sufficiently detailed to identify trade in particular medicinal species. Customs data for India represent an exception to this rule, and contain information on imports and exports of several of the species covered by this study. These data were obtained from the website maintained by the Government of India's Export Import Data Bank, Department of Commerce (http://dgft.delhi.nic.in). Customs data were also available and reviewed with regard to exports of *Nardostachys grandiflora* from Nepal.

Information on the value of harvests and trade is provided in original currency where this was available, with US dollar figures also provided, based on the conversion rate for the year to which the data relate, when this was known. In cases where the year for a particular figure was not provided, the conversion rate used was that for the year of publication. Currency data were not adjusted for inflation.

The species assessments were produced from this information by the authors, with ongoing consultation with colleagues where clarification was required. Drafts of individual species assessments were sent to CITES Management Authorities of key exporting range States for review, and also made available during the 16th meeting of the CITES Plants Committee (July 2006). A full set of draft assessments was also provided to the CITES Secretariat for review. Review comments were gratefully received from the Management Authorities of China, Nepal and Thailand.

The information provided herein reflects the hard work of Dr Uwe Schippmann and Asia-based IUCN and TRAFFIC colleagues and other experts who were willing to give so generously of their time and information. They deserve full credit for the breadth and depth of information in this report. Any errors of fact or interpretation remain the sole responsibility of the authors.

CITES MEDICINAL PLANT SPECIES IN ASIA – TREASURED PAST, THREATENED FUTURE?

Introduction

Wild plant species form the foundation of healthcare practices throughout much of Asia. This is particularly true in the case of traditional medicine practices, including codified systems such as traditional Chinese medicine, Ayurveda, Siddha, Unani and Tibetan medicines, and more localised healthcare traditions. Asia's wild plants also form a critical component of 'modern' healthcare practices. Compounds such as reserpine from Snakeroot *Rauvolfia serpentina* and paclitaxel from Himalayan Yew *Taxus wallichiana* have important pharmaceutical uses in Europe, North America and more widely. Some medicinal species are also in demand for their aromatic properties, the use of the oil of Jatamansi *Nardostachys grandiflora*, for example, appearing in written texts dating back over a thousand years. Still others, including Red Sanders *Pterocarpus santalinus*, are also valued for their timber.

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The combined and in many cases increasing demand for Asia's medicinal plants and the consequent increase in the rate of collection are having a negative impact on the wild populations of many species, to the point that some species are now considered to be threatened with extinction. National governments throughout the region have responded by establishing various systems of collection and trade controls to bring wild collection within sustainable levels. Governments, non-governmental organisations and in some cases the private sector have also begun investing in cultivation of certain species to meet demand. In order to help ensure that international trade was both sustainable and in accordance with national legislation, member countries of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) have also established international trade controls for some Asian medicinal species.

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Although the number of species studied was small, their diversity in terms of life forms, use and trade provides a useful basis from which to consider issues associated with Asia's medicinal plant trade more broadly. The following presents some of the overall findings based on a comparison of information available for the various species. Recommendations for addressing what appear to be generic problems associated with management of medicinal plant collection and trade, particularly in South Asia, are also provided.

Table 1. CITES-listed medicinal plant species included in this review

Taxa/life form	Distribution/habitat	Main part(s) used medicinally	Entry into effect of CITES listing; annotation at time of writing*
Desert Cistanche *Cistanche deserticola* (perennial parasitic herb)	China, Mongolia	Stems	19 July 2000 Annotation #1
Elephant's Foot *Dioscorea deltoidea* (deciduous perennial with annual climbing stem)	Afghanistan, Bhutan, Cambodia, China, India, Lao PDR, Nepal, Pakistan, Thailand, Viet Nam	Rhizomes	01 July 1975 Annotation #1
Jatamansi *Nardostachys grandiflora* (perennial herb)	Afghanistan (?), China, Bhutan, India, Myanmar (?), Nepal, Pakistan (?)	Rhizomes	18 September 1997 Annotation #3
Kutki *Picrorhiza kurrooa* (perennial herb)	India and Pakistan	Rhizomes	18 September 1997 Annotation #3
Red Sanders *Pterocarpus santalinus* (tree)	China (?), India, Pakistan (?), Philippines (?), Sri Lanka (?), Taiwan (?)	Wood	16 February 1995 Annotation #7
Snakeroot *Rauvolfia serpentina* (small, evergreen perennial, semi-shrub)	Bangladesh, Bhutan, China, Indonesia, India, Lao PDR, Malaysia, Myanmar, Nepal, Pakistan (?), Sri Lanka, Thailand, Viet Nam	Roots	18 January 1990 Annotation #2
Himalayan Yew *Taxus wallichiana* (small evergreen tree or shrub)	Afghanistan, Bhutan, China, India, Indonesia, Malaysia, Myanmar, Nepal, Pakistan, the Philippines, and Viet Nam	Bark and leaves	16 February 1995 Annotation #10

Annotation #1 designates "all parts and derivatives, except: a) seeds, spores and pollen (including pollinia); b) seedling or tissue cultures obtained in vitro, in solid or liquid media, transported in sterile containers; and c) cut flowers of artificially propagated plants".

Annotation #2 designates "all parts and derivatives, except a) seeds and pollen; b) seedlings or tissue cultures obtained *in vitro*, in solid or liquid media, transported in sterile containers; c) cut flowers of artificially propagated plants; and d) chemical derivatives and finished pharmaceuticals".

Annotation #7 designates "logs, wood-chips and unprocessed broken material".

Annotation #10: designates "all parts and derivatives except: a) seeds and pollen; and b) finished pharmaceutical products".

* A proposal to amend the CITES annotations for these species was accepted by the 14th meeting of the Conference of the Parties to CITES (June 2007). As of 13 September 2007, the annotation for *Cistanche deserticola*, *Nardostachys grandiflora*, *Picrorhiza kurrooa*, *Rauvolfia serpentina* and *Taxus wallichiana* is Annotation #2: "Designates all parts and derivatives except: a) seeds and pollen; and b) finished products packaged and ready for retail trade", and will take effect in September 2007. The annotation for *Dioscorea deltoidea* is now Annotation #1: "Designates all parts and derivatives, except: a) seeds, spores and pollen (including pollinia); b) seedling or tissue cultures obtained *in vitro*, in solid or liquid media, transported in sterile containers; c) cut flowers of artificially propagated plants; and d) fruits and parts and derivatives thereof of artificially propagated plants of the genus *Vanilla*." The annotation for *Pterocarpus santalinus* is Annotation #7:"Designates logs, wood-chips, powder and extracts."

Key findings

There is a growing body of work related to the use and trade of medicinal plants in Asia, with numerous NGOs, academics, government and intergovernmental agencies supporting and/or undertaking research. However, wider understanding of the domestic and international trade continues to rely primarily on the results of studies by NGOs and academics, with much of the work being very site specific. As a result, the information on both the species and trade is patchy. Research efforts appear to have been greatest in Nepal and India, with less work identified in other countries.

Status and threats

Somewhat surprisingly given their commercial importance and concerns regarding population declines, information on the status of the species throughout their range was generally limited. Information on declines and rarity appeared to be based largely on expert opinion, sometimes developed via Conservation Assessment and Management Plan (CAMP) workshops organised by members of the IUCN/SSC Medicinal Plant Specialist Group. Population surveys appeared to be limited to a small number of sites, with little

evidence of more widespread surveys to determine the status of the species at either the country or the global level. This situation can be explained in part by the vast size and remoteness of the species' habitats. For example, the appropriately named *Cistanche deserticola* is found in arid areas in China and Mongolia, while *Nardostachys grandiflora*, *Picrorhiza kurrooa* and *Neopicrorhiza scrophulariiflora* occur across large areas of the alpine Himalaya.

Based on the information that is available, it appears that all seven species have declined in the wild owing to over-collection to supply domestic and foreign medicinal markets. As a result, all are also considered to be threatened with extinction in at least parts of their range, although only one, the tree species *Pterocarpus santalinus*, has thus far been reviewed and classified as globally threatened (Endangered) in the IUCN Red List. In some cases, *P. santalinus* being one example, the threat of harvest for medicinal use appears to be secondary to that of harvest for other uses, e.g. timber and dyes. In only one case, that of *Cistanche deserticola*, a parasitic plant, was collection from the wild not considered the primary threat; here, the main threat was use of the host species, the trees *Haloxylon ammodendron* and *H. persicum*, for timber, fuelwood and fodder.

Medicinal and other uses

All seven species are used in traditional medicines domestically and to some extent regionally. Several species are used in more than one traditional medicine system. Kutki, for example, is listed in the Hamdard Pharmacopoeia of Eastern Medicine (Qarabadain-e-Hamdard), is used in Ayurveydic preparations, traditional Chinese medicine, and traditional Tibetan medicine. Three species are also used in western pharmaceutical products. *Dioscorea deltoidea* and *Taxus wallichiana* are exploited as a source of compounds first identified and extracted from other species in the two genera. Paclitaxel, more widely known by the trade name Taxol®, was first extracted from the North American species Pacific Yew *Taxus brevifolia*. The compound, used in treating cancer, was subsequently identified in *T. wallichiana* prompting a rapid increase in wild collection of the needles and bark of this Himalayan species for paclitaxel extraction. Similarly, diosgenin, which is extracted from *Dioscorea deltoidea*, was first discovered and extracted from Mexican *Dioscorea* species, one of the major uses of this compound being for the production of oral contraceptives. By contrast, *Rauvolfia serpentina* appears to have been the main initial source of the alkaloid reserpine, a compound used to treat hypertension among other ailments, and which is now also extracted from other *Rauvolfia* species, e.g. the African species *R. vomitoria*. It is possible that extracts from *Picrorhiza kurrooa* will soon join the list of medicinal plant-based pharmaceuticals, with phase three clinical trials underway in India for treatment of liver disorders.

All but one of the species (*Cistanche deserticola*) have multiple uses. The two tree species are valued for their timber, *Taxus wallichiana* for its resistance to rot, and *Pterocarpus santalinus* for its deep red colour and sometimes 'wavy' grain. The timber of *P. santalinus* is also used in powder and extract form as a dye, and that of *Taxus wallichiana* as a source of fuelwood, with *T. wallichiana* leaves also providing a source of fodder. In Miandam Valley of Pakistan's North-West Frontier Province, *T. wallichiana* is one of the most valued species for timber and fuelwood, with collection from the wild considered to be causing rapid population declines and to threaten the forest habitat upon which other medicinal plants depend (ADNAN *et al.* 2006).

While not a tree species itself, the reliance of *Cistanche deserticola* on its host species means that it is also impacted by harvest for timber, fuelwood and fodder. *Nardostachys grandiflora, Picrorhiza kurrooa* and *Pterocarpus santalinus* are all used in incense. In the case of *Nardostachys grandiflora*, this may be the main use, contrasting with *Pterocarpus santalinus*, where at present use in incense appears to be low, though identified as having growth potential. The tubers of *Dioscorea deltoidea* are eaten as food (although this requires repeated washing and boiling to remove toxins), and used in the western Himalayas to wash wool owing to their high saponin content. Only a single non-medicinal use was identified for *Rauvolfia serpentina* during this study - the species is planted in gardens in the Nepali Terai in the belief that this will ward off snakes.

Wild collection and trade

Similar to the information on status, information on wild collection and trade of these and other Asian medicinal species is patchy at best. Wild collection and trade in Nepal appears to be the most well-documented, with corresponding information for India being less comprehensive, although numerous site-specific studies have been undertaken. This may be explained in part by the much larger size of the country, and the greater complexity of manufacturing and trading structures.

Wild collection typically involves the rural poor. *Neopicrorhiza scrophulariiflora* and *Nardostachys grandiflora* provide almost 50% of the total annual income from alpine medicinal plant collection in Nepal, with alpine collection of medicinal plants believed to form an integral part of the livelihood strategies of 7-10% of Nepal's mountain regions (considered a conservative estimate), or approximately 25 000 – 35 000 peo-

ple (OLSEN & LARSEN 2003). In India, according to one estimate, collection and processing of medicinal plants contribute at least 35 million workdays per year to the "poor and underemployed workforce" (ANON. 2001). Collection of medicinal plants also makes an important contribution to rural household incomes in parts of India, with *Picrorhiza kurrooa* collection considered particularly important in the tribal areas of Himachal Pradesh studied by NEGI & BHALLA (2002), who noted that most collectors were "small and marginal farmers". *Rauvolfia serpentina* collection from the wild in Thailand and Myanmar was said to be undertaken on an opportunistic basis by local people, often at the same time they are collecting other forest products. Information indicating a large-scale trade in *R. serpentina* from Myanmar to India, and an increase in processing within Myanmar in the mid-1990s, suggests that targeted collecting may also be taking place. In Pakistan, where *Dioscorea deltoidea* was said to be one of the main medicinal species collected in the mid-1990s, collection also involves the rural poor.

Although all of the species are collected for local use, in many areas the main reason to collect the species is to provide cash income and supply demand that may be hundreds to thousands of kilometres away from collection areas: in the case of *Taxus wallichiana* the distance is potentially 10 000 km or more. The path from wild collection to end market generally involves a complex trade chain, a typology of which has been proposed by OLSEN & BHATTARAI (2005) for trade from Nepal to India. The journey often begins with one or more days of walking from the site of collection to village, and then again from village to the nearest roadhead. Based on available information, with regard to Himalayan species, most though not all roads lead to India, which is both a major manufacturing centre and end consumer market. This is particularly true of trade from Nepal, which is fed by hundreds of thousands of medicinal plant collectors supplying raw materials through a multi-tiered system of middlemen leading to large-scale wholesalers in Nepal and India (OLSEN & BHATTARAI 2005). Raw materials are often transported on to large wholesale markets, e.g. in Delhi, Amritsar and Kolkata (Calcutta) for onward sale. Alternatively, traders may work directly with pharmaceutical companies, providing them samples for product testing in advance of sales, for example in the trade of *Dioscorea deltoidea* in India.

Those collecting for onward sale typically undertake little value added processing beyond cleaning and air drying. In the case of *Dioscorea deltoidea*, collectors in India may chop the tubers into smaller pieces to aid drying before onward sale. There has been investment in promoting essential oil extraction, including of *Nardostachys grandiflora*, for export from Nepal.

India at the centre. . .

As indicated above, available information indicates that India is a major destination for trade in the raw medicinal plant materials, and apparently the major destination for all but two of the seven species in this study; *Cistanche deserticola*, native to and primarily used in China, and possibly *Taxus wallichiana*, trade patterns for which have changed in recent years.

India's long and rich history of traditional medicine practices such as Ayurveda and highly developed herbal and pharmaceutical products manufacturing industry combine with a potential domestic market of over one billion consumers to drive the wild collection, import and export of thousands of tonnes of medicinal plants and products each year. Both finished products and extracts for production of pharmaceuticals are manufactured in India. Ayurvedic products produced in India are sold both in that country and around the world, as are extracts such as reserpine and other *Rauvolfia* alkaloids, with exports of over 200 t recorded in India's Customs data for the years 1999/2000 – 2003/2004.

A significant segment of India's consumer and industrial demand continues to be met by national supplies delivered both via and outside of a complex system of wild collection, transport and trade controls. All supplies of *Pterocarpus santalinus*, native to India and, according to some authors, Sri Lanka, originate from India, the proportion used within the country relative to exported being unknown. However, as noted above, there is also a tremendous flow of raw materials to Indian markets from other Himalayan countries, particularly Nepal, with imports also recorded from Southeast Asia. This includes hundreds of tonnes of *Neopicrorhiza scrophulariiflora* and *Nardostachys grandiflora* rhizomes from Nepal and over 150 t of "serpentina roots" (most likely *Rauvolfia serpentina*) from Myanmar. Annual trade from Nepal to India of *Dioscorea deltoidea* has declined to less than ten tonnes in recent years, apparently as a result of increased diosgenin production within and outside of India from other sources of raw materials. The flow of *Taxus wallichiana* from Nepal to India similarly seems to have declined, reflecting in part increased extraction capacity within Nepal, but potentially also increased competition from taxane production in China and elsewhere.

. . . but China increasing in market share?

China is a major and growing manufacturing centre for medicinal extracts and finished products, including taxanes. Until recently, China's manufacture of taxanes was based on *Taxus wallichiana* and several other Asian yew species native to China. However, all wild harvest of native yew species for taxane extraction in China was banned in 2003, with a consequent need to import increasing amounts of material from other countries. CITES annual report data for China show major imports from Myanmar in 2003, however this trade was not recorded in corresponding records for Myanmar. Increased emphasis within China on cultivation, including of non-native species e.g. the hybrid *Taxus x media* (a hybrid of *T. cuspidata* and *T. baccata*) from Canada, may decrease raw material trade flows to this country in future. There are indications that sales of *Dioscorea* spp. and production of diosgenin within India may be suffering from import competition from China, and it does not seem unlikely that similar competition could emerge for the reserpine extraction industry. Bearing in mind its use in traditional Chinese medicine, it is not inconceivable that in future the flow of *Picrorhiza/Neopicrorhiza* supplies could shift to the north, particularly if the efficacy of *Picrorhiza kurrooa* in the treatment of liver disease is confirmed.

Wild collection versus cultivation

Cultivation is routinely promoted as the preferred (and sometimes the only) solution to the problem of dwindling supplies and over-collection of wild medicinal plant populations, with investment into research and/or associated cultivation efforts documented for all seven species covered by this study. Much less emphasis is being put on development and promotion of sustainable wild collection practices (SCHIPPMAN *et al*. 2006). Given the interest in cultivation, and the relative ease of collecting information on cultivation versus wild collection, which is by nature more widely distributed, it might be expected that information on the scale of cultivation of medicinal plant species would be readily accessible. This is not the case, however, the information is similarly scattered, site specific, and relatively inconclusive.

Cultivation is contributing an increasing share - possibly the majority - of pharmaceutical compounds extracted from *Taxus*, *Dioscorea* and *Rauvolfia* species; however, it appears that cultivation mainly involves species other than those covered by this study. As noted above, for example, diosgenin can be extracted from a number of *Dioscorea* species. In the case of *Dioscorea deltoidea*, for example, there is conflicting information regarding the scale of cultivation; although it appears to be relatively easy to cultivate, cultivation was said to be unprofitable for farmers owing to the long growing time (several years) between planting and commercial harvest. At least one pharmaceutical company was said to be growing this species, but also several non-native *Dioscorea* species, on a commercial basis in India. Cultivation within India, and possibly imports of diosgenin from *Dioscorea* cultivated in China and Mexico, seems likely to be linked to reduced demand for wild-collected *D. deltoidea* from Nepal.

It seems likely that the role of cultivation in meeting pharmaceutical demand will continue to expand in future, including through the selection of cultivars producing higher concentrations of the target compounds. Other technologies, e.g. plant cell fermentation technology, which is being used to produce paclitaxel, are also likely to replace wild collection as a source of pharmaceutical products.

Cultivation is also increasing for species used primarily in traditional medicine. Although it was considered difficult to cultivate until recently, owing to its life history strategy (being a parasitic species), an estimated 60-70% of *Cistanche deserticola* is now said to come from the wild, with cultivation increasing rapidly and considered as likely to overtake wild collection. Efforts to cultivate *Pterocarpus santalinus* have been underway since at least the mid-1960s, however information varies with regard to whether cultivation efforts have been successful, and it appears that the majority of trade is still met from wild-collected materials. Further clarification is required on this point. Cultivation is in the early stages of development for *Picrorhiza kurrooa* and *Nardostachys grandiflora*, although it appears to hold strong promise for *Picrorhiza kurrooa*, which propagates well from root cuttings.

Wild collection and trade controls

Although the characteristics of wild collection, use and trade vary significantly among the seven species covered by this study, characteristics of collection and trade controls appear to be relatively universal. Wild collection for commercial trade, whether domestic or international, is highly regulated, generally involving a series of collection and transport permits. However, implementation of collection and trade controls is generally ineffective. It appears to be minimal and/or ineffective in Nepal, more active in India, though illegal collection is believed to be widespread, and appears to be increasing in China. Exports are also highly regulated and frequently banned, particularly of materials in unprocessed form. International trade controls by both exporting and importing countries are also required through the species' listing in CITES Appendix II. All but *Cistanche deserticola* and *Dioscorea deltoidea* were included in Appendix II at the request of the Government of India out of concern for the threat to its domestic populations. Thus far,

CITES controls have had little impact on the trade, both because the main products in trade for some species, e.g. extracts, are not currently covered by the Convention, and because implementation effort has been low more generally. Of particular concern is the apparent lack of CITES implementation for imports into India, a key consumer, with imports apparently not required to be accompanied by CITES export permits or recorded in India's CITES annual reports. The February 2006 decision by the Government of India to implement import controls for *Rauvolfia* spp. and several other species, including agarwood *Aquilaria* spp. and cacti, indicates a shift towards more comprehensive CITES implementation in that country. The only major evidence of successful CITES enforcement action relates to the trade in *Pterocarpus santalinus* timber, with numerous seizures reported within India and in destination countries.

The failure to implement either wild collection or trade controls seems likely to reflect the sheer enormity and complexity of the medicinal plant collection and trade throughout the region, and the lower importance given to addressing issues of illegal or unsustainable collection of plants relative to animal species, particularly charismatic species such as Tigers. This pattern is repeated in the case of international trade, which takes place across long and porous borders with few staff resources to police them. The low level of awareness among enforcement staff of trade controls for plant species, particularly plant species traded as parts and derivatives, is a further contributing factor.

Discussion

Asia's wild medicinal plant populations continue to play a central role in human healthcare. This is true within Asia and more widely, within both rural and urban settings, and within traditional as well as modern healthcare practices. In some areas, Asia's medicinal plants also play a central role in income generation. It is therefore both surprising and worrying that the status and trade of medicinal plants is so poorly studied, particularly in light of concerns that wild populations are declining as a result of increased demand and unsustainable collection.

Though not well understood, wild collection and trade of Asia's medicinal plants are nevertheless highly regulated, with various government permissions and documents required for collection, transit and export. The often low level of regulatory implementation helps explain the low availability of wild collection and trade information - no permits issued and/or checked means no corresponding data collected.

The information that is available is nevertheless sufficient to conclude that traditional medicine, which consumes the majority of species in trade, relies on whole plant parts rather than single compounds and will continue to do so for the foreseeable future. For the majority of species, these plant parts are collected from the wild. Further research is required to identify whether traditional medicine practitioners and/or manufacturers have an established preference for wild-collected specimens of selected species, or whether cultivated specimens would be considered equally acceptable or preferable if they were available independent of the species concerned. Such information would be critical to informing investment in longer term species management and rural development efforts.

While the total number of species involved is much lower, pharmaceutical production is consuming a greater share of medicinal plant harvest from the wild for some species. Cultivation of these species is increasing, and increasingly likely to be preferred over wild collection for production of plant compounds used in pharmaceutical products. However, commercial cultivation may not be possible or may be more expensive in the short term, with the result that pharmaceutical production, like traditional medicine, will continue to depend on wild collection for many species.

Thus far the main management response to concerns about dwindling medicinal plant populations and supplies has been to increase regulation and/or cultivation. This includes at the international level, e.g. listings of species in the CITES Appendices and development agency investment in cultivation projects. Relatively little effort has been made to identify and promote sustainable collection practices, or to increase the economic incentives to use such practices. Where cultivation is being promoted, it is not clear whether and how the needs of those engaged in wild collection are taken into account, a problem noted for non-wood forest products more generally over a decade ago by NAIR (1995), or what the consequent impacts have been on collection rates.

A common response to this situation for other wildlife commodities is to invest more resources in enforcing existing laws. However, consideration needs to be given to the effects of any such 'crackdown' on unlicensed collection or trade, particularly where this takes place in only part of a species' range. Increased enforcement in one location/country may simply shift collection to other locations/countries. Further, rural communities dependent on wild collection for income may have little choice but to continue to collect medicinal species and risk detection, and so be at risk of increased "rent capture" by government personnel charged with enforcement, and lower prices from those traders willing to circumvent existing controls. The recent trend in some South Asian countries toward granting greater community rights over natural re-

sources, particularly forest resources, should be considered in conjunction with regulatory approaches for managing wild collection.

Summary and recommendations

Throughout much of human history, Asia's medicinal plant species have simultaneously been treasured and taken for granted. They have been available and used to treat the ills of countless generations, originally within Asia, and more recently throughout much of the rest of the world. Changes in current collection and trade practices will be required if these plants are to survive in the wild and continue to be available for use by future generations. Numerous authors and organisations with direct experience concerning medicinal plant collection, use, trade and conservation in Asia have provided recommendations for promoting such changes (e.g. see BHATTARAI 1997, KARKI 2006, KINHAL *et al.* 2006, OLSEN 2005, OLSEN & LARSEN 2003, PEI SHENGJI 2001 and many others). Hopefully the suggestions below will serve to reinforce their recommendations and encourage support for their and others' efforts.

Given that many Asian species in trade both occur and are used in more than one country, a collaborative, multi-country approach is likely to be both more efficient and more effective at achieving increased knowledge, conservation and sustainable use of these and other species in the longer term. Equally, given the importance of medicinal plants in the context of conservation, development (including healthcare and income generation), and manufacturing, a collaborative, multi-stakeholder approach is likely to be more effective and efficient than isolated efforts by different stakeholder groups.

All stakeholders with an interest in medicinal plant conservation, use and/or trade should work together through, for example, the Medicinal and Aromatic Plants Programme in Asia (MAPPA), to share and increase collective knowledge of:

- the species, origin and quantity of medicinal plant materials traded;
- market trends, including with respect to the preferred source (wild, cultivated) of specimens in trade;
- the current population status of traded species nationally and globally, and observed or suspected population trends;
- current wild collection practices (all uses), including extraction methods and intensity, and their impacts, including with respect to re-generation rates;
- the actors in the trade, building on the work of OLSEN & BHATTARAI (2003) to develop a typology of economic agents for trade from Nepal to India;
- the contribution of medicinal plants to healthcare and incomes along the trade chain from collector to end consumer, differentiating with respect to, e.g. gender, age and socio-economic status; and
- successful mechanisms to increase the value of medicinal plant collection to the rural and urban poor.

Government agencies, IGOs, NGOs and medicinal manufacturers and associations should promote conservation of wild populations and sustainable sourcing by:

- adopting and adhering to codes of practice for sustainable sourcing of wild medicinal plants, including CITES and the International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants (ISSC-MAP) (MPSG 2007)
- undertaking resource mapping to underpin development of site-based management plans;
- developing, with collectors, training materials and programmes appropriate for spreading of knowledge of sustainable collection techniques;
- exploring the potential for increasing production *in situ*, e.g. via enrichment planting; and
- when developing cultivation programmes, taking into account the potential for and reducing the possibility of hybridization of cultivated specimens with wild plants.

Governments should seek to increase collaboration in the enforcement of controls on international trade, including through:

- increased information exchange concerning national level trade restrictions, including through joint capacity building programmes and provision of copies of any documents required to accompany shipments exported;
- increased investment in CITES implementation for CITES-listed medicinal species;

- ensuring that any bilateral trade agreements, such as the Indo-Nepal treaty, are consistent with other international obligations, e.g. CITES, with respect to international trade controls; and
- developing more detailed Customs codes for species traded in large quantities, including, within India, the re-adoption of codes previously used for *Pterocarpus santalinus* chips and timber and *Rauvolfia serpentina* formulations.

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Cistanche deserticola

Taxonomy *Cistanche deserticola* Y.C. MA (family Orobanchaceae)

Synonyms *Cistanche ambigua* G. BECK (BUNGE)

Trade names Dan dan yu (chi), Dayun (chi), Desert Living Cistanche (eng), Herba Cistanches (latin, chi), Roucongrong (chi), Suosuo dayun (chi), Woestijnasperge (nld) (ANON. 2005a, LEE in litt. 2005).

Description. Perennial parasitic herb, parasitic primarily on the roots of *Haloxylon ammodendron* and *H. persicum* (GOVERNMENT OF CHINA 2000). Stems fleshy, yellow, 10-45 cm high. Leaves scale-shaped, yellow-brown, imbricated, ovate or ovate lanceolate, denser on lower part. Spikes 5-20 cm long, about 5 cm wide, flowers many and dense, bracts ovate lanceolate, 1.5 cm long; bracteoles two, narrow lanceolate, nearly as long as calyx; calyx campanulate, five-lobed, segments nearly round; perianth nearly labial, 5-divided at apex, segments blue-purple, tubular parts white; stamens four, hairy on anthers and at base of filaments; ovary four-celled. Capsules elliptic, two-lobed, styles persistent (GOVERNMENT OF CHINA 2000).

Distribution. China, Mongolia.

East Asia, China and Mongolia (FU & JIAN-MING 1992). In China, it occurs in the provinces of Gansu, Shaanxi, Qinghai, and the autonomous regions of Xingjiang, Ningxia and Inner Mongolia. The species primarily grows in Xingjiang Autonomous Region (Fuhai, Habahe, Fuwen, Chabuchaer, Jinghe, Wushu, Jumushaer, Qitai, Bole, Fukang, Manasi, Hebukeseer, Huocheng, Hutubi), Inner Mongolia Autonomous Region (Alashanzuoqi, Ejinaqi, Alashanyouqi, Wulatehouqi), Qinghai province (Haile, Hainan), and Gansu province (Wuwei, Zhangye, Jiuquan), Ningxia Hui Autonomous Region (Zhongwei, Lingwu, Yanci) (GOVERNMENT OF CHINA 2000). Found in Shaanxi (TAN & al. 2004). *C. deserticola* grows in desert areas of fine sandy, slightly acidic soil, at elevations of 225-1150 m (GOVERNMENT OF CHINA 2000). It is found on the high plains of Alxa, the Qaidam Basin, the Nomin Gobi, the Hashun Gobi, the eastern part of the Tarim Basin and the Junggar Basin, and in the *Haloxylon* deserts in southern Mongolia (ANON. 2002).

Its range is determined by distribution of the host plant *Haloxylon ammodendron* (ANON. 1995a), the only suitable habitat considered to be natural woodland of the host species (ZHAO RUN-HUAI in litt. 2005). *C. deserticola* occurs over a wide area, however its distribution area has declined (GOVERNMENT OF CHINA 2000); *C. deserticola* was considered to occur in 30-40% of Inner Mongolia in the 1950s compared to 5% in the 1980s (ANON. 1995b).

Population status and threats. The species is not included in the IUCN Red List (IUCN 2006). In the Action Plan for Plants of the Chinese Region it is listed as a "seriously threatened valuable medicinal plant" (WANG & YANG in press). It is classified as "critically endangered" in The China Species Red List (WANG & XIE 2004), with an estimated 80% decline owing to harvest for medicinal use, cutting of the host plant for fuelwood and overgrazing of the host plant by camels. China's CITES Scientific Authority described the species as "endangered" owing to these same threats (ANON. 2002).

Populations are declining in Gansu, Xingjiang and Inner Mongolia (GOVERNMENT OF CHINA 2000). The species is reported to have become very scarce in Inner Mongolia as reflected by substantial declines in annual collection rates over the last 20-30 years (TU & al. 1994). The species is most abundant in Xingjiang, followed by Inner Mongolia (MENG ZHIBIN in litt. 2005). The main area of collection in Inner Mongolia is Alxa League in the west (ZHAO RUN-HUAI in litt. 2005). The greatest losses occur near population centres from which people can easily reach the desert to collect the species (PENG & XU 1995), e.g. residential areas in Inner Mongolia and Xingjiang (GOVERNMENT OF CHINA 2000). In Shanxi and Shaanxi, the species' populations are considered to have been reduced to the point that production no longer takes place (TAN & al. 2004).

No survey data documenting changes in the species' population size or distribution were identified (IUCN/SSC & TRAFFIC 2004), and regular population monitoring was not being undertaken when the species was proposed for inclusion in Appendix II (GOVERNMENT OF CHINA 2000). MENG ZHIBIN (in litt. 2005) noted that various estimates of existing stock had been produced, but that the methodologies used to produce these estimates had not been made available. Further, such stock estimates may vary depending on whether the intention is to encourage development of new factories, when the abundance of the resource is emphasised, or overseas investment in cultivation, when shortages are emphasised. The total stock within Xingjiang and Inner Mongolia has been estimated at 5000 t and 400 t respectively (MENG ZHIBIN in litt. 2005).

Overharvesting is considered the primary threat to the species (GOVERNMENT OF CHINA 2000). Livestock grazing, agro-industry farming, clear-cutting and collection of the host species *H. ammodendron* for wood are reported as additional threats (ZHANG 2005). PENG & XU (1995) suggested that the loss of *H. ammodendron* is the major threat. MENG ZHIBIN (2005) noted that this species is used as fuelwood. Its woody stem and branches burn well, being referred to as "coal of the desert" and are also used by local people for building materials. Further, the tender branches are used as camel feed in the winter and spring (FU & JIAN-MING 1992, PENG & XU 1995). Between the late 1950s and the early 1960s, *H. ammodendron* covered 1 127 000 ha, supporting an annual collection of about 800 t of *Cistanche deserticola,* but by the late 1960s this area had been reduced by approximately 50%, and further reductions have taken place subsequently (FAN 2001). *H. ammodendron* is listed as "vulnerable" in the *China Plant Red Data Book* (FU & JIAN-MING 1992).

Medicinal uses

Plant parts used for medicinal purposes: Dried stems.

The primary plant part used is the underground stem. In its dried form, it is referred to as 'Herba Cistanches'. Herba Cistanches was described in the oldest surviving Chinese herb classic, *Shennong Bencao Jing* (*ca.* 100 A.D.) and has been used in traditional Chinese medicine for several thousand years to treat a wide variety of conditions such as kidney problems, constipation, impotence, and infertility (IUCN/SSC & TRAFFIC 2000, ZHANG 2005). One of the oldest formulas containing *Cistanche* is an anti-aging pill known as "Jichuanjian" (ZHANG 2005). The species was often used alongside other ancient Chinese medicines, such as blood tonic, lubricants, energy supplements and kidney nourishments (ZHANG 2005). *C. deserticola* is advertised for sale both as a single ingredient and as mixed formulations in China, Hong Kong, the UK and the USA (IUCN/SSC & TRAFFIC 2004). When included in tablets, powders and tonics, *C. deserticola* is variously referred to as "Cistanche" or "Rou Cong Rong". ZHAO & al. (2002) have identified over 100 different tonics and tablets containing the species. In Hong Kong alone, at least 42 different brands of proprietary Chinese medicinal products containing parts or derivatives of this species are available (CHU & LEE unpublished).

In Japan and Taiwan, *C. deserticola* is used as a tonic for kidney deficiency syndromes, including blurred vision, dizziness, poor memory, and palpitation, though it is mainly promoted as a treatment for impotence and constipation (ELLIS 2003, ZHANG 2005, ZHU & LUO 2000).

Twenty chemical compounds have been isolated from *C. deserticola* for their medicinal properties (TU 2000). It has been suggested that phenylethanoid glycosides isolated from *Cistanche* can be used for manufacturing drugs/health supplements for anti-aging (ZHU & LUO 2000).

Drug description: Compressed-cylindrical, slightly curved, 3-15 cm long, 2-8 cm in diameter. Externally brown or greyish-brown, densely covered with imbricate fleshy scales, usually the apex of scales broken. Texture heavy, hard and slightly flexible, unbreakable, fractured surface brown and showing brownish dotted vascular bundles, arranged in wavy rings. Odour slight; taste sweetish and bitterish (GOVERNMENT OF CHINA 2000).

Other uses. In Japan, the species is used to treat hair loss. Researchers in that country have started to extract the chemical compounds (cistanoside) from *C. deserticola* to produce drugs that treat impotence, for use in cosmetics and for treating hair loss (ZHU & LUO 2000).

Harvest and processing. *C. deserticola* is currently produced in Gansu, Qinghai, Ningxia, Xinjiang, and Inner Mongolia (TAN & al. 2004). Information varies regarding the time of harvest. According to XU HONGFA (in litt. 2005), experienced collectors search the ground around the host tree and dig out the fleshy underground stem, which is the primary part used, prior to the stem emerging above ground in the spring. This results in a higher quality drug. Others concur that the desirable part is collected in spring before sprouting, cut into sections and dried in the sun (GOVERNMENT OF CHINA (2000) and WU & ZHANG (1993)). Underground stems are also harvested after the stem has emerged, with the above ground parts then removed (XU HONGFA in litt. 2005). FAN (2001) and ZHAO RUN-HUAI (in litt. 2005) state that the stems are harvested between March and May, when the stem emerges from the soil and starts flowering, after growing underground for three years on the root of the host plant. After collection, regeneration of the stem can occur provided that the plant has not been dug up entirely and the point of attachment with the root of the host is not damaged (ANON. 1995a, ZHAO RUN-HUAI in litt. 2005).

The fresh stems are usually dried in the sun or processed with salt; sometimes they are sweetened, fermented or steamed (MENG ZHIBIN in litt. 2005). Medicinal plant collection and distribution centres sell the species on to national manufacturing companies. These companies, common in every major city in China, manufacture tablets approved for domestic use in, for instance, hospitals, and for export.

Estimates of prior and current harvest quantities vary. ZHU (1990) considered that total harvests of Herba Cistanches might be as high as 7000 t in 1990; it is unclear whether this estimate includes other *Cistanche* species in addition to *C. deserticola*. TAN & al. (2004) provide much lower estimates, estimating annual production at 800 t in the 1950s, falling to 300 t by the end of 1980s (FAN 2001 gives a figure of 300 t in the early 1980s), and to around 120 t in 1994. Annual production in Inner Mongolia is believed to have decreased significantly during the past 20 to 30 years, and in 2002 was estimated at 70 t. In the 1980s, annual harvest in Xingjiang was estimated at 300 t (ANON. 1995b). Production in North Xingjiang was estimated at 50 t in 2002 (GOVERNMENT OF CHINA 2000).

Organized collection was estimated to involve "several thousand" people at the end of the twentieth century, and more recently, "more than ten thousand" (SUN & al. 2003). Collectors often target only this species. Harvesters are local to the harvest areas and include professional harvesters. They obtain a maximum of 20% of the value, whilst middlemen receive 30-40% and manufacturers and dealers at the other end of the trade chain some 40% (ZHANG 2005). The species is sold in wholesale medicine markets in each of the Chinese provinces (ZHANG 2005).

Cultivation. Cultivation of *Cistanche* in China began in 1985 and by 1991 involved an area of 500 ha (LUO & al. 2002). The cultivation area was extended to 1334 ha in 1993, but the actual production volume was very low (TU & al. 1994). TAN & al. (2004) estimate 2001-2002 yields of cultivated *Cistanche deserticola* at 1000 t (dry weight). *C. deserticola* is reported to be cultivated in Xingjiang, but not in large quantities (TU & al. 1994). Three cultivation plots in Alashan, Xinjiang have yields as follows: 1167 ha - 0.25 kg/ha, 2120 ha - 0.25 kg/ha; and 700 ha - 0.34 kg/ha. The total yield from the three plots is one tonne (dry weight) (TAN & al. 2004). The species has been artificially propagated in Inner Mongolia, at the Arashanqi Cistanche Experiment Station, but limited adoption of the technique was noted (GOVERNMENT OF CHINA 2000). Cultivation is difficult as the species' host plant, *Haloxylon ammodendron*, is hard to cultivate and it takes time before specimens are large enough for *Cistanche deserticola* to grow on their roots (LEE in litt. 2005). According to TAN & al. (2004), in order to make cultivation successful, inoculation techniques need to be improved. All plant material exported from China has been reported by China to CITES as being of wild origin; importing countries have reported 540 kg as being from cultivated sources, however. According to TRAFFIC EAST ASIA (in litt. 2006), 60-70% of *C. deserticola* is harvested from the wild, however, cultivation is increasing rapidly and it is believed that it might replace wild harvesting in the future. According to CAO & WU (2004), the chemical constituents isolated from cultivated *C. deserticola* are the same as those from wild species.

National market. *A*ccording to the Pharmacopeia of China, Herba Cistanches refers only to the species *C. deserticola.* However, other *Cistanche* species are also traded as Herba Cistanches, and are often mixed together (Table 1) (ANON. 1995a, 1995b).

Table 1. Species traded as Herba Cistanches

Reference / Species	MENG ZHIBIN in litt. 2005	HE & SHI 1995	LUO & al. 2002	TU & al. 1994	YIN & al. 2002	ZHANG & al. 2001
C. ambigua	x		x			x
C. deserticola	x	x	x	x	x	x
C. fissa	x				x	
C. lanzhouensis	x		x			
C. salsa	x	x	x	x	x	
C. salsa var. albiflora			x	x		
C. sinensis	x	Not used as medicine		x		
C. tubulosa	x	x	x	x	x	

Noting the lack of information regarding the species and the technical difficulty in identifying the species in trade, China's CIT*ES Management Authority considers that information on the trade in this species actually reflects the trade in all species/subspecies in the genus *Cistanche*, rather than just *C. deserticola* (YUAN JIMING in litt. 2006).

The species, *C. ambigua* (BUNGE) G. BECK, *C. fissa* (C.A. MEY.) G. BECK, *C. lanzhouensis* ZHI Y. ZHANG, *C. tubulosa* (SCHENK), *C. salsa* (C.A. MEY.) G. BECK, *C. salsa* var. *albiflora* (P.F. TU & Z.C. LOU) and *C. sinensis* G. BECK parasitize different, more abundant host species such as *Tamarix ramosissima,*

T. arcenthoides, Kalidium foliatum, Reaumuria soongorica and *Nitraria sibirica* (IUCN/SSC & TRAFFIC 2004, LUO & al. 2002, MENG ZHIBIN in litt. 2005, TU & al. 1994, YIN & al. 2002, ZHANG & al. 2001). Species in other genera, e.g. *Boschniakia rossica* (CHAM. & SCHLTDL) B. FEDTSCH. *(*known as Cao Cong Rong, Grass Cistanche), are also said to be traded as substitutes (HE & SHI 1995).

In 1995, annual demand within China was estimated at between 450 t and 550 t (ANON. 1995a, 1995c). In 2002, demand was believed to be increasing in response to improved standards of living within China and a coinciding increase in demand for tonics (GOVERNMENT OF CHINA 2000). More recently, annual demand for *Cistanche* within China was estimated at around 3500 t (TAN & al. 2004).

Wholesale prices of Herba Cistanches are reported to have increased from CNY32-45/kg (USD3.86–5.07/kg) in September 1997 to CNY42-70/kg (USD5.07–8.44/kg) one year later (TRAFFIC EAST ASIA in litt. 2000). In December 2004, the wholesale price was advertised as CNY40/kg (USD4.8/kg) in the Guangzhou TCM market, one of the 17 largest official TCM markets (ANON. 2005b). Following implementation of the CITES listing, wholesale prices in Hong Kong increased eight-fold coinciding with a decline in annual imports from approximately 80 t to 10 t.

International trade. TAN & al. (2004) estimate annual demand for *Cistanche deserticola* outside of China at 1000 t, with the primary markets being other Asian countries (East, South and Southeast Asia).

CITES annual report data (Table 2) show the export from China of a total of 6255 kg of stems and 12 152 kg and 60 000 bottles of derivatives from 2000-2003. Data for 2000 represent only a partial year, as the CITES listing only took effect from July of that year. ZHANG (2005) comments that reported exports of Herba Cistanches from China to major destinations from 1994-2004 appear to be lower than those in the 1980s.

C. deserticola is exported from China primarily to Japan, Hong Kong and Southeast Asia, where demand has increased in recent years coinciding with heavy promotion of the herb for use in treating impotence and infertility (GOVERNMENT OF CHINA 2000). According to ZHU (1990), approximately 120 t of *C. deserticola* were exported per year in the 1980s. This figure may be an underestimate, however, as annual imports into the Republic of Korea alone averaged 120 t between 1989 and 1998, and ranged from 174 t in 1996 to 57 t in 1998 (TRAFFIC EAST ASIA, in litt.). Reported trade of Herba Cistanches, here a mixture of *C. deserticola* and *C. salsa,* from China to the Republic of Korea totaled 156 t for 2000-2001, 110 t in 2002, and 48 t in 2003. Approximately 45 t were imported in the first part of 2004, declared as *C. salsa* (SEOL SEOK-JIN in litt. 2004). This trade was not recorded in CITES data, which shows only the reported export of 2800 kg from China to the Republic of Korea in 2001.

Cistanche exports to Japan averaged approximately 19 t per year in the late 1990s, and appear to have involved significant quantities of *C. salsa* (TRAFFIC EAST ASIA in litt. 2000). China's CITES annual reports show the export to Japan of 9500 kg of *C. deserticola* derivatives from 2000-2003, and a further 3250 kg of stems. Corresponding imports of *C. deserticola* were not reported by Japan, which may reflect confusion regarding species taxonomy and identification of parts in trade in the context of enforcing the CITES listing (KIYONO in litt. 2005).

CITES data indicate that Hong Kong was primarily a re-exporter of raw materials (stems) during the early 2000s. About three tonnes of pre-Convention stock was registered with the Hong Kong CITES Management Authority and two shipments, one of 573 kg and another of 377 kg was exported (TONG in litt. 2004). CITES data differ from this assessment, showing the reported import of 3143 kg of pre-Convention stock from Hong Kong in 2001 and a further 456 kg in 2002.

Canada and the USA appear to provide relatively small markets for *Cistanche*, with 3693 kg of stems reported as imported from China and Hong Kong in 2001, but only 546 kg in 2002 and 317 kg in 2003. It seems possible that CITES trade data do not reflect total trade, given confusion regarding the products covered by the listing and the fact that much of the trade involved finished products.

The Middle East emerged as a potential new destination for *Cistanche* products, with a total of 60 000 bottles of *C. deserticola* derivatives reported as exported to Egypt and Bahrain in 2003. CITES data also show continuing confusion regarding plant parts in trade by importing CITES Management Authorities, with stems reported as "roots" in several cases.

Table 2. CITES-reported trade in *Cistanche deserticola* (1995-2003)

Year	Country of Export	Country of Import	Origin	Export					Import				
				Quantity	Unit	Term	P	S	Quantity	Unit	Term	P	S
2000	CN	JP		4 200	g	Derivatives	T	W					
2001	CN	CA							90	G	Stems	T	A
2001	CN	CA		90	g	Derivatives	T	A					
2001	CN	DE		5	g	Stems	T	A					
2001	CN	GB		14	g	Derivatives	T	A					
2001	CN	JP		950	g	Stems	T	W					
2001	CN	KR		2 800	g	Stems	T	W					
2001	CN	US							120	G	Derivatives	T	I
2001	CN	US		9	g	Derivatives	T	A					
2001	HK	CA	CN						250	G	Roots	T	A
2001	HK	US	CN						200	G	Roots	T	A
2001	HK	US	??						3 143	G	Roots	T	O
2002	CN	CA							179	G	Stems	T	W
2002	CN	CA		89	g	Derivatives	T	W					
2002	CN	GB							59 000		Derivatives		I
2002	CN	GB		200	g	Stems		W					
2002	CN	GR		1		Derivatives	L	W					
2002	CN	GR		1	Box	Derivatives	L	W					
2002	CN	JP		2 300	g	Stems	T	W					
2002	CN	MY		591	g	Derivatives	T	W					
2002	CN	MY		604	g	Derivatives	T	A					
2002	CN	NZ		124	g	Derivatives	T	W					
2002	CN	PH		3	g	Derivatives	T	W					
2002	CN	RU		10	g	Derivatives	T	W					
2002	CN	SG		450	g	Derivatives	T	W					
2002	CN	US		3	g	Derivatives	T	W	90	G	Derivatives	T	W
2002	HK	CA	??						456	G	Roots	T	O
2002	HK	CA	??	197	g	Stems	T	O					
2003	CN	AE		28 800	Bot	Derivatives	T	W					
2003	CN	BH		31 200	Bot	Derivatives	T	W					
2003	CN	GB							198	G	Derivatives		I
2003	CN	GB							100		Dried plants	T	W
2003	CN	GB		130	g	Derivatives	T	W					
2003	CN	GR							2		Specimens	E	W
2003	CN	JP		5 300	g	Derivatives	T	W					
2003	CN	MY		245	g	Derivatives	T	W					
2003	CN	PH		11	g	Derivatives	T	W					
2003	CN	SG		46	g	Derivatives	T	W					
2003	CN	TH		3	g	Derivatives	T	W					
2003	CN	US		230	g	Derivatives	T	W					
2003	HK	CA	??	91	g	Stems	T	O					
2003	HK	US	??	91	g	Stems	T	O					

Source: CITES annual report data compiled by UNEP-WCMC.

Table 3. Canadian seizures of *C. deserticola* products (January 2003-November 2004)

Year	Date	Quantity	Commodity
2003	Jan 23	90 bags	Roots
2003	Feb 18	30 bags	Roots
2003	June 3	1 bottle	Medicines
2003	Oct 24	10 bags	Roots
2004	Jan 8	10 bags	Roots
2004	Mar 26	180 bottles	Medicines
2004	April 14	360 bottles	Medicines
2004	April 16	20 bottles	Medicines
2004	April 26	36 bottles	Medicines
2004	April 26	100 bottles; 50 box; 450 bottles	Medicines
2004	April 28	25 bottles	Medicines
2004	May 28	60 bottles	Medicines
2004	May 28	50 bags	Roots

Source: RIBEYRON in litt. (2004).

Illegal harvest and trade. CITES annual report data record several seizures of *C. deserticola*, with 120 kg of derivatives seized by the USA in 2001, 59 000 derivatives (no unit provided) seized by the UK in 2002, and a further 198 kg of derivatives seized by the UK in 2003. There were numerous seizures of *Cistanche deserticola* products upon import into Canada in 2003 and 2004, appearing mainly to involve finished products (Table 3).

Legislation and regulations

Regulation of harvest, manufacture and domestic trade. *Cistanche deserticola* is protected under the Law on Wild Plant Protection (HE & SHI, 1995), which took effect 1 January 1997. Under this law, protected plant species are classified into those of "national key significance" and those of "local key significance". Protected plant species of national key significance are further divided into Category I and Category II-protected species. Trade in Category I-protected species is not allowed. Trade in plant species listed as Category II is subject to authorization by the relevant government agencies at the provincial/autonomous region level. The State Forestry Administration, the Ministry of Agriculture and other authorized governmental authorities at the provincial/autonomous region level are responsible for enforcing the Law of Wild Plant Protection. A list of 255 species is appended to this law.

The species is also listed in the Regulation on Wild Medicinal Resources Protection (RWMRP) as a Category III species, and therefore designated as a "major and commonly used wild medicinal species whose resources are reducing." The Government of China stated in 2002 that *C. deserticola* would be included as a Grade II species in the list of State Protected Species in China (ANON. 2002). However, it was not included in this list as of January 2005. Other *Cistanche* species are not listed as Grade II species, as the government does not consider them sufficiently threatened (TRAFFIC EAST ASIA in litt. 2006).

Harvest of *C. deserticola* was banned in 2000 via a Notification of the State Council (TRAFFIC EAST ASIA in litt. 2002, ZHAI BAOGUO in litt. 2005). However, *Cistanche* continues to be harvested in large quantities despite the ban on collection (CHEN & al. 2002). There are no restrictions on domestic use of the species, and management of the species in China is unclear, according to TRAFFIC EAST ASIA (in litt. 2006).

The use of wild Herba Cistanches to manufacture medicines is apparently prohibited through a formal Notification from the State Council by China's Ministry of Health (ZHAO & al. 2002). It is unclear whether this applies to all *Cistanche* species, or only *C. deserticola*. Incorporation of this notification into the legislation of individual provinces is not automatic, however, and the process may still be ongoing. The prohibition on manufacture does not apply more widely to all healthcare products such as medicated wines and tonics. Perhaps in response to this notification, medicated wine and tonics are increasingly purporting to contain *C. deserticola*.

Cistanche deserticola occurs in protected areas such as Linhe County, Inner Mongolia, where collection has not been observed (ZHAO RUN-HUAI in litt. 2005). Protected areas for *Haloxylon ammodendron* have been established (GOVERNMENT OF CHINA 2000).

Regulation of international trade

CITES listing: *Cistanche deserticola* was successfully proposed for inclusion in CITES Appendix II by China at CITES CoP 11 (Nairobi, February 2000), with the listing becoming effective on 19 July 2000. The listing was annotated with Annotation #3, and therefore applied only to "whole and sliced roots and parts of roots, excluding manufactured parts or derivatives such as powders, pills, extracts, tonics, teas and confectionery." However, as the primary parts in trade were stems and products made thereof, not roots (the species in fact lacking true roots), CITES Notification 2001/067 was issued advising that "roots"

should be interpreted to refer to “undeveloped inflorescences.” China submitted a proposal to delete the annotation to CITES CoP12 (Santiago, November 2002), with the intention both of correcting the misuse of the term “root”, and bringing under CITES trade controls all parts and derivatives. The latter decision reflected recognition that a substantial component of international trade involved manufactured products. This proposal was also accepted, and became effective 13 February 2003. Confusion regarding the interpretation of the Convention for plant species listed without an annotation, and the decision that such listings referred only to whole plants, not parts or derivatives, prompted China to submit a proposal to CITES CoP 13 (Bangkok, October 2004) to annotate the proposal with Annotation #1, designating “all parts and derivatives, except: a) seeds, spores and pollen (including pollinia); b) seedling or tissue cultures obtained *in vitro*, in solid or liquid media, transported in sterile containers and c) cut flowers of artificially propagated plants.” This proposal was also accepted, effective 12 January 2005. The annotation was modified yet again at CITES CoP 14 (The Hague, June 2007), as part of a Plants Committee process to clarify and harmonise annotations for medicinal plants. The revised annotation, coming into effect on 13 September 2007, "Designates all parts and derivatives except: a) seeds and pollen; and b) finished products packaged and ready for retail trade.”

At present, there is no law formulated specifically to implement CITES within China, however, a series of regulations implementing CITES, the Import and Export Regulations of Endangered Wild Fauna and Flora, came into effect on 1 September 2006.

From 1 January 1998, China’s regulatory system for the export of wild animals and plants was strengthened by the Endangered Species Import and Export Management Office (under the State Forest Administration), the designated CITES Management Authority, and the Customs Authority. A wide range of animals and plants with their corresponding Harmonized System Customs codes are specified in an annex attached to a Joint Notification from the Management Authority and the Customs Authority. The list is said to be compiled on the basis of the CITES Appendices and the lists of key national protected animals and plants. The notification has been circulated among the officers of the Management Authority and Customs across the country and was copied to various other governmental agencies. Trade in live animals or plants, parts in their raw form, and products made from those animals and plants specified on the said list are controlled. According to the Joint Notification, where applicable, import/export permits or certificates are required.

Both *C. deserticola* imports into and exports from China require CITES permits. Exports of RWMRP Category III species are subject to a quota system as specified in Article 15 of the regulation. However, it is not clear how the quota system is implemented (GOVERNMENT OF CHINA 2000). Presumably any exports of *C. deserticola* would be subject to this quota requirement. Export permits for this species have not been issued by the Government of China since January 2004 owing to the scarcity of the species.

In Hong Kong, import and export of *C. deserticola* has required advance issuance of a licence since early 2002, with a maximum penalty for failure to obtain such a licence being a fine of HKD5 000 000 (about USD640 000) and two years imprisonment (LAI 2001). Registration of pre-Convention stock has also been required; a total of three tonnes has been registered. The Republic of Korea similarly requires presentation of export permits for the import of *C. deserticola* (LEE in litt. 2005).

Conclusions

Cistanche deserticola is clearly in demand for medicinal use in China, and to a lesser but still significant extent, elsewhere in Asia. There is also evidence of ongoing demand within North America for both raw materials (stems) and finished products. It would appear to be the most popular of the *Cistanche* species, many others of which are also used medicinally. *C. deserticola* and several other *Cistanche* species are traded as “Herba Cistanches”, the term applied to the dried stem, the primary plant part in trade. They may be included in packaged medicines either singly or mixed. Such packages are frequently labeled as containing “Cistanche” rather than indicating the species involved. Owing to the mixing of the species in medicinal products, there do not appear to be any accurate data with regard to quantities harvested and/or in domestic or international trade. International trade to Japan may involve primarily *C. salsa*. The vast majority of *C. deserticola* in trade is from wild sources, with commercial cultivation, although promoted, not producing sufficient quantities to meet demand.

Although it appears that no thorough population studies have been done, there is general consensus that *C. deserticola* has declined significantly throughout much of its range as a result of harvest for medicinal use and trade (mainly domestic) and loss of the host species *Haloxylon ammodendron*. The latter is declining in part as a result of harvest for fuel wood and agricultural practices within its habitat. There is also concern that other *Cistanche species* are declining as a result of harvest for medicinal use.

Information regarding harvest and trade controls for *C. deserticola* within China remains unclear. Available information indicates that harvest is banned, at least at the national level; however this, and incorporation of the ban in the legislation of individual provinces and autonomous regions, requires confirmation. Domestic use in the manufacture of medicines appears to have been banned at the national level, however uptake within local-level legislation may not be universal, and use continues to be allowed in the manufacture of tonics and medicated wines. National-level export controls for *C. deserticola* and other *Cistanche* species similarly require further clarification. China's CITES Management Authority has suggested that inclusion of the entire genus *Cistanche* within CITES Appendix II be considered as a possible next step (YUAN JIMING in litt. 2006).

Possible next steps

The Government of China might be encouraged to:

- Clarify and confirm harvest and domestic trade controls for *C. deserticola* and other *Cistanche* species within China;
- Confirm how it discriminates between *C. deserticola* and other *Cistanche* species in controlling exports;
- Undertake status and trade studies and assess the level of threat to other *Cistanche* species posed by domestic and international trade;
- Based on the above information, consider proposing the listing of the remaining *Cistanche* species/subspecies in CITES Appendix II at the genus level;
- Establish a management system for *C. deserticola*, including establishment of protected areas with populations of *Haloxylon ammodendron*, with a particular emphasis on maintaining the species, and establishing harvest and ecological restoration areas;
- Establish harvest and domestic trade controls for the host species of *C. deserticola* (*Haloxylon ammodendron*)*;* and
- Further investigate the potential role of cultivation in meeting demand for *C. deserticola*.

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Dioscorea deltoidea

Taxonomy *Dioscorea deltoidea* WALL. (family Dioscoreaceae)

Synonyms *Dioscorea nepalensis* SWEET ex BERNARDI, *Tamnus nepalensis* (SWEET) JACQUEMONT ex PRAIN & BURKILL

Trade names Bahrahkanda (san), Bhyakur (nep) Deltoid Yam (eng), Dioscorea (eng), Dioscoreae deltoideae radix (pha), Dioscoreae deltoideae rhizoma (pha), Discory (Uttaranchal), Elephant's foot (eng), Ghunar (nep), Kanis (Pakistan), Kildri (kas), Kins (kas), Kithi (kas), Kitra (pun), Kniss (pun), Kreench, (kas), Kriss (pun), Kukurtarul (nep), Medicinal Yam (eng), San-jiao-ye-shu-yu (chi), Singlimingli (hin), Tar (pun), Tarul (new), Tentur (Gurung), Vyakur (nep) (IUCN NEPAL 2004, KAUL In litt. 2005, KHAN 2002, LANGE & SCHIPPMANN 1999, MANANDHAR 2002, OLSEN & LARSEN 2003, RAWAT. In litt. 2005, SCHIPPMANN 2001).

Description. Deciduous perennial with annual climbing stem up to 3 m tall and horizontal rhizome, 30-40 cm in length, borne close to the surface of the soil. Leaves alternate, 5-13 cm long, base deeply cordate, often triangular. Flowers dioecious, in small, distinct clusters. Fruits triangular, seeds winged (CHAUHAN 1999, NAYAR & SASTRY 1988). Flowers April-May, fruits October-November according to HUSSAIN & al. (1979). According to KHAN (2002), in Pakistan, it sprouts after the snowmelt in April-May and flowers in June-July, with fruits ripening in August-September.

Distribution. Afghanistan, Bhutan, Cambodia, China, India, Lao PDR, Nepal, Pakistan, Thailand, Viet Nam.

Himalayan region and Indochina. In western China it is found at altitudes of 2000-3100 m (ANON. 2002a), however, its range remains uncertain in that area. It is found in Yunnan province (HEINONEN & VAINIO-MATTILA 1999). In India it occurs in the northwestern Himalayas including the states of Jammu & Kashmir (at altitudes of 1700-2800 m), Arunachal Pradesh, Assam, Sikkim, Himachal Pradesh (from 900-3000 m in a variety of habitats), Uttaranchal, and in the Garo Hills, the Ri-Bhoi district and Jaintia Hills in Meghalaya (LOC 1986, NAYAR & SASTRY 1988, PRADHAN 1993, RASTOGI & PANT 2004, SHRESTHA 1988). In Nepal it is distributed in the subtropical and temperate zones from 450 to 3100 m (OLSEN & LARSEN 2003). Its range there includes the districts of Makwanpur, Chitwan, Jumla, Rolpa, Dang, Surkhet and Udayapur (MALLA & al. 1995). It is widely distributed in northern Pakistan, particularly the Astore Valley, where it has been identified in Rama, Rattu, Chittinadi, Faqir-kot, Chillum, Sardar Khoti, and Burzil. Grows on northern aspects of moderate slopes from 2000-3500 m and is shade loving (ZAIDI undated). This species has been found in forest undergrowth from 1000-3000 m in north Pakistan (IUCN PAKISTAN in litt. 2005) and in the Palas Valley at elevations of 2200-2700 m (SAQIB & SULTAN 2004). Found in the province of Son La, Viet Nam (DE BEER 1993).

D. deltoidea occurs in a range of habitats from rocky areas to (semi) shady woodland with acidic or alkaline soils, which can range from light and sandy to heavy clay, providing they are rich in humus and moist, but well drained (ANON. 2002a).

Population status and threats. The species is not included in the IUCN Red List (IUCN 2006). It has been described as "endangered" by AYENSU (1996). The most recent status assessment for this species took place at a Conservation Assessment and Management Planning (CAMP) workshop in **India** in 2003 where it was assessed as *Endangered*[2001] in Jammu & Kashmir, Himachal Pradesh and Uttaranchal due to decline caused by harvest for medicine and trade (VED & al. 2003). According to RAWAT (in litt. 2005) and KAUL (in litt. 2005), the main threats in India are currently human induced habitat loss and degradation, and harvest for domestic use. A prior CAMP assessment (1998) had considered the species to be *Critically Endangered*[1994] in northern India. This assessment was based on an estimated population decline of 80% in that region within the previous 10 years caused by loss of habitat and overexploitation for trade (MOLUR & WALKER 1998). In 1988, *Dioscorea deltoidea* was assessed as "vulnerable" in India in the *Red Data Book of Indian Plants* (NAYAR & SASTRY 1988). It is considered as "in danger of genetic erosion" in India (MAITI 2004).

The species was previously considered as "vulnerable" in **Nepal**, where supplies have declined considerably (BHATTARAI 1997), and, more recently, as *Endangered*[2001] in Nepal based on a CAMP workshop held there in January 2001 (TANDON & al. 2001). They key threats identified in Nepal were overexploitation for medicinal use and trade, "interference" and habitat loss. While considering the information from the CAMP workshop to be a useful starting point, OLSEN & LARSEN (2003) questioned the classifications; they considered that the empirical data were scant, quantitative information both on the status of the resource and on harvest levels across Nepal lacking, and evidence of overharvest inconclusive. They considered that the assessments were based on the assessors' perceptions in the context of applying the IUCN Red

List criteria rather than on comprehensive scientific evidence, and concluded that information was insufficient to determine the effects of current harvest levels. Declines in harvest rates from 1999 to 2004 are considered as a possible indication of overharvest in Nepal, though this could also reflect a decline in demand. Traders in Nepal believe that wild populations are sufficient to meet demand, should it increase in future (AMATYA in litt. 2005). Following consultation with representatives from the CITES Scientific Authority, Nepal's CITES Management Authority stated that they considered the species to be threatened in the wild in Nepal (SHARMA in litt. 2006).

Population declines have been observed in **Pakistan** due to overharvesting although regeneration from seeds is good. Habitat destruction due to agriculture, urbanization, population expansion, tourism and infrastructure is also considered to be a threat (IUCN Pakistan in litt. 2005). The species is considered threatened and in need of conservation by a recent study of medicinal resources of the Hindukush Himalayan regions (ZAIDI undated). The species has been considered "rare" in **Viet Nam** (LOC 1986).

Similar species: *Dioscorea prazeri* PRAIN & BURKILL is found in the rainforests of the eastern Himalayas and is an allied species (KAUL 1997). There are over 20 species of *Dioscorea, s*everal having properties similar to those of *D. deltoidea* and therefore being used in traditional and western medicines (ANON. 2003).

Medicinal uses

Plant parts used for medicinal purposes: Primarily dried rhizomes.

The species is considered a medicinal plant of major importance in continental Asia, particularly for the higher elevation regions of Nepal, Bhutan, northern India and Pakistan, and southwestern China (SAEED 1997).

Dioscorea deltoidea rhizomes contain diosgenin, which is widely used as a precursor in the synthesis of steroid hormones such as progesterone, corticosteroids, and anabolic steroids (ANON. 2002a). The most important sapogenins are diosgenin and yamogenin (HUSAIN & al. 1979), with the rhizomes said to contain 8-10% sapogenin (MORTON 1977), of which 4.8% is diosgenin (CHOPRA & al. 1986). A steroidal saponin is also found in the leaves (ANON. 2002b).

The plant is used both as traditional medicine and as a source of steroidal drugs for western medicine. In **India**, at least two international firms use the steroid extract of *D. deltoidea* in allopathic formulations and two herbal formulations derived from the species are manufactured there (JAIN in litt. 2005). In some treatments in India, *D. deltoidea* tends to be used in isolation rather than being mixed with other species (KAUL in litt. 2005). In traditional medicine in **Nepal**, auxiliary rhizomes from the upper parts of the plants are boiled and the liquid is used to treat gastric problems and bloody dysentery (MANANDHAR 2002). Extracts from the rhizomes are used to treat roundworm and have anti-rheumatic properties. It is not used in Ayurvedic medicines in India (TRAFFIC INDIA 1998, SHAH 1983) or Nepal (AMATYA in litt. 2005). In **Pakistan**, *D. deltoidea* is used to treat kidney problems (KHAN 2002).

According to LANGE (1999; 2005) diosgenin and other basic compounds for steroid hormones are largely produced from sources other than *D. deltoidea*, e.g. the seeds of *Trigonella foenum-graecum* (from cultivation) and *Solanum* spp. (e.g. *Solanum laciniatum, S. marginatum*), used to produce the compound Solasodine. Steroidal compounds, including diosgenin, are also synthesised directly. However, extraction from *D. deltoidea* for production of diosgenin-based drugs still occurred in the USA and Mexico during the late 1990s. The US seizure of large quantities of *Dioscorea* spp. imported from countries in Latin America indicates that demand for diosgenin may persist in that country.

Other uses. Like many other species of *Dioscorea*, or yams, the tuberous rhizomes are eaten. However, they have to be repeatedly washed and boiled to eliminate their toxic properties (LANGE 1999, TRAFFIC INDIA 1998). In Nepal, the rhizomes are mainly eaten by the rural communities in the Makwanpur, Chitwan and Dhadhing districts. The Chepang tribes of Nepal, suffering from food scarcity, have been overharvesting the species (AMATYA in litt. 2005). *Discorea* spp. are eaten as a famine food in Yunnan, China (HEINONEN & VAINIO-MATTILA 1999)

The rhizomes are traditionally used in the Western Himalayas to launder raw wool and woollen fabrics owing to their saponin content (MORTON 1977) and for washing clothes in Nepal (MANANDHAR 2002). As the saponins are toxic, rhizomes are also made into soap used to kill lice (ANON. 2002a), especially among hill tribe communities in Jammu & Kashmir, India (KAUL 1997). A mixture of juice from the rhizomes is also sprinkled on water as a poison to catch fish in Nepal (MANANDHAR 2002).

Harvest and processing. In **India**, the optimum time to harvest rhizomes of *D. deltoidea* is considered to be when the plants have reached their maximum size after three years, and when they are dormant from

November-December (RAWAT in litt. 2005). According to CHAUHAN (1999) the optimum harvest season is from November-March. During this dormant stage, before new buds emerge, the diosgenin and yamogenin contents are highest (HUSSAIN & al. 1979, MORTON 1977). Regeneration of the rhizomes is often more successful than seed germination, but harvesting inhibits both (KAUL in litt. 2005, RAWAT in litt. 2005). Collection mainly takes place in cool, temperate regions, in particular among shrubs on rocky substrates (KAUL 1997) and secondary forest and forest edges. Rhizomes are collected from the wild especially in Jammu & Kashmir and Uttaranchal (ANON. 2000). In Jammu & Kashmir, hill communities collect the species as an opportunistic activity (KAUL in litt. 2005). Collection causes soil erosion. Other species are not collected simultaneously (RAWAT in litt. 2005). *D. deltoidea* is cultivated in Karnataka and Tripura (ANON. 2000).

After collection, harvesters chop the plants into smaller units to dry in the sun (RAWAT in litt. 2005). This is sometimes done by local and regional middlemen instead, who also pack the plant materials. Exporters grade the material and verify if it is adulterant free. Pharmaceutical companies assess the quality of the product and active ingredients are tested, based on samples provided by the exporters. These companies then grind the plants to prepare powders or extract diosgenin before further processing into, for instance, 16 DPA (Dehydropregneninolone Acetate) (AMATYA in litt. 2005, KAUL in litt. 2005).

In **Nepal** the best time for harvest is similarly considered to be during the dormant phase (November-December), in order to get the maximum percentage of diosgenin; if delayed new buds may emerge, significantly decreasing the sapogenin content. *Dioscorea* rhizomes are considered difficult to harvest, and usually a portion remains buried in the soil (AMATYA in litt. 2005).

A survey in the Nepalese forest districts during the 1990s revealed that *D. deltoidea* was collected for export in three out of 75 districts (MALLA & al. 1995). *D. deltoida* is harvested and traded under two trade names in Nepal: Vyakur/Bhyakur and Kukurtarul. Under the Forest Regulation (1995), harvesters are charged a forest royalty fee of NPR10/kg (USD0.14/kg) for Vyakur/Bhyakur, in contrast to only NPR3/kg (USD0.04/kg) for Kukurtarul. As a result, it is expected that *D. deltoidea* is more commonly harvested and sold under the name Kukurtarul, as reflected in data provided by the Department of Forests (Table 1).

Table 1. Harvest figures based on Royalty (forest revenue) records for *D. deltoidea* traded as Vyakur and as Kukurtarul (Nepal)

Reported Vyakur harvests in Nepal (royalty: NPR10/kg)					
Fiscal year	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004
Quantity: kg dry weight	3 569	4 568	2 240	1 978	904
Reported Kukurtarul harvests in Nepal (royalty: NPR3/kg)					
Fiscal years	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004
Quantity: kg dry weight	6 671	4 421	2 286	6 002	41
Total kg	**10 240**	**8 989**	**4 526**	**7 980**	**945**

Source: Department of Forests, Ministry of Forests and Soil Conservation, Nepal.

RAWAL (1997) estimated collection quantities in Nepal as ranging from 2-20 t annually between 1989 and 1994. A mid-1990s survey in Nepalese forest districts indicated a total annual amount of licensed harvest of some two tonnes (MALLA & al. 1995). OLSEN (1998) estimated an annual average harvest of 10.9 t of wild-collected *D. deltoidea* traded from the Gorkha district and exported to India in 1994-1995, indicating that harvests significantly exceeded licensed levels. OLSEN & LARSEN (2003) estimated harvest quantities in 1997-1998 based on harvester and trader surveys in 15 districts to be of the order of 134 t (range 28-159 t). Harvest levels based on duties paid show a harvest of only 10 t in 1999-2000, falling to less than one tonne in 2003-2004 (Table 1). Declines in reported harvest rates seem likely to reflect, at least in part, a decline in demand in India (see below).

In **Pakistan**, the underground rhizomes are collected after seed dispersal (IUCN Pakistan in litt. 2005). In the North Western Frontier Province and Baluchistan, the approximate annual yield of *D. deltoidea* from Kashmir forests in the mid-1990s was 148 t of rhizomes and a further 233 t of stems (SAEED 1997). In 2001, the total estimated quantity of rhizomes extracted annually was 230 t, at a price of PKR16/kg (USD0.52/kg); however, the same source noted that a chemical company purchased the rhizomes for a much lower price, PKR4-5/kg (USD0.13-0.16/kg) (SABRA & WALTER 2001).

Cultivation. The species grows best in temperate climates and in rich organic soil. HUSSAIN (1992) reported that pieces of rhizome weighing 50-60 g with one to two buds were used commercially for mass propagation of the species, with optimum yield and maximum diosgenin content obtained if the plants

were harvested after growing for at least three years. He added that cultivation efforts had been made by various industries in India.

There is conflicting information regarding the levels of cultivation within **India**. Apparently considered to be cultivated on a commercial scale as of 1996 (ANON. 1996), according to MOLUR & WALKER (1998) there was no commercial cultivation within India at the time of writing, although the agrotechnology had been developed by two research institutes. SAMANT & al. (1998) stated that propagation protocols (tissue culture) had been developed for the species, which was reported to be cultivated in the Indian Himalayan region. The Himachal Pradesh Forest Department has experimented with cultivation of *D. deltoidea* in plantations of Deodar *Cedrus deodara*, fir *Abies* spp. and spruce *Picea* spp. in the Kullu and Sundernagar forest divisions. Rhizome pieces weighing 50-100 g were sown by dibbling and yielded around 500 g after 10 years (CHAUHAN 1999, GUPTA 1988). Similar experiments in the same region yielded 17.7 t of fresh rhizomes per hectare when harvested after just under four years (CHAUHAN 1999). *Dioscorea* spp. rhizomes are said to be cultivated in Karnataka and Tripura (ANON. 2000). After propagation of rhizome pieces, it takes between seven and 10 years for the species to reach harvestable levels under the most suitable conditions, with the result that cultivation on a commercial scale has not been attractive to farmers (FAROOQI & SREERAMU 2001).

Instructions for cultivating 'steroidal yams' such as *D. deltoidea* and other *Dioscorea* species in Andhra Pradesh are provided by Ikisan (ANON. 2000), and attention drawn to the availability of improved varieties, with an estimated net profit of INR25 000/ha (USD572/ha). The Indian National Scientific Documentation Centre estimates the cultivation cost per hectare of *D. deltoidea* and *D. floribunda* over three years at INR20 000 (USD458), with an expected net profit of INR10 000 (USD229), the latter figure considered more likely to reflect actual profits by JAIN (in litt. 2005). The Government of Jammu promotes cultivation by providing cultivation packs according to KAUL (in litt. 2005), however he did not believe that the species was cultivated on an organised basis. RASTOGI & PANT (2004) found that *D. deltoidea* "responded extremely well to mass propagation in nurseries and experimental plantation trials in the forests", with propagation initiated in eight "medicinal plant propagation areas" expected to yield between 4260 kg and 5680 kg (fresh weight) in 2006. Propagation was by seed, with yields expected to be from 300-400 kg in the third year. Cultivation has been promoted in the Parvati Valley of the Kullu District of Himachal Pradesh.

The Indian branch of an international pharmaceutical company reported that *D. deltoidea* plantations have been developed in southern India, with plants initially grown in nurseries and then transferred to farms, with "good yield in production….putting India on the map of corticosteroid producers". The roots are processed at a factory in Mumbai. This company has also begun cultivating the exotic species *D. composita* and *D. floribunda* for diosgenin production within India, with the claim that they were the first to successfully cultivate these species (ANON. undated). *D. floribunda* is also being commercially cultivated in Tripura (ANON. 2002c).

In **Nepal**, cultivation experiments have been carried out, but the species is not commercially cultivated. The species has been considered to have great commercial potential for cultivation in **Pakistan**, where trials were successful (SHER 2001).

National market. A study in the Chhakinal Watershed (Kullu district, Himachal Pradesh, **India**) found that *D. deltoidea* was of commercial value but not used locally. It was wild-collected and sold at USD0.1/kg in the villages and USD1/kg in the end market. An annual total of 5370 kg of *D. deltoidea* was sold from the region (DOBRIYAL & al. 1997).

In a trade survey carried out in 1997 by TRAFFIC India, *D. deltoidea* was found to be regularly available in the markets of Delhi, Amritsar and Kolkata (previously Calcutta), but only rarely in Haridwar and Mumbai. An Indian trade organization estimated India's annual demand at 700 t in 1997 (TRAFFIC INDIA 1998), this figure very high in comparison with other estimates. The dried plants were sold at INR20-65/kg (USD0.5-1.9/kg), the fresh plants at INR12-30/kg (USD0.3-0.8/kg). Amritsar was considered the only significant market, with trade there estimated at 40 t per year. Plant materials offered for sale at Amritsar were sourced from Jammu & Kashmir and Himachal Pradesh. Demand within India was estimated at 150 t per year in 2002, of which India was only able to supply 60 t (ANON. 2002c). This species is mainly sold in Amritsar, Delhi and Kolkata, which also supply smaller markets elsewhere. Prices vary with the diosgenin content (GUPTA 2005).

It seems likely that the main demand for *D. deltoidea* within India relates to production of diosgenin, and that the market is declining with the increased availability of other sources of diosgenin, e.g. from cultivation of *D. deltoidea* and other *Dioscorea* species within India, and imports of diosgenin from other countries. Diosgenin produced from cultivated *D. floribunda* by the Tripura Forest Development and Plantation Corporation was said in 2002 to be unable to compete on the market with lower priced imports from Mex-

ico and China, which sold for INR1200-1300/kg (USD32-35/kg), compared to INR1700-2000/kg (USD45-53/kg) from the corporation (ANON. 2002c).

According to OLSEN & LARSEN (2003), there is no domestic demand for this species in **Nepal**, with all harvests destined for export to India. Prices paid to harvesters in Nepal during the late 1990s ranged from USD0.1–0.7/kg, and averaged USD0.5±0.1/kg. In 1997/98, the average price paid was USD0.6/kg, *D. deltoidea* harvests accounting for approximately 2.7% of the total value of medicinal plant harvests during that period (OLSEN & LARSEN 2003). Quantities of *D. deltoidea* 'at the market' in Nepal are reported to have declined from 8.9 t in 1995 to six tonnes in 1999. Prices are said to have increased during this same period from NPR2/kg (USD0.03/kg) to NPR10.33/kg (USD0.14/kg) (NEW ERA 2001). The decline in harvest and trade volumes corresponds with information provided by traders in Nepal, who indicate that demand is declining, that quantities in trade are very small and that buyers in India are currently more interested in importing extract than raw *D. deltoidea* from Nepal. According to AMATYA (in litt. 2005), medicinal plants wholesalers in, for instance, the Kathmandu Valley, were selling less than in previous years, down to about 100 kg per annum. The growing availability of alternative sources of diosgenin and other compounds for use as steroid precursors, as mentioned under 'medicinal uses', as well as increases in cultivation, seem likely to be the cause of reduced demand in Nepal.

D. deltoidea was listed as one of the 12 medicinal species of greatest economic importance and high value nationally and internationally in a 2001 study in **Pakistan** (SHER 2001), where it was said to sell for a local price of PKR60/kg (USD0.98/kg) and a national price of PKR150/kg (USD2.46/kg). In Pakistan's Palas Valley *D. deltoidea* was considered to have market value but not to be overharvested (SAQIB & SULTAN 2004). This species has previously been reported as harvested in the province of Son La, north **Viet Nam**, and used for the production of diosgenin for use wholly in the domestic pharmaceutical industry (DE BEER 1993).

International trade

Table 2. CITES-reported trade in *Dioscorea deltoidea* (1995-2003)

Year	Country of Export	Country of Import	Origin	Export					Import				
				Quantity	Unit	Term	P	S	Quantity	Unit	Term	P	S
2000	DE	US							80		Live	T	A

Source: CITES annual report data compiled by UNEP-WCMC.

There is only one record of international trade in CITES annual report data for 1975-2003, with the USA reporting the import from Germany of 80 artificially propagated live specimens in 2000. However, wholesalers in **India** reported in the late 1990s that trade in the species was primarily for export (TRAFFIC INDIA 1998). According to an officer of India's CITES Management Authority, *D. deltoidea* is not exported in either raw or processed form (JAIN in litt. 2005). Neither Nepal's nor India's Customs data include a specific Customs code for *D. deltoidea*.

Based on district-level surveys, wholesaler interviews and a review of export documentation, OLSEN & LARSEN (2003) estimate that 78 t (range 36-129 t) of *D. deltoidea* roots were exported from **Nepal** during 1997/98, all which was destined for India.

According to a study by the Mountain Areas Conservancy Project (SHER 2001), *D. deltoidea* was being exported from **Pakistan** via exporters in Jodia Bazaar, Karachi and Akbari Mandi Lahore to Germany, Japan, France, Switzerland, India, South Africa and the Middle East. No information was provided on the form of these exports. Export from Pakistan to Japan had also been reported by FAO (1994) and SABRA & WALTER (2001).

An industry source in the **USA** indicated that a large number of US companies trade in *D. deltoidea*, primarily in the form of dry rhizomes, imported from different range States. The majority of the companies use more than one *Dioscorea* species in their botanical supplement lines. Only a few companies have specific guidelines to use raw materials identified to the species level. However, *D. deltoidea* is not recorded in the 'Herbs of Commerce', which implies that it is unlikely to be used in significant amounts in the USA. Only one product containing *D. deltoidea* was identified on the internet as being sold in the USA, targeted at athletes and bodybuilders, and which is apparently no longer available (TRAFFIC NORTH AMERICA 2005). The US market could reflect increased interest in Dehydroepiandrosterone (DHEA). DHEA is being promoted as having various anti-ageing properties, and is primarily produced from diosgenin. Some extracts from wild yams have been marketed as "natural DHEA" (UNIVERSITY OF MARYLAND MEDICAL CENTRE 2004).

There does not appear to be a market for this species within **Europe** (LANGE 2005).

Illegal harvest and trade. In **India**, the species is found in wildlife sanctuaries and other protected areas where some illegal collection is believed to occur (KAUL in litt. 2005). RAWAT (in litt. 2005) reported collection from at least three such sanctuaries in Uttaranchal, but believed amounts to be negligible. RASTOGI & PANT (2004) considered that a considerable amount collected in Himachal Pradesh entered trade illegally.

From 2000-2003, the Government of India recorded a single seizure of this species: 100 kg of dry roots were seized at the Mumbai sea docks in 2001, destined for France. These were seized in keeping with India's general ban on exports of wild-harvested specimens of this species (CITES MANAGEMENT AUTHORITY OF INDIA 2004).

Table 3. Seizures of *"D. deltoidea"* in the USA (1999-2004)

Date intercepted	Country of origin	Amount
01-03	Costa Rica	Unknown
01-03	Costa Rica	1 200 g
01-03	Colombia	59 203 g
01-03	Colombia	1 400 g
01-03	Costa Rica	44 793 g
11-03	Costa Rica	2 boxes
02-04	Ghana	123 cartons
02-04	Ghana	4 520 g
06-04	Jamaica	1 100 count
07-04	Gabon	4 tubers

Source: USFWS 2004.

In the **USA**, ten seizures of "*D. deltoidea"* were recorded by the US Fish and Wildlife Service from 1999-2004 (Table 3), half from Colombia and Costa Rica in January 2003 which totalled at least 107 t of, presumably, rhizomes, and the rest between January 2003 and July 2004 (USFWS 2004). Based on the amounts seized, it would be expected that *Dioscorea* spp. is in high demand in the USA. However, bearing in mind that *D. deltoidea* is native to Asia, and that trade to North America would not normally involve transit via Latin American countries, the seizures seem likely to involve other *Dioscorea* species, e.g. species native to the Americas.

Evidence of ongoing international trade, at minimum between Nepal and India, in the absence of CITES permits indicates steady, if perhaps declining, illegal trade in this species. Should reported trade to the USA be verified, this would similarly reflect violations of CITES trade controls.

Legislation and regulations

Regulation of harvest, manufacture and domestic trade. The main laws governing harvesting of medicinal plants in **India** are the Indian Forest Act (1927), and, to a lesser extent, the Wildlife (Protection) Act (1927/1991/2002). The Indian Forest Act (1927) consolidates the law relating to forest produce, the transit thereof and duty thereon, and empowers State Governments to regulate the transit of forest produce, e.g. medicinal plants. The Act deals specifically with reserved, protected, and village forests. Almost all the States and Union Territories in India have regulations regarding harvest, transit and trade in medicinal plants. Most have established lists of species banned from harvest from forests ("Negative lists"), which include threatened plants (JAIN 2000).

The Indian Forest Act (1927) has been adopted by most of the States and is directly applicable to the Union Territories of India. The remaining States have enacted State Forest Acts of their own, which are largely based on the Indian Forest Act. The Forest Acts of the States have been amended from time to time as required. The States have framed Rules under the Acts to protect and preserve the forest wealth of their respective States (JAIN 2000).

The State of Jammu & Kashmir has specifically included *Dioscorea deltoidea* in the Forest Act as important forest produce for regulation (JAIN 2000). The Kuth Act (1978) of Jammu & Kashmir provides for conservation, preservation and protection of the CITES Appendix I species Kuth *Saussurea lappa* and its produce in the State. The Act has been extended to several other plant species, including *Dioscorea deltoidea*. Stringent penalties are provided for under the Act (for first offence - imprisonment up to two years or fine up to INR5000 (USD114.5) or both; for subsequent offence - imprisonment up to four years or fine up to INR10 000 (USD229) or both).

The Himachal Pradesh Forest Produce Transit (Land Routes) Rules (1977) were amended in 1994 and establish "pass/export permit fees" for specified medicinal plants (this relates to exports from the State rather than the country). The trade in some important and threatened medicinal plants in the State has been restricted or banned. In 1994, the pass/export permit fee for *Dioscorea deltoidea* was set at INR900/100 kg (USD21/100 kg); it was also at this level in 2004 (RASTOGI & PANT 2004). Other states have similarly established local controls and fee structures on domestic trade in native medicinal species

(see JAIN 2000 for a state-by-state analysis of legislation relevant to the harvest and trade of medicinal plants).

Wildlife harvest and domestic trade controls are implemented in **Nepal's** national parks, conservation areas and protected areas via the National Parks and Wildlife Conservation Act (1973); elsewhere in the country, implementation is via the Forest Act (1993) and the accompanying Forest Regulation (1995) (AMATYA in litt. 2005, OLSEN in litt. 2000, SHRESTA in litt. 2000). A summary of these and related controls for medicinal plants and other non-timber forest products has been compiled by the Asia Network for Sustainable Agriculture and Bioresources (ANSAB) and can be found on their website (BINAYEE undated).

The Forest Act and Regulation stipulate rules pertaining to the collection of forest products. Collection is authorized via licences issued by District Forest Officers (DFO). Licences are required to specify the collection area; the period in which harvest is to take place; the species and quantities to be collected; and method of harvest (AMATYA in litt. 2005, ARYAL 2000, OLSEN in litt. 2000). Licence applicants are required to provide this information and specify the purpose of collection. In accordance with the Regulation, District Forest Officers are required to verify the quantity of medicinal plants collected, collect any associated fees, and issue a "release order", which is required to transport harvested plants out of the district of origin. The release order should state: the species and quantity transported, the destination, and the period in which transportation must take place (ARYAL 2000, OLSEN in litt. 2000). There is also a provision to allow harvest and trade licences to be sold at auction (ARYAL 2000). No limits or quotas have been established for the harvest of *Dioscorea deltoidea (*AMATYA in litt. 2005).

In their 2001 study in the Dhading District, PANDIT & THAPA (2004) found that implementation of these licensing provisions was low in government forests, reflecting a combination of a lack of resource management rights among the local population and low government enforcement capacity. Inspection of harvested materials to ensure compliance with licence provisions was considered to be low. Adherence to licence provisions was similarly found to be low in community forests, where permitting provisions still applied, but harvest rights were restricted to members of forest user groups. Others have similarly noted low levels of implementation of national harvest and trade controls for medicinal plants and other NTFPs (e.g. see MULLIKEN 2000, OLSEN 2005).

The harvest of medicinal plants in **Pakistan** is controlled by the Forest Department. Three different types of harvest controls were reported as practiced (IQBAL 1991, RAPA 1987):

- Leasing the area for collection of medicinal herbs. This method was said to have been used in the Hazara forests in the North-West Frontier Province;
- Collection by the traders from local people who pay nominal royalties to the Forest Department. This method was said to be common in the Malakand forests in the North-West Frontier Province;
- Fixed quantities are auctioned off, e.g. by the Forest Department in Azad Kashmir.

Before taking plants from the site of collection, the local Divisional Forest Officer must be approached for the issue of a transport permit, obtainable on the payment of a fixed duty. The size of the consignment and transport permits are checked at forest exit points. Commercial exploitation from reserved forests is forbidden throughout Pakistan by order of the Inspector General of Forests, Islamabad (MULLIKEN 2000).

Regulation of international trade

CITES listing: *Dioscorea deltoidea* was included in CITES Appendix II in 1975, and until September 2007 was listed with Annotation #1 (designates "all parts and derivatives, except: a) seeds, spores and pollen (including pollinia); b) seedling or tissue cultures obtained *in vitro*, in solid or liquid media, transported in sterile containers; and c) cut flowers of artificially propagated plants"). The annotation was modified at CITES CoP 14 (The Hague, June 2007), as part of a Plants Committee process to clarify and harmonise annotations for medicinal plants. The revised annotation, effective 13 September 2007, "Designates all parts and derivatives, except: a) seeds, spores and pollen (including pollinia); b) seedling or tissue cultures obtained *in vitro*, in solid or liquid media, transported in sterile containers; c) cut flowers of artificially propagated plants; and d) fruits and parts and derivatives thereof of artificially propagated plants of the genus *Vanilla*."

CITES is implemented in **India** through a combination of the Wildlife Protection Act (1972/1991/2002) and the Export and Import Policy (EXIM) of the Foreign Trade (Development and Regulation) Act (1992) and the Customs Act (1962). The Wildlife (Protection) Act prohibits export of a number of species, including all six CITES Appendix I plant species native to India, of which one, *Saussurea lappa*, is a medicinal plant.

Policy on trade in wildlife and wildlife products is established via the EXIM policy, which is revised periodically. The policy, as far as it concerns wildlife, is decided in consultation with the Director of Wildlife Pres-

ervation of the Government of India, who is the CITES Management Authority and oversees CITES implementation in the country. The Director has four Regional Deputy Directors and four sub-regional offices of wildlife preservation, these serving as assistant CITES Management Authorities. The EXIM policy is put into effect via the provisions of the Foreign Trade (Development and Regulation) Act (1992) and enforced via the Customs Act (CITES MANAGEMENT AUTHORITY OF INDIA in litt. 2004). The export of wild-collected *Dioscorea deltoidea* from India has been prohibited through its listing on the Negative List of Exports under the EXIM policy since at least March 1996 (TRAFFIC INDIA 1998) if not since March 1994 (LANGE & WÄCHTER 1996).

The EXIM policy was embedded within a broader Foreign Trade Policy for the period 2004–2009, this change coming into effect on 1 September 2004. The Foreign Trade Policy aims at doubling India's share in global trade and expanding employment opportunities, particularly in rural and semi-urban areas, and includes a Special Agricultural Produce Scheme, promoting the export of, *inter alia*, minor forest produce such as medicinal plants and their value-added products. The policy outlines that all export and import shall be "free", i.e. unrestricted, unless regulated under any legislation. Goods imported in accordance with this policy may be exported in the same form without a licence, provided that there is no import or export restriction for the items. Even goods restricted for import may be imported under Customs Bond for export without a licence, provided that the items are freely exportable. Specific note is made in the policy that this does not preclude the application of other laws (DIRECTORATE GENERAL OF FOREIGN TRADE 2004).

Import and export restrictions for specific products are established via India's ITC (HS) classifications in accordance with the broader policy. Several categories relevant to CITES-listed species have been identified as goods allowed to be imported without restriction (i.e. free of import duties or quotas), e.g. "medicinal plants, fresh or dried, whether or not cut, crushed or powdered" (Schedule 1 Chapter 12), lac, gums, resins and other vegetable extracts (Schedule 1, Chapter 13), pharmaceutical products (Schedule 1, Chapter 30) and essential oils (Schedule 1, Chapter 33). Although instructions under the EXIM policy for 1997-2002 stipulated that imports of plants, products and derivatives were subject to CITES provisions (TRAFFIC INDIA 1998), the low levels of trade data for imports of CITES-listed species into India indicate that these provisions were not implemented effectively.

It does not appear that any CITES-related import controls were established via the policy for 2004-2009 until early 2006, nor that these existed under other legislation (with the exception of *Saussurea lappa*), with the effect that imports of CITES-listed medicinal plant species was uncontrolled. However, on 6 February 2006 the ITC (HS) Classifications of Export and Import Items were amended such that imports of *Rauvolfia* spp. (all species) are to be subject to CITES provisions (Ministry of Commerce & Industry Department of Commerce Notification No. 42 RE-2005/2004-09). Similar amendments were made for Kuth (*Saussurea lappa*) roots, cacti, agarwood and agar oil. This would seem to indicate that CITES trade controls are not required for imports of other CITES-listed plant species, however confirmation of this is required.

As stipulated in Chapter 12 of the ITC (HS) classifications, the export of plants, plant portions, their derivatives and extracts of species included in CITES Appendix I and II obtained from the wild is generally prohibited. Further clarification is required to confirm whether this applies to wild specimens regardless of their country of origin, or to only those specimens obtained within India. An "Export Licensing Note" appended to Chapter 12 specifies 29 plant taxa for which export is generally prohibited. This list includes *Dioscorea deltoidea*. An exception for both CITES species and those listed in the Licensing Note is made for the export of "formulations", defined as including "products which may contain portions/extracts of plants on the prohibited list but only in unrecognizable and physically inseparable form" and "value-added formulations as well as herbal Ayurvedic" (Chapter 12, Export Licensing Note 3). It is not clear whether the term "recognizable" is defined per the CITES interpretation of "readily recognizable" such that if the ingredients of a particular formulation of Ayurvedic medicine are listed on the packaging, then they are considered to be "recognizable". The instructions include a note that states that "no certificate from any authorities whatsoever shall be required for their [formulations] export," implying that no CITES permits would be required for such exports. This would appear to allow for trade in violation of CITES for species included in the Appendices with Annotation #1, including e.g. *Dioscorea deltoidea*. Export Licensing Note 2 states that export permits are required, however it is not clear if this applies only to cultivated specimens, which are allowed to be exported (see below) or also to formulations. CITES Management Authority staff have advised that, if Customs staff refer a shipment of "formulations" containing CITES-listed species to the Management Authority for clearance, then issuance of a CITES export permit will be required (AARTI in litt. 2005).

A further exception is provided for exports of wild CITES-listed species on a case-by-case basis for "life saving drugs", which could presumably be applied to any medicinal species. However, in this case a

CITES permit would be required, with such trade only allowed on recommendation of the Ministry of Environment and Forests.

Exports of plants produced via cultivation are allowed subject to obtaining a transit pass from the relevant Divisional Forest Officer if the plants were cultivated in sites within forests, or a Certificate of Cultivation from a District Agriculture, Horticulture or Forest Officer if cultivated at sites outside forests. Export Licensing Note 2 included in this schedule states that "…however, in respect of CITES species, a CITES permit of export shall be required". As noted above, it appears that this provision relates to all but formulations, however this requires further clarification.

It does not appear that export restrictions on wild specimens of CITES-listed species apply to imported specimens, however this requires confirmation, nor does it appear that there are any specific provisions made for controlling re-exports of CITES-listed species, other than as may be required to prove that re-exports do not involve wild-collected stock from within India. No reference could be found to an earlier (2003) provision requiring exporters of value-added formulations made out of imported species from the list of "prohibited plants" to provide an affidavit to Customs authorities at the time of export that the specimens were legally imported (NTF NO. 03/2003 31/03/2003). However, CITES Management Authority staff state that proof of import is required prior to granting re-export permission, and that they take into account, for example, the amount of unprocessed product that would have been required on import to produce a given export quantity (JAIN in litt. 2005). CITES Re-export Certificates are issued for such shipments (AARTI 2005).

Exports are required to be limited to the following ports: Mumbai, Nhava Sheva, Kolkata, Cochin, Delhi, Chennai, Tuticorin, Amritsar, Calicut and Thiruvananthapuram (DIRECTORATE GENERAL OF FOREIGN TRADE 2004). It is not clear if this relates to all plants covered under this Customs classification, or only to CITES-listed species and other medicinal species for which export is prohibited.

All violations of the EXIM policy constitute an offence under the Customs Act and are dealt with by Customs officials, who alone have the responsibility to enforce compliance with CITES at border posts. Inspection of consignments by Wildlife Inspectors, co-operating with Customs staff, may also be carried out at border crossings, but such specialist investigations are few. Enforcement of any violations detected is the responsibility of the Customs authorities (PANDA in litt. 1998).

There is no specific CITES-implementing legislation in **Nepal**, however legislation to promote more effective CITES implementation has been under consideration since the late 1990s. If agreed, the Rare (Endangered) Wildlife and Plants Trade Control Act 2057 (2002) would provide a more powerful legal tool for CITES implementation within Nepal, and includes a number of CITES-relevant provisions (HEINEN & CHAPAGAIN 2002).

Nepal's CITES Management Authority for plants is the Department of Forests, Ministry of Forests and Soil Conservation. The CITES Scientific Authority for plants is the Department of Plant Resources, Ministry of Forests and Soil Conservation. The Management Authority issues export permits for plants covered by CITES and/or the Forest Act e.g. *D. deltoidea*, the export of which is allowed in raw and processed form.

The Management Authority also liaises with the Department of Customs, Intelligence, Police and other agencies. The Ministry of Commerce (Customs) and the police assist in the enforcement of import and export controls. However, it was noted in 2000 that Customs officers had not been trained in the identification of medicinal plants (BISTA in litt. 2000); it is unknown if training has been provided since then. Personnel from the Department of Forests and District Forest Offices have been posted at the Customs points in the Terai to examine consignments containing wild flora (ARYAL 2000).

Treaty of Trade between Nepal and India

In an effort to expand trade between their two countries, the Governments of India and Nepal entered into a bilateral trade agreement in 1991. The treaty provides for preferential treatment (exemption from Customs duty and quantitative restrictions) of trade of certain "primary products", which include forest produce that has not undergone processing, and Ayurvedic and herbal medicines (Article IV) (ANON. 2002d). Under this treaty, a certificate of origin issued by the Government of Nepal is the only document required for presentation to India's Customs authorities at the time of import (MULLIKEN 2000). Trade in conjunction with the treaty is required to take place via one of the 22 border crossings designated in Annex A of the treaty. During the late 1990s, border officials were unaware that CITES documentation might also be required for export (as noted above, under India's current CITES implementing legislation and the EXIM Policy, until recently, CITES export permits would not be required to accompany shipments into India in any event). The treaty contains provisions for stronger domestic measures on the part of national governments, and provides a list of articles not allowed preferential treatment (e.g. cigarettes and alcohol) as an annex. It appears that this Annex could be amended to reflect CITES requirements (MULLIKEN 2000).

TRAFFIC India informed Government authorities in both India and Nepal of the apparent relevance of this treaty with respect to CITES trade controls. Initial research results from this study were communicated to the second Indo-Nepal Trans-border Meeting in February 1999. As a result, the final resolution of that meeting called for bringing the bilateral treaty in line with CITES requirements (MULLIKEN 2000).

The treaty was extended for a further five years in 2002 and remained in effect until 5 March 2007 (ANON. 2002d). Although some amendments were made, these did not reflect the concerns raised regarding CITES implementation (AMATYA in litt. 2005). The treaty has been extended for a further five years, and will remain in effect until 5 March 2012.

Pakistan's CITES Management Authority is the National Council for the Conservation of Wildlife (NCCW), under the authority of the Ministry of Environment, Local Government and Rural Development, in Islamabad. CITES permits are issued by the NCCW, which is also responsible for formulating countrywide legislation for regulating harvest, national and international trade of CITES-listed species. It issues directives to various provincial Forest Departments to control the harvest and trade of medicinal plants and intervenes wherever a violation of CITES is reported. It is also responsible for inter-provincial and international coordination of CITES implementation. Enforcement officials interviewed at border posts were generally unaware of CITES requirements.

Conclusions

It appears that harvest for domestic and international trade in this widely distributed yam species has resulted in population declines in at least parts of its range, e.g. India. The main driver of demand appears to be production of diosgenin, a chemical widely used in the production of steroid hormones, and, more recently, in herbal supplements in the USA. *Dioscorea deltoidea* is only one of a number of *Dioscorea* species that produce diosgenin, many of which are already being commercially cultivated on a wide scale, including several within India. It appears that cultivation of *D. deltoidea* is similarly increasing, particularly within India. The decline in demand within India for *D. deltoidea* from Nepal corresponds with increased production from other sources, and may indicate that wild *D. deltoidea* stocks are no longer the main, or perhaps even a key, source of this species for the production of diosgenin. Concern remains regarding harvest levels, particularly within India, and it is therefore important that domestic trade monitoring is enhanced to determine the extent to which India's demand is being met through wild stocks. Less is known regarding trade within Pakistan, which is said to involve several hundred tonnes, and exports from this country, which therefore merit further review.

There has been virtually no international trade recorded in *D. deltoidea* within CITES annual reports, despite it having been listed in Appendix II of the Convention since 1975, without an annotation removing trade controls for parts or derivatives. Based on available information, this seems to reflect a failure to enforce CITES permitting requirements for the export of rhizomes from Nepal and into India, and for the export and/or re-export of diosgenin from India, rather than an absence of trade.

Possible next steps

Governments of *Dioscorea deltoidea* range States, and particularly India, Nepal and Pakistan, might consider:

- Undertaking a review of the current status of wild harvest, cultivation and domestic and international trade of the species;
- Supporting local communities in the development of sustainable harvest practices and management plans for this species, taking into account the species' status, regeneration capacity and predicted future demand; and
- Reviewing current CITES implementation procedures for the trade in this species with a view to implementing CITES trade controls for both raw materials (rhyzomes), extracts and finished products.

With India the apparent centre of processing and trade of this species for the production of extracts, the Government of India might consider:

- Reviewing the species, source and quantities of *Dioscorea* currently used by India's manufacturing and pharmaceutical industries;
- Encouraging industries reliant on this species to support development of sustainable harvest regimes, and to ensure that all raw materials are sourced from sustainable and legal sources; and
- Evaluating likely future demand for this species to underpin future management planning, including with regard to the potential need for increased cultivation.

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Nardostachys grandiflora

Taxonomy ***Nardostachys grandiflora* DC. (family Valerianaceae)**

Confusion regarding the taxonomy and trade names of *Nardostachys grandiflora* was noted in the IUCN Analyses of India's successful proposal to include this species in CITES Appendix II (ANON. 1997).

PRAKASH & MEHROTRA (1989) recognized two distinct species, *N. grandiflora* and *N. jatamansi*, providing a key illustrating differences and describing *N. jatamansi* as more widespread than *N. grandiflora*, but threatened. The US Department of Agriculture Germplasm Resources Information Network (GRIN) considers *Nardostachys jatamansi* (JONES) DC to be a synonym of *Valeriana jatamansi* JONES, and *Nardostachys jatamansi* auct. to be a synonym of *N. jatamansi* DC. USDA-GRIN treats *N. chinensis* BATALIN as a valid species, giving a range limited to Qinghai and Sichuan China (USDA 2006). In most other recent accounts and floras, only one taxon is recognized. However, authors vary as to which is the accepted name, either *N. grandiflora* DC or *N. jatamansi* DC (SCHIPPMANN in litt. 1997).

This review will treat the genus *Nardostachys* as monospecific, and use the name *Nardostachys grandiflora* to refer to the species under consideration. All references to *Valeriana jatamansi* will refer to the valid species *V. jatamansi* JONES.

Synonyms *N. jatamansi* DC., *N. chinensis, Fedia grandiflora* WALL., *Nardostachys gracilis* KITAM., *Patrinia jatamansi* D. DON, *Valeriana jatamansi* auct. non JONES, *Valeriana jatamansi* sensu D. DON (BHATTARAI in litt. 2005, GOVERNMENT OF INDIA 1997, JAIN 1994, LANGE & SCHIPPMANN 1999, SCHIPPMANN in litt. 1997).

Trade names Bala tagra (Pakistan), Balchara (India), Balchard (India), Balchhad (India, nep), Bhulte (India, nep), Bhutijatt (Kashmir), Gansong (chi), Gansongxiang (chi), Indian Nard (eng), Indian Valerian (eng), Indische valeriaan (nld), Indischer Baldrian (ger), Jata Jatila (India), Jatalasi (hin), Jatamashi (tam), Jatamansi (India, ben, hin, guj, Gurung, tel, kan, mal, mar, nep and Pakistan), Kalichhad (guj), Kan Sung Hsiang (chi), Kukilipot (Kashmir), K'U Mi Ch'E (?), Mansi (Kumaon region in Uttaranchal), Masi (Garhwal), Masijara (nep), Mushkbala (Pakistan), Musk root (eng), Nard (eng), Pampe (bhu), Pangbu (Sherpa), Poi (Tamang), Songban (chi), Spikenard (eng) Sumbul ut Teeb (India), Sumbul Ul Tib (Pakistan), Sumbulu (Pakistan), Tagara (?), Valeriane Indienne (fre) (AMATYA in litt. 2005, ANON. undated, DHARMANANDA undated, JAIN in litt. 2005, RAWAT in litt. 2005, SUBEDI & SHRESTHA 1999). Herbal traders in Tanakpur, Lucknow, Kanpur, Kannauj and Khari Baoli markets in India mostly use the Nepali names Balchhad and Bhulte (BHATTARAI in litt. 2005).

Description. *Nardostachys grandiflora* is a long-lived, erect perennial herb, growing to a height of 10-60 cm. The plant stem, which is partly underground (i.e. a rhizome), has a long, thickened, woody root stock that is generally enclosed in fibers from the petioles of dead leaves. Rhizomes are short, thick, and dark-grey in colour, and crowned with the reddish-brown coloured, tufted, fibrous remains of petioles of rootstock leaves (AMATYA & STHAPIT 1994, ANON. undated). DUTTA & JAIN (2000) describe the rhizome as being 2.5-8 cm long, densely covered with silky reddish brown fibres matted together. A transverse cut of the rhizome reveals a reddish brown surface and a prominent ring surrounding porous wood, with short fractures exposing a reddish brown uneven surface. BHATTARAI (in litt. 2005) draws attention to the thick hairs covering the rhizome, which set it apart from *Valeriana jatamansi*, a species with which it has been said to be confused in trade. The upper portion of the stem is hairy (AMATYA & STHAPIT 1994).

Leaves develop from the rootstock and stem; those that develop from the rootstock are 15-18 cm long and 2.5 cm wide, longitudinally veined, and have a petiole, while those that arise from the stem are in one or two pairs, approximately 7.5 cm long and 2.5 cm wide, oblong or ovate in shape, and sessile (AMATYA & STHAPIT 1994). The inflorescence may have one terminal capitate cluster, frequently with broad ovate bracts, or 3-7 terminal and axillary clusters. The flowers are rosy, pale pink or blue in dense cymes. Flowering takes place in June-July, and fruiting from August onwards (GHIMIRE & al. 2005). Fruits are one-seeded achenes, with approximately seven seeds per flowering ramet (GHIMIRE & al. 2005), small with white hairs and crowned by calyx teeth (AMATYA & STHAPIT 1994). Seed germination, which takes place in May-June, is very low (10-20% according to NAUTIYAL & al. 2003), with no persistent seed bank (GHIMIRE

& al. 2005). The species grows vegetatively with successive ramets (vegetative clones) produced very close together in a dense clump (GHIMIRE & al. 2005).

Distribution. Afghanistan (?), China, Bhutan, India, Myanmar (?), Nepal, Pakistan (?).

Nardostachys grandiflora has been confirmed to occur from Tehri Garhwal (Uttar Pradesh, now Utturanchal, India) in the western Himalayas to Yunnan and southwest Sichuan in the east and Tibet, its range including China, Bhutan, India, and Nepal (ANON. 1970, KIHARA 1955, KITAMURA 1954, TIWARI & JOSHI 1974, WEBERLING 1975). Its occurrence in Afghanistan, Pakistan and Myanmar is questionable (see below). AMATYA & al. (1995) cite an altitudinal range of 2200-5000 m, OLSEN (2005a) of 3200-4500 m and GHIMIRE & al. (2005) of 3500 to over 5000 m. It typically grows on rocky outcrops, but can also be found in meadows, shrubland and forests (GHIMIRE & al. 2005).

In **China** *Nardostachys grandiflora* can be found in Gansu, Sichuan and Yunnan provinces and the Xijang (Tibet) Autonomous Region (USDA 2006). The species has a large range in **India**, being found from Himachal Pradesh to Arunachal Pradesh, and including the states of Uttaranchal, Sikkim and Assam (CHAUHAN 1999, VED & al. 2003a, 2003b) and Jammu & Kashmir (ANON. undated, DUTTA & JAIN 2000). The species is found on moist and dry rocky surfaces and in crevices in the alpine regions of the Garhwal Himalaya, the soil generally sandy or silty loam, acidic and with a high organic content (NAUTIYAL & al. 2003). Population densities of sample plots containing *N. grandiflora* were found to range from a low of 19 plants per m^2 to a high of 32 plants per m^2, with significant variation in morphological characteristics. In the Sikkim Himalaya, the species is found at an elevation of 3600-4800 m, RAI & al. (2000) providing a map of the species' distribution in that area.

Nardostachys grandiflora is found throughout the Himalayan region of **Nepal**. However, there is no detailed information on the species' distribution or status (OLSEN 2005a). According to AMATYA & al. (1995), it is found in greatest numbers in the Mid-Western Development Region (Dolpa, Humla, and Jumla etc.), its population gradually decreasing towards the east. Populations are concentrated in the districts of Jumla, Dolpa, Humla, and Kalikot, and to some extent the northern part of Gorkha, Rasuwa, and the southern part of Ganesh Himal (Nuwakot District) and Mustang (AMATYA & al. 1995). *N. grandiflora* is thinly distributed at elevations above 3300-3400 m. However, the population density in areas where it does occur is higher above 3400 m (THAPA & PRASAD 2000).

The species grows in dry, open pine forests, among dwarf rhododendron and juniper scrub, on open, stony and grassy slopes, in alpine meadows or small depressions, and on the turf of glacial flats (AMATYA & STHAPIT 1994). Soils in the species' natural habitat are moderately acidic, sandy loam, with high organic matter and low phosphate content. Based on its distribution, the species is not believed to favour extremely dry or wet areas (AMATYA & al. 1995).

Conflicting information is available on the distribution of the species. According to BHATTARAI (in litt. 2005), its occurrence in **Afghanistan** and **Myanmar,** as referenced in a draft data sheet for a 1997 Conservation and Management Plan (CAMP) workshop (ANON. 1997), is not confirmed. No other sources were identified referring to the species in Afghanistan, and it seems likely that earlier references to its occurrence there could reflect confusion between this species and *Valeriana jatamansi,* which does occur in Afghanistan according to a US Department of Agriculture database (USDA 2006). *Nardostachys grandiflora* is said to occur in the state of Shan according to the *Checklist of Plants of Myanmar* (ANON. 2003), however no further information on its occurrence there was identified.

There are also questions regarding the species' occurrence in **Pakistan**. AKHTER (in litt. 2005) contends that *N. grandiflora* does not occur in Pakistan, and notes that it is not listed in the *Flora of Pakistan* (NASIR 1976). IUCN PAKISTAN (in litt. 2005) agrees, suggesting that information indicating its distribution in that country could reflect confusion with *Valeriana jatamansi*. The species' reported occurrence in Punjab, India suggests that it might be likely to occur in neighbouring areas of Pakistan (ANON. 1996). According to KAHN (in litt. 2005), the species has been reported from Shogran in the Mansehra District, North West Frontier Province. However, a 1976 review of the medicinal plants of the Siran Valley in this district reported the occurrence of *Valeriana jatamansi*, but not *Nardostachys grandiflora* (SHAH & KHAN, undated).

Population status and threats. There are gaps in the information available concerning the population status of this species throughout much of its range. However, it is clear that populations have been declining in many areas, particularly in India and Nepal, owing to overharvest and habitat loss.

According to RAWAT (in litt. 2005), human-induced habitat loss and degradation continue to be the major threats to the species in **India**. In 1997, during a Conservation Assessment and Management Plan (CAMP) workshop, the species was assessed as "seriously threatened" there due to an observed population decline of 80% during the preceding 10 years. In Uttaranchal, India, the loss was estimated to be

around 75% (KALA in litt. 1997, RAO in litt. 1997). In 2003, *Nardostachys grandiflora* was assessed at a CAMP workshop as *Endangered*[2001] in Arunachal Pradesh, Sikkim and Himachal Pradesh and *Critically Endangered*[2001] in Uttaranchal, due to habitat degradation and loss and also harvest and trade (VED & al. 2003a & 2003b). KAUL (2001) reported that the species does not respond well to habitat modification in the Kashmir Himalayas, and considers it to be "critically endangered".

In **Nepal**, overharvest of rhizomes, especially to supply the demand within India, seems to be the main threat. Habitat loss, fragmentation and degradation, due to over-grazing; and forest degradation, fires and logging were considered secondary threats to the species in the mid-1990s (AMATYA & STHAPIT 1994, ANON. 1997). *N. grandiflora* was assessed as *Vulnerable*[2001] in Nepal during a 2001 CAMP workshop (BHATTARAI & al. 2002). However, OLSEN & LARSEN (2003), while considering the information from the CAMP workshop a useful starting point, questioned the classifications. They considered the empirical data upon which the assessments were made to be scant, quantitative information on the status of the resource and on harvest levels across Nepal lacking, and evidence of overharvest inconclusive. While continuing to note a lack of detailed information on the distribution of the species, the stock of available resources or sustainable harvest rates, OLSEN (2005a) draws attention to the research of GHIMIRE & al. (2005), which indicates that *N. grandiflora* is very sensitive to harvest, a view also supported by other research.

In a study of commercial non-timber forest products (NTFP) collection in the Malekhukhola watershed (Central Development Region), PANDIT & THAPA (2004) found that collectors rarely left any parts of the rhizome in the ground, leaving little chance for regeneration. They considered that the high economic value combined with a lack of management had accelerated degradation of NTFPs such as *N. grandiflora* in community and government forests. GHIMIRE & al. (2005) analysed the impact on *N. grandiflora* of different harvesting regimes in the Dolpa region, finding that even low levels of harvesting had a "strong negative effect on ramet density, recruitment and survival rate". The high ramet density in close proximity to the parent plant was shown to reduce the potential for selective harvesting, these authors concluding that even low levels of harvest were likely to be unsustainable without long rotation times between harvests. A study of the effect of different harvesting practices in Jumla similarly found that regeneration in association with traditional harvest methods was very low (16.33%) (REGMI & al. 2000), with availability for harvest decreasing as a result of increased harvest to meet demand.

Similar species: Confusion regarding the taxonomy and associated nomenclature applied to *Nardostachys grandiflora* and *Valeriana jatamansi* has resulted in related confusion about description of products in trade. This is particularly the case as jatamansi is the most frequently used common name for *Nardostachys grandiflora*. Based on internet searches and a review of available literature it appears that jatamansi is not used to refer to *Valeriana* spp., which are generally referred to as valerian, with *V. jatamansi* frequently referred to as Indian Valerian. Although MULLIKEN (2000) refers to earlier information indicating that *mushkbala* is a common name for both *N. grandiflora* and *V. jatamansi* in Pakistan, this term appears to be much more commonly, if not universally, applied to the latter species.

There is disagreement regarding the similarity in appearance of the rhizomes of *N. grandiflora* and those of *Valeriana jatamansi*. The supporting statement of the 1997 proposal to include *Nardostachys grandiflora* in CITES Appendix II considered that the rhizomes of *Valeriana jatamansi* and *V. officinalis* look "superficially more or less alike" and that careful examination was required in order to distinguish them from each other **(**GOVERNMENT OF INDIA 1997). This point was supported by RAO (in litt. 1997). However, BHATTARAI (in litt. 2005) argues that the species are not similar in appearance, noting that while the rhizomes of *N. grandiflora* are covered with hairs, the rhizomes of *Valeriana jatamansi* are completely hairless. As a result, although the two species are used for similar purposes, e.g. incense, he does not believe they are used as adulterants for each other. AMATYA (in litt. 2005) similarly considers it unlikely that the species are confused, like BHATTARAI, noting the difference in their morphology and distribution (*V. jatamansi* is a temperate rather than an alpine species).

GRIEVE (1931) considered the properties of *N. grandiflora* to be analogous with those of *Valeriana jatamansi.* The essential oil of *Nardostachys grandiflora* has an aroma reminiscent of valerian oil *Valeriana jatamansi* (AMATYA & STHAPIT 1994) and both oils are mixed. *V. jatamansii* is more valuable but has a lower oil content (KAUL 2001). Information available to IUCN Pakistan (in litt. 2005) indicated that *V. jatamansi* is used as a substitute for and to adulterate *N. grandiflora*.

The rhizomes of two ragwort species, namely *Selinum candollii* and *S. wallichianum* (Bhutkesh in Nepali), are mixed or adulterated with *N. grandiflora*; alternatively, *N. grandiflora* may be traded under the name Bhutkesh. The rhizomes of all three species possess hairs which can confuse traders and others lacking in identification skills (AMATYA in litt. 2005). The rhizomes of *Selinum vaginaturm* are considered to be easily mistaken for *N. grandiflora* (RAO in litt. 1997).

Medicinal uses

Plant parts used for medicinal purposes: Rhizomes and, to a lesser extent, roots.

According to JAIN (1994) and YANG (1996), both the roots and rhizomes of *Nardostachys grandiflora* are used. Texts referring to the medicinal properties of these species (e.g., ANON. 1993, JAIN 1994, KEYS 1976, YANG 1996) use both "root" and "rhizome" to refer to the plant parts in trade. The text that follows generally refers to the parts used and traded as "rhizomes", following LANGE & SCHIPPMANN (1999); however, it should be understood that this may refer to both roots and rhizomes. "Root" is used in cases where this is the specific term used by the source being cited.

Nardostachys grandiflora has been widely used as medicine for centuries within **India**. It is valued for its antispasmodic and stimulant properties and is therefore useful in the treatment of fits and heart palpitations, to treat constipation and regulate urination, menstruation and digestion (JAIN 1994). The species is used in both the Unani and Ayurvedic systems of medicine. It is reportedly also widely used in the modern medicine industry (CHAUHAN & NAUTIYAL 2005). An ethanolic extract of *Nardostachys grandiflora* rhizomes was found to protect against liver damage induced by thioacetamide in rats (ALI & al. 2000).

In **Nepal** the rhizomes of *N. grandiflora* are used in brain or uterine tonics, stimulants, external pain killers, as an antiseptic, for the treatment of epilepsy, hysteria, convulsions, heart palpitations, high blood pressure, fever, anxiety, insomnia, asthma and other bronchial problems and acidity (AMATYA in litt. 2005, ANON. 1993). They are used the formulation of traditional Ayurvedic medicines as well as modern herbal preparations (AMATYA in litt. 2005). In the Dolpa region, rhizomes are used by *amchi* (traditional medicine practitioners trained in Tibetan medicine) for treating complaints including epilepsy, wounds, coughs, colds and high blood pressure (GHIMIRE & al. 2005).

Nardostachys grandiflora is used to treat hysteria, epilepsy, neurosis, insomnia, constipation and scorpion stings in **Pakistan**. Under the name of *Asaroon*, the plant is used in nine herbal preparations, according to the *Hamdard Pharmacopoeia* (Qarabadain-e-Hamdard), for treatment of hemiplegia (paralysis of one side of the body, usually following brain injury), Bell's Palsy, Parkinson's disease, tremors, indigestion and deafness due to age (ANON. 1982, KAZMI & SIDDIQUI 1953, KHAN & ZAIDI 1989, ZAMAN & KHAN 1970). According to ARORA (1965), it is used as a single compound to treat hypertension. It is also an ingredient in *Khamira Abresham Hakim Arshadwala*, which is used extensively to treat hypertension, arrhythmia, palpitation and cardiac debility. It is also said to have been used as an aphrodisiac and to aid memory (MULLIKEN 2000).

In **China**, medicinal use of *N. grandiflora* was first recorded in *The Compendium of Materia Medica,* compiled in the 16th century (FU 1993, ZHANG & al. 1994), with the species still listed in the 1995 edition of the *Pharmacopoeia of China* (ANON. 1995). It is considered to be effective in pain relief, regulating Qi and treating a "turgid" chest (ZHANG & al. 1994). Based on interviews, the species was not considered to be in common use in China for medicinal purposes in the late 1990s (MULLIKEN 2000). However, DHARMANANDA (undated) refers to widespread use of "*Nardostachys jatamansi*" (which he differentiates from *Valeriana jatamansi*) and *Nardostachys chinensis* (considered a synonym of *N. grandiflora* by most authors) as an analgesic in China. He comments that the Chinese names given in the Materia Medica, *gansong* and *gansongxiang*, refer to the fact that the material is used dried (*gan*), the location of collection (Songban in Sichuan) and its aromatic properties (*xiang*).

Small quantities are used in the preparation of indigenous medicine in **Bhutan** (MULLIKEN 2000).

Other uses. *Nardostachys grandiflora* is used for its aromatic as well as its medicinal properties. The essential oil is said to have a pleasant, heavy, sweet, woody and spicy aroma, reminiscent of valerian oil. The oil flavour is described as warm and spicy with a slightly bitter, burning power, and the colour noted as varying with the site of collection, maturity, and nature of the rhizomes (AMATYA & STHAPIT 1994).

In **Bhutan**, pounded plants are mixed with other plant material and used primarily to manufacture incense, which is burned during religious rites and ceremonies (MULLIKEN 2000). The demand for incense sticks is very high, this species being among the commonly used species (VANTOMME & al. 2002). Use as an incense in **China** appears to be less common. OLSEN (in litt. 2000) believed that use of *N. grandiflora* in incense, perfumery and in hair oils in the main consumer country, **India**, may be more common than use in medicines. RAWAT (in litt. 2005) notes that there is wide local use for incense at higher altitudes in Uttaranchal. It is also used to promote blackness and growth of hairs, and as an insect repellent (NAUTIYAL 1994, SUBEDI & SHRESTHA 1999), and used as an ingredient in perfumes (EDWARDS 1993, SUBEDI & SHRETHSTA 1999). Rhizomes are used as incense in **Nepal**, including within Buddhist monasteries (BHATTARAI in litt. 2005). Use as incense is noted in the Dolpa region (GHIMIRE & al. 2005). It is considered as the best ingredient for the production of traditional and higher-grade incense; the incense is used widely, especially at higher altitudes in the Himalayas. Newar communities burn the rhizomes in ritual

death ceremonies (RAWAT in litt. 2005). In **Pakistan**, the essential oil is used as a flavouring agent, a hair tonic to stimulate hair growth and dye the hair black, an insect repellent, a basic ingredient in quality perfumes and in the cosmetic industry (MULLIKEN 2000). *N. grandiflora* is also said to be made into stick incense and sold in the Middle East (BURBAGE 1981).

Harvest and processing. There is a relatively large and growing body of work on the harvest and trade in medicinal plants in **Nepal** – over 100 studies according to OLSEN & al. (2002), with several studies with a specific focus on *N. grandiflora* (e.g. see GHIMIRE & al. 2005, MULLIKEN 2000, OLSEN 2005a).

Collection of wild *N. grandiflora* in Nepal is highly dependent upon snowfall, and typically takes place from June to October. Early autumn and late spring snowfalls often cover the plant and prevent extensive collection, which is frequently limited to only 8-10 days due to snowstorms (AMATYA in litt. 2005, AMATYA & STHAPIT 1994). According to GHIMIRE & al. (2005), commercial harvest in the Dolpa region takes place at any time, depending on market demand, with the exception of the winter snowfall (December-February). The most favourable season for harvesting was considered to be during monsoon, when the ground was moist and so rhizomes could be removed more easily. In some cases commercial harvesting in this region was associated with herding activities as livestock was moved among high pastures during the summer (April-August) herding season.

Table 1. Estimated annual potential *N. grandiflora* collection in Nepal (mid-1990s)

Zone/collection centre	Estimated quantity (tons)
Zone: Karnali	
Humla	50-100
Jumla	150-200
Dolpa	50-100
Zone: Gandaki	
Jajarkot	50
Baglung	50
Zone: Gandaki and Bagmati*	
Gorkha	50
Trisuli	100
Rasuwa	100
Dhading	100
Zone: East Nepal	
Sagarmatha, Koshi and Mechi	50

* Figures include amounts speculated as originating from Tibet, China. Source: AMATYA & al. (1995).

Dry rhizome biomass production varies greatly with altitude and area, and also varies from location to location within larger areas. Significant differences were found between the Chaudabise Valley: 5.3-16.9 g root/m^2 (LARSEN 2002); the Tila Valley in Jumla: 1.1-57.7 g root/m^2 (CECI 1997) and in Manang: 8.6-154.8 g root/m^2 (SHRESTHA & al. 1996). THAPA & PRASAD (2000) conclude that the density of vegetative shoots is higher on south-western than northwestern slopes, averaging 90 shoots/m^2 and 74 shoots/m^2 respectively. Most of the rhizomes in trade are believed to come from the high mountain areas, with only small amounts coming from the middle hills (OLSEN 2005a).

The amount harvested also varies from region to region. In the mid-1990s, the main source of *N. grandiflora* was believed to have been areas in the western part of the country according to AMATYA & al. (1995), who provided estimates of the quantities of rhizomes that could be collected in different areas (Table 1).

Harvest and trade were believed to be increasing in the Jumla District (Mid-Western Development Region) during the mid-late 1990s, rising from 14 tons (dry weight) in 1995 to 66 tons in 1996 and 124 tons in 1997 according to the records of the District Forest Office, Jumla, and AMATYA & al. (1995). Surveys of harvesters and traders during 1998 and 1999 indicated that the Eastern and Central Development Regions were the most important supply areas, followed by the Mid-Western Development Region, with low amounts in trade reported for the Western Development Region (OLSEN 2005a). However, it was noted that exports from the Western Development Region are likely to be under-represented in this study, OLSEN (2005a) citing a previous study (OLSEN & HELLES 1997) reported estimated annual exports from Ghorka District to be from 25-84 t a year.

Reliable figures on harvest and trade of *N. grandiflora* are lacking, however efforts have been made to estimate harvest and trade volumes based on interviews with harvesters and traders, most notably by Dr. C.S. OLSEN, working with colleagues including Dr. N. BHATTARAI. Based on district-level surveys of harvesters and traders in 1997 and 1998, combined with information to calculate potential species distribution, OLSEN (2005a) estimated that the annual supply of unprocessed, air-dried rhizomes entering trade in Nepal ranged from a low of 73 t to a high of 327 t, with harvest in the financial year 1997/98 estimated at 181 t. However, this figure is believed to be an underestimate, with estimated consumption figures suggesting higher harvest rates. Using a combination of supply and consumption estimates, OLSEN (2005a) calculated the trade (domestic and export) of dried rhizomes of *N. grandiflora* in Nepal for 1997/98 as in the order of 300 t.

District Forest Office (DFO) records of harvests for 1997/98 are much lower, approximately 96 t, reflecting the low level of adherence to, and enforcement of, harvest and domestic trade controls. DFO records for 1999/2000-2003/2004 are provided in Table 2, with figures for the latter year more closely approaching but still likely to significantly under-represent harvest and trade levels. Based on discussions with traders, AMATYA (in litt. 2005) estimates that the total quantity of *N. grandiflora* collected from the Karnali (Mid-Western Development Region) and Seti zones (Far Western Development Region) alone is around 200-250 t per annum.

Table 2. National collection and sales figure in Nepal based on royalty (forest revenue) records

Jatamansi (*Nardostachys grandiflora*)					
Fiscal years	**1999/2000**	**2000/2001**	**2001/2002**	**2002/2003**	**2003/2004**
Quantity dry weight (kg)	83 590	46 768	127 853	46 734	208 464

Source: Dept. of Forests, Ministry of Forests and Soil Conservation, Nepal.

The importance of medicinal plant harvest and trade to rural economies in Nepal has been stressed by several authors (e.g. see AMATYA & al. 1995, BHATTARAI 1999, OLSEN 1999, OLSEN & BHATTARAI 2005, REGMI & al. 2000). OLSEN (1998) estimated that 470 000 households were involved in commercial medicinal plant collection in Nepal, AMATYA *&* al. (1995) estimated that nearly 90% of households in the Jumla District harvested medicinal plants.

Noting the recent increase in studies of the Himalayan medicinal plant trade, OLSEN & BHATTARAI (2005) have developed a typology for describing different actors in the trade, which they group according to three overall types: harvester, trader and wholesaler. These types are further broken down into "sub-types", e.g. harvesters who are either "collectors" versus "domesticators" and specific types, e.g. whether traders are specialists or generalists. Their hope is that adoption of a common typology to describe the different actors in the trade will increase the ability to compile and compare information from different studies to provide a greater understanding of the trade as a whole.

The importance of medicinal plant harvest and trade appears to increase with altitude, reflecting both the lower agricultural productivity of high altitude regions, and also, it would seem, increased access to some of the higher value species, e.g. *N. grandiflora*. OLSEN (1995) found that in Gorkha only 15-20 out of 900 households (2%) were engaged in medicinal plant collection in the lowlands (Barpak). This percentage increased with altitude to 100-50 out of 500 (25%) in Uhiya and Keraunja, 150-200 out of 500 (35%) in Sidhibas, and up to nearly 100% in Chhekampar and Samagaon. Similar results were found for the Chaudhabise area (Jumla), where harvesting of NTFPs, particularly *N. grandiflora* (said to make up 90% of the harvests) provided an income of NPR1000-3000 (USD14-42)/household/yr. This income was particularly significant considering that households spent NPR1200-8000 (USD16.8-112) on foodstuffs (AMATYA & al. 1995). According to REGMI & al. (2000), 47% of respondents to a survey on medicinal plant harvests in Jumla said they collected them to earn money in their spare time, and 32% as a central part of their livelihood strategy. Fifty-one percent of respondents said that *N. grandiflora* was a preferred species for income generation.

An analysis of the estimated distribution of income from medicinal plants harvested in the Dolpa region was presented in HERTOG (1995) (Table 3).

Table 3. Income distribution from trade in *Nardostachys grandiflora* from Dolpa

Beneficiaries	Price (NPR*/kg)	% of total
Collector	20	18
Porter	4	4
Dolpa trader	28	25
Air freight	18	16
Nepalgunj trader	42	37
Total	**112**	**100**

* 1 NPR = 0.014 USD. Source: HERTOG (1995).

The average purchase price paid by regional wholesalers in India to middle level traders was estimated at USD2.2/kg during 1997/98, the value of the harvest during that year therefore estimated to be on the order of USD400 000. The average value of rhizome sales by harvesters was estimated to be USD29.9 during that year (OLSEN 2005a).

Further information on the structure and the economics of the trade can be found in OLSEN (2005a & 2005b), OLSEN & BHATTARAI (2005), and OLSEN & LARSEN (2003), among others.

During their 2001 survey of NTFP use in the Malekhukhola watershed, located in Dhading District of the Central Development Region, PANDIT & THAPA (2004) found that there was keen competition for the collection of *N. grandiflora*, with collectors seeking to collect as much as possible of these high value plants, which sold for NPR90/kg (USD1.29/kg) in the study area. These and other high value species are harvested before they are mature partly owing to concern that others will harvest them first, with entire plants uprooted. GHIMIRE & al. (2005) similarly noted commercial harvesting of smaller, less mature plants in their study of harvests and trade in the buffer zone around Phoksundo National Park (Dolpa District).

BHATTARAI (1999) noted that although they had been functional for a long period, traditional systems of collection and use could not serve as a model for future harvests, owing to increased threats from human factors including habitat destruction and overexploitation. A study of the effect of different harvesting practices in Jumla (REGMI & al. 2000) found that regeneration following harvest using traditional methods was very low (16.3%) compared to harvest in conjunction with replanting (upper parts of rhizomes replanted after collection) and rotational harvesting systems (left untouched). The authors concluded that traditional harvest methods were very detrimental to plant regeneration in a natural state (REGMI & al. 2000). LARSEN (2005) also examined regeneration rates in the Gorkha District, finding that harvesting 100% of the plants in plots followed by replanting of upper plant parts and two centimetres of the rhizome provided the fastest regeneration and rhizome biomass growth.

Rhizomes are dried and either traded whole, as powder or as essential oil. As the volatile oil cells are generally located on the fine fibrous hairs of the rhizome, preparation of rhizome powder leads to rupture of some of these oil glands and, consequently, a loss of oil. In commercial operations, the rhizomes are left whole. They are graded and the oil distilled. Oil yields vary greatly from 0.57-1.67% of dry weight, but some pilot tests have indicated that extractable volatile oil can be up to 2.9% of the rhizome dry weight after a distillation period of 15 hours (AMATYA in litt. 2005). OLSEN (2005a) suggests an average oil content of 1.5%. The quality and aroma of the essential oils are influenced by the growing conditions and altitude of the harvest area, the maturity of the rhizomes at the time of harvest, the process of preparation and the duration of storage. The older the rhizomes, it is believed, the higher the percentage of essential oil in plants of up to two or three years (AMATYA in litt. 2005). Drying in the shade as opposed to the sun also increases the quality (KAUL 2001).

The technology to produce essential oils was recently introduced in Nepal, which has led to increased local production of and trade in "Jatamansi oil" (AMATYA in litt. 2005). Based on personal communications with traders, AMATYA (in litt. 2005) estimated that of the approximately 200-250 t of *N. grandiflora* rhizomes collected from the Seti and Karnali Zones, around 50-100 t was processed for the production of essential oils, and the rest sold directly to traders.

In **India**, the main geographical areas of collection are Uttaranchal and Himachal Pradesh, in particular moist, steep and rocky habitat at 3000 m altitude or more (RAWAT in litt. 2005). Harvest mainly takes place from April-May (RAWAT in litt. 2005). In the Garhwal Himalaya, rhizomes are preferably harvested during their reproductive phase, after three to four years, when the content of the active ingredient is highest. Production from a mature natural stand in that region has been esimated at 1760 kg/ha (NAUTIYAL & NAUTIYAL 2004). Harvesters both collect and dry the rhizomes (RAWAT in litt. 2005). RAI & al. (2000) estimated that 7.7 million *N. grandiflora* plants were collected annually from the wild in the Sikkim Himalaya. Although the collection sites for these and other species are meant to be rotated to avoid repeated exploitation, this is not well enforced, owing to the remoteness of some areas, with significant illegal harvest as a result. Collection is said to take place primarily in November and December.

Cultivation. Efforts to cultivate *N. grandiflora* in **Nepal** date back at least to the early 1990s, with AMATYA & STHAPIT (1994) noting that cultivation of the species in Nepal at that time was at the experimental stage, based on propagation from seeds and cuttings of underground parts. Research on the potential for cultivation and regeneration of the species in community forests and private lands in the Jumla district of Nepal achieved average germination rates of over 60%, with greater success achieved with the addition of organic fertilizers and at elevations above 2800 m (REGMI & al. 2000). Propagation protocols using tissue culture were described by SAMANT & al. (1998).

N. grandiflora was ranked as one of the top species for development of cultivation for the 'Cold Desert' zone of Himachal Pradesh in **India**, with priority activities to include selection of elite stock and seed planting and stock manipulation (ANON. 2002a). Cultivation trials undertaken in Uttaranchal (elevation 2200 m) achieved nursery germination rates of 80%, of which 50-60% survived as seedlings. The estimated yield from plants grown from seed was 831 kg/ha, while that from plants grown from rhizome cuttings was 1142 kg/ha, slightly over half the estimated yield from a mature natural stand (NAUTIYAL & NAUTIYAL 2004). CHAUHAN & NAUTIYAL (2005) report on the results of cultivation trials carried out in the Garhwal Himalaya at 1800 m, 2200 m and 3600 m, under a variety of conditions, and using both seedlings and vegetatively

propagated plants. Cultivation was found to be commercially viable at the higher altitudes, but not at an altitude of 1800 m.

National market. *Nardostachys grandiflora* was one of the 162 species for which a demand and supply study was commissioned by the Department of Indian System of Medicine & Homeopathy, the Government of India and the World Health Organization (WHO), New Delhi. **India's** demand was estimated as 675 t during 2001-2002 and projected to be 867 t in 2004-2005, based on an annual projected growth of 8.7%. The price during 1999-2000 was reported to be INR150/kg (USD3.4/kg) (ANON. 2001-2002).

According to GUPTA (in litt. 2005) rhizomes are sold for INR115-125/kg (USD2.6-2.9/kg) in the main market for this species in Delhi, from which other markets are supplied. One well-known medium-size pharmacy in south India was said to have an annual demand of 2000 kg, which was purchased at the average price of INR170-175/kg (USD3.9-4.0/kg) from Uttaranchal (RAMACHANDRAN in litt. 2005).

Most of the information available for **Nepal** focuses on harvest for export rather than domestic demand for use in medicine and incense. Based on interviews with nine processors of *N. grandiflora* rhizomes for oil production, OLSEN (2005a) estimated annual industrial demand for rhizomes to range from 10-246 t, with an estimated 201 t purchased in 1997/1998.

OLSEN (2005a) estimated that Nepal supplies 82±5 per cent of the total global (domestic and international) trade in *N. grandiflora* rhizomes, followed by India (13±5%) and Bhutan (5±4%).

International trade. The main form of *N. grandiflora* in international trade is unprocessed rhizomes, OLSEN (2005a) estimated that this involves a minimum of 100 t and a maximum of 500 t per year, with approximately 300 t likely to have been traded in 1997/1998, and suggesting that semi-processed products such as oil and marc (the remains of the rhizomes after oil extraction) are traded in smaller amounts. There is also likely to be at least a limited trade in finished products, e.g. incense and Ayurvedic medicines. Information on the quantities of *N. grandiflora* in international trade is limited, as much of the trade is either unregulated or occurring outside of established trade controls, and therefore undocumented. Virtually no trade has been recorded in CITES annual reports, the one exception being China's report of the export of 12 500 kg of unprocessed rhyzomes to Nepal in 2001 (Table 4). No trade was reported during 2002 and 2003, with reported trade during 2004 limited to the trade in specimens used for training purposes.

Table 4. CITES-reported trade in *Nardostachys grandiflora* (1995-2003)

Year	Country of Export	Country of Import	Origin	Export					Import				
				Quantity	Unit	Term	P	S	Quantity	Unit	Term	P	S
1997	CL	DE	??						200	g	Derivatives	E	U
1997	CL	DE	??	200	g	Dried plants	E	U					
1997	DE	CL	??	200	g	Derivatives	E	U					
2000	DE	CH	NP						2		Specimens		W
2001	CN	NP		12 500	kg	Roots	T	W					

Source: CITES annual report data compiled by UNEP-WCMC.

Nepal is the main source of *N. grandiflora* in international trade, exporting significant quantities of rhizomes, oil and marc. Based on discussions with traders in Nepal and India (see below), it appears that China may be the second largest source of rhizomes (export from China to Nepal), followed by Bhutan (export from Bhutan to India).

OLSEN (1999) considered *N. grandiflora* to be one of the two most important medicinal plant species traded from **Nepal**. Based on interviews with traders, OLSEN (2005a) estimated that exports of unprocessed air-dried rhizomes from Nepal to India could range from 100-435 t, with an estimate of 289 t in 1997/98. However, this figure could involve some re-export of rhizomes imported into Nepal from China.

As export of unprocessed rhizomes is banned under national legislation, there are no official government export data for rhizome exports. Reported exports of "jatamansi marc" are recorded in Nepal's Customs export database. These totalled 148 t for 2000-2003 (Table 5). OLSEN (2005a) notes that marc is sold to India and abroad by central wholesalers. It is unclear whether the Customs data for Nepal presented in Table 5 include exports to India, or only to overseas buyers.

Table 5. Overseas export of "Jatamansi Marc" from Nepal

Fiscal year	Quantity (kg)
2000/2001	25 146
2001/2002	100 350
2002/2003	22 270
Total	**147 766**

Source: Department of Customs, Nepal.

As noted above, there appears to be a growing trade from Nepal of *N. grandiflora* oil, the vast majority of which is destined for export to India. Nepali Customs data from three border posts showed the export of 3202 kg of oil to India during 1996/1997. Nepal's Customs export database also includes data on export to India of essential oils, with specific data for Jatamansi provided for 2000/2001 and 2001/2002 (Table 6), these exports totalling 21 t. It seems likely that some exports of Jatamansi oil are also included in the categories for medicinal herb oils.

The main export destination for oil is India, with smaller amounts exported to Europe and the USA (OLSEN 2005a).

Table 6. Reported export of essential oils from Nepal to India (1999/2000 - 2002/2003)

Fiscal year	Quantity (kg)	Description commodity	Quantity (kg)	Description commodity
1999/2000	8 484	Medicinal herb oil	2 173	Essential oil
2000/2001	18 081	Jatamansi oil	12 414	Essential oil
2001/2002	2 914	Jatamansi oil	8 235	Essential oil
2002/2003	1 203	Medicinal herb oil	29 988	Essential oil

Source: Department of Customs, Nepal.

Table 7. Reported export of *Nardostachys grandiflora* oil from Nepal to overseas destinations (1998/1999-2002/2003; kg)

Fiscal year	USA	France	Germany	Spain	UK	Japan	Switzerland	Taiwan	Total
1998/1999	15	5	15	25	10				70
1999/2000	8			150		3			161
2000/2001	19	35					31	102	187
2001/2002	4	5		25					34
2002/2003	24	152							176
Total	**70**	**197**	**15**	**200**	**10**	**3**	**31**	**102**	**558**

Source: Nepal Overseas Trade Statistics, Trade Promotion Centre, Kathmandu, Nepal.

The reported export of Jatamansi oil from Nepal to overseas destinations totalled 558 kg from 1998-2003, with EU countries identified as the main importers, particularly France and Spain (Table 7).

A significant quantity of *N. grandiflora* is said to be regularly imported into Nepal from Tibet, where the oil is extracted. It is thought that the marc may possibly be mixed with unprocessed Nepalese plant materials and exported to India (BHATTARAI in litt. 2000). These imports are apparently in response to the growing demand for oil in Nepal in the face of declining supplies (AMATYA in litt. 2005).

All of the wholesalers in **India** interviewed by OLSEN (2005a) obtained at least 70% of *N. grandiflora* rhizomes from Nepal. India was cited as the second largest supplier, followed by Bhutan. Very little information is available regarding the export of *N. grandiflora* from India. It seems likely that at least limited trade in Ayurvedic medicines and other finished products takes place; these would appear to be allowed under India's current export controls. Of the rhizomes imported into India roughly 80% were believed to be processed and consumed locally (MULLIKEN 2000). OLSEN (1999) estimated that approximately 17% of *N. grandiflora* imports from Nepal were subsequently re-exported from India.

As noted above, international trade in *N. grandiflora* rhizomes from **China** to Nepal has been reported by traders in Nepal, with imports estimated at approximately 100 tons in 2001/2002, 80-90 tons in 2002/2003, and 50-60 tons 2003/2004 (AMATYA in litt. 2005). CITES-reported trade is limited to the export of 12 500 kg of rhizomes from China to Nepal in 2001, as was recorded in China's CITES annual report data. Imports are said to be in response to the growing demand for oil. Based on interviews with wholesalers in India and supply and consumption estimates, OLSEN (2005a) estimated that exports of unprocessed air-dried *N. grandiflora* rhizomes from **Bhutan** to India totalled somewhere between 3-35 t during 1997/98.

In the USA *N. grandiflora* is readily available for purchase via the internet where US-based companies market 'Spikenard essential oil'. The average price is approximately USD70/kg. The source of oil offered for sale is generally not identified, but Nepal has been given as the origin in some cases. There is no information to indicate quantities of oil traded to the USA (TRAFFIC NORTH AMERICA in litt. 2005). As noted above, there is a small but potentially growing trade in oil to countries in the European Union; there is also a small trade in rhizomes for medicinal use, with one company known to make a phytopharmaceutical based on this species (LANGE & VAN DEN BERG-STEIN in litt. 2005).

Illegal harvest and trade. Significant differences between harvest and trade volumes recorded in Nepal's District Forest Office records and the likely trade volumes based on interviews with harvesters and traders indicate that illegal harvest of *N. grandiflora* is widespread in **Nepal** (OLSEN 2005a). Further evidence is provided by the large quantities of rhizomes exported to India in raw form despite an export ban on unprocessed products. The lack of CITES trade data for exports from Nepal to China similarly indicate that this trade is illegal; exports from **Bhutan** would similarly be illegal given that country's ban on exports.

There have been several seizures of small quantities of *Nardostachys grandiflora* in **India** that were destined for export (Table 8).

Table 8. Seizures of *Nardostachys grandiflora* in India destined for export (2000-2003)

Date	Place	Destination	Commodity	Quantity
03.10.00	CFS, Patparganj New Delhi	Australia	Oil	2 kg
25.01.01	Cochin	Switzerland	Medicines	
05.03.01	Sea Docks Mumbai	Yemen	Rhizome	20 kg
12.01	JNPT New Mumbai	Czech Republic	-	20 kg
31.07.01	FPO New Delhi	USA	Powder	300 g
10.06.03	FPO New Delhi	Finland	Oil	1 bottle

Source: CITES MANAGEMENT AUTHORITY OF INDIA 2001, 2002, 2004.

Legislation and regulations

Regulation of harvest, manufacturing and domestic trade. The main laws governing harvesting of medicinal plants in **India** are the Indian Forest Act (1927), and, to a lesser extent, the Wildlife (Protection) Act (1927/1991/2002). The Indian Forest Act (1927) consolidates the law relating to forest produce, the transit thereof and duty thereon, and empowers State Governments to regulate the transit of forest produce, e.g. medicinal plants. The Act deals specifically with reserved, protected, and village forests. Almost all the States and Union Territories in India have regulations regarding harvest, transit and trade in medicinal plants. Most have established lists of species banned from harvest from forests ("Negative lists"), which include threatened plants (Jain 2000).

The Indian Forest Act (1927) has been adopted by most of the States and is directly applicable to the Union Territories of India. The remaining States have enacted State Forest Acts of their own, which are largely based on the Indian Forest Act. The Forest Acts of the States have been amended from time to time as required. The States have framed Rules under the Acts to protect and preserve the forest wealth of their respective States (JAIN 2000). The Himachal Pradesh Forest Produce Transit (Land Routes) Rules 1977 were amended in 1994 and now lay down the "pass/export permit fee" for specified medicinal plants. The trade in some of the important and threatened medicinal plants of the State has been restricted or banned. See JAIN (2000) for a state-by-state analysis of legislation relevant to the harvest and trade of medicinal plants in general.

Wildlife harvest and domestic trade controls are implemented in **Nepal's** national parks, conservation areas and protected areas via the National Parks and Wildlife Conservation Act (1973); elsewhere in the country, implementation is via the Forest Act (1993) and the accompanying Forest Regulation (1995) (AMATYA in litt. 2005, ARYAL 2000, OLSEN in litt. 2000, SHRESTHA in litt. 2000). A summary of these and related controls for medicinal plants and other non-timber forest products has been compiled by the Asia Network for Sustainable Agriculture and Bioresources (ANSAB) and can be found on their website (BINAYEE undated).

The Forest Act and Regulation stipulate rules governing the collection of forest products. Collection is authorized via licences issued by District Forest Officers (DFO). Licences are required to specify the collection area; the period in which harvest is to take place; the species and quantities to be collected; and method of harvest (AMATYA in litt. 2005, OLSEN in litt. 2000). Licence applicants are required to provide this information and specify the purpose of collection. In accordance with the Regulation, District Forest Officers are required to verify the quantity of medicinal plants collected, collect any associated fees, and issue

a “release order”, which is required to transport harvested plants out of the district of origin. The release order should state: the species and quantity transported; the destination; and the period in which transportation must take place (ARYAL 2000, OLSEN in litt. 2000). There is also a provision to allow harvest and trade licences to be sold at auction (ARYAL 2000).

In their 2001 study in the Dhading District, PANDIT & THAPA (2004) found that implementation of these licensing provisions was low in government forests, reflecting a combination of a lack of resource management rights among the local population and low government enforcement capacity. Inspection of harvested materials to ensure compliance with licence provisions was considered to be low. Adherence to licence provisions was similarly found to be low in community forests, where permitting provisions still applied, but harvest rights were restricted to members of forest user groups. Others have similarly noted low levels of implementation of national harvest and trade controls for medicinal plants and other NTFPs (e.g. see MULLIKEN 2000, OLSEN 2005a).

Protection of flora and fauna in **Bhutan** is provided for under the *Forest and Nature Conservation Act.* Collection of *N. grandiflora* from the wild is allowed under this Act, and transport within Bhutan controlled under a system of permits through a related regulation. According to a regulation issued by the Royal Government Forestry Service Division, it is necessary for regional forestry divisions to submit a quarterly report of extraction of all forest products to the central headquarters. The reports are based on the quantities stated on permits.

Regulation of international trade

CITES listing: *Nardostachys grandiflora* was first proposed for inclusion in CITES Appendix II in 1989 (CITES CoP 7, Lausanne), with a proposal submitted by India. However, this proposal was withdrawn, as the information available was considered insufficient to judge the merits of the listing. India proposed the species for inclusion in Appendix II again at CITES CoP 9 (Fort Lauderdale, November 1994) the proposal was once again withdrawn, and instead referred to the CITES Plants Committee (ANON. 1997). A successful listing proposal was put forward by India to CITES CoP 10 (Harare, June 1997), which became effective 18 September 1997. The listing was annotated to include only “whole and sliced roots and parts of roots, excluding manufactured parts or derivatives such as powders, pills, extracts, tonics, teas and confectionery“ (Annotation #3). The annotation was modified at CITES CoP 14 (The Hague, June 2007), as part of a Plants Committee process to clarify and harmonise annotations for medicinal plants. The revised annotation "Designates all parts and derivatives except: a) seeds and pollen; and b) finished products packaged and ready for retail trade”, and is in effect as of 13 September 2007.

It is important to note that while the earlier annotation of the CITES listing for *N. grandiflora* referred to “roots”, the main parts of the plants in trade are not actually roots but rather rhizomes (i.e. underground stems). The latter term is used in the *CITES Guide to Plants in Trade* (MATHEW 1994) and the *Checklist of Medicinal and Aromatic Plants and Their Trade Names Covered by CITES and EU Regulation 2307/97* (LANGE & SCHIPPMANN 1999). Texts referring to the medicinal properties of these species (e.g. ANON. 1993, JAIN 1994, KEYS 1976, YANG 1996) use both “root” and “rhizome” to refer to the plant parts in trade. It seems unlikely that the lack of CITES trade data for this species reflects a conscious decision not to implement trade controls for rhizomes, however there is nevertheless the potential confusion on this point by government staff charged with implementing CITES trade controls.

CITES is implemented in **India** through a combination of the Wildlife Protection Act, 1972/1991/2002 and the Export and Import Policy (EXIM) of the Foreign Trade (Development and Regulation) Act, 1992 and the Customs Act, 1962. The Wildlife (Protection) Act prohibits export of a number of species, including all six CITES Appendix I plant species native to India, of which one, Kuth *Saussurea lappa*, is a medicinal plant.

Policy on trade in wildlife and wildlife products is established via the EXIM policy, which is revised periodically. The policy, as far as it concerns wildlife, is decided in consultation with the Director of Wildlife Preservation of the Government of India, who is the CITES Management Authority and oversees CITES implementation in the country. The Director has four Regional Deputy Directors and four sub-regional offices of wildlife preservation, these serving as assistant CITES Management Authorities. The EXIM policy is put into effect via the provisions of the Foreign Trade (Development and Regulation) Act 1992 and enforced via the Customs Act (CITES MANAGEMENT AUTHORITY OF INDIA in litt. 2004).

The EXIM policy was embedded within a broader Foreign Trade Policy for the period 2004–2009, this change coming into effect on 1 September 2004. The Foreign Trade Policy aims at doubling India’s share in global trade and expanding employment opportunities, particularly in rural and semi-urban areas, and includes a Special Agricultural Produce Scheme, promoting the export of, *inter alia*, minor forest produce such as medicinal plants and their value-added products. The policy outlines that all export and import

shall be “free”, i.e. unrestricted, unless regulated under any legislation. Goods imported in accordance with this policy may be exported in the same form without a licence, provided that there is no import or export restriction for the items. Even goods restricted for import may be imported under Customs Bond for export without a licence provided that the items are freely exportable. Specific note is made in the policy that this does not preclude the application of other laws (DIRECTORATE GENERAL OF FOREIGN TRADE 2004).

Import and export restrictions for specific products are established via India’s ITC (HS) classifications in accordance with the broader policy. Several categories relevant to CITES-listed species have been identified as goods allowed to be imported without restriction (i.e. free of import duties or quotas), e.g. “medicinal plants, fresh or dried, whether or not cut, crushed or powdered” (Schedule 1 Chapter 12), lac, gums, resins and other vegetable extracts (Schedule 1, Chapter 13), pharmaceutical products (Schedule 1, Chapter 30) and essential oils (Schedule 1, Chapter 33). Although instructions under the EXIM policy for 1997-2002 stipulated that imports of plants, products and derivatives were subject to CITES provisions (TRAFFIC INDIA 1998), the low levels of trade data for imports of CITES-listed species into India indicate that these provisions were not implemented effectively.

It does not appear that any CITES-related import controls were established via the policy for 2004-2009 until early 2006, nor that these existed under other legislation (with the exception of *Saussurea lappa*), with the effect that imports of CITES-listed medicinal plant species was uncontrolled. However, on 6 February 2006 the ITC (HS) Classifications of Export and Import Items were amended such that imports of *Rauvolfia* spp. (all species) are to be subject to CITES provisions (Ministry of Commerce & Industry Department of Commerce Notification No. 42 RE-2005/2004-09). Similar amendments were made for Kuth (*Saussurea lappa*) roots, cacti, agarwood and agar oil. This would seem to indicate that CITES trade controls are not required for imports of other CITES-listed plant species, including *Nardostachys grandiflora*, however confirmation of this is required.

As stipulated in Chapter 12 of the ITC (HS) classifications, the export of plants, plant portions, their derivatives and extracts of species included in CITES Appendix I and II obtained from the wild is generally prohibited. Further clarification is required to confirm whether this applies to wild specimens regardless of their country of origin, or to only those specimens obtained within India. An “Export Licensing Note” appended to Chapter 12 specifies 29 plant taxa for which export is generally prohibited. This list includes *Nardostachys grandiflora*. An exception for both CITES species and those listed in the Licensing Note is made for the export of “formulations”, defined as including “products which may contain portions/extracts of plants on the prohibited list but only in unrecognizable and physically inseparable form” and “value added formulations as well as herbal Ayurvedic” (Chapter 12, Export Licensing Note 3). It is not clear whether the term “recognizable” is defined per the CITES interpretation of “readily recognizable” such that if the ingredients of a particular formulation of Ayurvedic medicine are listed on the packaging, then they are considered to be “recognizable”. The instructions include a note that states that “no certificate from any authorities whatsoever shall be required for their [formulations] export,” implying that no CITES permits would be required for such exports. Export Licensing Note 2 states that export permits are required, however it is not clear if this applies only to cultivated specimens, which are allowed to be exported (see below) or also to formulations. CITES Management Authority staff have advised that, if Customs staff refer a shipment of “formulations” containing CITES-listed species to the Management Authority for clearance, then issuance of a CITES export permit will be required (AARTI in litt. 2005).

A further exception is provided for exports of wild CITES-listed species on a case-by-case basis for “life saving drugs”, which could presumably be applied to any medicinal species. However, in this case a CITES permit would be required, with such trade only allowed on recommendation of the Ministry of Environment and Forests.

Exports of plants produced via cultivation are allowed subject to obtaining a transit pass from the relevant Divisional Forest Officer if the plants were cultivated in sites within forests, or a Certificate of Cultivation from a District Agriculture, Horticulture or Forest Officer if cultivated at sites outside forests. Export Licensing Note 2 included in this schedule states that “However, in respect of CITES species, a CITES permit of export shall be required”. As noted above, it appears that this provision relates to all but formulations, however this requires further clarification.

It does not appear that export restrictions on wild specimens of CITES-listed species apply to imported specimens, however this requires confirmation, nor does it appear that there are any specific provisions made for controlling re-exports of CITES-listed species, other than as may be required to prove that re-exports do not involve wild-collected stock from within India. No reference could be found to an earlier (2003) provision requiring exporters of value-added formulations made out of imported species from the list of “prohibited plants” to provide an affidavit to Customs authorities at the time of export that the specimens were legally imported (NTF NO. 03/2003 31/03/2003). However, CITES Management Authority staff state that proof of import is required prior to granting re-export permission, and that they take into account,

for example, the amount of unprocessed product that would have been required on import to produce a given export quantity (JAIN in litt. 2005). CITES Re-export Certificates are issued for such shipments (AARTI in litt. 2005).

Exports are required to be limited to the following ports: Mumbai, Nhava Sheva, Kolkata, Cochin, Delhi, Chennai, Tuticorin, Amritsar, Calicut and Thiruvananthapuram (DIRECTORATE GENERAL OF FOREIGN TRADE 2004). It is not clear if this relates to all plants covered under this Customs classification, or only to CITES-listed species and other medicinal species for which export is prohibited.

All violations of the EXIM policy constitute an offence under the Customs Act and are dealt with by Customs officials, who alone have the responsibility to enforce compliance with CITES at border posts. Inspection of consignments by Wildlife Inspectors, co-operating with Customs staff, may also be carried out at border crossings, but such specialist investigations are few. Enforcement of any violations detected is the responsibility of the Customs authorities (PANDA in litt. 1998).

There is no specific CITES-implementing legislation in **Nepal**, however legislation to promote more effective CITES implementation has been under consideration since the late 1990s. If agreed, the Rare (Endangered) Wildlife and Plants Trade Control Act, 2057 (2002) would provide a more powerful legal tool for CITES implementation within Nepal, and includes a number of CITES-relevant provisions (HEINEN & CHAPAGAIN 2002).

Nepal's CITES Management Authority for plants is the Department of Forests, Ministry of Forests and Soil Conservation. The CITES Scientific Authority for plants is the Department of Plant Resources, Ministry of Forests and Soil Conservation. The Management Authority issues export permits for plants covered by CITES and/or the Forest Act that are in a processed or semi-processed form (BISTA in litt. 2000).

Export of *Nardostachys grandiflora* from **Nepal** was banned in 1995 via publication of a notification in the Nepal Gazette (under rule 12 and 13 (2) of the Forest Regulation, 1995) on 3 April 1995. This was amended in 2001 to allow export in processed form, as long as processing takes place within Nepal and permission is obtained from the Department of Forests, advised by the Department of Plant Resources and Herb Production and Processing Co. Ltd. (per Clause 2 of Nepal Gazette vol. 3, Section 51 No. 36, dated December 31, 2001 issued by Ministry of Forests and Soil Conservation) (AMATYA in litt. 2005). According to PANDIT & THAPA (2004), the ban on export of raw materials of certain medicinal species has been misinterpreted by some District Forest Office staff as relating to trade from one District to another, rather than to export from Nepal, increasing the incentive for illegal trade by village collectors.

The Management Authority also maintains liaison with the Department of Customs, Intelligence, Police and other agencies. However, it was noted in 2000 that Customs officers had not been trained in the identification of medicinal plants (BISTA in litt. 2000); it is unknown if training has been provided since that time. Personnel from the Department of Forests and District Forest Offices have been posted at the Customs points in the Terai to examine consignments containing wild flora (ARYAL 2000).

Treaty of Trade between Nepal and India

In an effort to expand trade between their two countries, the Governments of India and Nepal entered into a bilateral trade agreement in 1991. The treaty provides for preferential treatment (exemption from Customs duty and quantitative restrictions) of trade of certain "primary products", which include forest produce that has not undergone processing, and Ayurvedic and herbal medicines (Article IV) (ANON. 2002b). Under this treaty, a certificate of origin issued by the Government of Nepal is the only document required for presentation to India's Customs authorities at the time of import (MULLIKEN 2000). Trade in conjunction with the treaty is required to take place via one of the 22 border crossings designated in Annex A of the treaty. During the late 1990s, border officials were unaware that CITES documentation might also be required for export (as noted above, under India's current CITES implementing legislation and the EXIM Policy, CITES export permits would not be required to accompany shipments into India in any event). The treaty contains provisions for stronger domestic measures on the part of national governments, and provides a list of articles not allowed preferential treatment (e.g. cigarettes and alcohol) as an annex. It appears that this Annex could be amended to reflect CITES requirements (MULLIKEN 2000).

TRAFFIC India informed Government authorities in both India and Nepal of the apparent relevance of this treaty with respect to CITES trade controls. Initial research results from this study were communicated to the second Indo-Nepal Trans-border Meeting in February 1999. As a result, the final resolution of that meeting called for bringing the bilateral treaty in line with CITES requirements (MULLIKEN 2000).

The treaty was extended for a further five years in 2002 and remained in effect until 5 March 2007 (ANON. 2002b). Although some amendments were made, these did not reflect the concerns raised regarding

CITES implementation (AMATYA in litt. 2005). The treaty has been extended for a further five years, and will remain in effect until 5 March 2012.

At present, there is no law formulated specifically to implement CITES within **China**, however, a series of regulations implementing CITES, the Import and Export Regulations of Endangered Wild Fauna and Flora, came into effect on 1 September 2006. China's Law of Wild Plant Protection took effect 1 January 1997. Under this law, protected plant species are classified into those of "national key significance" and those of "local key significance". Protected plant species of national key significance are further divided into Category I and Category II-protected species. Trade in Category I-protected species is not allowed. Trade in plant species listed as Category II is subject to authorization by the relevant government agencies at the provincial/autonomous region level. The State Forestry Administration, the Ministry of Agriculture and other authorized governmental authorities at the provincial/autonomous region level are responsible for enforcing the Law of Wild Plant Protection. A list of 255 species is appended to this law. From 1 January 1998, China's regulatory system for the export of wild animals and plants was strengthened by the Endangered Species Import and Export Management Office (under the State Forest Administration), the designated CITES Management Authority, and the Customs Authority. A wide range of animals and plants with their corresponding Harmonized System Customs codes are specified in an annex attached to a Joint Notification from the Management Authority and the Customs Authority. The list is said to be compiled on the basis of the CITES Appendices and the lists of key national protected animals and plants. The Notification was amended in February 1999 to include *Nardostachys grandiflora*. The Notification has been circulated among the officers of the Management Authority and Customs across the country and was copied to various other governmental agencies. Trade in live animals or plants, parts in their raw form, and products made from those animals and plants specified on the said list are controlled. According to the Notification, where applicable, import/export permits or certificates are required.

Exports of most medicinal plants, including *N. grandiflora*, from **Bhutan** are banned (MULLIKEN 2000).

Conclusions

There is a rapidly growing body of information concerning the harvest and trade of *N. grandiflora*, particularly within Nepal, and to a lesser extent, in India, with detailed studies of regeneration rates having been undertaken at some sites. Available evidence supports earlier conclusions that the species is declining in parts of its range, to the point that many consider it to be threatened. There is no indication that demand, and therefore harvest to meet it, will decline in the foreseeable future.

Demand for *N. grandiflora* within India remains strong and is met largely by imports of rhizomes from Nepal (illegal according to Nepal's export controls), followed by harvest of rhizomes within India, and then by imports from Bhutan (illegal according to Bhutan's export controls). Nepal's domestic processing of rhizomes to produce essential oil is increasing, reflecting the government ban on exports of unprocessed rhizomes and increased access to distillation technology.

The history and similarity in the scientific and common names of *N. grandilfora* (Jatamansi) and *Valeriana jatamansi* (Indian Valerian) and in their usage are contributing to the lack of clarity regarding the distribution of *N. grandiflora*, particularly within Pakistan. In addition, it seems likely that a lack of knowledge of the difference between these and several other species, e.g. *Selinum* spp., could undermine efforts to enforce national and/or international trade controls, as well as lower product quality as a result of adulteration.

Although local and national harvest and trade controls for *N. grandiflora* appear to be comprehensive on paper in India and Nepal, implementation and enforcement of these controls appear to be minimal for this species. CITES implementation seems to be virtually non-existent, as reflected by the ongoing trade in rhizomes from Nepal and Bhutan to India without accompanying CITES documentation or reporting in CITES annual reports.

It is now more than 15 years since India first sought assistance with controlling the international trade in *N. grandiflora* through a CITES listing, and nine years since that listing took effect. More than five years have passed since a CITES Secretariat-funded study documented problems associated with the trade and implementation of trade controls was presented to the CITES Plants Committee and subsequently published. Although a great deal more research on the species has been published since that study, the situation with regard to harvest management and trade controls remains largely unchanged.

Given the strong and persistent demand for *N. grandiflora*, evidence of declines in parts of its range, and the importance of harvest and trade to rural livelihoods, greater attention should be paid to developing and promoting sustainable harvest methods. Implementation of these methods should be supported by a policy framework that provides incentives for sustainable management and trade within established controls, including CITES. As noted by OLSEN (2005b), concerted action to reduce harvests or trade in one country

may simply shift harvest pressure to neighbouring countries, and therefore fail to achieve wider conservation objectives. A regional approach to managing this regional resource would be preferable, involving a range of stakeholders from both range States and consumer countries.

Possible next steps

Range States for *Nardostachys grandiflora* might consider:

- Co-convening a regional multi-stakeholder workshop to facilitate sharing of information and experiences, and facilitate development of a regional strategy for sustainable management of *Nardostachys grandiflora* and other Himalayan medicinal plant species;
- Pursuing a programme of collaborative research and action to:

  Determine the distribution and status of these species, including confirmation of rates and causes of decline and regeneration;

  Determine the source and quantity of specimens in domestic and international trade;

  Identify and develop sustainable harvest practices;

  Review and clarify domestic harvest and trade controls and export policies for *N. grandiflora*, and identify appropriate and mutually reinforcing responses with regard to harvest and trade control problems identified; and

  Develop and distribute local language and visual educational materials to support the implementation of sustainable harvest practices.

The Government of China might consider:

- Expanding national legislation to address harvest and trade of *N. grandiflora.*

The Government of India might consider:

- Reviewing and revising existing legislation to include CITES-related controls on imports, and, if not already in place, re-exports of *N. grandiflora* and all other CITES-listed plant species.

The Government of Nepal might consider:

- Establishing a process to review and improve the structure and implementation of current national-level legislation for the harvest and trade of *N. grandiflora* and other alpine species.

The Governments of both India and Nepal might consider:

- Modifying the Treaty of Trade between Nepal and India in order to reflect CITES requirements.

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Picrorhiza kurrooa

Taxonomy *Picrorhiza kurrooa* ROYLE ex BENTH (family Scrophulariaceae)

Synonyms *Picrorhiza scrophulariiflora* PENNELL (part); *Neopicrorhiza scrophulariiflora* (PENNELL) HONG (part)

Note: The genus *Picrorhiza* was originally considered monotypic, comprising the single widespread species *P. kurrooa*, until PENNELL (1943) distinguished a second species, *Picrorhiza scrophulariiflora,* which was subsequently placed in a separate genus, *Neopicrorhiza*, by HONG (1984), although the original generic name is still widely used for the latter species. The two species are apparently largely or entirely allopatric, with *P. kurrooa* occurring in the Western Himalaya and *N. (P.) scrophulariiflora* found further east, although a sketch map in SMIT (2000) indicates a small area of apparent sympatry in northeast Uttar Pradesh (the Himalayan sections of which are now Uttaranchal), India. MILL (2000) has subsequently described a second species of *Neopicrorhiza* (*N. minima*) from northern Bhutan. For further details on the taxonomic history of *Picrorhiza* and *Neopicrorhiza scrophulariiflora* see SMIT (2000). The species *P. kurrooa* and *N. scrophulariiflora* are distinguished solely on floral characteristics and there is currently no way of separating those parts in trade (rhizomes and various derivatives thereof), other than by inference when the collection locality is known. Moreover, the designation *Picrorhiza kurrooa* is still sometimes used to cover all populations, although the CITES listing of *P. kurrooa* is contains a note stating that it excludes *Picrorhiza scrophulariiflora*.

The account in preparation includes information on both *Picrorhiza kurrooa* and *Neopicrorhiza scrophulariiflora*. Every attempt has been made to avoid ambiguity. Where appropriate, the common name Kutki, which can apply to rhizomes of both *Picrorhiza* and *Neopicrorhiza,* is used rather than one or other scientific name.

It is important to note that while the existing CITES annotation for *P. kurrooa* refers only to "roots", the main parts of the plants that are in trade are not actually roots but underground stems or rhizomes. The latter term is used in the *CITES Guide to Plants in Trade* (MATHEW 1994) and the *Checklist of Medicinal and Aromatic Plants and Their Trade Names Covered by CITES and EU Regulation 2307/97* (LANGE & SCHIPPMANN, 1999). Texts referring to the medicinal properties of these species (e.g. ANON. 1993, JAIN 1994, KEYS 1976, YANG 1996) use both "root" and "rhizome" to refer to the plant parts in trade. The extent to which the true roots are used is unclear. The text that follows generally refers to the parts used and traded as "rhizomes", following LANGE & SCHIPPMANN (1999); however, it should be understood that this may refer to both roots and rhizomes. "Root" is used in cases where this is the specific term used by the source being cited. A proposal to amend this annotation to cover all parts and derivatives except "seeds and pollen" and "finished products packaged and ready for retail trade" will be considered by the 14th meeting of the Conference of the Parties to CITES (The Hague, June 2007).

Trade names Gorki (Gurung), Hodling (she), Honglen (she), Hong-len (tib), Hugling (she), Kadu (Himachal Pradesh), Karroo (Pakistan), Katuka (san), Kaur Kutki (Pakistan), Kuraki (Tamang), Kutaki (Gurung, Lhotshampkha), Kutki (Lhotshampkha, nep), Ngo-Honglen (bhu), Picrorhiza rhizome (chi), Puti-shing (Dzongkha), Xuan hu lian (chi) (AKHTER in litt. 2005, AMATYA in litt. 2005, CHU 2004, MUKHIA 2004, RASTOGI & PANT 2004).

Description. Both *Picrorhiza kurrooa* and *Neopicrorhiza scrophulariiflora* are small, slightly hairy, long-lived perennial herbs with elongated creeping stolons emerging from a rhizomatous rootstock which is described as having a thick skin, wrinkled and prominently striated. The vegetative parts of the two species are visually indistinguishable. Rhizomes are long and slender, often zigzagging, and do not taper. They are evanescent inside and can be easily compressed. Dried rhizomes are cylindrical, deep greyish brown in colour and longitudinally wrinkled with annulations at the tip. Leaves mainly basal, narrowly elliptic to spatulate and coarsely, sharply dentate, 1.5-5 cm long, 0.5-1.2 cm wide (SMIT 2000). Flowers pink, light blue or purple-blue, in a cylindrical terminal spike, arising from a rosette. According to NAUTIYAL & NAUTIYAL (2004) two morphological variants of *Picrorhiza kurrooa* exist in Garhwal Himalayas (India), a narrow-leaf variant generally found in open pastures and near springs, and a broad-leaf variant found generally under the shrub canopy. It is not clear if these are genetic variants or merely reflect phenotypic variation under different growing conditions.

The flowers of the two species can be distinguished as follows: in *Picrorhiza kurrooa* the corolla is 4-5 mm long, five-lobed and nearly actinomorphic (that is nearly radially symmetrical, an unusual feature in members of the Scrophulariaceae); the stamens are many times longer than the corolla; in *Neopicrorhiza scrophulariiflora* the corolla is 9-10 mm long, four-lobed and bilabiate with stamens equalling the corolla in length (SMIT 2000). The fruits of *N. scrophulariiflora* are found in many-seeded capsules, with about eight fruits per flowering ramet and some 6-18 seeds per fruit (GHIMIRE & al. 2005).

N. scrophulariiflora has been reported to flower in June-July and to fruit from August onwards in Nepal by GHIMIRE & al. (2005), who note that the timing of fruiting varies with altitude. Others report that flowering extends into August with fruiting taking place from October to November (AMATYA in litt. 2005). Seeds of *N. scrophulariiflora* are dispersed by wind, water and gravity, and germinate in May or June but germination rates are low and there is no persistent seed bank (GHIMIRE & al. 2005). According to RASTOGI & PANT (2004), flowering and seed production of *P. kurrooa* in Himachal Pradesh take place in the third year. Plants may root from stem nodes. In addition, underground rhizomes may sprout to form new rosettes some distance from the mother plant (AMATYA in litt. 2005, ANSAB 1999, GHIMIRE & al. 2005, IUCN-NEPAL 2004, LAMA & al. 2001, MANANDHAR 2002).

Distribution. See SMIT (2000) for a detailed list of localities in which *P. kurrooa* and *Neopicrorhiza scrophulariiflora* have been identified.

Picrorhiza kurrooa is recorded from India and Pakistan. In **India**, SMIT (2000) lists localities in Jammu & Kashmir, Himachal Pradesh and Uttar Pradesh (the Himalayan sections of which are now Uttaranchal). The main altitudinal range is 3000-4300 m, although there are records from as low as 2500 m and high as 5300 m (SMIT 2000). It occurs from 2700-4500 m in Himachal Pradesh, with its distribution in the Great Himalayan National Park complex fairly well known both through scientific surveys and the native knowledge of collectors (RASTOGI & PANT 2004). KAUL & HANDA (2000) studied the species at seven sites in the states of Jammu & Kashmir, Himachal Pradesh and Uttar Pradesh (Uttaranchal, per the above). The habitat characteristics of each site were found to be more or less similar, suggesting microhabitat homogeneity. Soil conditions were mostly acidic with ample organic matter. The plant was found to prefer broken rocky substrate and gentle slopes. In **Pakistan** *Picrorhiza kurrooa* is reported from the Qamri and Bruzil passes and the high-altitude Deosai plains (RASOOL 1998). The species prefers alpine moist rocky slopes, and typically grows above 4000 m (AKHTER in litt. 2005).

Neopicrorhiza scrophulariiflora is recorded from Bhutan, China, India and Nepal, with the main altitudinal range being 4300-5200 m (SMIT 2000). Most of the range is within **Nepal**, with the species said to be distributed abundantly throughout the alpine Himalaya of the entire country. The altitudinal range of the species is reported to be from 3500 m to over 5200 m with preferred habitat homogeneous, broken rocky substrate, mainly on moist acidic soils rich in organic matter in meadows and shrublands, including open rocky pasture land, and on stony slopes, with a preference for rocky crevices (GHIMIRE & al. 2005, IUCN NEPAL 2004, MANANDHAR 2002). In **India** there are records from eastern Uttar Pradesh and Sikkim (SMIT 2000). The species occurs in protected zones, in particular in Uttaranchal: Askot, Govind and Kedarnath Wildlife Sanctuaries and Valley of Flowers, Nanda Devi, Govind and Gangotri National Park (KAUL in litt. 2005).

In **Bhutan** the species is said to occur from 2700-4880 m and to be found in Lhedi, Threga, Tshangza, Tsodzong in Lunana, Gogona, Sephu, Pelela, Dagala (top), in Haa above 4500 m, the higher altitudes of Khebesa-Dagana, Thimphu, Punakha, Upper Mo Chu, Upper Bumthang Chu and Upper Kulong in Tashiyangtshi (ANON. 1998, MUKHIA 2001, 2003, Unpublished, NOLTIE 1994). In **China** the species is recorded from the southern part of Xizang (Tibet Autonomous Province) and southwestern Yunnan (ANON. 1997, CHU 2004 and see map in SMIT 2000).

Population status and threats. *Picrorhiza kurrooa* and *Neopicrorhiza scrophulariiflora* are not included in the IUCN Red List (IUCN 2006), although the family Scrophulariaceae has not been systematically reviewed. Both species are wide ranging in suitable habitat. Populations have reportedly declined in parts of the range owing to overharvest. Habitat loss is also considered to have adversely affected populations (GOVERNMENT OF INDIA 1997). Collection is said to have increased in Nepal and the eastern Himalaya (i.e. within the range of *N. scrophulariiflora*) but to have decreased in the Kashmir Himalaya (where the species present is *P. kurrooa*) as a result of which populations there are reportedly regenerating rapidly (KAUL in litt. 2005).

Neopicrorhiza scrophularifolia was assessed as *Vulnerable*[2001] in **Nepal** during a 2001 CAMP workshop (BHATTARAI & al. 2002). However, OLSEN & LARSEN (2003), while considering the information from the CAMP workshop a useful starting point, questioned the classifications, considering the empirical data upon which the assessments were made to be scant, quantitative information on the status of the re-

source and on harvest levels across Nepal lacking, and evidence of overharvest inconclusive. AMATYA (in litt. 2005) notes that deforestation, forest fires, grazing and agriculture have contributed to habitat loss, but considers unregulated overharvesting to be the main threat. Uncontrolled burning of pasture and forest fires were considered the primary threats in Humla in the late 1990s, along with premature collection and unscientific harvest practice (ANSAB 1999).

GHIMIRE & al. (2005) found that *N. scrophulariiflora* appeared to be much less susceptible to the effects of indiscriminate harvest than *Nardostachys grandiflora*. This was because in harvesting *N. scrophulariiflora*, it was very likely that fragments of rhizomes extending laterally underground from the mother plant would be left behind and would be capable of regenerating the following season. They observed significant regeneration even in study plots where 100% of plants were harvested in a season. Such regeneration was thought much more likely to be from rhizome fragments than from seed – as noted above, seed germination rate appears to be very low.

In the *Red Data Book of Indian Plants* (NAYAR & SASTRY 1988), *P. kurrooa* (*sensu lato,* that is, including any Indian populations of *N. scrophulariiflora*) is classified as "vulnerable". According to the supporting statement provided with India's CITES listing proposal for the species, *Picrorhiza kurrooa* was thought to be common in **India** until the 1970s or 1980s, when perhaps over 60% of the population was destroyed because of collection prior to the fruiting season, which inhibited regeneration GOVERNMENT OF INDIA (1997). KALA (1997) considered that populations had declined by 75% in Uttar Pradesh, a Conservation Assessment and Management Plan (CAMP) workshop in the same year considering India's population as "threatened with extinction" and classifying it as "endangered" (TANDON 1997). In 2003, a second CAMP workshop assessed populations as: *Critically Endangered*[2001] in Uttaranchal (where the species concerned would be *P. kurrooa*); *Endangered*[2001] in Arunachal Pradesh (*P. kurrooa*), Jammu & Kashmir (*P. kurrooa*) and Himachal Pradesh (*P. kurrooa*); and *Vulnerable*[2001] in Sikkim (*N. scrophulariiflora*), on the basis of each population being affected by habitat degradation and loss, and harvest for medicine and trade (RAWAT in litt. 2005, VED & al. 2003a & 2003b). RAWAT (in litt. 2005) states that natural disasters (e.g. floods, land slides), human-induced habitat loss and degradation, and harvest for sale to domestic markets continue to be the major threats in India.

MUKHIA (2004) refered to the species as being "very rare" in **Bhutan**, noting that detailed surveys have not been done to confirm the availability of the resource. A review of its abundance in the Dzongkhags indicated it was "quite rare" in that location. In **China**, quantitative data are lacking, but *N. scrophulariiflora* was assessed as "endangered" in the *China Plant Red Data Book* (FU & JIN 1992), and as a Category III species in the Regulation of China on Protection of Medicinal Resources (1987), indicating it is considered a "major and commonly used and wild medicinal species whose resources are reducing" (TRAFFIC EAST ASIA in litt. 2004).

In **Pakistan** the species is reported to be declining because of habitat disturbance related to changes in land use brought about by increased tourism, human settlement and road building. Unsustainable harvest and natural disasters, e.g. floods and landslides, are also considered a threat, though less severe than habitat disturbance. Pollution is considered a lesser threat. Climate change is causing an upward shift in the permanent snow cover and therefore population declines in the lower elevation range of distribution (AKHTER in litt. 2005).

Medicinal uses

Plant parts used for medicinal purposes: Rhizomes and, to a lesser extent, roots. As far as is known, no distinction in use is made between *P. kurrooa* and *N. scrophulariiflora.*

In **Bhutan**, Kutki is used as a medicine for coughs, colds and fever. The National Institute of Traditional Medicines and other indigenous hospitals use the rhizomes as an ingredient in manufacturing medicine (MULLIKEN 2000).

Use of Kutki in traditional medicine is **China** is believed to date back at least to the first century AD (FU 1993, ZHANG & al. 1994). It is said to have an effect on fever, malnutrition due to digestive disorders, jaundice, diarrhoea and dysentery (ZHANG & al. 1994). The species is also used in traditional Tibetan medicine. In Hong Kong, the plant is probably not widely used and rarely traded.

Kutki is widely used in Ayurvedic and Unani traditional medicines in **India** with the rhizomes prized for their efficacy as an antibiotic. It is regarded as one of the major components of *Arogyavardhini*, a potent Ayurvedic formulation used to treat liver ailments. Kutki is also used as an adulterant of, or as a substitute for, *Gentiana kurroo* (KHAN & ZAIDI 1989, ZAMAN & KHAN 1970). Pharmaceutical uses of Kutki are also being explored within India (see below).

In **Nepal**, the roots have a wide range of uses, for example to treat coughs, skin disease, fever, indigestion, liver disease, jaundice, hepatitis and metabolic disorders. Formulators in Kathmandu reported that it is used as a purgative and laxative and to treat scorpion bites (AMATYA in litt. 2005), with uses also including treatment of high blood pressure, intestinal pain, eye disease, gastritis, bile disease, sore throats, blood, and lung fever (LAMA & al. 2001). It is considered a bitter tonic, antiperiodic (preventing regular reoccurrence of the symptoms of a disease), used as a cholagogue (promoting the flow of bile from the gall bladder), stomachic (stimulating gastric activity) and cathartic (purgative) (IUCN NEPAL 2004). GHIMIRE & al. (2005) note that in Nepal Kutki is used both by *amchi* (specialists trained in the Tibetan medical system or Sowa Rigpa) and by non-specialists, in the latter case largely for treating coughs and colds.

Kutki is used in the Ayurvedic and Greek-Arab systems of medicine in **Pakistan**, most commonly as an aromatic, carminative agent, stimulant and as a remedy for coughs, bronchial asthma, persistent hiccups and diseases of blood, liver, kidney and skin. Under the name of *Qusttalakh, P. kurrooa* is used in two herbal preparations (*Maajon-e-murravehul-azwah* and *roghane-qust-talakh*, an essential oil), which are also used for treatment of hypothermia, debility, tremors, tetanus and gout (HAMDARD 1968).

Research has been undertaken to explore the pharmaceutical use of Kutki, the active compounds of which include the iridoid glycosides picroside and kutkoside. SINGH (2004) uses the term “kutkins” to refer to these compounds, a term also used to refer to the active ingredients in several over-the-counter herbal products containing Kutki marketed, for example, in North America. Some products contain “Picroliv”, a mixture containing 60% picroside I and kutoside in the ratio of 1:1.5 obtained from *Picrorhiza kurrooa* (roots and rhizomes) developed by India’s Central Drug Research Institute (CDRI, undated), and in phase III clinical trials for hepatoprotective functions (IMAM 2006).

Other uses. The rhizomes are used locally in Pakistan as an insect repellent and to prevent moth damage to woollen clothing (HAMDARD 1968). They are also used in the religious ceremonies of Buddhists and burnt as aromatic incense (IUCN PAKISTAN in litt. 2005).

Harvest and processing. OLSEN (2005a) estimated that global annual production of Kutki for trade was in the order of 650-1000 t, of which a maximum of 50-300 t was believed on the basis of origin to be *Picrorhiza kurrooa* and the remainder *Neopicrorhiza scrophulariiflora.* This figure excluded production within China and Pakistan. Amounts produced in each of these countries are unknown, but are unlikely to be very large, given the apparently limited range of the species in these two countries. Approximately two-thirds of the Kutki in trade was believed to originate in Nepal, around 20% in India and the remaining 15% in Bhutan.

It appears that the common practice throughout the range of the species is to uproot the entire plant during collection, but to use only the rhizome, and possibly also the roots. Mature plants – those three to four years old – are considered most suitable for harvest, particularly after fruiting and especially when dormant as this is when the content of the active ingredients is highest (KAUL in litt. 2005, RASTOGI & PANT 2004, RAWAT in litt. 2005, SINGH 2004). As noted above, the timing of fruiting varies with altitude and can range from August until November (GHIMIRE & al. 2005).

In their study comparing harvesting patterns of *Nardostachys grandiflora* (q.v.) and *Neopicrorhiza scrophulariiflora* in northwest Nepal, GHIMIRE & al. (2005) noted that collection for trade (that is for national and international markets away from the study site) was far more indiscriminate than collection by *amchi* for local use. The latter harvested selectively, only taking older plants and harvesting at the optimum season, while the former harvested largely in response to market demand, irrespective of season and maturity of the plants concerned. In areas where Kutki is collected for trade, collectors perform the primary processing, such as cleaning and drying. Regional traders sometimes dry and repack the rhizomes and national wholesalers sort and dry as well. The exporter grades the trade stock, as required by the buyers, e.g. the pharmaceutical manufacturers. The latter conduct quality assessments, testing the active ingredients in samples provided by the exporter (AMATYA in litt. 2005).

Harvest and trade of the species in **Nepal** has been extensively studied (see GHIMIRE & al. 2005, MULLIKEN 2000, OLSEN 2005a). OLSEN (2005a) estimated total annual production as varying from something under 200 t to around 800 t, with perhaps 500 t harvested in fiscal year 1997/1998. Virtually all production is in high mountain regions, with just under 40% believed to come from the Mid-Western Development Region and 30% from the Eastern Development Region, the remainder being divided between the Central, Western and Far Western Development Regions (OLSEN 2005a). Production is highest between 4000-4250 m altitude (estimated at *ca.* 1300 kg/ha/year) and decreases with decline in altitude; annual yield at 3800-4000 m is estimated at around 820 kg/ha and at 3650-3800 m, 500 kg/ha (AMATYA in litt. 2005, ANSAB 1999). There are no figures for overall standing stock. However, ANSAB (1999) made some assessment of abundance in Humla District. They estimated the area occupied by *N. scrophulariiflora*

there to be some 28 000 ha, with overall total stock (fresh weight) in the range 2300-3300 t, with a median estimate of 2800 t.

OLSEN & LARSEN (2003) found that commercial harvest of medicinal plants in general formed an integral part of the livelihood strategies of, conservatively, 7-10% of the population in areas classified as 'mountain regions' in Nepal (that is, some 25 000-35 000 people), providing from 3-44% of annual income (mean 12%). Using 1997/1998 data, they estimated the total annual harvester value of alpine and sub-alpine medicinal plants to be in the range of USD0.8-3.3 million. *N. scrophulariiflora* was the second-most important species involved, accounting for around 30% of harvester value (USD0.2-1.0 million).

Harvest figures in Nepal based on forest revenue figures indicate far lesser quantities harvested (see Table 1), particularly from 2001-2003 when a restriction on collection was in force (see 'legislation') (AMATYA in litt. 2005). There is insufficient information to confirm whether these figures demonstrate a genuine dramatic decrease in harvest levels since the work of OLSEN in the late 1990s. Given what is believed to be continued strong demand for Kutki and generally low enforcement of national harvest and trade controls (e.g. see OLSEN 2005a), it seems more likely that official trade figures reflect only a portion of actual harvest levels during the years in question.

Table 1. National collection and sales figures based on royalty (forest revenue) records

Kutki (*Neopicrorhiza scrophulariiflora*)					
Fiscal year	**1999/2000**	**2000/2001**	**2001/2002**	**2002/2003**	**2003/2004**
Quantity kg (dry weight)	46 905	39 106	115	350	5 200

Source: Department of Forests, Ministry of Forests and Soil Conservation, Nepal, cited in AMATYA in litt. (2005).

In **India**, the main geographical area of collection is Uttaranchal, in particular Kumaon between 3400-4000 m altitude. This area is barely cultivated (RAWAT in litt. 2005).

In **Pakistan**, IUCN PAKISTAN (in litt. 2005) notes that local peoples (Gujjars (Bakarwal) and Hakims) collect the plant as and when needed. The forest department has reportedly not been involved in the harvest of Kutki since 1992 (AKHTER in litt. 2005).

The species is not known to be commercially cultivated in **China**; all plant material is believed to be derived from wild sources (TRAFFIC EAST ASIA in litt. 2004).

Cultivation. RASTOGI & PANT (2004) report that *Picrorhiza kurrooa* was found to respond "extremely well" to mass propagation in nurseries and experimental plantation trials in the forests of Himachal Pradesh, **India**, with multiplication best achieved through root cuttings, an average of four of which could be obtained from a year-old plant. This species was planted in 25 Medicinal Plant Propagation Areas in 2001 and 2002, with an inventory of 145 300 plants in 2003 expected to yield 2179-2906 kg of *P. kurrooa* rhizomes (net weight in fresh condition soon after harvesting) in 2006. This was based on an estimated net harvest of 15-20 g per plant harvested after three years of growth.

Propagation protocols using tissue culture are known (SAMANT & al. 1998).

NAUTIYAL & NAUTIYAL (2004) report that in nurseries about 80-90% of the seed germinates, of which 50-60% of the seedlings survive. They estimate maximum production after three years in cultivation to be 450 kg/ha at 1800 m altitude and 612 kg at 2200 m altitude. The broad-leaved variety of *P. kurrooa* grows more rapidly, produces more and has a higher content of active ingredients than the narrow-leaved one.

KAUL & HANDA (2000) report on domestication experiments performed in three sites in India: Srinagar (1600 m), Kud (1750 m) and Verinag (3050 m). Mortality was highest in Srinagar, the site at the lowest altitude, where only 20% of the cultivated specimens flowered and no seed was set. In Kud, vegetative growth was abundant in the shade, but no flowering was observed and in Verinag, cultivation was most successful with 50% flowering and normal seed set. KAUL & HANDA (2000) concluded that the crude drug yield for dried rhizomatous stolons and the active content were highest at higher altitude for both wild and domesticated plants.

In Jumla, Dolpa, Gorkha and Humla, all high altitude regions in **Nepal**, small-scale cultivation is currently being tested. Most projects are demonstration projects with up to one hectare of cultivated area (AMATYA in litt. 2005).

The species is reportedly not cultivated in **Pakistan** (IUCN PAKISTAN in litt. 2005) and is not believed to be cultivated in **China** (TRAFFIC EAST ASIA in litt. 2004). `

National market. The main commodities in national and international trade are unprocessed rhizomes, with smaller amounts of trade in processed products such as oil. Quantitative information on trade volumes is limited, as much of the trade is apparently unregulated and/or occurring outside established trade controls, and therefore undocumented.

In **Nepal**, where most harvesting of Kutki takes place, there is no industrial processing (OLSEN 2005a). The bulk of harvest is evidently destined for export, primarily to India but also to China. The remainder is used locally, apparently on a small scale. Ayurvedic formulators use Kutki as a basic ingredient, for instance in the treatment of liver diseases. A sample of eight formulators in Kathmandu reported using quantities ranging from 300-500 kg annually, with total use in the range of 700-1400 kg (AMATYA in litt. 2005).

Available data indicate that **India** is the major global consumer of Kutki, importing large amounts but also making use of local harvest. *Picrorhiza kurrooa* was one of the 162 species for which a demand and supply study was commissioned by the Department of Indian System of Medicine & Homeopathy, the Government of India and the World Health Organization (WHO), New Delhi. Demand for Kutki was estimated at 220 t during 2001/2002 and projected to reach 317 t in 2004/2005. The price during 1999-2000 was reported as INR150 000 (USD3435) per tonne (ANON. 2001-2002). In India, roots of Kutki were reported in 2004 as sold for INR180-190/kg (USD4.1-4.4/kg) at markets in Amritsar, Delhi and Kolkata (previously Calcutta) from where they are also distributed to smaller markets (GUPTA in litt. 2004). One typical Indian pharmacy reported annual demand of Kutki at 8000 kg, which was bought in Uttar Pradesh at an average price of INR250-260/kg (USD5.7-6.0/kg) (RAMACHANDRAN in litt. 2005).

No further information was identified on markets within Bhutan, China or Pakistan, however based on information on international trade, these may be significant.

International trade. As noted above, OLSEN (2005a) estimated the total amount of Kutki in trade (both domestic and international) in 1997/1998 as between 650 t and 1000 t. Of this, domestic production and trade within India was estimated to account for 50-300 t. A majority of the remainder was believed to be exported to India from Nepal with lesser amounts exported from Nepal to China and from Bhutan to India.

With regard to China, a significant quantity of Kutki is reported to be exported regularly to Chinese Tibet from Nepal through the northern frontiers in the Eastern and Central Development Regions of Nepal, although no official records or Customs data are available. OLSEN (2005a) estimated this trade at between 18 and 57 t annually, with around 47 t exported in 1997/1998. Earlier data indicate a substantial official trade: during the period 1980-1985 the total import of *Picrorhiza* spp. (sic) into China was 456 t; data were next available for 1994 when 100 t were reported as imported (MULLIKEN 2000). It is not known whether export of Kutki takes place from Bhutan to China.

There is also reportedly some trade in Kutki between India and Pakistan. MULLIKEN (2000) noted that demand in Pakistan may exceed the amounts harvested domestically, with the remainder imported from India. However, OLSEN (1999) suggested that *P. kurrooa* was exported from Pakistan to Uttar Pradesh. No accurate statistical data are available, as the trade is kept secret by the traders and the companies that manufacture products (IUCN PAKISTAN in litt. 2005).

Table 2. CITES-reported trade in *Picrorhiza kurrooa* (1995-2003)

Year	Country of Export	Country of Import	Origin	Export					Import				
				Quantity	Unit	Term	P	S	Quantity	Unit	Term	P	S
1997	IN	NZ		11	kg	Roots	T	A					
1999	CN	DE							5	kg	Fruit	T	A
1999	TW	DE	CN						40	g	Dried plants	S	W
2001	CN	IT							100	kg	Derivatives	T	W
2001	CN	IT		100	kg	Roots	T	W					
2002	CN	IT							300	kg	Extract	T	W
2002	CN	IT		300	kg	Roots	T	W					

Source: CITES annual report data compiled by UNEP-WCMC.

Trade in *Picrorhiza kurrooa* reported to CITES is negligible (Table 2). A possible explanation was provided by interviews which indicated that 80% of the material imported into India was processed and consumed locally, with relatively small amounts re-exported in the form of manufactured products, e.g. medicines,

which are not subject to CITES controls (MULLIKEN 2000). The great majority of international trade in unprocessed Kutki (i.e. dried rhizomes) evidently originates in Nepal and Bhutan. Neither of these countries is a range State for *Picrorhiza kurrooa*, so that all this trade is exempt from CITES controls.

On the internet, raw materials, extracts and oils made of *Picrorhiza kurrooa* and used in pharmaceuticals, cosmetics, perfumes and food are widely advertised by Indian companies (ANON. 2004). US companies also offer the species, mainly under 'Kutki' and in particular as powder or in capsules, sometimes whole "roots". Prices range from USD48-86/kg. Some sites indicated that packaging is done in China by a major traditional Chinese medicine manufacturer. A minimal trade has been reported in Europe, including both Ayurveydic and traditional Chinese medicine products (LANGE & VAN DEN BERG-STEIN in litt. 2005).

Similar species
The rhizomes are similar in appearance to some other medicinal plant species in the region and may also be used in a similar way to treat the same or similar ailments. This increases the difficulty of acquiring an accurate picture of the trade and trade volumes (both domestically and internationally). *Gentiana kurroo* has similar properties, e.g. the ability to stimulate appetite and treat indigestion (JAIN 1994).

Illegal harvest and trade. At least some illegal collection has been reported from protected areas in **Nepal**, e.g. from Shey-phoksundo National Park, Dolpa (AMATYA in litt. 2005). According to AMATYA (in litt. 2005), there is probably illegal trade from Nepal, for which no data are available, for instance through misdeclaration either of quantities or commodities in trade. Olsen (2005a) draws attention to indications of "huge illegal harvest and trade" of this species in Nepal, with official District Forest Office Records for 1997/1998 being far below district level estimates of harvest. Customs authorities are generally not familiar with the species, which can facilitate illegal trade.

In **India**, Illegal collection takes place in wildlife sanctuaries, but is negligible in national parks (RAWAT in litt. 2005). From 2000-2003, four seizures of *Picrorhiza kurrooa* (sic) destined for Malaysia, the USA and Austria were registered, with amounts ranging from 5-300 kg.

Table 3. Seizures of *Picrorhiza kurrooa* in India (2000-2003)

Date	Place	Destination	Part	Quantity	Offence
06.06.00	CWC, Virugampakkam Chennai	Malaysia	- (presumably rhizomes)	300 kg	EXIM policy
31.07.01	IGI Air Cargo New Delhi	USA	- (extracts?)	5 kg	EXIM policy and CITES
01.10.02	Seaport Chennai	Malaysia	- (extracts?)	10 kg	EXIM policy and CITES
13.11.02	IGI Air Cargo New Delhi	Austria	- (extracts?)	10 kg	EXIM policy and CITES

Source: CITES Management Authority of India 2001, 2002 & 2003.

Legislation and regulations

Regulation of harvest, manufacturing and domestic trade. The main laws governing harvesting of medicinal plants in India are the Indian Forest Act (1927), and, to a lesser extent, the Wildlife (Protection) Act (1927/1991/2002). The Indian Forest Act (1927) consolidates the law relating to forest produce, the transit thereof and duty thereon, and empowers State Governments to regulate the transit of forest produce, e.g. medicinal plants. The Act deals specifically with reserved, protected, and village forests. Almost all the States and Union Territories in India have regulations regarding harvest, transit and trade in medicinal plants. Most have established lists of species banned from harvest from forests ('Negative lists'), which include threatened plants (Jain 2000).

The Indian Forest Act (1927) has been adopted by most of the States and is directly applicable to the Union Territories of India. The remaining States have enacted State Forest Acts of their own, which are largely based on the Indian Forest Act. The Forest Acts of the States have been amended from time to time as required. The States have framed Rules under the Acts to protect and preserve the forest wealth of their respective States (Jain 2000). The Himachal Pradesh Forest Produce Transit (Land Routes) Rules 1977 were amended in 1994 and now lay down the "pass/export permit fee" for specified medicinal plants. The trade in some of the important and threatened medicinal plants of the State has been restricted or banned. In 2004, the fee for a transit pass for Picrorhiza kurrooa was INR5.4/kg (USD0.12/kg) (Rastogi & Pant 2004). See Jain (2000) for a state by state analysis of legislation relevant to the harvest and trade of medicinal plants in general.

Wildlife harvest and domestic trade controls are implemented in **Nepal's** national parks, conservation areas and protected areas via the National Parks and Wildlife Conservation Act (1973); elsewhere in the country, implementation is via the Forest Act (1993) and the accompanying Forest Regulation (1995)

(AMATYA in litt. 2005, ARYAL 2000, OLSEN in litt. 2000, SHRESTHA in litt. 2000). A summary of these and related controls for medicinal plants and other non-timber forest products has been compiled by the Asia Network for Sustainable Agriculture and Bioresources (ANSAB) and can be found on their website (BINAYEE undated).

The Forest Act and Regulation stipulate rules governing the collection of forest products. Collection is authorized via licences issued by District Forest Officers (DFO). Licences are required to specify the collection area; the period in which harvest is to take place; the species and quantities to be collected; and method of harvest (AMATYA in litt. 2005, OLSEN in litt. 2000). Licence applicants are required to provide this information and specify the purpose of collection. In accordance with the Regulation, District Forest Officers are required to verify the quantity of medicinal plants collected, collect any associated fees, and issue a "release order", which is required to transport harvested plants out of the district of origin. The release order should state: the species and quantity transported; the destination; and the period in which transportation must take place (ARYAL 2000, OLSEN in litt. 2000). There is also a provision to allow harvest and trade licences to be sold at auction (ARYAL 2000). Conflicting information was received regarding whether export of *N. scrophulariiflora* was limited to processed or partially processed products, or whether export of unprocessed rhizomes was also allowed.

In their 2001 study in the Dhading District, PANDIT & THAPA (2004) found that implementation of these licensing provisions was low in government forests, reflecting a combination of a lack of resource management rights among the local population and low government enforcement capacity. Inspection of harvested materials to ensure compliance with licence provisions was considered to be low. Adherence to licence provisions was similarly found to be low in community forests, where permitting provisions still applied, but harvest rights were restricted to members of forest user groups. Others have similarly noted low levels of implementation of national harvest and trade controls for medicinal plants and other non-timber forest products (e.g. see MULLIKEN 2000, OLSEN 2005a).

In 2001, a restriction on collection, utilization, sale, transport, distribution and particularly export of *N. scrophulariiflora* was adopted (Clause 1 of Nepal Gazette Vol. 3, Section 51 No. 36 dated 31 December 2001 issued by Ministry of Forests and Soil Conservation). In 2003, this restriction was lessened by a further notification (Nepal Gazette Vol. 3 Section 53 No. 31 dated 17 November 2003) based on the Forest Act 1993. The Department of Forests may supply export permits for *N. scrophulariiflora* based on a recommendation by the Department of Plant Resources on the availability of the species (AMATYA in litt. 2005).

Protection of flora and fauna in **Bhutan** is provided for under the Forest and Nature Conservation Act, 1995. Despite its rarity, *Neopicrorhiza scrophulariiflora* has not been included in Schedule I (the list of totally protected species) of that Act (MHUKIA 2004). Collection from the wild, transport and trade are regulated via a permit system established under the Forest and Nature Conservation Rules, 2003. According to a regulation issued by the Royal Government Forestry Service Division, it is necessary for regional forestry divisions to submit a quarterly report of extraction of all forest products to the central headquarters. The reports are based on the quantities stated on permits.

Regulation of international trade

CITES listing: *Picrorhiza kurrooa* was first proposed for inclusion in CITES Appendix II in 1994 (CITES CoP 9, Fort Lauderdale), with a proposal submitted by India, however this proposal was withdrawn and instead referred to the CITES Plants Committee (KELSO 1995). A successful listing proposal was put forward by India to CITES CoP 10 (Harare, June 1997), which became effective 18 September 1997. The listing was annotated to include only "whole and sliced roots and parts of roots, excluding manufactured parts or derivatives such as powders, pills, extracts, tonics, teas and confectionery" (Annotation #3). The annotation was modified at CITES CoP 14 (The Hague, June 2007), as part of a Plants Committee process to clarify and harmonise annotations for medicinal plants. The revised annotation, effective 13 September 2007, "Designates all parts and derivatives except: a) seeds and pollen; and b) finished products packaged and ready for retail trade".

It is important to note that while the previous annotation of the CITES listing for *P. kurrooa* referred to "roots", the main parts of the plants in trade are not actually roots but rather rhizomes (i.e. underground stems). According to JAIN (1994) and ZHANG & al. (1994) only the rhizomes of *Picrorhiza kurrooa* are used. By contrast, KEYS (1976) refers only to roots when describing the medicinal properties of this species. "Rhizomes" is used in the *CITES Guide to Plants in Trade* (MATHEW 1994) and the *Checklist of Medicinal and Aromatic Plants and Their Trade Names Covered by CITES and EU Regulation 2307/97* (LANGE & SCHIPPMANN 1999). It seems unlikely that the lack of CITES trade data for this species reflects a conscious decision not to implement trade controls for rhizomes, however there was nevertheless the potential confusion on this point by government staff charged with implementing CITES trade controls.

CITES is implemented in **India** through a combination of the Wildlife Protection Act, 1972/1991/2002 and the Export and Import Policy (EXIM) of the Foreign Trade (Development and Regulation) Act, 1992 and the Customs Act, 1962. The Wildlife (Protection) Act prohibits export of a number of species, including all six CITES Appendix I plant species native to India, of which one, Kuth *Saussurea lappa*, is a medicinal plant.

Policy on trade in wildlife and wildlife products is established via the EXIM policy, which is revised periodically. The policy, as far as it concerns wildlife, is decided in consultation with the Director of Wildlife Preservation of the Government of India, who is the CITES Management Authority and oversees CITES implementation in the country. The Director has four Regional Deputy Directors and four sub-regional offices of wildlife preservation, these serving as assistant CITES Management Authorities. The EXIM policy is put into effect via the provisions of the Foreign Trade (Development and Regulation) Act 1992 and enforced via the Customs Act (CITES MANAGEMENT AUTHORITY OF INDIA in litt. 2004).

The EXIM policy was embedded within a broader Foreign Trade Policy for the period 2004-2009, this change coming into effect on 1 September 2004. The Foreign Trade Policy aims at doubling India's share in global trade and expanding employment opportunities, particularly in rural and semi-urban areas, and includes a Special Agricultural Produce Scheme, promoting the export of, *inter alia*, minor forest produce such as medicinal plants and their value-added products. The policy outlines that all export and import shall be "free", i.e. unrestricted, unless regulated under any legislation. Goods imported in accordance with this policy may be exported in the same form without a licence, provided that there is no import or export restriction for the items. Even goods restricted for import may be imported under Customs Bond for export without a licence provided that the items are freely exportable. Specific note is made in the policy that this does not preclude the application of other laws (DIRECTORATE GENERAL OF FOREIGN TRADE 2004).

Import and export restrictions for specific products are established via India's ITC (HS) classifications in accordance with the broader policy. Several categories relevant to CITES-listed species have been identified as goods allowed to be imported without restriction (i.e. free of import duties or quotas), e.g. "medicinal plants, fresh or dried, whether or not cut, crushed or powdered" (Schedule 1 Chapter 12), lac, gums, resins and other vegetable extracts (Schedule 1, Chapter 13), pharmaceutical products (Schedule 1, Chapter 30) and essential oils (Schedule 1, Chapter 33). Although instructions under the EXIM policy for 1997-2002 stipulated that imports of plants, products and derivatives were subject to CITES provisions (TRAFFIC INDIA 1998), the low levels of trade data for imports of CITES-listed species into India indicate that these provisions were not implemented effectively. Given that virtually all imports of this species into India are likely to involve *Neopicrorhiza scrophulariiflora*, CITES-related import controls would not appear to be relevant to India's Kutki trade at this time.

As stipulated in Chapter 12 of the ITC (HS) classifications, the export of plants, plant portions, their derivatives and extracts of species included in CITES Appendix I and II obtained from the wild is generally prohibited. Further clarification is required to confirm whether this applies to wild specimens regardless of their country of origin, or to only those specimens obtained within India. An "Export Licensing Note" appended to Chapter 12 specifies 29 plant taxa for which export is generally prohibited. This list includes *Picrorhiza kurrooa*. An exception for both CITES species and those listed in the Licensing Note is made for the export of "formulations", defined as including "products which may contain portions/extracts of plants on the prohibited list but only in unrecognizable and physically inseparable form" and "value added formulations as well as herbal Ayurvedic" (Chapter 12, Export Licensing Note 3). It is not clear whether the term "recognizable" is defined per the CITES interpretation of "readily recognizable" such that if the ingredients of a particular formulation of Ayurvedic medicine are listed on the packaging, then they are considered to be "recognizable". The instructions include a note that states that "no certificate from any authorities whatsoever shall be required for their [formulations] export," implying that no CITES permits would be required for such exports. Export Licensing Note 2 states that export permits are required, however it is not clear if this applies only to cultivated specimens, which are allowed to be exported (see below) or also to formulations. CITES Management Authority staff have advised that, if Customs staff refer a shipment of "formulations" containing CITES-listed species to the Management Authority for clearance, then issuance of a CITES export permit will be required (AARTI in litt. 2005).

A further exception is provided for exports of wild CITES-listed species on a case by case basis for "life saving drugs", which could presumably be applied to any medicinal species. However, in this case a CITES permit would be required, with such trade only allowed on recommendation of the Ministry of Environment and Forests.

Exports of plants produced via cultivation are allowed subject to obtaining a transit pass from the relevant Divisional Forest Officer if the plants were cultivated in sites within forests, or a Certificate of Cultivation from a District Agriculture, Horticulture or Forest Officer if cultivated at sites outside forests. Export Licensing Note 2 included in this schedule states that "However, in respect of CITES species, a CITES permit of

export shall be required". As noted above, it appears that this provision relates to all but formulations; however, this requires further clarification.

It does not appear that export restrictions on wild specimens of CITES-listed species apply to imported specimens, however this requires confirmation. It also does not appear that there are any specific provisions made for controlling re-exports of CITES-listed species, other than as may be required to prove that re-exports do not involve wild-collected stock from within India. No reference could be found to an earlier (2003) provision requiring exporters of value-added formulations made out of imported species from the list of "prohibited plants" to provide an affidavit to Customs authorities at the time of export that the specimens were legally imported (NTF NO. 03/2003 31/03/2003). However, CITES Management Authority staff state that proof of import is required prior to granting re-export permission, and that they take into account, for example, the amount of unprocessed product that would have been required on import to produce a given export quantity (JAIN in litt. 2005). CITES Re-export Certificates are issued for such shipments (AARTI in litt. 2005).

Exports are required to be limited to the following ports: Mumbai, Nhava Sheva, Kolkata, Cochin, Delhi, Chennai, Tuticorin, Amritsar, Calicut and Thiruvananthapuram (DIRECTORATE GENERAL OF FOREIGN TRADE 2004). It is not clear if this relates to all plants covered under this Customs classification, or only to CITES-listed species and other medicinal species for which export is prohibited.

All violations of the EXIM policy constitute an offence under the Customs Act and are dealt with by Customs officials, who alone have the responsibility to enforce compliance with CITES at border posts. Inspection of consignments by Wildlife Inspectors, co-operating with Customs staff, may also be carried out at border crossings, but such specialist investigations are few. Enforcement of any violations detected is the responsibility of the Customs authorities (PANDA in litt. 1998).

As *Neopicrorhiza scrophulariiflora*, the only species to occur in Nepal, is not listed in the CITES Appendices, the following is not relevant at present. However, it would become so should the species be included in the Appendices in future, as has been recommended for consideration. There is no specific CITES-implementing legislation in **Nepal**, however legislation to promote more effective CITES implementation has been under consideration since the late 1990s. If agreed, the Rare (Endangered) Wildlife and Plants Trade Control Act, 2057 (2002) would provide a more powerful legal tool for CITES implementation within Nepal, and includes a number of CITES-relevant provisions (HEINEN & CHAPAGAIN 2002).

Nepal's CITES Management Authority for plants is the Department of Forests, Ministry of Forests and Soil Conservation. The CITES Scientific Authority for plants is the Department of Plant Resources, Ministry of Forests and Soil Conservation. The Management Authority issues export permits for plants covered by CITES and/or the Forest Act that are in a processed or semi-processed form (BISTA in litt. 2000).

The Management Authority also maintains liaison with the Department of Customs, Intelligence, Police and other agencies. However, it was noted in 2000 that Customs officers had not been trained in the identification of medicinal plants (BISTA in litt. 2000); it is unknown if training has been provided since that time. Personnel from the Department of Forests and District Forest Offices have been posted at the Customs points in the Terai to examine consignments containing wild flora (ARYAL 2000).

Treaty of Trade between Nepal and India

In an effort to expand trade between their two countries, the Governments of India and Nepal entered into a bilateral trade agreement in 1991. The treaty provides for preferential treatment (exemption from Customs duty and quantitative restrictions) of trade of certain "primary products", which include forest produce that has not undergone processing, and Ayurvedic and herbal medicines (Article IV) (ANON. 2002). Under this treaty, a certificate of origin issued by the Government of Nepal is the only document required for presentation to India's Customs authorities at the time of import (MULLIKEN 2000). Trade in conjunction with the treaty is required to take place via one of the 22 border crossings designated in Annex A of the treaty. During the late 1990s, border officials were unaware that CITES documentation might also be required for export (as noted above, under India's current CITES implementing legislation and the EXIM Policy, CITES export permits would not be required to accompany shipments into India in any event). The treaty contains provisions for stronger domestic measures on the part of national governments, and provides a list of articles not allowed preferential treatment (e.g. cigarettes and alcohol) as an annex. It appears that this Annex could be amended to reflect CITES requirements (MULLIKEN 2000).

TRAFFIC India informed Government authorities in both India and Nepal of the apparent relevance of this treaty with respect to CITES trade controls. Initial research results from this study were communicated to the second Indo-Nepal Trans-border Meeting in February 1999. As a result, the final resolution of that meeting called for bringing the bilateral treaty in line with CITES requirements (MULLIKEN 2000).

The treaty was extended for a further five years in 2002 and remained in effect until 5 March 2007 (ANON. 2002). Although some amendments were made, these did not reflect the concerns raised regarding CITES implementation (AMATYA in litt. 2005). The treaty has been extended for a further five years, and will remain in effect until 5 March 2012.

As *Neopicrorhiza scrophulariiflora* is not listed in the CITES Appendices, the following is not relevant at present. However, it would become so should the species be included in the Appendices in future, as has been recommended for consideration. A series of regulations implementing CITES within **China**, the Import and Export Regulations of Endangered Wild Fauna and Flora, came into effect on 1 September 2006. In addition, other laws contribute to the implementation of the Convention in this country. China's Law of Wild Plant Protection took effect 1 January 1997. Under this law, protected plant species are classified into those of "national key significance" and those of "local key significance". Protected plant species of national key significance are further divided into Category I and Category II protected species. Trade in Category I protected species is not allowed. Trade in plant species listed as Category II is subject to authorization by the relevant government agencies at the provincial/autonomous region level. The State Forestry Administration, the Ministry of Agriculture and other authorized governmental authorities at the provincial/autonomous region level are responsible for enforcing the Law of Wild Plant Protection. A list of 255 species is appended to this law. From 1 January 1998, China's regulatory system for the export of wild animals and plants was strengthened by the Endangered Species Import and Export Management Office (under the State Forest Administration), the designated CITES Management Authority, and the Customs Authority. A wide range of animals and plants with their corresponding Harmonized System Customs codes are specified in an annex attached to a Joint Notification from the Management Authority and the Customs Authority. The list is said to be compiled on the basis of the CITES Appendices and the lists of key national protected animals and plants. The Notification was amended in February 1999 to include *Picrorhiza kurrooa*. The Notification has been circulated among the officers of the Management Authority and Customs across the country and was copied to various other governmental agencies. Trade in live animals or plants, parts in their raw form, and products made from those animals and plants specified on the said list are controlled. According to the Notification, where applicable, import/export permits or certificates are required.

It is unclear whether exports of *Neopicrorhiza scrophulariiflora* are allowed from **Bhutan** at present. The Forest Resources Development Division of the Royal Government of Bhutan has suggested that harvest be limited to domestic use, and conducted in accordance to strict guidelines owing to the species' rarity, and comment that it was important to be very cautious with respect to exports, which the Division did not like to recommend at that time (MHUKIA 2004).

Conclusions

There is a rapidly growing body of information concerning the harvest and trade of Kutki, particularly within Nepal, and, to a lesser extent, in India. This trade involves the rhizomes of two, and possibly three species, *Picrorhiza kurrooa*, *Neopicrorhiza scrophulariiflora* and the recently described *N. minima*. *Picrorhiza kurrooa* is found mainly in India, its range extending into Pakistan. *Neopicrorhiza scrophulariiflora* is found throughout much of Himalayan Nepal. Its range extends into China and both westwards and eastwards into India, with *N. scrophulariiflora* and *Picrorhiza kurrooa* having overlapping ranges in Uttaranchal, and only *Neopicrorhiza scrophulariiflora* being found in Sikkim. *N. scrophulariiflora* also occurs in Bhutan, which is also home to *N. minima*.

The main demand for Kutki is within India, where the rhizomes are used for the preparation of traditional medicines. This demand is met by both domestic and foreign harvests, with Nepal the main source of foreign supply, and trade also taking place from Bhutan and possibly Pakistan. China, where the species is also used in traditional medicines, obtains supplies both from domestic populations and through imports from Nepal. There are at least small-scale exports of finished products containing Kutki from both China and India. Kutki is also used in traditional medicines within Bhutan and Pakistan.

There is no indication that demand for Kutki, and therefore harvest to meet it, will decline in the foreseeable future. As a result, concerns regarding the impacts of harvest on the status of the species, including evidence of declines in India and Nepal, continue to be merited. Detailed studies of regeneration rates have been undertaken at some sites, with a recent study in Nepal indicating that *Neopicrorhiza scrophulariiflora* can regenerate well under suitable harvest conditions.

Although local and national harvest and trade controls for Kutki appear to be comprehensive on paper in India and Nepal, implementation and enforcement of these controls seem to be low. The role of CITES in the regulation of international trade in Kutki is minimal, as the main species in trade, *N. scrophulariiflora*, is not CITES-listed, and trade in the CITES-listed species *Picrorhiza kurrooa* from India is likely to involve finished products, which are not covered by the CITES listing of this species.

More than five years have passed since a CITES Secretariat funded study first drew attention to the problems associated with the trade and implementation of trade controls for Kutki, the findings of this study having been presented to the CITES Plants Committee and subsequently published. Although a great deal more research on the species has been published since that study, the situation with regard to harvest management and trade controls remains largely the same.

Given the strong and persistent demand for Kutki, evidence of decline in some of the range of the two main species in trade, and the importance of harvest and trade to rural livelihoods, greater attention should be paid to developing and promoting sustainable harvest methods. Implementation of these methods should be supported by a policy framework that provides incentives for sustainable management and trade within established controls. The dependence of rural households on Kutki for income should be taken into account in any policy development, including when considering whether additional species should be listed in CITES Appendix II. Further, as noted by Olsen (2005b), concerted action to reduce harvests or trade in one country may simply shift harvest pressure to neighbouring countries, and therefore fail to achieve wider conservation objectives. A regional approach to managing this regional resource would be preferable, involving a range of stakeholders from both range States and consumer countries.

Possible next steps

Range States for *Picrorhiza kurrooa* and *Neopicrorhiza* spp. might consider:

- Co-convening a regional multi-stakeholder workshop to facilitate sharing of information and experiences, and facilitate development of a regional strategy for sustainable management of these and other Himalayan medicinal plant species;
- Pursuing a programme of collaborative research and action to:

  Determine the distribution and status of these species, including confirmation of rates of regeneration and causes of decline;

  Determine the source and quantity of specimens in domestic and international trade;

  Identify and develop sustainable harvest practices;

  Review and clarify domestic harvest and trade controls and export policies for Kutki, and identify appropriate and mutually reinforcing responses with regard to the harvest and trade control problems identified;

  Develop and distribute local language and visual educational materials to support the implementation of sustainable harvest practices; and

  Consider the merits of a CITES Appendix II listing for *Neopicrorhiza* spp.

The Government of India might consider:

- Submitting a proposal to CoP 14 to modify the current annotation of the listing of the species in the CITES Appendices to include the term “rhizomes” in addition to roots, ensuring that the term “root” is maintained in the annotation as it is more likely to be understood by Customs officials and others implementing CITES for these species; and
- Expanding existing national legislation to specifically include CITES-related controls on imports and re-exports of all CITES-listed medicinal plant species, including *Picrorhiza kurrooa*.

The Governments of both India and Nepal might consider:

- Modifying the Treaty of Trade between Nepal and India in order to reflect CITES requirements.

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Pterocarpus santalinus

Taxonomy *Pterocarpus santalinus* L. f. (family Leguminosae)

Trade names Agaru (kan), Agarugandhamu (tel), Almug (eng), Atti (tam), Bois de Santal rouge (fre), Chandana (mar), Honne (kan), Kempugandha Chekke (kan), Lalchandan (hin), Lalchandan (ben), Leno de Sandalo rojo (spa), Lignum Santali rubrum (pha), Lignum Santalinum rubrum (pha), Patrangam (mal), Pterocarpi lignum (pha), Rakta Chandan (hin), Rakta Chandan (ben), Rakta Gandhamu (tel), Raktacandana (san), Raktacandanah (san), Raktacandanam (san), Raktachandan (ori), Raktachandana (san), Ratanjali (guj), Red Sandalwood (eng), Red Sanders (eng), Red Sanderswood (eng), Rotes Sandelholz (ger), Rotsandelholz (ger), Sanalho vermelho (por), Santali lignum rubri (pha), Saunderswood (eng) Sivappu Chandanam (tam), Tambada (mar), Tilaparnni (mal), Yerra Chandanamu (tel), Zitan (chi) (GREEN 1995, IUCN 2004, LANGE & SCHIPPMANN 1999).

Description. Deciduous tree, girth 1.5-1.9 m, height 9-11 m. Mature after 15 years. Bark blackish-brown, deeply cleft into rectangular plates. Heartwood dark purple and exuding a deep red juice when cut. Leaves usually imparipinnate, leaflets three, rarely five. Flowers large and yellow, bisexual, in simple or sparingly branched racemes (SINGH 1997). Flowering from March-late May, during the dry season (RAO & RAJU 2002). Pods 3-8 cm in diameter including the wing. Seeds reddish brown, smooth, leathery (SINGH 1997), produced prolifically (HENRY 1994).

P. santalinus is pollinated by nocturnal bees, but geitonogamy occurs as well, as cross-pollination is limited by dry and hot conditions. The wood of most trees has a normal grain, however, there is also a rare variant with a 'wavy' grain. Efforts have been made to distinguish trees with wavy-grained wood from others using morphological characteristics (LOHI DAS & DAYANAND 1984), however there does not appear to be any morphological differences between the normal and wavy-grained trees (RAO & RAJU 1992).

The growth rate is said to be slow (ANON. 1994, ANON. 2002a), however HENRY (1994) considered that natural regeneration would be secured owing to high seed production. The tree is said to regenerate well from coppicing, and a 40-year coppice rotation said to be practised in India (GREEN 1995).

Distribution. China (?), India, Pakistan (?), Philippines (?), Sri Lanka (?), Taiwan (?)

Generally considered as endemic to India in the southern parts of the Eastern Ghats in the states of Andhra Pradesh, Karnataka and Tamil Nadu (JAIN & RAO 1983, MOLUR & al. 1995, OLDFIELD & al. 1998). Found in the dry deciduous forests of the southern Central Deccan Plateau (Andhra Pradesh, Karnataka) (RAWAT & al. 2001); grows in the southern and eastern parts of Bidar district of Karnataka (ANON. 2005a); grows in approximately 50 000 ha of forest area in Cuddapah, Chittoor, Kurnool, and Nellore districts in Andhra Pradesh according to the Andhra Pradesh Forest Development Corporation (ANON. 2002a). According to RAO & RAJU (2002), however, it is limited to Cuddapah and Kurnool districts in that state. The species is limited mainly to State Forests according to a Forest Department staff member (JAIN in litt. 2005). According to NIRAJ (in litt. 2004) the species occurs in the Arcot and Chengalpattu districts of Tamil Nadu, in the Sri Venketswar Wildlife Sanctuary and is found on private land as well as in protected areas. The Srilankamalleswara Sanctuary between the Nallamalais and Sechachalam hill ranges is known for populations of the species (RAWAT & al. 2001). It is also reported as occurring sporadically in other states (ANON. 1994). The natural range is restricted to typically dry, hilly, often rocky ground, at altitudes of 150-900 m (ANON. 1994, GREEN 1995), in areas receiving around 100 mm of rain in each of the two annual monsoons (GREEN 1995). *P. santalinus* does not tolerate overhead shade or waterlogged conditions (RAO & RAJU 2002). HENRY (1994) considered it to be sparsely distributed, with populations known to differ genetically. There is one report of the species being native to Africa (ROUBIK 1995), but this seems likely to be in error. Its status is reported as uncertain in China (INTERNATIONAL LEGUME DATABASE & INFORMATION SERVICE 2003) but likely to be introduced (KUMAR & SANE 2003), occurrence reported in Pakistan (RICHTER & DALLWITZ 2002) but likely to be introduced (KUMAR & SANE 2003), and introductions reported in Sri Lanka and Taiwan. The species is said to be cultivated in the Philippines (LIST & HÖRHAMMER 1977).

Population status and threats. *Pterocarpus santalinus* was classified as *Endangered*[1994] in the 1997 *IUCN Red List of Threatened* Plants (WALTER & GILLETT 1998) based on results of Conservation and Assessment and Management Plan (CAMP) workshops for plants of southern India in 1995 and 1997. The species is similarly assessed as *Endangered*[1994] in the *World List of Threatened Trees* (OLDFIELD & al. 1998) and the 1994 IUCN Red List due to its small range, fragmented populations and continuing decline (IUCN 2006).

The Government of India considered both legal and illegal trade to threaten *P. santalinus* at the time they proposed it for inclusion in CITES Appendix II, with its restricted distribution and slow generation rate increasing the level of threat (ANON. 1994). The species was similarly considered "threatened" by GUAR (1994) and KHAN (1994), the latter also considering habitat destruction to be a threat. RAO & RAJU (2002) consider habitat alteration to be the primary threat. Habitat in the Central Deccan Plateau is considered under severe threat from conversion to cash crop plantations, fuel wood collection, and overgrazing by cattle (RAWAT & al. 2001).

HENRY (1994) considered the species unlikely to be threatened with extinction owing to its high seed production, and believed that adequate conservation methods have been taken by the Andhra Pradesh Forest Department to ensure that it was not threatened by habitat destruction or international trade. According to an Andhra Pradesh Forest Department staff member, there are very few specimens of harvestable size in the State Forests. Illegal harvest continues to be considered a key threat (ANON. 2004a).

Medicinal uses

Plant parts used for medicinal purposes: Heartwood and its derived extracts and powders.

In India, the heartwood of *P. santalinus* is used in the treatment of diabetes; the anti-diabetic constituent is pterostilbene (HAU 1997). Water held in barrels made from the wood is used in the treatment of this disease (ANON. 2005a). Preparations made from the wood are used to reduce swelling, alleviate pain, stop bleeding and treat infections (HAU 1997). A paste made from the wood has also been used to treat inflammation and skin diseases (HENRY 1994). It is also considered to be astringent, tonic disphoretic, antibilious anti-inflammatory, emetic, febrifuge and is used in treating boils, scorpion-stings and in skin diseases (TRAFFIC INDIA 1998).

Other uses. The heartwood of this species is used in the making of furniture, carvings and musical instruments. The timber has previously been reported as 'widely used' within India (ANON. 1994), the wood said to be in high demand for carved house posts (ANON. 2005a). In Japan, the heartwood is used to make musical instruments, 'hankos' (name seals), frames, traditional dishes and carvings (KIYONO 2005). Timber with a 'wavy' grain is in particularly high demand in Japan for the manufacture of the musical instrument the 'shamisen', a three-stringed lute used in classical music. In general, only the neck of the shamisen is made of *P. santalinus* (TRAFFIC EAST ASIA-JAPAN in litt. 1994).

The heartwood of *P. santalinus* is also used to produce red pigments, specifically santalin, which is used in the furniture and crafts industry and as a colouring agent in cosmetics and food (GREEN 1995, IUCN & TRAFFIC 1994, KIYONO 2005, OLDFIELD & al. 1998). A yellow isoflavone pigment, santal, is also present (GREEN 1995).

GREEN (1995) classed *P. santalinus* with other "insoluable redwoods", noting that while in the past it was used for dyeing wool, cotton and leather, with trade to Europe averaging 3000 t per year in the late 1800s, its main use in recent years was in the food industry. It is said to impart a "sweet-spicy flavour and orange-red shades" and was normally sold to the food industry in the alcohol-soluble form, either as liquids or powders; water-soluble forms (salts) were also available. GREEN (1995) added that the species was traditionally used with fish products in Europe (e.g. pickled herrings). Other applications included the colouring of seafood sauces, meat products, snack food, breadcrumbs and alcoholic drinks.

P. santalinus is approved as a food dye for alcoholic beverages in the USA (HENRY 2005), and is approved as a food dye within Europe, where it has been classified as a "spice extract" rather than a food colourant (GREEN 1995). It has therefore not been assigned an 'E number', with the effect that its presence does not have to be declared on packaging. It has been imported into Germany in the form of powder or as an extract (oleoresin). According to two German traders, the use is declining, at least in part owing to difficulties in securing CITES documents for supplies from India and the wide availability of substitute colourings (see below) (LANGE 2005). *P. santalinus* has been mentioned as a flavouring for tea by an Australian company (ANON. 2001).

The species is used in incense, although having little scent of its own; it is used primarily as a base powder according to web-based offers for sale. Research is said to be under way in India to exploit the species' potential application in soaps, dyes, toys, agarbathis (incense sticks) etc. (ANON. 2002a). GREEN (1995) commented that interest had also been shown by the European food industry to expand the range of applications.

In India, inferior wood is sold as fuel (ANON. 2002a) and the species is also used for charcoal (GREEN 1995). The leaves are used for cattle fodder (GREEN 1995). In Myanmar, it is used in fragrances and scented (incense) sticks (KHIN 1995). Pterostilbene has insecticidal properties (HAU 1997).

Substitutes: RAO & RAJU (2002) state that three of the four *Pterocarpus* species occurring in India are valued and harvested for santalin: *P. santalinus*, *P. dalbergioides*, limited to the Andamans and *P. indicus*, introduced from Malaysia. A trader in Germany notes that there are many alternative products, that can be used as substitutes, for example cochineal and santalins from other species (LANGE 2005). Another species, *Andenathera pavonina,* also regularly referred to as 'red sandalwood', 'rubywood' and other common names used for *P. santalinus*is, is similarly used to produce santalin-based dyes. A US chemical supplier offering 'red sandalwood powder' appeared to treat the two species interchangeably (ANON. 2004b). Most of the "red sanders" currently available on the German market (e.g. in pharmacies) comes from other trees, mainly West African Red Sanders. The colour obtained from these trees is light red and not as dark as the true Red Sanders colour (LANGE 2005).

All four *Pterocarpus* species occurring in India are said to be valued for their wood, but only *P. santalinus* is highly valued for its heavy dark red heartwood, especially that possessing a wavy grain (RAU & RAJU 2002).

Harvest and processing. The colourant is only extracted from the heartwood, which is first reduced to chips or powder and the colourant then extracted with alcohol. The extract may be concentrated or stripped of solvent to give a solid product prior to sale. Specific formulations (as liquids, dispersed solids or water-soluble forms) are prepared prior to sale to particular users at strengths appropriate for the food product. No reliable published information was available on commercial extraction yields as of the mid-1990s (GREEN 1995).

Cultivation. The species can be artificially propagated via both seeds and cuttings (GREEN 1995). Plantations of *P. santalinus* were established as early as 1964 by the Andhra Pradesh Forest Department, with research into vegetative propagation reported in the 1990s with encouraging results (HENRY 1994). Plantations were also established in Kerala in 1983, with three different sites planted that were said to show promise. It was estimated that the trees would take 18-20 years to produce heartwood, but was not known if that heartwood would possess the high value wavy grain (BABU 1992). Cultivation trials were said to be aimed primarily at producing this higher value wood (REDDY & SRIVASUKI 1990, MOLUR & al. 1995).

SINGH (1997) gave precise instructions for commercial propagation but the extent of cultivation is not known. The Botanic Gardens at the University of Agricultural Sciences in Bangalore carried out germination and propagation studies between 1996 and 1997. The germination rate was found to be low, in part because many seedpods are empty, but germination could be improved by rubbing the pod or treating it with water or sulphuric acid. The rooting success of stem cuttings was found to depend on seasonal variations and the age of the mother tree (GEETHA 1996).

VEDAVATHY (2004) calculated that if, for commercial cultivation, 500 trees are planted on one hectare, a minimum of 500 kg wood per tree, or 250 000 kg/ha, could be harvested after 25 years. At an average anticipated market rate of INR75/kg (USD1.72/kg) an income of some INR187.5 lakhs/ha (USD430 000/ha) was expected after 25 years. Seedlings were available from an Indian NGO, HFRC at a cost of INR8 each (USD0.18). Genetic selection for elite germplasm that can produce wavy-grained timber and improvement of propagation techniques has been recommended (GREEN 1995, VEDAVATHY 2004).

Cultivation on a commercial scale was not known to exist as of the late 1990s (SCHIPPMAN 2001). Plans to promote cultivation in Andhra Pradesh and the Andhra Pradesh Forest Development Corporation (APFDC) of the Forest Department have included promoting the establishment of nurseries and plantations, although plantation-produced wood was often of low quality, and therefore more effort was needed to improve production (ANON. 2002a). The 2004-05 Annual Plan for Tamil Nadu's State Planning Commission included a plan to raise plantations of Red Sanders, teak and other hardwood species in order to "augment the timber resources and convert the unproductive degraded forest area into valuable timber bearing forests" (ANON. 2004h).

India's CITES annual reports record all exports as being of cultivated origin (artificially propagated). An August 2004 offer for sale posted to the internet stated that 12 t of *P. santalinus* logs were available for sale from standing stocks of over 30 000 t of timber from farmed trees 20 years old. The timber was said to be available with full government permissions for felling and shipping. Confirmation of the validity of this offer would indicate that cultivated timber was now produced in commercial quantities.

The species is cultivated in China (HAU 1997, KHIN 1995), and said to be cultivated in the Philippines (LIST & HÖRHAMMER 1977).

National market. In 1991 it was estimated that 800 kg of *P. santalinus* were used annually by India's herbal industries and Ayurvedic drug producers of Maharashtra (KHADIWALE 1998). In a market survey carried out by TRAFFIC India in 1997, *P. santalinus* was found to be traded in the markets of Delhi, Kol-

kata (previously Calcutta), Mumbai and Haridwar. It was commonly used by India's herbal medicine industry and readily available. Estimates of domestic trade volumes varied widely – two traders estimated that sales in Delhi markets (presumably for all uses) were in the order of 100-400 t; the Dabur Research Foundation estimated the annual demand from the Ayurvedic industry to be 16 t. India's Ayurvedic Drug Manufacturer's Association 1999 estimate of annual production of crude herbal drugs in India considered that 3000 t of *P. santalinus* was produced per year, of which only 5% (i.e. 150 t) was used by Indian Ayurvedic pharmacies (KHADIWALE 1998, SCHIPPMANN 2001).

Pterocarpus santalinus was one of the 162 species for which a supply and demand study was commissioned by the Department of Indian System of Medicine & Homeopathy, Government of India and the World Health Organization (WHO). The authors predicted that demand from India's herbal medicine industry and practitioners would be 169.9 t during 2001-2002 and 287.8 t during 2004-2005 (ANON. 2003). A Mumbai Ayurvedic medicine manufacturer responding to a survey from the Task Force on Conservation and Sustainable Use of Medicinal Plants stated that their annual demand for *P. santalinus* was 1.025 t. A well-known medium-size pharmacy in south India estimated their annual demand for *P. santalinus* to be 2 t, which was purchased at the average price of INR55-60/kg (USD1.2/kg) from Uttar Pradesh in the north of India (RAMACHANDRAN 2005). The Mumbai company considered *P. santalinus* to have been in short supply for approximately 18 years, another manufacturer similarly considered supplies to be limited (KHADIWALE 1998).

The price of *P. santalinus* wood in Indian markets was found to vary between USD0.5-3.1/kg. The price of the powder was considerably lower, between USD0.4-1.7/kg. This difference was believed to be due to adulteration of the powdered form as indicated by a number of traders (TRAFFIC INDIA 1998). The price during 1999-2000 was reported to be INR50 000/t (USD1036/t) (ANON. 2003), or approximately INR50/kg (USD1.1/kg). In 2002, good quality Red Sanders was said to sell for between INR300 000-400 000/t (USD6870–9160/t) in the global market, despite a ban on exploitation and sale (ANON. 2002a).

International trade. As noted above under 'uses', *Pterocarpus santalinus* is in demand outside India as a high quality timber, a source of dyes and, less importantly, for other uses such as incense. Indian Customs data and CITES annual report data provide further evidence of demand, as do records of seizures of *P. santalinus* both within India and in other countries. International trade primarily involves wood chips, extract, timber (apparently illegal) and carvings.

Until recently, Indian Customs data documented the trade in three different *P. santalinus* product categories: chips, powder and timber (Table 1), with the greatest share of the trade reported as involving chips (see below). However, as of 1 April 2003, it appears that the trades in chips and timber are no longer being differentiated in India's Customs data. It is important to note that different Customs codes are provided to record the trade in the fragrant and lightly coloured Sandalwood *Santalum album*, occasionally also referred to as "Sanders" or "Sanders Wood".

Table 1. Indian Customs codes for trade in *Pterocarpus santalinus*

Product name	Customs code	Notes
"Sander wood chips"	12119027	Customs code no longer in use for this product as of 1 April 2003
"Red sandal wood powder used in dyeing"	14041002 (until April 2003) 14041020 (from April 2003)	
"Wood in the rough, whether or not stripped of bark or sapwood, or roughly squared; multiple species including Red Sanders *Pterocarpus santalinus*"	44039200	Includes but is not specific to this species
"Wood in the rough, whether or not stripped of bark or sapwood, or roughly squared; *Pterocarpus santalinus*"	44039918	Customs code no longer in use for this product as of 1 April 2003

Source : Export Import Data Bank, Department of Commerce, India.

Exports of *P. santalinus* wood recorded during the 1970s and early 1980s ranged from a high of 444 t in 1973 to a low of 100 t in 1981 (AHMED & NAYAR 1984). In general, smaller quantities of *P. santalinus* were reported in trade in subsequent years, with Indian Customs data showing an annual average of 76 t of "Sander Wood" chips exported from 1996/1997-2002/2003, with a peak of 181 t in 2000/2001. As noted above, the Customs code for chips was no longer valid as of 1 April 2003. A further average of 22 t of "Red Sandalwood Powder Used in Dyeing" was exported annually from 1997/1998-2003/2004 (Tables 2-5). Thirteen tonnes of powder were reported as exported from 1 April 2004-December 2004.

Table 2. Reported exports of *Pterocarpus santalinus* chips, extract and powder from India (tonnes) (1991/1992-2002/2003)*

Year	1992/ 1993	1993/ 1994	1994/ 1995	1995/ 1996	1996/ 1997	1997/ 1998	1998/ 1999	1999/ 2000	2000/ 2001	2001/ 2002	2002/ 2003
Chips (1) (2) (3)	25.0	-	5.2+ 50.0	104.8							
Chips (4)					106.8	77.0	81.6	-	181.1	46.1	40.1
Extract (4)				6.7	4.1						
Powder (1) (2) (4)	56.8					4.7	13.1	21.7	47.6	24.3	18.1
Total	**81.8**	**-**	**55.2**	**111.5**	**110.9**	**81.7**	**94.7**	**21.7**	**228.7**	**70.4**	**58.2**

*Financial year from April 1st -March 31st. Sources: (1) INDIA 1994; (2) LANGE & WÄCHTER 1996; (3) TRAFFIC INDIA 1998; (4) Export Import Data Bank, Department of Commerce, India.

Table 3. Total annual exports of "Sander Wood" chips recorded in Indian Customs data (1996/1997-2003/2004)*

Year	Quantity (tonnes)	Value INR (lac**)	Value USD (x 1 000 000)	Value INR/kg
1996/1997	106.8	314.03	0.88	294
1997/1998	77.0	349.71	0.91	454
1998/1999	81.6	290.90	0.69	356
1999/2000	-	-	-	-
2000/2001	181.1	726.56	1.55	401
2001/2002	46.1	181.19	0.38	393
2002/2003	40.1	356.30	0.74	889
Total	**532.7**	**2218.69**	**5.15**	**Av. = 465**

* Financial year from April 1st -March 31st. **1 lac = INR100 000. Source: Export Import Data Bank, Department of Commerce, India.

Table 4. Exports of "Sander Wood" chips recorded in Indian Customs data per import destination (tonnes) (1996/1997-2003/2004)*

Importer	1996/ 1997	1997/ 1998	1998/ 1999	1999/ 2000	2000/ 2001	2001/ 2002	2002/ 2003
China		64.9					
Hong Kong	61.8	12.1	12.0		23.0		
Saudi Arabia	42.0						1.4
Sudan	2.0						
United Arab Emirates	1.0				30.7		0.9
Taiwan			37.6		94.4	9.0	7.0
Singapore			32.0		100.0	20.0	1.0
Oman					8.0	8.0	
Ethiopia							0.6
Japan					15.0	0.1	0.2
Netherlands							0.1
Nepal						9.0	
Total	**106.8**	**77.0**	**81.6**		**181.1**	**46.1**	**40.1**

*Financial year runs from 1 April to 31 March. Source: Export Import Data Bank, Department of Commerce, India.

Table 5. Exports of "Red Sandal Wood" powder recorded in Indian Customs data per import destination (tonnes) (1996/19972003/2004)*

Importer	1997/ 1998	1998/ 1999	1999/ 2000	2000/ 2001	2001/ 2002	2002/ 2003	2003/ 2004
France	0.3			0.3			
Germany	0.5	0.9	0.8				
Hong Kong	2.6						
Malaysia	1.3				1.6	0.4	
United Arab Emirates		12.3		1.1	2.7	10.9	15.0
Taiwan			14.3	40.0	0.03	0.3	0.5
Japan**				0.6	0.02	1.1	0.3
Oman			2.7		0.03	0.1	0.03
Pakistan				5.0			
Saudi Arabia			1.7				
Singapore			2.2		9.4	0.5	
Switzerland				0.6			
Canada						0.01	
Indonesia					8.8	0.02	
Madagascar					0.01		
Mauritius						1.1	
Fed R of Russia						0.2	
South Africa						3.5	0.1
UK					1.7		
USA					0.01		4.4
Algeria							1.1
Bangladesh							0.1
China							0.3
Rep of Korea							0.1
Spain							1.3
Total	**4.7**	**13.1**	**21.7**	**47.6**	**24.3**	**18.1**	**23.3**

*Financial year runs from 1 April to 31 March. **NB: From April-June 2004, one tonne was exported to Japan.
Source: Export Import Data Bank, Department of Commerce, India.

India's CITES annual reports recorded much lower trade volumes, with the total export of approximately 22 t of 'extracts' and 30 m^3 of timber reported for 1995, the year the species was listed in CITES Appendix II, through 1999. India also reported the export of smaller quantities of carvings (1147 sets). No trade was reported by India in subsequent years. It is interesting to note that India reported trade in extract, which was not covered by the CITES listing (per Annotation # 6, see below), but did not report trade in wood chips, which was covered by the listing. All products reported as exported were reported as coming from cultivated sources (Table 6).

European Union (EU) countries were the reported import destinations for all but 50 kg of extract recorded in India's CITES trade data. By contrast, EU countries appear as a relatively minor destination for extract and Sander Wood chip exports in Customs data. Corresponding imports of *P. santalinus* are not recorded in CITES annual report data. This could reflect the interpretation by EU countries that as extracts were exempt from CITES trade controls, they should not be reported in CITES data. Reported imports were limited to 5100 kg of sawn wood reported as seized by the USA in 1999, and imports of timber reported by China. China reported the import of 280 m^3 and a further 20 m of sawn wood and timber in 1999 and 2000, reported as originating in Cambodia, Brazil and Madagascar, none of which are range States for the species. Reported imports jumped to over 100 t in 2003, of which 96 t was reported as originating from the wild in Nepal, also not a range State, and 4.6 t as originating in India.

Table 6. CITES-reported trade in *Pterocarpus santalinus* (1995-2003)

Year	Country of Export	Country of Import	Origin	Export					Import				
				Quantity	Unit	Term	P	S	Quantity	Unit	Term	P	S
1995	IN	DK		2 700	kg	Extract	T	A					
	IN	FR		1 220	kg	Extract	T	A					
	IN	GB		100	kg	Extract	T	A					
	IN	IL		50	kg	Extract	T	A					
	IN	IT		1 650	kg	Extract	T	A					
	IN	NL		1 000	kg	Extract	T	A					
1996	IN	FR		1 500	kg	Extract	T	A					
	IN	GB		600	kg	Extract	T	A					
	IN	IT		2 000	kg	Extract	T	A					
1997	CL	DE	??						200	g	Derivatives	E	U
	DE	CL	??	200	g	Derivatives	E	U					
	CL	DE	??	200	g	Dried plants	E	U					
1998	CH	ES	IN	3		Timber	S	W					
	CH	ES	IN	3		Specimens	S	W					
	IN	DE		2 850	kg	Extract	T	A					
	IN	GB		1 350	kg	Extract	T	A					
	IN	IT		4 624	kg	Extract	T	A					
	IN	JP		377	Set	Carvings	T	A					
	IN	SG		770	Set	Carvings	T	A					
	JP	MX	MX	1		Carvings	Q	W					
	MX	JP							1		Chips	S	W
	MX	JP		1		Carvings	E	W					
1999	IN	IT		2 497	kg	Extract	T	W					
	IN	US							5 100	kg	Sawn wood	T	I
	KH	CN							30	m^3	Timber	T	W
2000	BR	CN							250	m^3	Sawn wood	T	A
	MG	CN							20	m	Timber	T	W
2003	CN	CN	IN						4 900	kg	Timber	T	W
	NP	CN							96 000	kg	Timber	T	W

Source: CITES annual report data compiled by UNEP-WCMC.

It is clear that foreign markets for *P. santalinus* are considered important to State governments. The Government of Bidar District (Karnataka) notes that the "timber is a very good foreign exchange earner" (ANON. 2005a), for example. The Andhra Pradesh Forest Development Corporation reported selling timber to the "global market" (ANON. 2002a) and has undertaken a programme to boost production.

Japan appears to remain an important market for timber, although there are no CITES or Customs data to confirm this. GREEN (1995) estimated annual demand within Japan to be several hundred tonnes, the Andhra Pradesh Forest Development Corporation having exported approximately 200 t of timber to Japan during the late 1990s and/or early 2000s (ANON. 2002a). The seizure of over 90 t of timber en route to or in Singapore could indicate increased demand for *P. santalinus* timber in that country and/or the use of Singapore as a transit point for onward shipment. The recent rise of reported imports of timber into China is of particular interest. Although India's Customs data included a code for *P. santalinus* timber until 1 April 2003, trade was only reported under this category during 2003/2004, when 0.38 m^3 of timber were reported as exported to Europe, 0.18 m^3 to Germany, and 0.20 m^3 to the UK.

Singapore has also emerged as a major destination for the reported export of "Sander Wood" chips. As with timber, it is unknown whether Singapore is an end destination or an intermediary in the trade. Middle Eastern countries, particularly the United Arab Emirates, have emerged as an important market for chips and powder, the use of which in the Middle East is unknown. There would appear to be possible parallels between the agarwood trade, in which both Singapore and the Middle East play a major role, and the trade in *P. santalinus*. Taiwan has also been identified in Customs data as a major destination for the trade in both powder and wood chips (over 200 t reported as exported to Taiwan from 1997/1998–2003/2004). Trade to Europe appears to be declining, which is said to be at least in part owing to difficul-

ties in obtaining CITES permits in India. It appears that North America provides a relatively minor market, with reported trade limited to the seizure of five tonnes of timber in 1999, and the import of 4.4 t of powder in 2003/2004. *P. santalinus* powder is offered for sale via the web for use in incense, with prices quoted by US suppliers on the order of USD66-67/kg for bulk purchases.

Other than those products seized outright, it is unclear what proportion of the international trade in timber and possibly other products is illegal according to national export restrictions, which are unclear (see below).

Illegal harvest and trade. Illegal harvest and trade in *Pterocarpus santalinus* appears to be widespread, with numerous seizures reported both within India and in other countries (Tables 7 and 8).

Table 7. *Pterocarpus santalinus* seizures of more than one tonne

Date	Location of seizure	Product	Quantity (tonnes)	Seizing authority	Source
1999	USA	Sawn wood	5	US Government	CITES trade statistics
11.2002	Madavaram, Tamil Nadu		26	Andhra Pradesh and Tamil Nadu Forest Departments	ANON. 2002b
2003	JNPT Mumbai, en route to Colombo Sri Lanka	Chips	1.8	JNPT Mumbai	CITES MA India (2003)
01.2004	Kilkattalai, Tamil Nadu		15	Tamil Nadu Forest Department	ANON. 2004f
24.01.2004	Chennai, Tamil Nadu		18	Indian Department of Revenue Intelligence (DRI), Chennai	
2004	Singapore, exported from Mumbai	Logs	8		NIRAJ in litt. 2004.
02.2004	Mumbai, en route to Singapore	Wood pieces and logs	28	DRI	NIRAJ in litt. 2004.
27.02.2004	Singapore, exported from Cochin		12		KHIM 2005
03.2004	Pune	Freshly cut logs, believed to be from the wild	15	DRI and the officials of Directorate of Wildlife Preservation, Regional Office West, Mumbai	ANON. 2004g
17.03.2004	Singapore, exported from Mumbai	Logs	24	Singapore Immigration and Checkpoints Authority	KHIM 2005
30.04.2004	Tuticorin harbour Sellipalayam		16 48	DRI, Chennai (Seizure valued at 2.54 crore)	ANON. 2004j
07.05.2004	Singapore, exported from Chennai	Logs	20		KHIM 2005
12.2004	Chennai, en route to Malaysia	Logs	20	DRI	ANON. 2004e
12.2004	Chennai	Logs	20	DRI	ANON. 2004e
13.01.2005	Perfume making unit Madras (Madras Export Processing Zone)	Wood	20	Forest Department (Seizure valued at INR 10 000 000)	ANON. 2005b
22.02.2005	Raunaq Nagar, Andrha Pradesh	Logs (102)		Anti-poaching squad (Seizure valued at 5 lakhs)	ANON. 2005c
17.03.2005	Cuddapah Andrha Pradesh	Logs (80)		Forest Department	ANON. 2005d
02.04.2005	Tirupati, Andrha Pradesh	Logs (128)		Forest Department	ANON. 2005e
10.05.2005	Venkatagiri, Andrha Pradesh	Logs (80)		Forest Department (Seizure valued at 2.5 lakhs)	ANON. 2005f
23.05.05	Chennai, en route to Colombo	Logs	15	DRI Chennai (Seizure valued at 62 lakhs)	ANON. 2005g

Illegal harvest and trade is said to have increased in Andhra Pradesh following the ban on harvests in State Forests in 1982. In Andhra Pradesh, the Andhra Pradesh Forest Development Corporation (FDC) was appointed by the State Government as the main selling agent for seized timber (approximately 1800 t were seized by the Andhra Pradesh Government from 1992-2002). The FDC was said to sort the timber for sale onto the global (and presumably domestic) market (ANON. 2002a). In 2004 the Andhra Pradesh Forest Department was reported to have 2381 t of confiscated *P. santalinus* available for internal sale (ANON. 2004c).

There has been a rise in smuggling activity since approximately 2002 from Nellore, Chittoor and Kadapa districts, with demand for the wood in Japan and elsewhere in East Asia being cited as the main cause. Government forest department staff have been active in the busting of smuggling gangs (ANON. 2004d).

The Chennai unit of the Department of Revenue Intelligence seized over 73 t of *P. santalinus* worth INR1.5 crore (USD343 500) and arrested four persons from April 2003-March 2004. A further 175 t valued at over INR3.4 crore (USD778 600) was seized in six cases, with 11 people arrested, from April to December 2004. This included 20 t of logs seized in December 2004 destined for Malaysia (ANON. 2004e).

Twenty-eight tonnes of *P. santalinus* were seized in Mumbai en route to Singapore in February 2004, and a further 15 t seized in Pune approximately two weeks later (NIRAJ in litt. 2004). There were also three seizures of *P. santalinus* in Singapore in 2004. The shipments, totalling 56 t, were all intercepted by Customs officers after arriving from India. Two out of the three shipments were concealed with other commodities including cereals and coconut husks. The shipments were claimed to be “Poha” or Indian rice, “blended black tea” and “natural slate stone” (TRAFFIC SOUTHEAST ASIA 2004). In 2005, 20 t of wood were seized in a perfume factory in Madras (ANON. 2005b).

There were also numerous smaller seizures of *Ptercarpus santalinus* at various sea ports and airports, destined for the EU, the USA (mainly powder) and some other parts of the world. These items were seized as a result of violations of either India’s EXIM policy and/or CITES trade controls (Table 8).

Seized material may be sold by the Government (ANON. 2002a), however, under India’s Import and Export Policy, it would appear that this may only be exported as a value added product.

Table 8. *Pterocarpus santalinus* seizures of less than one tonne (2000-2003)

Year	Location	Destination	Product	Quantity
2000	IGI Air Cargo, New Delhi	Dubai, UAE	Powder	107 kg
2000	Sea Dock, Mumbai	Durban	Wood	5 kg
2000	Courier, Delhi	Germany	Wooden necklaces	400 pc.
2000	IGI Air Cargo, New Delhi	USA	Wooden necklaces	20 pc.
2001	Sea Port Chennai	Singapore	-	1 kg
2001	FPO New Delhi	USA	Wood chips	2 kg*
2002	Airport Kolkata	USA	Powder	20 kg**
2002	FPO Kolkata	Italy	Wooden beads	70 pc.
2002	Air Cargo Mumbai	USA	Powder	6 kg
2002	IGI Air Cargo, New Delhi	Scotland	Wooden necklaces	80 pc.
2002	Seaport Chennai	Malaysia	-	30 kg
2003	FPO Kolkata	Taiwan	Wood	4 pc.
2003	CFS Patparganj Delhi	Austria	Powder	70 boxes
2003	CFS Patparganj Delhi	Czech Republic	Wooden necklaces	400 pc.
2003	Airport Kolkata	China	Wood articles	8 kg
2005			Logs	102

*Seizure: 5.5 kg of mixed herbs, sandalwood and red sander chips.
**Seizure: 40 kg of mixed *Inula recemosa* and *Pterocarpus santalinus*.
Source: CITES Management Authority of India (2001; 2002; 2003 & 2004).

Legislation and Regulations

Regulation of harvest, manufacture and domestic trade. The main laws governing harvesting of medicinal plants in India are the Indian Forest Act (1927), and, to a lesser extent, the Wildlife (Protection) Act (1927/1991/2002). The Indian Forest Act (1927) consolidates the law relating to forest produce, the transit thereof and duty thereon, and empowers State Governments to regulate the transit of forest produce, e.g. medicinal plants. The Act deals specifically with reserved, protected, and village forests. Almost all the States and Union Territories in India have regulations regarding harvest, transit and trade in medicinal

plants. Most have established lists of species banned from harvest from forests ("Negative lists"), which include threatened plants (Jain 2000).

The Indian Forest Act (1927) has been adopted by most of the States and is directly applicable to the Union Territories of India. The remaining States have enacted State Forest Acts of their own, which are largely based on the Indian Forest Act. The Forest Acts of the States have been amended from time to time as required. The States have framed Rules under the Acts to protect and preserve the forest wealth of their respective States (JAIN 2000). See JAIN (2000) for a state-by-state analysis of legislation relevant to the harvest and trade of medicinal plants.

P. santalinus is classified as a "reserved tree" under the Andhra Pradesh Preservation of Private Forest Rules, 1978. Cutting, transport and sale require permission from the Divisional Forest Officer in accordance with rules set by the State Government. According to a State Forest Officer, felling of this species in State Forests has been banned since 1982 (JAIN in litt. 2005). The Andhra Pradesh Sandal Wood and Red Sanders Wood Transit Rules (1969) also specify that any import, export or transport of *P. santalinus* wood, chips or powder must be accompanied by a permit detailing the items and quantities involved, their source and destination. Further, the rules require that all items in trade (including individual wood pieces, bags of powder, etc.) be marked and if relevant, sealed. There are also provisions for the marking of individual trees at the time of felling and onward chain of custody requirements. The Andhra Pradesh Red Sanders Possession Rules require that a licence be obtained for possession of *P. santalinus* in excess of a certain amount, and the manufacture and/or trade of *P. santalinus* products, and to keep detailed records of stocks, transactions and storage facilities. This rule does not apply to domestic use (JAIN 2000). The government of Andhra Pradesh has considered charging *P. santalinus* smugglers under the *Preventive Detention Act* (ANON. 2004d). The Andhra Pradesh Forest Department has initiated a programme to improve regeneration of *P. santalinus* and therefore harvestable stock in natural forest areas through fire management, weed suppression and other activities (ANON. 2004i).

Possession and transport of *P. santalinus* timber, chips and powder similarly require permits from the District Forest Officer in the state of Tamil Nadu, but only if the quantity involved exceeds five kilogrammes. Felling of this species is currently banned in Tamil Nadu (NIRAJ in litt. 2005). There are also restrictions and government permissions required for the cutting of trees in hill areas, and provision made for dictating the right to fell trees on private lands (JAIN 2000). There do not appear to be any rules specific to *P. santalinus* in Karnataka, but the species is subject to detailed permit requirements for transport and sale, along with all other "forest produce". This includes the requirement that products be sold via auction, tender or 'tender-cum-auction', at sanctioned prices in sales depots, or via licence at sanctioned prices. Harvest in village forests functioning under the Panchayat system is allowed with permission of the Panchayat; harvest in district and protected forests requires the permission of the Forest Officers (JAIN 2000).

Regulation of international trade

CITES listing: *Pterocarpus santalinus* was included in CITES Appendix II effective 16 February 1995 following acceptance of a proposal from India. The listing was annotated to cover only "logs, wood-chips and unprocessed broken material" (Annotation #7). The annotation was modified at CITES CoP 14 (The Hague, June 2007), as part of a Plants Committee process to clarify and harmonise annotations for medicinal plants. The revised annotation, effective 13 September 2007, "Designates logs, wood-chips, powder and extracts".

CITES is implemented in **India** through a combination of the Wildlife Protection Act, 1972/1991/2002 and the Export and Import Policy (EXIM) of the Foreign Trade (Development and Regulation) Act, 1992 and the Customs Act, 1962. The Wildlife (Protection) Act prohibits export of a number of species, including all six CITES Appendix I plant species native to India, of which one, Kuth *Saussurea lappa*, is a medicinal plant.

Policy on trade in wildlife and wildlife products is established via the EXIM policy, which is revised periodically. The policy, as far as it concerns wildlife, is decided in consultation with the Director of Wildlife Preservation of the Government of India, who is the CITES Management Authority and oversees CITES implementation in the country. The Director has four Regional Deputy Directors and four sub-regional offices of wildlife preservation, these serving as assistant CITES Management Authorities. The EXIM policy is put into effect via the provisions of the Foreign Trade (Development and Regulation) Act 1992 and enforced via the Customs Act (CITES MANAGEMENT AUTHORITY OF INDIA in litt. 2004).

A series of specific export rules for *P. santalinus* has been in place since at least the early 1990s, alongside more general provisions for CITES-listed species. A government ban on exports imposed in April 1992 was modified in October 1996 to relate only to unprocessed products (ANON. 2000b). The species was included in India's Negative List of Exports of the Export and Import Policy in March 1996, in theory

banning virtually all exports of wild-harvested specimens. The listing for 1997-2002 and 2002-2007 was annotated such that "value added products" of the wood such as extracts, dyes and musical instruments and parts of musical instruments could be exported as long as the wood was procured from legal sources. Clarification is required regarding whether the term 'legal' only applies to wood from cultivated sources, or whether wood harvested from the wild was also allowed to be exported under this provision.

Exporters must obtain a licence, which requires that they provide certified copies of certificates of origin issued by the Principal Chief Conservator of Forests of the State from which the stocks were procured, giving details of the date of procurement and quantities. The stocks must be verified by a nominee of the Principal Chief Conservator and a certificate of their current position also provided with the application (ANON. 2005h).

Reference is made to the fact that the export may also be subject to other conditions such as "MEP [minimum export price], quantity ceilings requirements under CITES, etc." (ANON. 2005h). It is unclear whether and what such restrictions might be in place. No reference is made to cultivation.

The export of large quantities of wood chips recorded in Customs data would seem to indicate that these were considered 'value added' products. It would also appear that wood seized by the government (e.g. in Andhra Pradesh) is considered as coming from 'legal sources'. The reported shipment of approximately 200 t of seized timber from Andhra Pradesh to Japan in recent years (Anon. 2002a) calls into question whether exports of wild-collected material are being limited to value added products.

The EXIM policy was embedded within a broader Foreign Trade Policy for the period 2004-2009, this change coming into effect on 1 September 2004. The Foreign Trade Policy aims at doubling India's share in global trade and expanding employment opportunities, particularly in rural and semi-urban areas, and includes a Special Agricultural Produce Scheme, promoting the export of, *inter alia*, minor forest produce such as medicinal plants and their value-added products. The policy outlines that all export and import shall be "free", i.e. unrestricted, unless regulated under any legislation. Goods imported in accordance with this policy may be exported in the same form without a licence, provided that there is no import or export restriction for the items. Even goods restricted for import may be imported under Customs Bond for export without a licence provided that the items are freely exportable. Specific note is made in the policy that this does not preclude the application of other laws (DIRECTORATE GENERAL OF FOREIGN TRADE 2004).

Import and export restrictions for specific products are established via India's ITC (HS) classifications in accordance with the broader policy. As stipulated in Chapter 12 of the ITC (HS) classifications, the export of plants, plant portions, their derivatives and extracts of species included in CITES Appendix I and II and obtained from the wild is generally prohibited. Further clarification is required to confirm whether this applies to wild specimens regardless of their country of origin, or to only those specimens obtained within India. An "Export Licensing Note" appended to Chapter 12 specifies 29 plant taxa for which export is generally prohibited. This list includes *Pterocarpus santalinus*. An exception for both CITES species and those listed in the Licensing Note is made for the export of "formulations", defined as including "products which may contain portions/extracts of plants on the prohibited list but only in unrecognizable and physically inseparable form" and "value added formulations as well as herbal Ayurvedic" (Chapter 12, Export Licensing Note 3). It is not clear whether the term "recognizable" is defined per the CITES interpretation of "readily recognizable" such that if the ingredients of a particular formulation of Ayurvedic medicine are listed on the packaging, then they are considered to be "recognizable". The instructions include a note that states that "no certificate from any authorities whatsoever shall be required for their [formulations] export", implying that no CITES permits would be required for such exports. Export Licensing Note 2 states that export permits are required, however it is not clear if this applies only to cultivated specimens, which are allowed to be exported (see below) or also to formulations. CITES Management Authority staff have advised that, if Customs staff refer a shipment of formulations containing CITES-listed species to the Management Authority for clearance, then issuance of a CITES export permit will be required (AARTI in litt. 2005).

A further exception is provided for exports of wild CITES-listed species on a case by case basis for "life saving drugs", which could presumably be applied to any medicinal species. However, in this case a CITES permit would be required, with such trade only allowed on recommendation of the Ministry of Environment and Forests.

Exports of plants produced via cultivation are allowed subject to obtaining a transit pass from the relevant Divisional Forest Officer if the plants were cultivated in sites within forests, or a Certificate of Cultivation from a District Agriculture, Horticulture or Forest Officer if cultivated at sites outside forests. Export Licensing Note 2 included in this schedule states that "…However, in respect of CITES species, a CITES permit of export shall be required". As noted above, it appears that this provision relates to all but formulations, however this requires further clarification.

CITES would not appear to be being implemented for *P. santalinus* exports from India or in countries of import. Over 500 t of wood chips have been exported from India since the CITES listing took effect according to India's Customs data. However, India's CITES annual reports do not show the export of any wood chips, with CITES-reported exports instead limited to extract and carvings, with these ceasing in 1999. Little trade has been reported by importing Parties with the exception of China, which reported significant imports from non-range States in 2002 and 2003.

It does not appear that export restrictions on wild specimens of CITES-listed species apply to re-exports of imported specimens, however this requires confirmation, nor does it appear that there are any specific provisions made for controlling re-exports of CITES-listed species, other than as may be required to prove that re-exports do not involve wild-collected stock from within India. No reference could be found to an earlier (2003) provision requiring exporters of value-added formulations made out of imported species from the list of "prohibited plants" to provide an affidavit to Customs authorities at the time of export that the specimens were legally imported (NTF NO. 03/2003 31/03/2003). However, CITES Management Authority staff state that proof of import is required prior to granting re-export permission, and that they take into account, for example, the amount of unprocessed product that would have been required on import to produce a given export quantity (JAIN in litt. 2005). CITES Re-export Certificates are issued for such shipments (AARTI 2005).

Exports are required to be limited to the following ports: Mumbai, Nhava Sheva, Kolkata, Cochin, Delhi, Chennai, Tuticorin, Amritsar, Calicut and Thiruvananthapuram (DIRECTORATE GENERAL OF FOREIGN TRADE 2004). It is not clear if this relates to all plants covered under this Customs classification, or only to CITES-listed species and other medicinal species for which export is prohibited.

All violations of the EXIM policy constitute an offence under the Customs Act and are dealt with by Customs officials, who alone have the responsibility to enforce compliance with CITES at border posts. Inspection of consignments by Wildlife Inspectors, co-operating with Customs staff, may also be carried out at border crossings, but such specialist investigations are few. Enforcement of any violations detected is the responsibility of the Customs authorities (PANDA in litt. 1998).

Conclusions

The wood and wood products of *Pterocarpus santalinus* continue to be in demand and traded internationally in large volumes. India's Customs data and information on seizures indicate the trade of tens, if not hundreds, of tonnes of wood, wood chips and powder each year, with strong markets particularly in East Asian and Middle Eastern countries. Commercial cultivation is being actively promoted as a means of producing timber for trade, however the percentage of products currently in international trade coming from cultivated stocks is unknown. Illegal felling and habitat loss are both considered threats.

It appears that, if allowed at all, legal export of wild-sourced material is limited to value-added products, i.e. products other than timber (though apparently including wood chips). It is not clear whether timber from cultivated stocks is allowed to be exported. Export restrictions for timber seized by government authorities are also unclear.

CITES implementation for trade in the species appears to be virtually non-existent with regard to exports from India and imports by other countries, with the exception of detecting and seizing timber shipments exported illegally. The only CITES-reported trade in recent years appears to involve exports from non-range States (and therefore to be in question), with no trade reported directly from India.

No recent status information for *Pterocarpus santalinus* was available at the time of this study. However, earlier information indicated that it had been significantly reduced in the wild, to the point that it has been classified as Endangered. With no signs that demand has declined or that cultivation has reached sufficient levels to undercut the incentives for illegal felling, it is clear that increased action is required, both within India and internationally, to reduce illegal trade, and ensure that any specimens exported legally are from sustainable sources.

Possible next steps

The Government of India might consider:

- Clarifying national level export controls for the species, both for specimens from wild, and for cultivated and seized stocks;
- Encouraging greater dialogue amongst CITES Management Authority, Customs, and state Department of Forestry staff with regard to export controls and CITES implementation for the species;

- Re-instating the Customs codes for the timber and wood chips of this species to allow for better monitoring of international trade.

Governments of countries identified as importers of *P. santalinus* timber, particularly Japan and China, might consider:

- Reviewing domestic markets for P. santalinus timber in order to assess the likely level of trade; and
- Being more vigilant in checking for and confirming the validity of CITES permits upon presentation of shipments for import, and to seize shipments lacking such documentation.

Countries identified as importers of *P. santalinus* chips, particularly Singapore and the United Arab Emirates, might also be encouraged to be more vigilant with regard to shipments offered for import.

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Rauvolfia serpentina

Taxonomy *Rauvolfia serpentina* (L.) BENTH. ex KURZ (family Apocynaceae)

Synonyms *Ophioxylon salutiferum* SALISB., *Ophioxylon obversum* MIQ., *Ophioxylon serpentinum* L., *Rauvolfia obversa* (MIQ.) BAILL., *Rauvolfia trifoliata* (GAERTN.) BAILL.

Trade names Araba (mun), Arachontita (ass), Arbre aux serpents (fre), Asrel (urd), Bomayaza (bur) Chandmaruwa (nep), Chandra (ben), Chandra (hin), Chandra (Mumbai), Chandrabhaga (hin), Chandrabhoya (hin), Chhota Chand (hin), Chandrika (India), Chivan Amelpodi (tam), Chivanamelpodi (tam), Chovannamilpori (tam), Chuvannavilpori (mal), Chuvannavilpuri (mal), Darujikipota (mun), Harkaya (mar), Harki (mar), Huring (mun), Indische Schlangenwurzel (ger), Jowansu (mik), Lotu-chand (hin), Makalmaran (Delhil), Paataala Garuda (tel), Paataalagani (tel), Patala-agandhi (tel), Patalagandhi (kan), Patalgarur (ori), Phulchiso (nep), Racine de serpentine (fre), Radix Rauwolfiae (pha), Rauwolfia (fre), Rauwolfia root (eng), Rauwolfiae radix (pha), Rauwolfiawurzel (ger), Ra-yom (tha), Sanochado (ori), Sarpaganda (fre), Sarpagandha (nep), Sarpagandha (san), Sarpagandhi (kan), Sarpaganthi (tam), Sarpaghanda (san), Schlangenholz (ger), Segno serpentino (ita), Serpentine root (eng), Serpentine wood (eng), Shegenmu (chi), Shivanabhiballi (kan), Simjenga (mun), Snakewood (eng), Supurolid (mun), Sutranavi (kan), Suvapavalporiyan (mal), Todong-pait-parao (kha) (FAO 2002, IUCN NEPAL 2004, JAICHAGUN in litt. 2006, LANGE & SCHIPPMANN 1999, MANANDHAR 2002).

Description. An erect, small evergreen perennial, semi-shrub, usually 15-45 cm, sometimes up to 90 cm tall. Stems usually unbranched and slender, when broken exude a pale, sticky sap. Root, nearly vertical, a taproot system, tuberous, up to 50 cm long, sometimes irregularly nodular, developing several smaller, fibrous side roots, grayish-yellow externally, pale-yellow within; acrid in odour when fresh, odourless when dried, very bitter. The root bark, which constitutes 40-60% of the whole root, is rich in 'reserpine', an alkaloid. Leaves grouped near stem apex in whorls of 3-5, elliptical lanceolate or obovate, pointed, dark-green on the upper surface and pale-green on the underside, 7.5-20 cm. Inflorescence generally a terminal, densely flowered cyme. Flowers in long-stalked cluster, tubular, five lobed, 1-3 cm long, vary in colour from white over pinkish to red, with red pedicel and calyx. Flowering from February to October. Fruit egg-shaped with pointed ends, purplish black when ripe (EVERETT 1981-1982, HENDRIAN 1997, MORTON 1977). Additional details on the morphology of the species and particularly the root can be found in WHO (1990).

Distribution. Bangladesh, Bhutan, China, Indonesia, India, Lao PDR, Malaysia, Myanmar, Nepal, Pakistan (?), Sri Lanka, Thailand, Viet Nam.

The species is wide ranging in Asia. In **China** it is found in the provinces of Guangdong, Guangxi, Hainan, and Yunnan (MISSOURI BOTANICAL GARDENS 1996). It is found in almost all parts of **India**, up to an altitude of about 1000 m. It is more common in submontane regions of the Himalayas and in lower ranges of the Eastern and Western Ghats, also in the states of Himachal Pradesh, Uttaranchal, Sikkim, Assam, Kerala, Orissa, Tamil Nadu, Bengal, Bihar and Maharashtra and the Andaman Islands (JAIN 1996). The species occurs in **Indonesia** on Kalimantan, Java (Purwakarta, Cirebon, Pekalongan, Tegal, Semarang, Rembang, Jepara, Pasuruan, Kediri, Madiun and Ngawi), Sumatra and the Lesser Sunda Islands (BALAKRISHNA 1993a, HARA & al. 1978-1982, HENDRIAN 1997, HOOKER 1872, JAIN & RAO 1983, SHRESTHA 1988, SUVATTI 1978, WIART 2000). In the northern part of Central Java the species is usually found under stands of *Tectona grandis* (HENDRIAN 1997). The occurence of *R. serpentina* in **Lao PDR** is reported by WICHTL (1997). It grows well and sometimes abundantly in natural moist deciduous forest in **Myanmar**, where it occurs in six of its 14 regions: the states of Kayah, Kayin and Shan and the divisions of Sagaing, Bago and Manadalay (ZAW in litt. 2005). It occurs widely in the tropical regions of eastern and central **Nepal** up to 1150 m and is associated with *Shorea robusta* (Sal) forests as an understorey species (AMATYA in litt. 2005). According to AKHTER (2005), the species does not occur in **Pakistan**. In **Thailand** it is found in evergreen forest or open areas up to 800 m altitude in the north (Chiang Mai, Lampang, Lamphun, Nan, Phitsanulok, Phrae, Tak), northeast (Loei, Nong Khai, Phetchabun), southwest (Kanchanaburi, Khiri Knan, Prachuap), central (Bangkok, Saraburi) and southeast (Chanthburi, Chon Buri, Surat Thani) (SANKASUBUAN in litt. 2005).

Generally, *R. serpentina* favours humus-rich soils with a pH of 4 and where annual rainfall reaches at least 2500 mm. It occurs in open areas, well-drained rainforests and secondary thickets and deciduous forests up to 2100 m.

Population status and threats. The species is not included in the IUCN Red List (IUCN 2006).

In **India**, the species was considered to be 'endangered' in southern (Karnataka, Kerala, Tamil Nadu) and central India. Three Conservation Assessment and Management Plan (CAMP) workshops concluded that populations have declined more than 50% from 1985-1995 owing to loss of habitat and over-collection for the medicinal plant trade (MOLUR & al. 1995, MOLUR & WALKER 1998). ANSARI (1993) stated that genetic erosion has affected the species greatly and populations left in India have a very poor alkaloid content. Another CAMP workshop was held in Bhopal in 1998 when the species was assessed as *Critically Endangered*[1994] in Maharashtra owing to the same threats. The observed decline was, however, more than 80% from 1988-1998 (PATNAIK 1999). A CAMP workshop in July 2003 assessed the species *as Critically Endangered*[2001] in Chhattisgarh, Andhra Pradesh and Maharashtra and *Vulnerable*[2001] in Madhya Pradesh, Jammu & Kashmir, Uttaranchal, Assam and Meghalaya. Major threats were harvest for medicinal use and trade (VED & al. 2003). BALAKRISHNA (1993b) and JAIN & RAO (1983) reported the species to be 'vulnerable' in the Indian states of Kerala, Orissa and Tamil Nadu. Participants during a workshop on 'Endangered Medicinal Plant Species in Himachal Pradesh' described it as "endangered" (ANON. 2002a). AYENSU (1996) considers it to be threatened in India.

SIDDIQUE & al. (2004) consider the species to be "endangered" in the Barind Tract of **Bangladesh**. The species has been reported as being "vulnerable" in **Myanmar** in the UNEP-WCMC Threatened Plants Database, however, according to ZAW (in litt. 2005), populations are still abundant in the moist forest areas where it occurs, but could be declining in areas where habitat is degraded. AUNG DIN (2005) considered the major threat to be habitat degradation and change of land use. The species was assessed as *Critically Endangered*[2001] in **Nepal** during a 2001 CAMP workshop (BHATTARAI & al. 2002), where it has "already approached extinction in most areas of the country", according to BHATTARAI (1997). Here, overharvesting, burning to create areas for livestock grazing, shifting cultivation and land encroachment for cultivation are the major threats (AMATYA in litt. 2005). Following consultation with representatives from the CITES Scientific Authority, Nepal's CITES Management Authority stated that they considered the species to be "threatened in the wild" in Nepal (SHARMA in litt. 2006). The status has been described as "indeterminate" in **Sri Lanka** (WIJESINGHE & al. 1990) and as "endangered" in **Viet Nam** (PHAN THUC VAT 1996).

Medicinal uses

Plant parts used for medicinal purposes: Roots.

Rauvolfia serpentina contains over 60 indole alkaloids, the most significant being *rescinamine, doserpidine, reserpinine, serpinine, serpentinine, ajmaline, ajmalicine, rauvolfinine* and *yohimbine*. The principal hypertensive alkaloids are reserpine and rescinnamine (MONACHINO 1954, NATIONAL FORMULARY BOARD, AMERICAN PHARMACEUTICAL ASSOCIATION 1975). The alkaloid content varies from 1.4-3%, depending on location, season and soil conditions (FAROOQI & SREERAMU 2001). The drug 'Rauvolfia' consists of the air-dried roots of *R. serpentina* (SHELDON & al. 1997).

In **India**, *R. serpentina* has been employed for centuries in the treatment of various central nervous disorders, including anxiety states, maniacal behaviour associated with psychosis, schizophrenia, insanity, insomnia, and epilepsy. Extracts of the roots are valued for the treatment of intestinal disorders and also as an anthelmintic. Mixed with other plant extracts, they have been used in the treatment of cholera, colic and fever (GOVERNMENT OF INDIA 1989). Twelve herbal formulations using *Rauvolfia serpentina* were manufactured in India in the late 1990s (TRAFFIC INDIA 1998). The species is also used by traditional healers to treat snake and dog bites (OUDHIA 2003).

In **Nepal**, traditional healers use the roots of *R. serpentina* to treat hypertension, fever, mental disorders, depression and memory loss. The species is used as "*Sarpagandha*" in *Sarpagandhadi churana, Sarpagandhadi yog,* as "*Srpagandhadi bati"* by Singhgadarbar Vaidya Khana, as "*Tensarin*" by Gorkha Ayurveda, and as "*Nindra karak*" by Arogya Bhawan (AMATYA in litt. 2005). Very small quantities are usually used. In addition, the juice of the root is applied in hypnosis and to treat dysentery and fever (MANANDHAR 2002). *R. serpentina* is used by traditional healers in **Bangladesh** to relieve stomach ache and to expel thread worms (SIDDIQUE & al. 2004). In **Myanmar**, it is used in indigenous medicines, to treat hypertension, as a sedative, and for treatment of intestinal disorders (AUNG DIN 2005). Other species are not substituted for *R. serpentina* (ZAW in litt. 2005). The species is also used in traditional medicine in **Thailand** (TRAFFIC SOUTHEAST ASIA in litt. 2005).

In traditional East Asian medicine, *R. serpentina* roots are used "to remove heat, reduce liver wind, promote subsidence of swelling and lower blood pressure" (HAU 1997). The term Radix Rauvolfiae is referred to in the Hong Kong Chinese Medicine Ordinance (Chapter 549, 06/08/1999) as the root of either *R. verticillata* (LOUR.) BAILL. or *R. serpentina*. However, during a TRAFFIC East Asia trade survey in Hong Kong in 1997, none of the traders interviewed knew about the drug 'Rauvolfia' (HAU 1997).

In western medicine, the alkaloid reserpine, first isolated from *Rauvolfia* roots in the early 1950s, quickly became important in the treatment of hypertension and mental illnesses through its effect as a tranquillizer (SHELDON & al. 1997). Use has decreased in Europe owing to side effects (FROHNE 1994, WICHTL 1997), with sales of reserpine-based pharmaceuticals having declined in Germany, where smaller amounts of *R. serpentina* continue to be used in phyto-pharmaceutical preparations (LANGE 2005). According to information available from the US National Library of Medicine, it has been used as an antihypertensive and an antipsychotic, but its adverse effects limit its clinical use (CHEMIDPLUS 2005). It is considered a carcinogen (ANON 2002b).

Other uses. The plant has no ornamental potential (EVERETT 1981-1982). According to local healers in the Terai, Nepal, rural people plant *R. serpentina* in their gardens because it is believed to keep snakes away (AMATYA in litt. 2005). The species is also planted to ward off snakes in rural India (OUDHIA 2003).

Similar species/substitutes. Reserpine is also extracted from three other species: *R. tetraphylla* from tropical America, *R. vomitoria* from Africa and *R. confertiflora* from Madagascar (ANON. 2005a, EVERETT 1981-1982, SHELDON & al. 1997). *R. confertiflora* is said to have already disappeared due to indiscriminate collection (RASOANAIVO 1990). HAU (1997) reports that *R. latifrons, R. verticillata* and *R. yunnanensis* are also used in Chinese medicines. Further research is required to determine whether reserpines are also now being produced via cell culture.

Harvest and processing. According to information contained within the Tenth Report on Carcinogens (ANON. 2002b), there was no known commercial production of synthetic reserpine, with the chemical extracted from the roots of *R. serpentina* with alcohols or aqueous acid and then purified.

Generally, roots and sometimes leaves are harvested. Roots can be harvested when the plants are 15 months old, although the yield is low and it is commonly suggested that plants should be harvested only after three to four years, when they are mature (AMATYA in litt. 2005, SHELDON & al. 1997). Up to 30-40% of the harvest in India is eventually lost due to spoilage (CHATTERJEE 2004).

In **Myanmar**, the species is collected and traded mainly for domestic use in indigenous medicines. Local people collect the species and sell it to small traders in the nearest towns, who distribute the plants to major traders in big cities such as Yangon and Mandalay (ZAW in litt. 2005). Wholesalers also have agents who collect the species in local areas, possibly buying from village collectors (AUNG DIN 2005). The roots are usually dried, losing approximately two-thirds of their weight, although indigenous healers often prefer to use fresh roots (AUNG DIN 2005). Some local collectors sell directly to cottage medicine industries. Only a small number of individuals and households are believed to be involved in the collection of *R. serpentina*, but because collection is not specialised, this number is hard to estimate. The species is collected opportunistically, at the same time as people harvest other forest products for local use. Despite existing market demand, no special efforts are made to collect *R. serpentina* (ZAW in litt. 2005). From 2001 to 2004 the Forest Department allowed approximately 68 t to be harvested (fresh weight) for domestic use.

In **Nepal**, the preferred harvesting season is winter, after flowering, when the plants shed their leaves and the alkaloid content is highest (AMATYA in litt. 2005). They are dug out carefully from the sub-soil, as the root bark needs to be kept intact because it contains 40-60% of the alkaloid found in the entire root. Primary processing such as cleaning and sun drying is performed by the collectors. *R. serpentina* is traded under the names “Sarpagandha” and “Chandmaruwa”. Although there is no physical difference between the two, under the Forest Regulation (1995), harvesters are charged a forest royalty fee of NPR10/kg (USD0.14/kg) for Chandmaruwa, in contrast to NPR50/kg (USD0.7/kg) for Sarpagandha, the export of which is also prohibited in raw form. As a result, it is expected that *R. serpentina* is more commonly harvested and sold under the name Chandmaruwa, however forestry records show very little harvest under this name (and none under Sarpagandha). According to forest royalty records, no Chandmaruwa was harvested from 1999/2000-2002/2003, and only 52.5 kg in 2003/2004. Regional traders dry and repack the roots and exporters grade the roots to ensure they are free from adulteration. Manufacturers usually assess the quality of the material by testing samples provided by exporters for the active ingredient (AMATYA in litt. 2005).

Harvest in **Thailand** is said to mainly involve villagers who collect the species as an opportunistic activity, with companies involved in internal trade and export (SANKASUBUAN in litt. 2005). Collection takes place during the rainy season, in May-June, with collectors drying the roots prior to sale. Exporters only buy the root once a year, from middlemen, during the rainy season (JAICHAGUN 2005). It does not appear that other species with similar properties are mixed with or substituted for *R. serpentina* (SANKASUBUAN in litt. 2005).

AYENSU (1996) also refers to collection within **Lao PDR** and **Viet Nam**.

Cultivation. Efforts to domesticate the species were said in the 1990s to have only been partially successful, as seed germination is low and alkaloid content varies. Better results have been achieved when propagating via rootstock cuttings, but here the alkaloid content proved to be lower than in plants produced from seed (GOVERNMENT OF INDIA 1989, SAMANT & al. 1998, SHELDON & al. 1997). Efforts have also been made to propagate plants from tissue culture (CHANDEL & SHARMA 1996) and to produce the alkaloid in cell suspension cultures (HERMAN 1989). Cultivation methods have been steadily improving over the years (IUCN & TRAFFIC 1989, SINGH 1997).

In **India**, TRAFFIC INDIA (1998) noted that various forest departments had undertaken cultivation projects, but observed that cultivation had not been taken up commercially. This conflicts with AYENSU (1996), who stated that the species was commercially cultivated in India. Under irrigated conditions, optimum yield is achieved only after two to three years of cultivation from seed. *R. serpentina* has been selected for *in situ* and *ex situ* propagation in Chhattisgarh, and was considered a top priority species for development of *ex situ* cultivation in Himachal Pradesh (ANON. 2002a). The economic size for commercial cultivation of *R. serpentina* and other root yielding medicinal plants in India is said to be 25-30 ha (CHATTERJEE 2004).

According to RAJKARNIKAR & al. (2000), the species was not cultivated on a commercial scale in **Nepal**. However, germplasm has been conserved and propagated and experimental cultivation has been conducted in the past on two farms owned by the government, in Bara and Makwanpur. Seeds were planted in nurseries and after two months the seedlings were transplanted in the fields. Seeds directly sown in the fields did not succeed and here regeneration after collection only occured through remnants of roots left behind. More recently, in these and other Nepali regions, Kerkha (Jhapa), Dhakeri (Banke) and Shripur (Kailali), cultivation experiments were conducted on areas of three hectares or less with an average yield of 2000-2500 kg fresh root per hectare (AMATYA in litt. 2005). AYENSU (1996) has stated that *R. serpentina* is in commercial cultivation in Nepal.

Mature seeds are usually collected from September onwards, ideally at an interval of 10-12 days. Only a few fruits ripen at a time and they are dispersed if not immediately collected. The collected fresh seeds should be sown immediately to retain viability and to obtain a high germination rate (AMATYA in litt. 2005). Seeds are usually collected for commercial propagation. Shoots, root stumps and root cuttings are alternative sources for artificial propagation and natural regeneration occurs through remains of roots left behind in the soil (AMATYA in litt. 2005).

According to JARYAL (2001) seeds should be less than one year old when planted, but germination is still only 10-50%. The species is irrigated for 18 months and the yield per hectare is around 30-40 kg seed and 2-2.25 t of dried roots.

In **Bangladesh,** *in vitro* propagation has been carried out with the aim of cultivating the species within agroforestry systems (ROY & HOSSAIN 1999). In **China**, *R. serpentina* has been cultivated in the provinces of Guangdong, Hainan, Guangxi, and Guizhou (HAU 1997). WICHTL (1997) reported on commercial cultivation also taking place in **Malaysia**. Some small-scale trial plantations for local medicinal supply have been established in **Myanmar** (ZAW in litt. 2005). According to SANKASUBUAN (in litt. 2005), cultivation has been studied in **Thailand**. AYENSU (1996) refered to commercial cultivation in **Viet Nam**.

National market. A research institute in **India** reported that during the years 1984-1990 only 1.6 t of *R. serpentina* roots were harvested annually for local industrial production (HENDRIAN 1997). At the time of its inclusion in Appendix II (1989), annual domestic demand in India was estimated to be 50 t of dried roots while only 30 t were available (IUCN & TRAFFIC 1989). According to a 1995 study, 21 t of roots were required to meet demand in Kerala alone (AFC 1995). According to data provided by the Ayurvedic Drug Manufacturers Association in Mumbai, India produced 800 t of *Rauvolfia* crude drugs in 1999, of which only 20% (160 t) was used by India's Ayurvedic industry (GOVERNMENT OF INDIA PLANNING COMMISSION 2000).

During the late 1990s, the Dabur Research Foundation estimated the annual demand of the Ayurvedic industry to be 11 t while an Indian trade organization assessed the overall Indian demand as 60 t per year (TRAFFIC INDIA 1998). A supply and demand study including *R. serpentina* commissioned by the Department of Indian Systems of Medicine & Homeopathy, the Indian Government and the World Health Organization (WHO) estimated demand for 2001-2002 as 423.6 t and for 2004-2005 as 588.7 t, much higher than earlier estimates. The price during 1999-2000 was reported to be INR150 000/t (USD3435/t) (ANON. 2001-2002). This would appear to contradict the contention in India's 1989 CITES proposal for this species that "most of the produce is exported because only a small fraction is used by Indian pharmaceutical firms" (GOVERNMENT OF INDIA 1989). DHAWAN (in litt. 2005) indicates widespread use of the species in India by phyto-pharmaceutical companies.

During a TRAFFIC India market survey in 1997 the species was found to be commonly traded in the markets of Delhi, Kolkata, Mumbai, Haridwar and Amritsar. It was among the most significantly traded medicinal plants and was readily available. At the Delhi market, the species was said to come mainly from Uttaranchal, but with substantial quantities also imported from Bhutan, Nepal and Pakistan (TRAFFIC INDIA 1998). According to GUPTA (in litt. 2005), the main markets where the species is sold are Amritsar, Delhi, Kolkata (previously Calcutta) and Mumbai, with roots sold at INR80-90/kg (USD1.8-2.1/kg) dry weight. These markets in turn supply smaller markets within India. A well-known, medium-sized pharmacy in south India whose annual demand for *R. serpentina* was 300 kg purchased the roots from Delhi at an average price of INR120-125/kg (USD2.7-2.9/kg) (RAMACHANDRAN in litt. 2005).

Harvest within **Myanmar** is said to be primarily to meet domestic demand, although CITES trade data and other information indicate that harvest for export is also undertaken. The market price in a major local market was said to be about MMK850/kg (USD136/kg) (ZAW 2005), a figure that seems unlikely when compared with prices in other countries.

International trade. The development of reserpine-based pharmaceuticals in the 1950s led to increasing demand for *R. serpentina*, which was mainly supplied by India (SHELDON & al. 1997), with this country at one time having a monopoly on supplies of the crude drug for the world market (GOVERNMENT OF INDIA 1989). The global demand for *R. serpentina* was estimated in the early 1980s to be 100-150 t annually. This appears to have grown significantly, with domestic demand in India alone estimated at over 400 t in 2000/2001 (ANON. 2001-2002). Prior to inclusion of *R. serpentina* in CITES Appendix II, most of the drugs used in the USA and Europe originated from India, Pakistan, Sri Lanka, Myanmar and Thailand (GOVERNMENT OF INDIA 1989). A 1993 FAO study estimated that 400-500 t of roots were harvested annually, mainly in India, Thailand, Bangladesh and Sri Lanka (IQBAL 1993). Traders in the Delhi markets stated in the late 1990s that although the species was mainly supplied from Uttaranchal, substantial quantities were also imported from Bhutan, Nepal and Pakistan (TRAFFIC INDIA 1998).

CITES annual report data show trade in both roots and extract (Tables 1 and 6).

Table 1. CITES-reported trade of *Rauvolfia serpentina* roots (1999-2003; in kg)

Year	Importer	Exporter	Origin	Imports reported	Exports reported	Purpose	Source
1999	IN	MM		7 114 (seized)	14 340	T	U
1999	DE	TH			3 300		A
2000	AU	DE	TH		11	T	W
2000	CH	IN			100	T	A
2000	DE	TH		9 011	9 500		W
2001	DE	TH		4 020	4 020		W
2002	DE	TH		1 740	1 740		W
2002	DE	IN		125			A
2003	CH	DE	TH		170	T	W
2003	US	DE	TH		10	T	W
2003	ZA	DE	TH		5	T	W
2003	ZA	DE	TH		15	T	A
Total				**14 896**	**33 211**		

Source: CITES annual report data compiled by UNEP-WCMC.

CITES data show the reported export of approximately 33 t of *R. serpentina* roots from 1999-2003, dominated by exports from Myanmar and Thailand. Importing Parties showed trade in less than half that amount. Of these, seven tonnes were reported as seized on import by the Government of India, originating from Myanmar; exports from Myanmar to India reported for the same year show the trade of 14 t. Thailand's CITES Management Authority reports the further export of roots for 2002-2005: in 2002, 186 kg exported to the USA; 2003, 2370 kg exported to Germany; 2004, 3050 kg exported to Germany; 2005, 3030 kg exported to Germany (JAICHAGUN in litt. 2006, SANKASUBUAN in litt. 2005).

Customs data for **India** include two specific codes for imports and exports of *Rauvolfia* products (Table 2), with data compiled for the fiscal year running from 1 April to 31 March. Both imports and (re) exports of

roots and processed products are recorded in Customs data, which can therefore be compared with CITES annual report data.

Table 2. Indian Customs codes for trade in *Rauvolfia* spp.

Product name	Customs code	Notes
"Serpentina roots"	12112005 (until April 2003) 12119044 (after April 2003)	Serpentina roots (*Rauvolfia serpentina* and other species of rauvolfias) (ANON. 2005b)
"Formulations of reserpine & other *Rauvolfia* alkaloids in tablets"	30044015 (until April 2003, then discontinued)	Includes reserpines produced from *Rauvolfia* species in addition to *R. serpentina*

Source: Export Import Data Bank, Department of Commerce, India.

According to TRAFFIC INDIA (1998), India banned the export of raw material in the 1960s with the result that export of alkaloids extracted from the roots increased. The ban on raw material exports would not appear to be supported by Customs data, however, unless these data reflect exports of *R. serpentina* previously imported from other countries, i.e. re-exports, or involve species other than *R. serpentina* that were imported into and/or cultivated in India prior to (re-)export. According to Customs data, India exported over 100 t of "Serpentina roots," from 1971/1972-2003/2004. Approximately 29 t were reported as exported from 1999/2000-2003/2004 (Tables 3 and 4), with 14 t exported in 2003/2004 alone. This trade has not been captured in India's CITES data or the data of importing Parties. Based on what is known of the trade, it seems likely that the record of exports from India to Nepal in 2001/2002 is in error, and was actually an import; an identical quantity is recorded in India's import data (Table 5).

Table 3. Export of "Serpentina" roots recorded in India's Customs data (1971-2004; t)

1971/72-1975/76	1976/77-1980/81	1981/82		1991/92	1992/93		1995/96		1999/2000		2001/02	2003/04
Total: 3.6 Annual average: 0.7	Total: 53.3 Annual average: 10.6	26.3		0.3	0.1		3.9		9.0		6.0	14.2

Sources: LANGE & WÄCHTER (1996). Quantities for 1963-68 from GOVERNMENT OF INDIA (1989). Quantities for 1995/96 from TRAFFIC INDIA (1998), for 1999-2004 from Export Import Data Bank, Department of Commerce, India.

Table 4. Export of "Serpentina roots" recorded in India's Customs data (1999/2000-2003/2004)

Year	Country of Import	Quantity (kg)
1999-00	Italy	3 120
	UK	5 900
2000-01	-	-
2001-02	Nepal	6 000
2002-03	-	-
2003-04	Kuwait	1 000
	United Arab Emirates	13 200
Total		**29 220**

Source: Export Import Data Bank, Department of Commerce, India.

Table 5. Import of "Serpentina roots" into India (1999/2000-2003/2004)

Year	Country of Export	Quantity (t)
1999-00	Myanmar	19.8
	Singapore	6.0
2000-01	Myanmar	6.0
2001-02	Myanmar	19.3
	Nepal	6.0
2002-03	Myanmar	36.1
2003-04	Belgium	1.0
	Congo DR	35.3
	Kenya	12.1
	Myanmar	70.4
Total		**212.0**

Source: Export Import Data Bank, Department of Commerce, India.

Table 6. CITES-reported trade of *Rauvolfia serpentina* extract (1999-2003)

Year	Importer	Exporter (origin)	Exports reported (g)	Purpose	Source
1998	RU	IN	600	T	A
1998	SG	IN	1 830	T	A
1998	US	IN	45	T	A
1999	BG	IN	60	T	W
1999	CY	IN	150	T	W
1999	RU	IN	2 175	T	W
1999	RU	IN	1 015	T	W
1999	SY	IN	5 200	T	W
1999	US	IN	500	T	W
2000	RU	IN	2 235	T	A
2003	ZA	DE (TH)	20 000	T	A
Total			**33 810**		

Source: CITES annual report data compiled by UNEP-WCMC.

Table 7. Export of "Formulation of reserpine and other Rauvolfia alkaloids in tablets etc." recorded in India's Customs data (1999/2000-2003/2004)

Year	Country of Import	Quantity (t)
1999/2000	Estonia	0.30
	Kazakhstan	0.90
	Mozambique	0.08
	Russian Fed.	22.22
	Singapore	0.03
	Ukraine	3.25
	USA	0.90
2000/2001	Kazakhstan	1.50
	Russan Fed.	22.90
2001/2002	Georgia	0.06
	Germany	0.00
	Hong Kong	0.02
	Russian Fed.	80.76
	South Africa	0.50
	Ukraine	112.08
	USA	1.00
2002/2003	Azerbaijan	0.50
	Kenya	4.55
	Latvia	2.00
	Mauritius	0.05
	Myanmar	0.85
	Russian Fed.	12.32
2003/2004	-	-
Total		**266.77**

Source: Export Import Data Bank, Department of Commerce, India.

India's Customs data also show the import into India of significant quantities of "Serpentina roots" from 1999/2000-2003/2004, with over 200 t of roots imported during this period (Table 5). Myanmar, a range State for *R. serpentina*, was the reported source of nearly three quarters of this trade (158 t). According to data provided by CHEMEXIL (1997/1998), 28 t of *Rauvolfia serpentina* was imported from Myanmar (GOVERNMENT OF INDIA PLANNING COMMISSION 2000).

Trade data for 1999-2000 correspond very roughly to CITES annual report data from Myanmar for 1999; none of the other imports are reflected in CITES data, however.

Two African countries were reported as the source of 47 t of roots, these are most likely another *Rauvolfia* species (e.g. *R. vomitoria*) rather than *R. serpentina*.

TRAFFIC INDIA (1998) identified the UK, the Netherlands and the Philippines as the main importers of *Rauvolfia* products from India. LANGE & WÄCHTER (1996) named the United Arab Emirates and the USA as importing countries in the late 1970s and the Philippines, Portugal and Singapore in the early 1990s. According to a formulator in Nepal (AMATYA in litt. 2005), preparations containing "*Rauvolfia"* were also exported to the Netherlands until the Dutch Government imposed a restriction on the importation of formulations containing *Rauvolfia serpentina,* as it might encourage fungal infection in the digestive system.

CITES reporting of trade in extracts was limited to exporting Parties (Table 6), with approximately 33 kg of extract exports reported from 1999-2003. Virtually all of this trade originated from India, from a mix of wild and cultivated sources. Trade in extracts was unreported, and therefore theoretically unmonitored, by importing Parties. This presumably reflects a decision to consider extracts to be "chemical derivatives" and therefore not subject to CITES trade controls per CITES Annotation #2, which applied to the CITES listing of this species.

Exports of *Rauvolfia* extract and associated products recorded in India's Customs data are larger by several orders of magnitude, with exports totalling over 250 t from 1999/2000-2003/2004 (Table 7). The main export destinations were the Russian Federation and countries in Eastern Europe, with the Ukraine the reported export destination for 112 t in 2001/2002 alone.

Table 8. CITES-reported trade in *Rauvolfia serpentina* (1997-2003)

	Country of Export	Country of Import	Origin	Export					Import				
				Quantity	Unit	Term	P	S	Quantity	Unit	Term	P	S
1997	CL	DE	??						200	g	Derivatives	E	U
1997	DE	CL	??	200	g	Derivatives	E	U					
1997	IN	RU		2000 000	?	Derivatives	T	A					
1997	IN	RU		14	kg	Derivatives	T	A					
1997	CL	DE	??	200	g	Dried plants	E	U					
1997	IN	PH		50	kg	Powder	T	A					
1998	IN	RU		600	g	Extract	T	A					
1998	IN	SG		1 830	g	Extract	T	A					
1998	IN	US		45	g	Extract	T	A					
1999	IN	BG		60	g	Extract	T	W					
1999	IN	CY		150	g	Extract	T	W					
1999	IN	RU		2	kg	Extract	T	W					
1999	IN	RU		1 015	g	Extract	T	W					
1999	IN	SY		5	kg	Extract	T	W					
1999	IN	US		500	g	Extract	T	W					
1999	MM	IN							7 114	kg	Roots	T	I
1999	MM	IN		14 340	kg	Roots	T	U					
1999	TH	DE		3 300	kg	Roots		A					
2000	DE	AU	TH	11	kg	Roots	T	W					
2000	IN	CH		100	kg	Roots	T	A					
2000	IN	RU		2 235	g	Extract	T	A					
2000	TH	DE							9 011	kg	Roots	T	W
2000	TH	DE		9 500	kg	Roots		W					
2001	TH	DE							4 020	kg	Roots	T	W
2001	TH	DE		4 020	kg	Roots		W					
2002	IN	DE							125	kg	Roots	T	A
2002	IN	DE							250	g	Roots	T	A
2002	TH	DE							1 740	kg	Roots	T	W
2002	TH	DE		1 740	kg	Roots		W					
2002	TH	US							186		Live	T	W
2002	TH	US		186		Live		W					
2003	DE	BG	??	1		Specimens	L	I					
2003	DE	CH	TH	170	kg	Roots	T	W					
2003	DE	US	TH	10	kg	Roots	T	W					
2003	DE	ZA	TH	20	kg	Extract	T	A					
2003	DE	ZA	TH	5	kg	Roots	T	W					
2003	DE	ZA	TH	15	kg	Roots	T	A					
2003	TH	DE		2 370	kg	Roots	T	W					

Source: CITES annual report data compiled by UNEP-WCMC.

According to a CITES Management Authority staff member, exports are limited to only one *Rauvolfia* alkaloid, reserpine, produced from imported *R. vomitoria*, with an affidavit to this effect obtained from exporters prior to permitting export. Quantities are checked to ensure that exports do not exceed those that could

have been produced from imported *R. vomitoria*, and the exporter is provided with a No Objection Certificate. As the trade does not involve the CITES-listed *R. serpentina*, this trade is not recorded in CITES annual reports. *R. serpentina* is also exported in the form of formulations. As this product had been exempt from CITES provisions under Annotation #2, no CITES permits were issued and no records maintained (JAIN in litt. 2005).

CITES annual report data (Table 8) and India's Customs data differ further in terms of the countries identified as trading partners. CITES-reported exports from India to China and the Russian Federation in 2000 (100 kg roots and 2.2 kg extract respectively) are not reflected in Customs data. Similarly, Customs-reported imports of roots from other *R. serpentina* range States (e.g. Myanmar and Nepal) are not reflected in CITES data. While it is possible that this trade involves other *Rauvolfia* species, this seems unlikely. Based on available information, it appears that only two species, *R. serpentina* and the African *R. vomitoria*, are used in significant quantities to produce reserpine, and there is no evidence of cultivation of the latter species in either Myanmar or Nepal.

Thailand emerged as a significant exporter of *R. serpentina* roots in 1999, exporting 24 t of roots from 1999-2004, primarily to Germany, with a peak of 9.5 t exported in 2000. In 2003, Germany re-exported relatively small quantities (20 kg extracts (artificially propagated) and 200 kg roots) to various countries (South Africa, China and the USA).

Twelve US suppliers of reserpine were identified in the **USA** in 2001 (CHEM SOURCES 2001). However, a US industry source indicated that only a few companies currently use the species in the USA, although there has been a recent increase in interest in the species. Trade primarily involves dry roots. Based on an internet survey, medicinals containing *R. serpentina* or reserpine extracted from similar species appear to be unavailable in North America (TRAFFIC NORTH AMERICA in litt. 2005). The only references to the species found were the sale of *R. serpentina* seeds by a Canadian company, at USD3.75 per package and sale by a company in Hawaii which markets live plants for USD12.50 each. US exports were considered to be negligible (HSDB 2001). As noted under uses, reserpine is considered to have "adverse effects" (CHEMIDPLUS 2005), and is anticipated to be a carcinogen (ANON. 2002b), which seems likely to explain its absence from US markets.

R. serpentina has also been imported into the **Republic of Korea** according to the Ministry of Environment (CHUNG 1998).

Illegal harvest and trade. According to OUDHIA (2001-2003), *R. serpentina* was illegally harvested and traded in Chhattisgarh, in India, sometimes falsely labelled as turmeric, the trade of which is not controlled, and sometimes passed off as cultivated specimens. At the time of *R. serpentina's* inclusion in Appendix II, illegal exports from India were believed to be substantial (GOVERNMENT OF INDIA 1989). However, seizures reported in India generally concerned very small quantities (Table 9). An exception to this was a consignment of approximately seven tonnes of *R. serpentina* roots, seized at the Kolkata dock in September 1999 (ANON. 2001).

Table 9. Offences related to the export of *Rauvolfia serpentina* from India (2000-2003)

Date	Place	Destination	Part	Quantity	Offence
29.08.00	FPO, Kolkata	The Netherlands	Roots	1.8 kg	EXIM and CITES
31.07.01	FPO, New Delhi	USA	Powder	100 g	EXIM
03.04.02	Air Cargo, Mumbai	Egypt	-	100 kg	EXIM
13.11.02	IGI Air Cargo, New Delhi	Austria	-	10 kg	EXIM
25.11.02	IGI Air Cargo, New Delhi	Hong Kong	Extract	2 kg	EXIM
20.10.03	FPO, Kolkata	Russia	Tablets	1.5 kg*	EXIM

* Estimated amount based on the total seizure.
Source: CITES MANAGEMENT AUTHORITY OF INDIA 2001, 2002, 2003 and 2004.

TRAFFIC INDIA (1998) reported on undocumented imports into India from Bhutan, Nepal and Pakistan. From 2000-2003, only one offence involved such imports: on 4 March 2002, one tonne of *R. serpentina* exported from Belgium to India was seized at Air Cargo Mumbai (CITES MANAGEMENT AUTHORITY OF INDIA 2003). As noted below, until recently India did not generally implement CITES trade controls for imports of this species, with the effect that imports recorded in Customs data were not illegal according to Indian law. However, they were in violation of CITES requirements.

Noting high demand from pharmaceutical industries, particularly from traditional Chinese medicine, and **Myanmar**'s long common borders with China, Thailand and India, the Director of Myanmar's CITES Scientific Authority believes that illegal trade may occur. However, there have been no reports of large seizures by Customs staff in border areas. He reported that no applications for CITES export permits had

been received (ZAW in litt. 2005). Reports of large-scale imports from Myanmar documented in India's Customs data were received with surprise, and further enquiries were being made by the Forest Department as a result of receiving this information (AUNG DIN 2005).

Illegal trade from **Nepal** is suspected, potentially under the name "Chandmaruwa" (AMATYA in litt. 2005).

Legislation and regulations

Regulation of harvest, manufacturing and domestic trade. The main laws governing harvesting of medicinal plants in **India** are the Indian Forest Act (1927), and, to a lesser extent, the Wildlife (Protection) Act (1927/1991/2002). The Indian Forest Act (1927) consolidates the law relating to forest produce, the transit thereof and duty thereon, and empowers State Governments to regulate the transit of forest produce, e.g. medicinal plants. The Act deals specifically with reserved, protected, and village forests. Almost all the States and Union Territories in India have regulations regarding harvest, transit and trade in medicinal plants. Most have established lists of species banned from harvest from forests ("Negative lists"), which include threatened plants (JAIN 2000).

The Indian Forest Act (1927) has been adopted by most of the States and is directly applicable to the Union Territories of India. The remaining States have enacted State Forest Acts of their own, which are largely based on the Indian Forest Act. The Forest Acts of the States have been amended from time to time as required. The States have framed Rules under the Acts to protect and preserve the forest wealth of their respective States (JAIN 2000). Harvest and trade of *Rauvolfia serpentina* is banned in Chhattisgarh (OUDHIA 2001-2003). See JAIN (2000) for a state-by-state analysis of legislation relevant to the harvest and trade of medicinal plants in general.

Wildlife harvest and domestic trade controls are implemented in **Nepal's** national parks, conservation areas and protected areas via the National Parks and Wildlife Conservation Act (1973); elsewhere in the country, implementation is via the Forest Act (1993) and the accompanying Forest Regulation (1995) (AMATYA in litt. 2005, ARYAL 2000, OLSEN in litt. 2000, SHRESTHA in litt. 2000). A summary of these and related controls for medicinal plants and other non-timber forest products has been compiled by the Asia Network for Sustainable Agriculture and Bioresources (ANSAB) and can be found on their website (BINAYEE undated).

The Forest Act and Regulation stipulate rules pertaining to the collection of forest products. Collection is authorized via licences issued by District Forest Officers (DFO). Licences are required to specify the collection area; the period in which harvest is to take place; the species and quantities to be collected; and method of harvest (AMATYA in litt. 2005, ARYAL 2000, OLSEN in litt. 2000). Licence applicants are required to provide this information and specify the purpose of collection. In accordance with the Regulation, District Forest Officers are required to verify the quantity of medicinal plants collected, collect any associated fees, and issue a "release order", which is required to transport harvested plants out of the district of origin. The release order should state: the species and quantity transported; the destination; and the period in which transportation must take place (ARYAL 2000, OLSEN in litt. 2000). There is also a provision to allow harvest and trade licences to be sold at auction (ARYAL 2000).

In their 2001 study in the Dhading District, PANDIT & THAPA (2004) found that implementation of these licensing provisions was low in government forests, reflecting a combination of a lack of resource management rights among the local population and low government enforcement capacity. Inspection of harvested materials to ensure compliance with licence provisions was considered to be low. Adherence to licence provisions was similarly found to be low in community forests, where permitting provisions still applied, but harvest rights were restricted to members of forest user groups. Others have similarly noted low levels of implementation of national harvest and trade controls for medicinal plants and other non-timber forest products (e.g. see MULLIKEN 2000, OLSEN 2005).

The species is not protected within national legislation in **Myanmar** (ZAW in litt. 2005), however harvests are controlled via the Forest Law and The Protection of Wildlife and Conservation of Natural Areas Law, with very clear procedures being declared to the public (AUNG DIN 2005). Annual harvest quotas are set by the Forest Department based on information provided by foresters in their forestry operation reports, and harvesting instructions announced by regional offices (ZAW in litt. 2005). Regular forest operations are undertaken annually under Myanmar's Forest Management System, and information recorded (AUNG DIN 2005), however no scientific surveys have been undertaken of this species (ZAW in litt. 2005). Harvest is allowed in buffer zones around protected areas. In **Thailand**, harvesting in protected areas is prohibited under the Forest Act and National Park Act.

Regulation of international trade

CITES listing: *Rauvolfia serpentina* was listed in CITES Appendix II effective 18 January 1990 following acceptance of a proposal from India. The listing was annotated with Annotation #2, which designates "all parts and derivatives, except a) seeds and pollen; b) seedlings or tissue cultures obtained *in vitro*, in solid or liquid media, transported in sterile containers; c) cut flowers of artificially propagated plants; and d) chemical derivatives and finished pharmaceuticals". The annotation was modified at CITES CoP 14 (The Hague, June 2007), as part of a Plants Committee process to clarify and harmonise annotations for medicinal plants. The revised annotation, effective 13 September 2007, "Designates all parts and derivatives except: a) seeds and pollen; and b) finished products packaged and ready for retail trade".

There is conflicting information regarding **India's** export controls for this species prior to the mid-1990s. Bans on the export of *Rauvolfia serpentina* have been stated as being in place in India since 1955 (IUCN & TRAFFIC 1989) and 1969 (TRAFFIC INDIA 1998). India's CITES listing proposal for this species stated that the export of the crude drug from wild origin was banned in 1981 (GOVERNMENT OF INDIA 1989). As of March 1994, the export of wild-harvested *R. serpentina* was prohibited through the species' inclusion in the Negative List of Exports in March 1994. However, this ban would not appear to have extended to exports of formulations (see below) or cultivated products.

CITES is implemented in India through a combination of the Wildlife Protection Act, 1972/1991/2002 and the Export and Import Policy (EXIM) of the Foreign Trade (Development and Regulation) Act, 1992 and the Customs Act, 1962. The Wildlife (Protection) Act prohibits export of a number of species, including all six CITES Appendix I plant species native to India, of which one, Kuth *Saussurea lappa*, is a medicinal plant.

Policy on trade in wildlife and wildlife products is established via the EXIM policy, which is revised periodically. The policy, as far as it concerns wildlife, is decided in consultation with the Director of Wildlife Preservation of the Government of India, who is the CITES Management Authority and oversees CITES implementation in the country. The Director has four Regional Deputy Directors and four sub-regional offices of wildlife preservation, these serving as assistant CITES Management Authorities. The EXIM policy is put into effect via the provisions of the Foreign Trade (Development and Regulation) Act 1992 and enforced via the Customs Act (CITES MANAGEMENT AUTHORITY OF INDIA in litt. 2004).

The EXIM policy was embedded within a broader Foreign Trade Policy for the period 2004-2009, this change coming into effect on 1 September 2004. The Foreign Trade Policy aims at doubling India's share in global trade and expanding employment opportunities, particularly in rural and semi-urban areas, and includes a Special Agricultural Produce Scheme, promoting the export of, *inter alia,* minor forest produce such as medicinal plants and their value-added products. The policy outlines that all export and import shall be "free", i.e. unrestricted, unless regulated under any legislation. Goods imported in accordance with this policy may be exported in the same form without a licence, provided that there is no import or export restriction for the items. Even goods restricted for import may be imported under Customs Bond for export without a licence provided that the items are freely exportable. Specific note is made in the policy that this does not preclude the application of other laws (DIRECTORATE GENERAL OF FOREIGN TRADE 2004).

Import and export restrictions for specific products are established via India's ITC (HS) classifications in accordance with the broader policy. Several categories relevant to CITES-listed species have been identified as goods allowed to be imported without restriction (i.e. free of import duties or quotas), e.g. "medicinal plants, fresh or dried, whether or not cut, crushed or powdered" (Schedule 1 Chapter 12), lac, gums, resins and other vegetable extracts (Schedule 1, Chapter 13), pharmaceutical products (Schedule 1, Chapter 30) and essential oils (Schedule 1, Chapter 33). Although instructions under the EXIM policy for 1997-2002 stipulated that imports of plants, products and derivatives were subject to CITES provisions (TRAFFIC INDIA 1998), the low levels of trade data for imports of CITES-listed species into India indicate that these provisions were not implemented effectively.

It does not appear that any CITES-related import controls were established via the policy for 2004-2009 until early 2006, nor that these existed under other legislation (with the exception of *Saussurea lappa*), with the effect that imports of CITES-listed medicinal plant species was uncontrolled. However, on 6 February 2006 the ITC (HS) Classifications of Export and Import Items were amended such that imports of *Rauvolfia* spp. (all species) are to be subject to CITES provisions (Ministry of Commerce & Industry Department of Commerce Notification No. 42 RE-2005/2004-09). Similar amendments were made for Kuth (*Saussurea lappa*) roots, cacti, agarwood and agar oil. This would seem to indicate that CITES trade controls are not required for imports of other CITES-listed plant species, however confirmation of this is required.

As stipulated in Chapter 12 of the ITC (HS) classifications, the export of plants, plant portions, their derivatives and extracts of species included in CITES Appendix I and II and obtained from the wild is generally

prohibited. Further clarification is required to confirm whether this applies to wild specimens regardless of their country of origin, or to only those specimens obtained within India. An "Export Licensing Note" appended to Chapter 12 specifies 29 plant taxa for which export is generally prohibited. This list includes *Rauvolfia serpentina*. An exception for both CITES species and those listed in the Licensing Note is made for the export of "formulations", defined as including "products which may contain portions/extracts of plants on the prohibited list but only in unrecognizable and physically inseparable form" and "value-added formulations as well as herbal Ayurvedic" (Chapter 12, Export Licensing Note 3). It is not clear whether the term "recognizable" is defined per the CITES interpretation of "readily recognizable" such that if the ingredients of a particular formulation of Ayurvedic medicine are listed on the packaging, then they are considered to be "recognizable". The instructions include a note that states that "no certificate from any authorities whatsoever shall be required for their [formulations] export," implying that no CITES permits would be required for such exports. This would appear to allow for trade in violation of CITES for species included in the Appendices with Annotation #1, including e.g. *Dioscorea deltoidea*, but not for *R. serpentina,* the annotation for which excludes chemical derivatives and finished pharmaceuticals. Export Licensing Note 2 states that export permits are required, however it is not clear if this applies only to cultivated specimens, which are allowed to be exported (see below) or also to formulations. CITES Management Authority staff have advised that, if Customs staff refer a shipment of "formulations" containing CITES-listed species to the Management Authority for clearance, then issuance of a CITES export permit will be required (AARTI in litt. 2005).

A further exception is provided for exports of wild CITES-listed species on a case-by-case basis for "life saving drugs", which could presumably be applied to any medicinal species. However, in this case a CITES permit would be required, with such trade only allowed on recommendation of the Ministry of Environment and Forests.

Exports of plants produced via cultivation are allowed subject to obtaining a transit pass from the relevant Divisional Forest Officer if the plants were cultivated in sites within forests, or a Certificate of Cultivation from a District Agriculture, Horticulture or Forest Officer if cultivated at sites outside forests.

Export Licensing Note 2 included in this schedule states that "However, in respect of CITES species, a CITES permit of export shall be required". As noted above, it appears that this provision relates to all but formulations, however this requires further clarification.

It does not appear that export restrictions on wild specimens of CITES-listed species apply to imported specimens, however this requires confirmation, nor does it appear that there are any specific provisions made for controlling re-exports of CITES-listed species, other than as may be required to prove that re-exports do not involve wild-collected stock from within India. No reference could be found to an earlier (2003) provision requiring exporters of value-added formulations made out of imported species from the list of "prohibited plants" to provide an affidavit to Customs authorities at the time of export that the specimens were legally imported (NTF NO. 03/2003 31/03/2003). However, CITES Management Authority staff state that proof of import is required prior to granting re-export permission, and that they take into account, for example, the amount of unprocessed product that would have been required on import to produce a given export quantity (JAIN in litt. 2005). CITES Re-export Certificates are issued for such shipments (AARTI in litt. 2005).

Exports are required to be limited to the following ports: Mumbai, Nhava Sheva, Kolkata, Cochin, Delhi, Chennai, Tuticorin, Amritsar, Calicut and Thiruvananthapuram (DIRECTORATE GENERAL OF FOREIGN TRADE 2004). It is not clear if this relates to all plants covered under this Customs classification, or only to CITES-listed species and other medicinal species for which export is prohibited.

All violations of the EXIM policy constitute an offence under the Customs Act and are dealt with by Customs officials, who alone have the responsibility to enforce compliance with CITES at border posts. Inspection of consignments by Wildlife Inspectors, co-operating with Customs staff, may also be carried out at border crossings, but such specialist investigations are few. Enforcement of any violations detected is the responsibility of the Customs authorities (PANDA in litt. 1998).

There is no specific CITES-implementing legislation in **Nepal**, however legislation to promote more effective CITES implementation has been under consideration since the late 1990s. If agreed, the Rare (Endangered) Wildlife and Plants Trade Control Act, 2057 (2002) would provide a more powerful legal tool for CITES implementation within Nepal, and includes a number of CITES-relevant provisions (HEINEN & CHAPAGAIN 2002).

Nepal's CITES Management Authority for plants is the Department of Forests, Ministry of Forests and Soil Conservation. The CITES Scientific Authority for plants is the Department of Plant Resources, Ministry of Forests and Soil Conservation. The Management Authority issues export permits for plants covered by CITES and/or the Forest Act that are in a processed or semi-processed form (BISTA in litt. 2000).

Export of *Rauvolfia serpentina* from **Nepal** was banned in 1995 via publication of a notification in the Nepal Gazette (under rule 12 and 13 (2) of the Forest Regulation, 1995) on 3 April 1995. This was amended in 2001 to allow export in processed form, as long as processing takes place within Nepal and permission is obtained from the Department of Forests, advised by the Department of Plant Resources and Herb Production and Processing Co. Ltd. (per Clause 2 of Nepal Gazette vol. 3, Section 51 No. 36, dated 31 December 2001 issued by Ministry of Forests and Soil Conservation) (AMATYA in litt. 2005). According to PANDIT & THAPA (2004), the ban on export of raw materials of certain medicinal species has been misinterpreted by some District Forest Office staff as relating to trade from one District to another, rather than to export from Nepal, increasing the incentive for illegal trade by village collectors.

The Management Authority also maintains liaison with the Department of Customs, Intelligence, Police and other agencies. However, it was noted in 2000 that Customs officers had not been trained in the identification of medicinal plants (BISTA, *in litt.* 2000); it is unknown if training has been provided since that time. Personnel from the Department of Forests and District Forest Offices have been posted at the Customs points in the Terai to examine consignments containing wild flora (ARYAL 2000).

Treaty of Trade between Nepal and India

In an effort to expand trade between their two countries, the Governments of India and Nepal entered into a bilateral trade agreement in 1991. The treaty provides for preferential treatment (exemption from Customs duty and quantitative restrictions) of trade of certain "primary products", which include forest produce that has not undergone processing, and Ayurvedic and herbal medicines (Article IV) (ANON. 2002c). Under this treaty, a certificate of origin issued by the Government of Nepal is the only document required for presentation to India's Customs authorities at the time of import (MULLIKEN 2000). Trade in conjunction with the treaty is required to take place via one of the 22 border crossings designated in Annex A of the treaty. During the late 1990s, border officials were unaware that CITES documentation might also be required for export (as noted above, under India's current CITES implementing legislation and the EXIM Policy, CITES export permits would not be required to accompany shipments into India in any event). The treaty contains provisions for stronger domestic measures on the part of national governments, and provides a list of articles not allowed preferential treatment (e.g. cigarettes and alcohol) as an annex. It appears that this annex could be amended to reflect CITES requirements (MULLIKEN 2000).

TRAFFIC INDIA informed Government authorities in both India and Nepal of the apparent relevance of this treaty with respect to CITES trade controls. Initial research results from this study were communicated to the second Indo-Nepal Trans-border Meeting in February 1999. As a result, the final resolution of that meeting called for bringing the bilateral treaty in line with CITES requirements (MULLIKEN 2000).

The treaty was extended for a further five years in 2002 and remained in effect until 5 March 2007 (ANON. 2002c). Although some amendments were made, these did not reflect the concerns raised regarding CITES implementation (AMATYA in litt. 2005). The treaty has been extended for a further five years, and will remain in effect until 5 March 2012.

In **Myanmar**, exports and imports are required to take place in accordance with CITES trade controls, however thus far there have been no applications for CITES permits (ZAW in litt. 2005). In **Thailand**, export, import and re-export are restricted under the Plants Act B.E. 2518 (1975) (SANKASUBUAN in litt. 2005).

Conclusions

Use of the roots of *Rauvolfia serpentina* for traditional medicine and, since the 1950s, as the source of reserpine used widely in western pharmaceutical products, has resulted in declines in wild populations, particularly in India, where the species is considered to be threatened through much of its range, and Nepal, where it is similarly considered at risk. Little information appears to be available regarding its status in Myanmar and Thailand, which, along with India and Nepal, appear to be the main countries engaged in international trade.

R. serpentina continues to be an important component of traditional medicine within India, as well as the starting material for production of reserpine, with India's demand predicted to have increased to nearly 600 t for 2004/2005. Much, if not the majority, of this demand appears to be supplied from other range States, where the species also continues to be used for medicinal purposes, and by other species, particularly *R. vomitoria*, which is native to Africa. Available information indicates that use of reserpine in western pharmaceutical products in the USA and western Europe is declining, with India's exports of reserpine having shifted to Eastern Europe and the Middle East.

CITES implementation for this species is incomplete at best with a significant part, if not the vast majority, of international trade taking place outside of CITES trade controls. This is reflected in CITES trade data, which capture only a small segment of the international trade in this species, with no documentation of

trade from Nepal to India. The export of *Rauvolfia* spp. extracts and formulations from India is very large – over 260 t were exported from 1999/2000-2002/2003, however it is not known what proportion of this involves *R. serpentina*. India imports *Rauvolfia* roots from other countries, including from *R. serpentina* range States, to supply domestic production, including 70 t of roots from Myanmar between April 2003 and March 2004. This trade seems likely to have involved *R. serpentina*, as there is no information to suggest that *R. vomitoria* is cultivated in or exported from Myanmar, or of trade in other *Rauvolfia* species from that country. This and other trade to India therefore requires further examination, particularly in view of the fact that India only recently began applying CITES trade controls to imports of this species from other countries.

Exports (possibly re-exports) of roots and extract from India similarly require further examination.

Although it appears that efforts to cultivate *R. serpentina* on a commercial scale are underway in India and Nepal, and to a lesser extent in other range States, there is no evidence that cultivation is meeting a significant portion of demand in India or elsewhere. Given concerns regarding the status of the species, urgent action is required to document the source and quantity of specimens in trade, both domestically within India and internationally, and to develop mechanisms to ensure that wild harvests and trade are maintained within sustainable levels.

Possible next steps

Governments of *Rauvolfia serpentina* range States, particularly within India, Myanmar, Nepal and Thailand, might consider:

- Undertaking further work to document the population status and trends of this species, and identify factors contributing to population declines where these are found to occur;
- Examining harvest and exports in order to ensure that they are maintained within sustainable levels;
- Confirming domestic cultivation levels and the species and origin (wild, cultivated) of specimens exported and imported;
- Supporting local communities in the development of sustainable harvest practices and management plans for this species, taking into account the species' status, regeneration capacity and predicted future demand;
- Encouraging industries reliant on this species to support development of sustainable harvest regimes, and to ensure that all raw materials are sourced from sustainable and legal sources; and
- Working collaboratively to ensure that any international trade in this species is in accordance with national harvest and trade controls, as well as accompanied by appropriate CITES documents.

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Taxus wallichiana

Taxonomy *Taxus wallichiana* ZUCC. (family Taxaceae)

The taxonomy of Asian *Taxus* species is uncertain, including with regard to populations within Afghanistan, Pakistan, India, Nepal and Bhutan (currently considered as *T. wallichiana*), with the differences between the species not always consistent. *Taxus wallichiana* is said to differ from European *Taxus baccata* in the longer leaves, which are generally not abruptly cuspidate, and may only merit sub-specific rank. The species in the Philippines and Indonesia has been said to be *T. sumatrana* and that in Viet Nam to be *T. chinensis* var. *mairei* (ANON. 2004a). The populations of *T. wallichiana* in Yunnan are sometimes regarded as a separate species, *T. yunnanensis* (XU 1997), but were included in *T. wallichiana* by FARJON (1998). Clarification of the taxonomy of *T. wallichiana* and related species and parts harvested and traded is required, including molecular studies in order to verify the species status of some of the isolated groups in the Hindu Kush region (AHMAD in litt. 2005). Detailed research is being undertaken at the Royal Botanic Garden, Edinburgh in this regard (KHAN in litt. 2005).

Synonyms *Taxus baccata* subsp. *wallichiana* (ZUCC.) PILGER, *Taxus nucifera* WALL., *Taxus contorta* GRIFF., *Taxus orientalis* BERTOL., *Taxus yunnanensis* W.C. CHENG & L.K. FU (only the last three are currently in use and are included in the CITES identification sheet).

In 2001, FARJON gave as synonyms: *T. wallichiana* var. *yunnanensis, T. chinensis* var. *yunnanensis* (IUCN SPECIES SURVIVAL COMMISSION & TRAFFIC 2004). *T. wallichiana* varieties: *T. chinensis* (PILGER) REHDER var. *chinensis*, *T. chinensis* (PILGER) REHDER var. *mairei* (LEMÉE & LÉVEILLÉ) W.C. CHENG & L.K. FU.

Trade names Banrya (pus), Barma salla (nep), Barmi (hin), Barmi (Pakistan: Murree Valley), Bham salla (nep), Birmi (Hindko, Gojri), Bung (nep), Common yew (eng), English yew (eng), Folia Taxi (pha), Himalayan yew (eng), Hong dou shan (chi), Laswan (new), Lauth Salla (nep), Lwait (North Kumaon, Uttaranchal), Patte salla (nep), Salin (Gurung), Sigi (Tamang), Talispatra (hin), Taxi Folium (pha), Taxus wallichiana-Blätter (ger), Thingre salla (nep), Thuna (Pakistan: Palas Valley), Thuno (hin), Ximalaya Hong dou shan (chi), Zi shan chun (chi) (AHMAD in litt. 2005, IUCN NEPAL in litt. 2004, KHAN in litt. 2005, LANGE & SCHIPPMANN 1999, MANANDHAR 2002, RAWAT in litt. 2005).

Description. Small evergreen tree or shrub, 6-12 m tall (FU & JIN 1992), reaching 18 m according to KHAN (in litt. 2005) and up to 30 m according to information for Nepal, though more typically 10-12 m (IUCN NEPAL 2004, MALLA & al. 1996, MANANDHAR 2002). Girth 1.5-1.8 m when mature. Bark reddish brown, thin, scaly (FU & JIN 1992). Stem fluted; branches horizontal, wide spreading, not whorled (AHMAD in litt. 2005). Leaves spirally arranged, irregularly two-ranked, linear, with recurved margins, 2.5-4 cm (FU & JIN 1992), upper surface green, shiny (KHAN in litt. 2005). AHMAD (in litt. 2005) describes the leaves 2.5-8 cm long, linear, flattened, diastichous, acute narrowed into a short petiole which is decurrent along the twig.

Individual trees are either male or female according to KHAN (in litt. 2005), FU & JIN (1992) stating that flowers are usually dioecious. Male strobilus shortly stalked, globose, arising from axils of the leaves on the underside of the branchlets of the previous year (FU & JIN 1992). Staminate cone solitary. Sporophylls 6-10 in number, peltate, each with 5-8 pendent sporangia (KHAN in litt. 2005), arranged in catkins (AHMAD in litt. 2005); microspore not winged (KHAN in litt. 2005). Female strobili solitary, subsessile (FU & JIN 1992), axillary, green, with three pairs of scales, decussate (KHAN in litt. 2005), resembling leafbuds (AHMAD in litt. 2005). In fruit the disk (aril) enlarges, becomes succulent and bright red, *ca.* 8 mm long and surrounds the olive green seed of which only the tip is exposed; embryo with 6-7 cotyledons (AHMAD in litt. 2005).

Flowers appear in mid-February to early March and fruit ripens in September/October according to KHAN (in litt. 2005), possibly referring to populations in Pakistan. Flowering cones March/April-May and fruits September-October in Himachal Pradesh (CHAUHAN, 1999); fruits appearing in November-December in Nepal (IUCN NEPAL 2004, MALLA & al. 1996, MANANDHAR 2002).

Slow growing (CHAUDHARY & al. 1999), extremely so according to RIKHARI & al. (1998), with an annual growth rate of less than 12 inches per year (CHAUDHARY & al. 1999). Some *Taxus* specimens reach great ages (AHMAD in litt. 2005). Regeneration is said to be poor and the recruitment rate low, linked to poor seed germination; consumption of the aril by monkeys, birds and rats; and possibly reduced pollination in response to clipping of foliage and reduction of the canopy for paclitaxel production (RIKHARI & al. 1998).

PUROHIT & al. (2001) also draw attention to the negative effects of grazing by livestock, bark stripping by deer, exposure to direct sunlight and freezing temperatures and fire.

Distribution. Depending on the taxonomic treatment, *T. wallichiana* can be said to be wide-ranging in Asia, occurring from Afghanistan through the Himalayas to the Philippines (HARA & al. 1978-1982, RIEDL 1965). Its range comprises Afghanistan, Bhutan, China, India, Indonesia, Malaysia, Myanmar, Nepal, Pakistan, the Philippines and Viet Nam.

In **China** *Taxus* spp. are mainly distributed in the southwest, in Xizang (FU & JIN 1992) and Yunnan Provinces (XU 1997), but are also reported to occur in the central Provinces of Ganshu, Shaanxi, Sichuan, Guizhou, Hubei, Hunan, Guangxi and Anhui (ANON. 2004a). According to KHAN (in litt. 2005), *T. wallichiana* populations are confined to Gyirong, Xizang, where the species is threatened by logging. According to the *China Species Red List 2004* (WANG & XIE 2004), the *Taxus* in Xizang is called *T. fauna* and the range of *T. wallichiana* is mainly in the southwest of China.

In **India** *Taxus* spp. occur in the northern states of Jammu & Kashmir, Himachal Pradesh, Uttaranchal, Sikkim, Arunachal Pradesh, Assam, Manipur and Meghalaya (MILL 1994). Preferred habitats for *T. baccata* subsp. *wallichiana* [*T. wallichiana*] in Uttaranchal are deeply-shaded, moist and sheltered areas, e.g. gorges (RIKHARI & al. 1998). This species occurs naturally in Nanda Devi Biosphere Reserve, Garhwal Himalaya, particularly on the north and northwest slopes, where it is closely associated with *Betula utiliz, Abies pindrow, Acer caesium* and *Pinus wallichiana*; *T. baccata* is also found in small patches under the *Quercus semecarpifolia* and *Rhododendron arboreum* association in other parts of the Himalayas (SINGH & al. 1992). Primarily an understorey species, it is said never to form extensive cover but rather to occur in patches under other species (RIKHARI & al. 1998).

In **Nepal**, the species is sparsely distributed in the western, central and eastern regions at altitudes of 2200 to 3400 m (IUCN NEPAL 2004, MANANDHAR 2002). Found in most forests, including shady ravines, usually as an understorey plant (ANON. 2001a).

Taxus wallichiana is the most common yew species in **Pakistan**, with almost all *Taxus* specimens considered to be this species despite intra-specific variation/genetic diversity (AHMAD in litt. 2005), NASIR (1987) having considered that all yews in Pakistan belong to this species. It grows in the moist temperate forests of the Hindukush-Himalaya (AHMAD in litt. 2005, KHAN in litt. 2005). Information on its altitudinal distribution varies slightly, KHAN (in litt. 2005) considered it to occur as low as 1500 m, while AHMAD (in litt. 2005) stated that its lower limit is 2000 m. The species is said to occur up to 3500 m (AHMAD in litt. 2005, KHAN in litt. 2005). The species occurs in mixed conifer forest. It is usually associated with *Abies* spp., *Picea* spp. and *Juglans* spp. according to AHMAD (in litt. 2005), who adds that it sometimes forms pure stands in sheltered sites on chalk in the southeast and on limestone in the northwest. Beautiful stands of *T. wallichiana* can be seen at Miandam forest (REHMAN 2002) and near Adidar in Manikhel forest-Orakzai Agency (AHMAD 1999). It is found in Dunga, Tirah in Khyber agency, Dunga Gali, Khaira Gali and Kaghan in Hazara District, Sho Nala in Swat and Palas valley in District Kohistan (KHAN in litt. 2005). The species occurs mostly in reserved and protected forests (AHMAD in litt. 2005).

The taxonomy and distribution of the genus in **Viet Nam** is unclear. FARJON (2001) cites *T. chinensis* var. *mairei* as the only representative. Other works record two species: *T. wallichiana* from the Dalat plateau of southern Viet Nam and *T. chinensis* from the karst limestone areas in northern and north western Viet Nam (HIEP & VIDAL 1996, LUU NGUYEN DUC & THOMAS 2004, PHAN THUC VAT 1996, VU VAN DUNG 1996). The correct identification of the southern populations remains uncertain.

Population status and threats. IUCN considers *T. wallichiana* to be *Data Deficient*[1994] (IUCN 2006); it is listed as *Lower Risk*[1994] in the *World List of Threatened Trees* (OLDFIELD & al. 1998) and FARJON (1998) regards it as "not threatened". According to FARJON & al. (1993) most, if not all populations of *Taxus* spp. were in decline. The species is said to be very sensitive to forest fires and to dry easily with ground fires (MC CUNE & ALLEN 1985).

A recent assessment of **China's** population of *T. wallichiana* concluded that the species is *Vulnerable*[2001] there based on population declines (XIANG in litt. 2004). A prior assessment of the species' status (using different criteria) considered it to be "endangered" in China (FU & JIN 1992). In a three-year period prior to a ban on wild collection that came into effect in 2003, more than 80% of the *Taxus* resources of Yunnan were destroyed (ZHANG & al. 2004). XU (in litt. 2005) reports that harvesting both for sale to domestic and foreign markets is currently the main threat and XU (1997) and XU (in litt. 2004) report continuing loss of genetic diversity as threats. KHAN (in litt. 2005) considers the population in China to be critically low, greatly restricted, and threatened by logging.

Other species similar to *T. wallichiana* occurring in China and listed in the CITES Appendices include *Taxus fuana* and *T. cuspidata. T. fuana* is considered to be *Vulnerable*[1994] globally by IUCN (IUCN 2004). However, revised evaluations provided by XIANG (in litt. 2004) for the Chinese populations only, consider *T. fuana* to be *Endangered*[2001] and *T. cuspidata* to be *Critically Endangered*[2001] in China. The IUCN Conifer Specialist Group has not yet undertaken regional assessments of these species.

Concern regarding declines of *T. wallichiana* in **India** were voiced in the early 1900s owing to harvest for use as timber, for religious purposes, in tea and in medicine (RIKHARI & al. 1998). A Conservation Assessment and Management Plan (CAMP) workshop in Lucknow, India assessed the northeastern Indian populations of *T. wallichiana* to be *Critically Endangered*[1994] as they had undergone a decline of more than 90% from 1988-1998 due to harvest for medicinal trade purposes (MOLUR & WALKER 1998). In 2003, CAMP workshops in Guwahati and Shimla assessed populations as *Endangered*[2001] in Arunachal Pradesh, Sikkim, Jammu & Kashmir, Himachal Pradesh and Uttaranchal and as *Critically Endangered*[2001] in Megahalaya; these declines were due to habitat degradation and loss and trade (VED & al. 2003a, 2003b). RAWAT (in litt. 2005) confirms that populations have declined drastically in many places. Selective logging, harvest for small-scale subsistence and fires are considered the main threats followed by harvesting for domestic use, human induced habitat loss and degradation (RAWAT in litt. 2005).

A CAMP workshop held in **Nepal** in 2001 classified Nepal's population of *T. wallichiana* as *Endangered,*[2001] due to a reduction in population size and decrease in range caused by exploitation (ANON. 2001a). Exploitation for wood shingles in rural areas was considered a major threat in Nepal in the mid-1990s (AMATYA in litt. 2005). Following consultation with representatives from the CITES Scientific Authority, Nepal's CITES Management Authority stated that they considered the species to be threatened in the wild in Nepal (SHARMA in litt. 2006).

The population size in **Pakistan** is very small and declining rapidly due to overharvesting including for use as fuel according to IUCN PAKISTAN (in litt. 2005), with habitat transformation due to alteration in forest composition from selective logging, forest clearing, agriculture expansion also considered a threat. AHMAD (in litt. 2005) is not aware of any scientific studies of the species' status within Pakistan, but agrees that it is declining in terms of population size and areas of occupancy. He considers the main threats to be: harvest for fodder, harvest of aerial parts for paclitaxel production, illegal harvest to supply markets (presumably for paclitaxel), harvest for fuelwood and timber, and conversion of land for agriculture. He notes that illegal harvest of the species has declined significantly since 2001 owing to effective enforcement of harvest controls. He also notes surveys showing that there is little regeneration of fodder species such as *T. wallichiana* in areas where grazing is allowed. Loss of habitat through unsustainable use of associated species, mainly *Quercus dilatata*, *Abies pindrow, Pinus wallichiana* and *Picea smithiana,* which are extracted for fuelwood, and *Juglans regia,* illegally extracted for its commercially important root bark, is also a threat. In some areas such harvests are diminishing the canopy and the soil moisture content, thereby affecting regeneration of *T. wallichiana*. Lack of management policies and tenure conflicts, the species' limited genetic diversity, slow growth rate and narrow ecological amplitude are key factors leading to declines (AHMAD in litt. 2005). The species is endangered in the Galliyat areas of Northwest Frontier Province (NWFP) due to its extensive and poorly managed use (AHMED & al. 2004).

In northern **Viet Nam**, *Taxus* spp. occur as scattered individuals or in small clumps and populations are regarded as "vulnerable", although total population sizes are difficult to estimate. In southern Viet Nam, *Taxus* populations are small and highly fragmented due to extensive clearance resulting from changes in land use; these populations are regarded as "endangered" (THOMAS & LUU NGUYEN DUC 2004). Both *T. chinensis* and *T. wallichiana* are included in the most recent Red Data Book of Viet Nam (PHAN THUC VAT 1996).

T. wallichiana has been described as "rare" in **Bhutan** (PRADHAN 1993).

Medicinal uses

Plant parts used for medicinal purposes: bark, leaves.

For at least several centuries the young shoots, leaves and bark of *T. wallichiana* have been used for their medicinal properties. In **India** extracts from bark and leaves are used in Unani medicine as a source of the drug zarnab, prescribed as a sedative and aphrodisiac and for the treatment of bronchitis, asthma, epilepsy, snake bites and scorpion stings (ANON. 1976, BECKSTROM-STERNBERG & DUKE 1993, PUROHIT & al. 2001, RIKHARI & al. 1998). In Ayurvedic medicine, young shoots are used to prepare a medicinal tincture for the treatment of headache, diarrhoea and biliousness. The leaves are also used for the treatment of hysteria, epilepsy and nervousness. Bark and leaves are considered to possess anti-fertility properties (TRAFFIC India 1998). It has been used in steam baths to treat rheumatism (DUKE 1992). A paste made from the bark is also used to treat fractures and headaches (GAUR 1999). The inhabitants of the buffer

zone villages of Nanda Devi Biosphere Reserve in India collect *Taxus* bark and leaves mainly for traditional teas and for curing colds and coughs, a practice also common in other rural areas (MAIKHURI & al. 1998, MANANDHAR 2002). Two herbal formulations using *T. wallichiana* are manufactured in India (TRAFFIC INDIA 1998). Extracts are also used in medicinal hair oils. In Pakistan, decoction of the stem is used against tuberculosis (AHMED & al. 2004). Only a small fraction (*ca*. 1000 kg) of the total amounts harvested are used in traditional medicine in that country (AHMAD in litt. 2005).

Taxus wallichiana is, along with other *Taxus* species, the source of taxanes, a group of compounds of which one, paclitaxel, has proved effective in the treatment of certain cancers, particularly ovarian and breast cancers, and AIDS-related Karposi's sarcoma. Paclitaxel was discovered by the US National Cancer Institute (NCI) in the bark of the North American species Pacific Yew *Taxus brevifolia* and demonstrated to have cancer-fighting properties. Further research was conducted by the US National Institutes of Health, and a private-sector partner sought to further develop and market paclitaxel. The pharmaceutical company Bristol Meyers Squibb (BMS) was selected in this regard, and subsequently brought paclitaxel to the market under the trade name Taxol® (MCCOY 2004, US GOVERNMENT ACCOUNTING OFFICE 2003). Concern regarding the sustainability of *T. brevifolia* harvests and the availability of supplies needed to produce paclitaxel spurred development of methods to synthesize paclitaxel from another taxane (10-Deactylbaccatin III or 10-DAB), found in other *Taxus* species, including *T. wallichiana*. This new development not only increased the number of species from which to derive paclitaxel, but also expanded the extraction of taxanes to leaves, a more sustainable source of taxanes than bark. Although leaves are needed in large quantities, methods of extraction have become increasingly efficient (SCHIPPMAN 2001).

By 1993, the amount of *Taxus* bark required to yield one kilogramme of paclitaxel was said to have been reduced from approximately 13 500 kg to 6800 kg, the equivalent of the bark of some 1000 trees (SHELDON & al. 1997). According to BEDI & al. (1996), 7272 kg of bark were required to produce one kilogramme of paclitaxel. PHILLIPS & DWYER (1999) calculated production of one kilogramme of paclitaxel to require 10 000 kg of bark or approximately 3000 trees. According to a more recent estimate, three tons of leaves are required to make one kilogramme of paclitaxel (MCCOY 2004).

The number of paclitaxel manufacturers and of paclitaxel and other taxane-based drugs has expanded in recent years. This is in part owing to the entry into the market of generic paclitaxel drugs, and in part to the development of new treatments. For example, the anti-cancer treatment Taxotere® is based on docetaxel, derived from 10-DAB, and in 2004 was considered a faster-growing drug than paclitaxel in US markets (MCCOY 2004). In January 2005, the US Food and Drug Administration approved Abraxane®, made by attaching paclitaxel molecules to albumin protein, for the treatment of breast cancer (POLLACK 2005). Paclitaxel has also been used as a coating in coronary stents (FOREMAN 2002).

BEDI & al. (1996) projected world demand for paclitaxel to be 700 kg per year. This appears to have been an overestimate; global demand for paclitaxel in 2004 was estimated at 400 kg per year (MCCOY 2004). However, while the US market was described as “stagnant”, the European market was expected to expand with the entry into the market of generic products (MCCOY 2004). Further growth in the global market for paclitaxel is expected, with a prediction that it will climb to over 1000 kg per year by 2008, according to one Canadian paclitaxel producer (MCCOY 2004).

Similar species**.** Besides the North American *Taxus brevifolia* and the European *T. baccata*, a number of Asian species other than *T. wallichiana,* such as *T. chinensis* and *T. cuspidate*, are the source of taxanes from which paclitaxel can be derived chemically. *T. wallichiana* was said by BASYAL & al. (1997) to contain higher amounts of taxane compounds than *T. brevifolia* and *T. media* (the latter a hybrid). The bark of *T. yunnanensis* [considered *T. wallichiana yunnanensis* by FARJON] contains 0.02%-0.03% paclitaxel, and shoots/small branches contain ~ 0.01% paclitaxel (WANG & al. 2004). Other genera such as *Cephalotaxus* yield similar compounds with medicinal qualities (FARJON & PAGE 1999). According to a Chinese manufacturer of paclitaxel, *T. baccata, T. brevifolia* and *T. yunnanensis* supply most of the trade, and market research suggests *T. canadensis* and *T. media* are also important sources (TRAFFIC NORTH AMERICA 2004).

In 2004, four more Asian yew species were included in CITES Appendix II: *T. chinensis, T. cuspidata, T. fuana* and *T. sumatrana* (and all infraspecific taxa of these species i.e.: *T. chinensis* var. *chinensis, T. chinensis* var. *mairei, T. cuspidata* var. *cuspidata*). *T. sumatrana* occurs in the Philippines and Indonesia (Sulawesi and Sumatra) and *T. chinensis* var *marei* in Viet Nam (FARJON 2001). *T. cuspidata* and *T. cuspidata* var. *cuspidata* occur in China, Republic of Korea, Japan and (Far East) Russia. *T. chinensis, T. chinensis* var. *chinensis* and *T. fuana* can be found in China.

Other uses. The wood is valued for its strength, durability, decay resistance and decorative characteristics. It is used locally for cabinet making, furniture, veneers, parquet floors, gates, and roofs (IUCN &

TRAFFIC 1994, OLDFIELD & al. 1998). In Pakistan *T. wallichiana* is the species most preferred as a source of timber for roofing traditional houses; the wood is also used in Pakistan to make furniture and grave coverings (AHMAD in litt. 2005). The species is also used for roof shingles in rural areas in Nepal (AMATYA in litt. 2005). The Tolchha and Marcha Bhotia and other indigenous people in the Indian Himalayas use the wood for carving, house construction and construction of beehives (PUROHIT & al. 2001). In China, wood is harvested (illegally) when trees have reached the age of 25 for use in furniture, boats and sculptures and cups sold to tourists. In Viet Nam, where the wood of *Taxus* spp. is valued for its water and rot resistance, *T. wallichiana* is used for water wheel paddles (VU VAN DUNG 1996). *T. wallichiana* is also a valued source of fuel-wood in Pakistan, its wood considered second in quality only to that of Oak *Quercus* spp. in that country (AHMAD in litt. 2005).

The leaves are used as fodder in Pakistan, particularly in winter and early spring, when the snows reduce access to grazing (AHMAD in litt. 2005, KHAN in litt. 2005), and also grazed by livestock. They are used for thatching by the Tolchha and Marcha Bhotia and other indigenous people in the Indian Himalayas (PUROHIT & al. 2001). Ripened fruits (the red, cup-shaped aril, not the seeds, which are toxic) are eaten in rural Nepal and Pakistan (AHMED & al. 2004, MANANDHAR 2002). Leaves are also used to produce beverages (teas) known as Namkin Chay in India in the buffer areas of the Nanda Devi Biosphere Reserve (PUROHIT & al. 2001).

Harvesting and processing. Bark and more recently leaves and twigs of *Taxus wallichiana* and other *Taxus* species are harvested for extraction of paclitaxel, 10-DAB and other taxanes. In 2004 the majority of paclitaxel manufacturing facilities are located in China (a *T. wallichiana* range State) and the USA, with much smaller numbers in Canada. Manufacturing facilities are also found in India (also a range State) and several European countries (TRAFFIC NORTH AMERICA 2004).

The main collection areas in **China** are located in the southwest, especially Yunnan and Sichuan, between 1000 and 1500 m altitude (TRAFFIC EAST ASIA in litt. 2005). As this elevation is lower than the altitude that *T. wallichiana* is believed to occur at elsewhere in its range, it seems possible that this refers to all *Taxus* species rather than specifically *T. wallichiana*. Harvest takes place year round (TRAFFIC EAST ASIA in litt. 2005). Given the 2003 ban on harvest of *Taxus* species (see legislation), any current harvest would presumably be illegal.

It is estimated that a total of 2000 t of leaves and twigs and 5000-10 000 t of bark were collected in Yunnan until 1997 (presumably on an annual basis), with highly detrimental impacts on the populations (XU 1997). Clarification is required to confirm whether this is a total figure or an annual estimate.

According to LU (1998), production of one kilogramme of paclitaxel would require the bark of seedlings aged three years or more from a 1.6 ha plantation. Preliminary processing to produce a paste for future refining could be undertaken by rural enterprises (two existed in western Sichuan at the time of writing, and a third, in Maoxian County, was under development), with final processing undertaken by primary processing factories. Cultivation does not yet supply significant amounts of plant materials for extraction, according to staff within China's CITES Management Authority, with the result that raw materials need to be imported. These include both raw materials and also partially processed extracts, which are further refined in China (ZHAI 2005).

China is now believed to be one of the world's main producers of paclitaxel (ZHANG & al. 2004). According to XU (1997), *T. wallichiana* was mainly processed in Yunnan during the 1990s, where an extraction company with a capacity of producing 150 kg of paclitaxel annually was established in 1995, this company requiring 500 t of dried leaves or bark per year. ZHANG & al. (2004) give a more conservative figure, stating that China's annual production was approximately 50 kg per year, or roughly 10% of global production. Production of paclitaxel increased in 2003 as more factories were established and imports increased (ZHANG & al. 2004).

The website of a paclitaxel manufacturer based in Sichuan Province, China indicated that *T. baccata*, *T. brevifolia* and *T. yunnanensis* [*T. wallichiana*] were the most commonly grown and harvested species for paclitaxel production. A UK-based company informed TRAFFIC that it extracts paclitaxel from *T. yunnanensis* [*T. wallichiana*], the North American species *T. brevifolia*, and *T. media*, a North American cultivar. The company said they used both cultivated and wild material to produce the drug (TRAFFIC NORTH AMERICA 2004).

The main harvesting areas in **India** are the cool temperate zones between 2200-3000 m, mainly in Uttaranchal and Himachal Pradesh (where the species was assessed in 2003 as *Endangered*[2001]) Harvesting takes place all year around, preferably when the tree is tall and mature, 15-20 years old (RAWAT in litt. 2005). Trade figures compiled by the Arunachal Pradesh State Forest Department based on royalty fee payments give an indication of the scale of earlier harvests in that state (Table 1).

Table 1. Reported legal trade in *T. wallichiana* in Arunachal Pradesh

Year	Amount legally traded (t dry weight)
1993/1994	586
1994/1995	1674
1995/1996	52
1996/1997	0
1997/1998	82

Source: HANDIQUE & al. (2000).

Taxus is processed on an industrial scale within India for the production of Ayurvedic medicines as well as extraction of taxanes such as paclitaxel for (re-)export. Paclitaxel extraction was reported as taking place during the 1990s, for instance by Indo-Italian companies, for export to the USA (CHAUHAN 1999), and appears to be expanding. India is believed to be one of the world's main producers of paclitaxel, with exports of this and the related taxane docetaxel recorded in India's Customs data indicating the scale of processing. Processing is now said to involve primarily, if not entirely, imported *T. baccata* (JAIN in litt. 2005).

From 1997 to 2000 PUROHIT & al. (2001) studied the impact of bark removal for traditional use (as a tea) on survival of *T. wallichiana* in the buffer zone of the Nanda Devi Biosphere Reserve, Garhwal, India. The average collection of bark per family per year was about 1.7±0.3 kg dry weight, with weight harvested varying according to family size. Poor families relied on the bark of this species for tea year-round and consumed all they collected, whereas rich families also distributed bark to their kin living elsewhere. There was no organized market for selling *Taxus* bark in the area.

In the study area, the bark of *T. baccata* is peeled off from the main stem with a sharp sickle. The quantity of bark removed averaged 0.4-1 kg dry weight for trees with girths of 0.5-0.9 m; some 712 kg was collected each year, representing 712-1780 trees. Tree survival rates were linked to the depth and extent (percentage of the circumference) to which the bark was cut. Survival rates were maximum when bark was removed to a depth of 0.2 cm in a scattered manner, and minimum when bark was removed beyond the limit of average bark thickness (0.43 cm) or as a whole ring on the trunk (PUROHIT & al. 2001), i.e. girdling. RAWAT (in litt. 2005) confirms that girdling can cause death of the tree.

A second study in this area found that 4.96±0.65 kg of *Taxus* products were harvested per household per year in the core zone, and 3.92±1.21 kg per year per household away from the core zone (MAIKHURI & al. 2000). The study did not indicate whether this included leaves, bark or a combination.

In **Nepal**, *T. wallichiana* is mainly harvested and traded under the name "Lauth Salla", but is also referred to as "Talispatra" and "Thingre Salla". The main parts harvested are leaves and twigs, but bark is also harvested. Harvest takes place in 15 districts, with summer being the preferred harvesting season (AMATYA in litt. 2005). Harvesters can collect up to 72 kg of fresh leaves (equivalent to 36 kg of dry leaves) per day (PAUDEL & ROSSET 1998). According to PHILLIPS & DWYER (1999) the yield of leaf clippings varies from 15-25 kg per tree (fresh weight). Harvest figures provided by Dabur Nepal Private Ltd. (in VANTOMME & al. 2002) are as follows: 1995, 60 t; 1996, 142 t; 1997, 302 t; 1998, 289 t; 2000, 185 t. Those for fiscal years 1999/2000-2003/04 are provided in Table 2, based on records of forest royalty fees from Nepal's Department of Forests. It is not clear whether this includes leaves and twigs only or also bark. Reported harvests reached a peak of over 500 t in 2001/02. Cultivation schemes underway in Nepal are also likely to be an increasing source of *Taxus* leaves and bark. Most of the leaves are used for chemical extraction (of crude extracts) by two companies (AMATYA in litt. 2005).

Table 2. Reported harvest and sale of *T. wallichiana* in Nepal

Lauth salla					
	1999/2000	**2000/2001**	**2001/2002**	**2002/2003**	**2003/2004**
Quantity (kg dry weight)	177 896	416 389	507 222	285 414	78 472
Thingure salla and Talispatra*					
Quantity (kg dry weight)	5 400	4 000	-	1 000	200 *1 500
Total	**183 296**	**420 389**	**507 022**	**286 414**	**80 172**

Source: Ministry of Forests and Soil Conservation, Department of Forests, Nepal.

It is estimated that 30 000 tons of leaves were illegally extracted from 1996 to 2001 in **Pakistan**, on average 6000 tons per year (AMIN & al. 2004). No significant extraction has been recorded since 2001 as a

result of enforcement of harvest bans (AHMAD in litt. 2005). Harvesters sort the leaf-bearing shoots from the branches before onward sale to middlemen, who separate the leaves from the shoots, dry and pack them. Regional traders sort the leaves according to quality for onward sale to wholesalers and exporters. There is no pharmaceutical extraction of taxanes within Pakistan (AHMAD in litt. 2005).

There are no extraction facilities for *Taxus* in **Viet Nam** (THOMAS & LUU NGUYEN DUC 2004).

Cultivation. Much of the information regarding cultivation of *Taxus* for production of taxanes is not specific with regard to the species involved. In countries where more than one species occurs, e.g. China, it seems likely that cultivation efforts are not focused entirely or perhaps even predominantly on *T. wallichiana*. Even in countries where *T. wallichiana* is the dominant native species, it could be that non-native species or cultivars are being cultivated. The following text should therefore not be considered as referring specifically to *T. wallichiana,* except where specified.

Cultivation efforts during the 1990s were focused on breeding for higher yields of paclitaxel and improved propagation techniques (IUCN & TRAFFIC 1994, SHELDON & al. 1997), and it seems likely that this remains the case today. Propagation can be via stem cuttings or through seed; the latter is considered time consuming, owing to the long dormancy of the seeds (one year) and the slow growth of plants. The aim of experiments with mass macro-propagation of elite plants is to obtain optimal harvest of clippings from cloned trees closely planted together. Cultivation trials also include other species like *T. baccata, T. cuspidata* and *T. chinensis* (BEDI & al. 1996, RIKHARI & al. 1998, SHELDON & al. 1997).

In recent years a number of studies have been conducted to understand the regeneration of the tree and to explore cultivation in **China**. Cultivation studies for *Taxus* spp. were undertaken in the early 1990s in western Sichuan, and methods to produce seedlings on a large scale via grafting developed (LU 1998). Grafting has proved a successful method of propagating *T. wallichiana* in Xizang (DA & JIN 2003). Progress has been made in the cultivation of *T. chinensis* var. *mairei* using seeds for propagation. Researchers have found a way to reduce the long seed dormancy from one year to around 20 days by increasing soil temperature (FANG & al. 2000). According to ZHANG & al. (2004), *Taxus* plantation development has thus far not been very successful owing to slow growth rates and low paclitaxel content. It appears that significant investment is being made in such development, however. No significant difference between paclitaxel content between wild-collected and cultivated plants has been found according to WANG & al. (2004).

RIKHARI & al. (1998) call for initiatives to improve seed germination and cloning to address the urgent need for reforestation and cultivation for commercial purposes in **India**, and note that efforts initiated at that time included: (1) Development of a simple, relatively cheap technique for vegetative propagation (cloning) using first year shoots and chemical treatments (NANDI & al. 1996); (2) Transfer of cloned plants (cuttings) to the study site (increased survival, 50% instead of 42%, was recorded over a period of two years in natural *Taxus* habitat at Jageshwar); (3) Enhancement (70%) of 'seed' germination (normally 8-15%) by various treatments (PANDEY & al. (unpubl.). They proposed that the above mentioned techniques could be applied to propagate selected plants from other parts of the Himalayas, containing higher levels of paclitaxel, for conservation and afforestation.

Propagation protocols for tissue culture of the species have been developed (SAMANT & al. 1998) and information packs provided by research institutes. These include guidelines on determination of suitable cultivation areas for *Taxus*, fast regeneration using seeds (within 4-5 months) and clonal propagation through layering and stem cutting, productive and economic plantations, ensuring regular harvests of leaves and twigs, and training of personnel (ANON. 2002a). Cultivation is being promoted by the State Governments of Arunachal Pradesh, Meghalaya and Uttaranchal (ALAM 2004).

As natural regeneration is slow and difficult, artificial propagation is preferred in **Nepal**, in particular through stem cuttings (AMATYA in litt. 2005). *Taxus* cultivation has been supported by a commercial greenhouse facility initially planned to have a capacity of 600 000 plants per year, to be accompanied by an outgrower programme and training for rural harvesters. It was estimated that 3600 t of leaves would be produced annually after 10 years (PHILLIPS & DWYER 1999). Seedling production was reported by Dabur Nepal Private Ltd, to be 160 953 in 1999 and 185 000 in 2000 (VANTOMME & al. 2002). Dabur was said to be growing over 800 000 *Taxus baccata* [sic] saplings on plantations on leased lands in Nepal in 2002, with the expectation that in another five or six years the company would be collecting from its plantations, for which it would require approximately 10 million trees (ANON. 2002b).

Taxus wallichiana is not cultivated commercially on any significant scale in **Pakistan** (AHMAD in litt. 2005, KHAN in litt. 2005). However, it may have been grown experimentally in some research institutes, e.g. the Forest Institute of Peshawar (KHAN in litt. 2005).

Some research into propagation methods has been carried out by the Forest Science Institute in southern **Viet Nam**, and there is a strong interest in the establishment of plantations. Field gene banks derived from locally sourced material have been set up as part of a conservation and utilization programme (NGHIA 2000).

National market. Information provided by ZHANG & al. (2004) indicated that as well as producing *Taxus* extracts for export, there is a domestic market for paclitaxel within China, with exports being lower than domestic production. Imports of finished paclitaxel products were reported from the USA between 2000 and 2003. With harvests of native *Taxus* banned in 2003 and cultivation not yet producing significant yields, most of China's market is apparently now supplied via imports, and, to a lesser extent, confiscated specimens (see below).

A 1997 market survey by TRAFFIC INDIA showed that *T. wallichiana* was commonly traded at the national level at that time in **India** including in the markets of Delhi, Kolkata (previously Calcutta), Mumbai, Amritsar, and Haridwar. Rough estimates of the annual turnover at the Delhi market ranged from 300-700 t, with demand said to exceed supply. Himachal Pradesh and Jammu & Kashmir were said to be the main source of *T. wallichiana* sold on the Delhi market (TRAFFIC INDIA 1998). However, trade data for Arunachal Pradesh (Table 1) indicate that it was also a significant, albeit declining, source of *T. wallichiana* in trade. The species was said to be easily available in Kolkata (previously Calcutta), with one trader reporting imports from Bhutan. *Acacia* leaves were said to be mixed with *T. wallichiana* according to market sources in Mumbai (TRAFFIC INDIA 1998). Delhi, Kolkata (previously Calcutta) and Amritsar are now said to be the main market centres of the trade, from which the material is distributed to smaller markets (JAIN in litt. 2005). According to a survey of traditional healers in Kameng district, Arunachal Pradesh, in 2005 local collectors received INR4 (USD0.8) per kilogramme of *T. wallichiana*, which was subsequently sold at nearby markets for INR35/kg (USD0.09/kg) (ANON. 2001b). The price paid for leaves (dry weight) in India was reported to be INR35-40/kg (USD0.8-0.9/kg) in 2005 (JAIN in litt. 2005).

Total demand for the species within India was previously estimated at 500 t (TRAFFIC INDIA 1998). There were at least three companies in Himachal Pradesh that extracted paclitaxel from *Taxus* leaves and the bark in the late 1990s, their demand estimated at 120-150 t annually. The Dabur Research Foundation estimated the demand by the Ayurvedic industry to be significantly less than this, only 23.6 t annually (TRAFFIC INDIA 1998). A single natural products company reported requiring six tonnes of *T. baccata* (presumably *T. wallichiana*) raw materials in the 12-month period from April 1999-March 2000 (GOVERNMENT OF INDIA PLANNING COMMISSION 2000).

According to one estimate in relation to the period 1996-2001, *Taxus* collectors in **Pakistan** received PKR1000/t (USD20/t) for fresh foliage. Local middleman received PKR6000/t (USD120/t) and regional traders PKR10 000/t (USD200/t) (AMIN & al. 2004). The main commercial trading centres for this species are found in Mingora Swat, Lahore and Karachi (AHMAD in litt. 2005).

International trade. The centre of demand for finished products made from paclitaxel and related compounds continues to be within the USA and, to an increasing extent, in Europe (MCCOY 2004. The US Scientific Authority believes that the bulk of *Taxus* trade consists of Asian rather than North American species (TRAFFIC NORTH AMERICA 2004). It therefore seems likely that at least some *T. wallichiana* is in trade to North America, either as raw materials or, more likely, as chemical derivatives following processing in India, China, or perhaps other range States.

Despite the listing of *T. wallichiana* in CITES Appendix II in 1995, little of this trade has been recorded in CITES data (Table 3). This reflects a combination of the relatively low level of CITES implementation for this and many other CITES-listed medicinal plant species, and, more specifically, the exclusion of chemical derivatives from the CITES listing between 2000 and 2005 (see below under 'Regulation of international trade').

Following **China's** ban on *Taxus* harvests, *Taxus* used for extraction of paclitaxel was increasingly imported from other countries. An estimated 300 t of bark was imported in 2003 according to ZHANG & al. (2004), this figure apparently based on an assumption that imported materials contained between 0.01-0.02% paclitaxel. China's CITES annual report data show the import of 500 t of bark of *T. wallichiana* during that year, all from Myanmar. The bark was reported as being from cultivated sources. China's annual reports also showed the import of 50 t of extracts from Myanmar, reported to have originated from wild sources. Although China's Management Authority believed that the information in the annual report was correct (TRAFFIC EAST ASIA in litt. 2005), Myanmar's CITES Scientific Authority stated that no permits had been issued for the harvest or export of this species. There had therefore been correspondence with China's CITES authorities regarding fraudulent CITES permits, and the matter had been brought to the attention of the CITES Secretariat by both Myanmar and China (KHIN in litt. 2005).

According to the Director of the Shanghai branch of China's CITES Management Authority, most of the *Taxus* materials imported for the production of paclitaxel come from the USA and Canada, with importing companies saying that the specimens come from plantations (TRAFFIC NORTH AMERICA 2004.). More recently, Management Authority staff advised that almost all material used to extract paclitaxel in China has increasingly been imported from other countries, primarily Canada, with small quantities imported from Germany, and no materials imported from India or Nepal (ZHAI 2005).

Table 3. CITES-reported trade in *Taxus wallichiana* (1997-2003)

Year	Country of Export	Country of Import	Origin	Export					Import				
				Quantity	Unit	Term	P	S	Quantity	Unit	Term	P	S
1997	CL	DE	??						200	g	Derivatives	E	U
1997	DE	CL	??	200	g	Derivatives	E	U					
1999	CN	ID		2000	kg	Derivatives	T	W					
1999	CN	IN		2000	kg	Derivatives	T	W					
1999	IT	MT							1		Live	T	I
2000	CN	KR		200	g	Extract	T	W					
2000	CN	US		55	kg	Extract	T	W					
2000	CN	US		615	g	Extract	T	W					
2000	DE	CH	BT						1		Specimens		A
2001	CN	US		38	kg	Extract	T	W					
2001	IN	IT		100	kg	Leaves	T	A	100	kg	Leaves	T	W
2002	CN	US		1	g	Extract	T	W					
2002	CN	US		3	kg	Extract	T	W					
2003	MM	CN							500 000	kg	Bark	T	A
2003	MM	CN							50 000	kg	Extract	T	W

Source: CITES annual report data compiled by UNEP-WCMC.

In line with the above, many Chinese manufacturers of paclitaxel claim to source their raw materials from North American *Taxus* species and plantations, but it is not clear to what extent this is the case (TRAFFIC NORTH AMERICA 2004). In 2003, two Chinese companies contacted a US company requesting the purchase of an estimated 20 [shipping] containers of *T. brevifolia* per year. The US company, which has been cultivating the species since 1998, provides materials in the form of ground 'tops' (above-ground parts), ground whole plants (tops and bottoms dried separately but ground and mixed together) and roots (TRAFFIC NORTH AMERICA in litt. 2005).

China also imported finished paclitaxel products during the years 2000 to 2003, with an estimated import value of around USD2.92 million, USD11.14 million, USD7 million and USD12.38 million (ZHANG & al. 2004). It is not known whether any of these imports would have involved products derived from *T. wallichiana*.

China's CITES annual report data show the export of significant quantities of *T. wallichiana* derivatives from 1999-2003 (see Table 3), the most significant record being the export of two tonnes of derivatives each to India and Indonesia. It seems likely that this would have represented semi-processed materials rather than purified paclitaxel. Exports reported in CITES data in subsequent years were of much lower quantities. No extract exports were reported in 2003, reflecting recognition by China's CITES Management Authority that extracts were not covered by the CITES listing (TRAFFIC EAST ASIA in litt. 2005).

According to ZHANG & al. (2004), China exported a total of 143 kg of paclitaxel (99.9% pure) to western countries (mainly the USA) from 2000-2003, as follows: 2000, 39 kg; 2001, 48 kg; 2002, 21 kg; 2003, 35 kg. The decline in exports in 2002 is said to have corresponded with strengthened management within China, and the increase in 2003 to the opening of new processing factories and increased import of raw materials.

Table 4. Exports of paclitaxel and docetaxel recorded in India's Customs data (t)* (1999/2000-2004/2005)

Importer	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004	2004/2005
Argentina					0.15	
Bahrain		0.10				
Barbados					0.30	
Brazil					8.68	
Belarus					0.20	2.48
Colombia						0.43
Cuba					0.60	
Denmark			1.80			
Ethiopia		0.06				
Germany		3.00		0.32		
Georgia					0.18	
Ghana					0.01	
Guadeloupe	0.02					
Guatemala			0.50			
Hong Kong			0.30		0.68	
Iran	4.20					
Jordan		0.10				
Kenya				0.74	0.23	
Malaysia		0.10			2.36	2.19
Mauritius					0.04	
Mexico		22.00			0.35	0.17
Nepal				0.10		
Nigeria					0.08	
Pakistan		1.00				
P. N. Guinea	0.15					
Philippines					1.00	1.36
Poland				0.20		
Russian Federation					0.31	
Slovenia						0.00
South Africa			0.03			
Sri Lanka				0.22	1.30	0.54
Surinam						0.15
Switzerland			0.01			
Tanzania Rep.		0.10				0.01
Thailand		1.30			2.85	1.87
Togo				0.90		
Trinidad					1.52	0.90
Ukraine					0.14	
USA				3.10		
Venezuela				0.10	0.01	1.50
Viet Nam			1.01		0.59	
Zambia			0.25			
Total	**4.37**	**27.76**	**3.90**	**5.68**	**21.58**	**11.60**

* Although the data source indicates the following figures are in thousands of kilogrammes (tonnes), it seems more likely that they represent kilogrammes. Source: India Department of Commerce Export Import Databank, Categories 30049044 PACLITAXEL and DOCETAXEL.

In **India**, the export of *Taxus wallichiana* has been prohibited through its listing on the Negative List of Exports since March 1996 (TRAFFIC INDIA 1998), and possibly as early as March 1994 (LANGE & WÄCHTER 1996). India is estimated to have exported 5500 t of leaves during 1994 (SHELDON & al. 1997). MOLUR & WALKER (1998) report that according to 1995 data of the 'Botanical Survey of India' 170 710 kg of dried leaves were exported from the state of Arunachal Pradesh in a single month (it is possible that this represents trade within India). From 1994-1996, the main producer of 10-DAB, the Italian company Indena, relied heavily on *T. wallichiana* plant materials from India (SHELDON & al. 1997) but subsequently

switched to using cultivated *T. baccata*. In 2001, 100 kg of leaves from cultivated sources were reported as exported by India, Italy reporting the import as wild sourced. No other exports are reported in India's CITES annual reports.

Paclitaxel extraction was reported as taking place within India in the 1990s, for instance by Indo-Italian companies, for export to the USA (CHAUHAN 1999). India's Customs data show the export of both paclitaxel and docetaxel beginning in 1999/2000 (Table 4). Although exports are reported in units of 'thousands of kilogrammes', it seems more likely that the units are in fact kilogrammes, i.e. 21.58 kg in 2003/04, and 11.60 kg from April 2004-June 2005. According to CITES Management Authority staff, exports involve extracts from imported *T. baccata* rather than from native or imported *T. wallichiana*, and are permitted in trade based on corresponding evidence of previous *T. baccata* imports; *T. wallichiana* is not believed to be exported in any form. Other sources have also stated that *Taxus* is imported in large quantities for processing (JAIN in litt. 2005). The establishment of additional companies for the manufacture and/or marketing of taxane-based drugs within India could result in an increase in international trade in paclitaxel and other derivatives, some of which may derive from *T. wallichiana*. In 2001, for example, a US-based company announced that its India-based subsidiary was entering into an agreement with a China-based manufacturer of paclitaxel from propagated *T. yunnanensis* (XECHEM INTERNATIONAL 2001).

In **Nepal**, although export of leaves was banned in 1993 (MANANDHAR 1994), annual exports increased in response to the ban of exports from India. Since 1995, when *Taxus wallichiana* was listed on CITES Appendix II, only export of *Taxus* spp. processed in Nepal has been allowed. The total exports of leaves increased during 1995-1997, from 60 t to 360 t (PHILLIPS & DWYER 1999). No CITES permits were issued for these exports and no trade with Nepal is recorded in the CITES trade database.

KHAN (in litt. 2005) believes that *Taxus wallichiana* has not been exploited commercially for international trade in **Pakistan**, though states that domestic use as fodder and fuel is common.

Illegal harvest and trade. Illegal harvest to support domestic extraction is thought to have been the main cause for the dramatic population declines in **China** (WANG & YANG 1999). According to VITI & al. (2001), illegally harvested *Taxus* was frequently confiscated by Government authorities, sometimes misdeclared as processed material originally imported from North America or as *T. wallichiana,* when in fact another species was involved (GOVERNMENTS OF CHINA AND THE USA 2004, ZHOU 2001). Chinese authorities make the seized plant material available to domestic extraction facilities (GOVERNMENTS OF CHINA AND THE USA 2004).

Illegal harvest has also been reported in **India,** and was the main reason behind India's CITES listing proposal for *T. wallichiana*. Illegal extraction of *T. wallichiana* is said to take place in several protected areas in Uttaranchal: the Wildlife Sanctuaries of Askot and Kedarnath, and Nanda Devi and Govind Pashu Vihar National Parks (RAWAT in litt. 2005). Two shipments of *Taxus wallichiana* destined for Singapore (2 kg) and Malaysia (75 kg) were confiscated in 2001; the commodities in trade were not specified (CITES MANAGEMENT AUTHORITY OF INDIA 2002).

Following the ban on exports of raw materials from **Nepal**, and its apparent misinterpretation by some government staff as also relating to processed products, illegal export of *T. wallichiana* leaves was noted in a study of the medicinals trade in the Malekhukhola watershed area (PANDIT & THAPA 2004). The illegal extraction and trade of *T. wallichia* foliage in **Pakistan** under different trade names (Jari Bootian) in recent years is said to have damaged the species (AMIN & al. 2004)**.**

Legislation and regulations

Regulation of harvest, manufacture and domestic trade. A series of regulations implementing CITES within **China**, the Import and Export Regulations of Endangered Wild Fauna and Flora, came into effect on 1 September 2006. In addition, other laws contribute to the implementation of the Convention in this country.

China's Law of Wild Plant Protection took effect 1 January 1997. Under this law, protected plant species are classified into those of "national key significance" and those of "local key significance". Protected plant species of national key significance are further divided into Category I and Category II-protected species. Trade in Category I-protected species is not allowed. Trade in plant species listed as Category II is subject to authorization by the relevant government agencies at the provincial/autonomous region level. All species of *Taxus* have been listed as Category I Protected Species in China since 1999, with harvest of this and other native *Taxus* species prohibited since that year except with the authorization of the State Forestry Administration. The State Forestry Administration banned all harvest of wild *Taxus* in 2003 (XU in litt. 2005). The State Forestry Administration, the Ministry of Agriculture and other authorized governmental authorities at the provincial/autonomous region level are responsible for enforcing the Law of Wild Plant Protection. The Native Flora Protection Act outlines rules for protection and management of native flora,

but does not establish requirements with regard to the size of specimens allowed to be harvested (MACIVOR & PETERS 2000).

The main laws governing harvesting of medicinal plants in **India** are the Indian Forest Act (1927), and, to a lesser extent, the Wildlife (Protection) Act (1927/1991/2002). The Indian Forest Act (1927) consolidates the law relating to forest produce, the transit thereof and duty thereon, and empowers State Governments to regulate the transit of forest produce, e.g. medicinal plants. The Act deals specifically with reserved, protected, and village forests. Almost all the States and Union Territories in India have regulations regarding harvest, transit and trade in medicinal plants. Most have established lists of species banned from harvest from forests ("Negative lists"), which include threatened plants (JAIN 2000).

The Indian Forest Act (1927) has been adopted by most of the States and is directly applicable to the Union Territories of India. The remaining States have enacted State Forest Acts of their own, which are largely based on the Indian Forest Act. The Forest Acts of the States have been amended from time to time as required. The States have framed Rules under the Acts to protect and preserve the forest wealth of their respective States (JAIN 2000).

The Himachal Pradesh Forest Produce Transit (Land Routes) Rules 1977 were amended by a notification in 1994 and establish "pass/export permit fees" for specified medicinal plants. The trade in some of the important and threatened medicinal plants of the State has been restricted or banned. Pass/export permit fees for *Taxus wallichiana* in 2000 were INR600/100 kg (USD14/100 kg) (JAIN 2000). In 1996, *T. baccata* was designated as a protected species in Sikkim (JAIN 2000), more likely reflecting confusion regarding species taxonomy rather than protection of a non-native species.

Other states have similarly established local controls and fee structures on domestic trade in native medicinal species (see JAIN 2000 for a state-by-state analysis of legislation relevant to the harvest and trade of medicinal plants).

Taxus wallichiana occurs in several protected areas in Uttaranchal, India: Wildlife Sanctuaries of Askot and Kedarnath, and Nanda Devi and Govind Pashu Vihar National Parks (RAWAT in litt. 2005).

Wildlife harvest and domestic trade controls are implemented in **Nepal's** national parks, conservation areas and protected areas via the National Parks and Wildlife Conservation Act (1973); elsewhere in the country, implementation is via the Forest Act (1993) and the accompanying Forest Regulation (1995) (AMATYA in litt. 2005, ARYAL 2000, OLSEN in litt. 2000, SHRESTA in litt. 2000). A summary of these and related controls for medicinal plants and other non-timber forest products has been compiled by the Asia Network for Sustainable Agriculture and Bioresources (ANSAB) and can be found on their website (BINAYEE undated).

The Forest Act and Regulation stipulate rules pertaining to the collection of forest products. Collection is authorized via licences issued by District Forest Officers (DFO). Licences are required to specify the collection area, the period in which harvest is to take place, the species and quantities to be collected and method of harvest (AMATYA in litt. 2005, ARYAL 2000, OLSEN in litt. 2000). Licence applicants are required to provide this information and specify the purpose of collection. In accordance with the Regulation, District Forest Officers are required to verify the quantity of medicinal plants collected, collect any associated fees, and issue a "release order", which is required to transport harvested plants out of the district of origin. The release order should state: the species and quantity transported, the destination and the period in which transportation must take place (ARYAL 2000, OLSEN in litt. 2000). There is also a provision to allow harvest and trade licences to be sold at auction (ARYAL 2000).

In their 2001 study in the Dhading District, PANDIT & THAPA (2004) found that implementation of these licensing provisions was low in government forests, reflecting a combination of a lack of resource management rights among the local population and low government enforcement capacity. Inspection of harvested materials to ensure compliance with licence provisions was considered to be low. Adherence to licence provisions was similarly found to be low in community forests, where permitting provisions still applied, but harvest rights were restricted to members of forest user groups. Others have similarly noted low levels of implementation of national harvest and trade controls for medicinal plants and other non-timber forest products (e.g. see MULLIKEN 2000, OLSEN 2005).

In 1995, the Government banned export of *Taxus* spp. through publication of a notification in the Nepal Gazette (under rule 12 and 13 (2) of the Forest Regulation, 1995 on 3 April 1995, which was amended as mentioned as per Clause 2 of Nepal Gazette vol. 3, Section 51 No. 36, dated 31 December 2001 issued by MoFSC, HMG/Nepal). The ban excludes export of *Taxus* spp. in processed form, however, as long as processed within Nepal and a permission obtained from the Department of Forest, advised by the Department of Plant Resources and Herb Production and Processing Co. Ltd. (AMATYA in litt. 2005).

The harvest of medicinal plants in **Pakistan** is controlled by the Forest Department.

Three different types of harvest controls were reported as practised (IQBAL 1991, RAPA 1987):

- Leasing the area for collection of medicinal herbs. This method was said to have been used in the Hazara forests in the North-West Frontier Province;
- Collection by the traders from local people who pay nominal royalties to the Forest Department. This method was said to have been common in the Malakand forests in the North-West Frontier Province; and
- Auctioning off fixed quantities, e.g. by the Forest Department in Azad Kashmir.

Before taking plants from the site of collection, the local Divisional Forest Officer must be approached for the issue of a transport permit, obtainable on the payment of a fixed duty. The size of the consignment and transport permits are checked at forest exit points. Commercial exploitation from reserved forests is forbidden throughout Pakistan by order of the Inspector General of Forests, Islamabad (MULLIKEN 2000).

Harvesting *T. wallichiana* is banned and its extraction is totally restricted in Pakistan (AMIN & al. 2004). Community protected forests in some areas are also contributing to the conservation of the species. The Manikhel forests in Orakzai Agency are a typical example of the traditionally managed forests, where even a twig of *Taxus* can not be extracted from the forest. The only use of *Taxus* branches allowed is for roping mosques and community meeting places. The forests of Manikhel are intact and are managed by tribal rules (AMIN & al. 2004).

Regulation of international trade

CITES listing. *Taxus wallichiana* was included in CITES Appendix II in 1995, following acceptance of a listing proposal put forward by India to the ninth meeting of the Conference of the Parties to CITES (Fort Lauderdale, November 1994). The proposal reflected concern that international trade in leaves and bark to produce paclitaxel was resulting in the decline of the species' wild populations, particularly in India. The listing became effective on 16 February 1995, and was annotated with what was at that time Annotation #8: "Designates all parts and derivatives, except: a) seeds and pollen; b) seedlings or tissue cultures obtained *in vitro*, in solid or liquid media, transported in sterile containers; c) cut flowers of artificially propagated plants; and d) finished pharmaceutical products". The original listing therefore covered extracts as well as raw materials in international trade. However, this annotation was changed at CoP 11 (Gigiri, April 2000) following a proposal from Switzerland aimed at harmonizing annotations for medicinal plants with the effect that chemical derivatives such as paclitaxel were excluded (Annotation #2: Designates all parts and derivatives, except: a) seeds and pollen; b) seedling or tissue cultures obtained *in vitro*, in solid or liquid media, transported in sterile containers; c) cut flowers of artificially propagated plants; and d) chemical derivatives and finished pharmaceutical products). It became clear in subsequent years, however, that chemical derivatives (extracts) formed a significant share, if not the vast majority, of international trade in this species in terms of the numbers of wild specimens affected by trade. The Governments of China and the USA therefore submitted a proposal to CITES CoP 13 (Bangkok, October 2004) to amend the annotation, which was accepted. *T. wallichiana* and other CITES-listed *Taxus* species (see below) was subsequently covered by Annotation #10: "Designates all parts and derivatives except: a) seeds and pollen; and b) finished pharmaceutical products", which entered into effect on 12 January 2005. The annotation applied to *Taxus* was modified yet again at CITES CoP 14 (The Hague, June 2007), as part of a Plants Committee process to clarify and harmonise annotations for medicinal plants. The revised annotation, effective 13 September 2007, "Designates all parts and derivatives except: a) seeds and pollen; and b) finished products packaged and ready for retail trade".

CITES Parties also responded at CITES CoP 13 to the threat to other Asian *Taxus* species posed by demand for paclitaxel and other taxanes by including a further four Asian *Taxus* species in CITES Appendix II (*Taxus chinensis, T. cuspidata, T. fuana, T. sumatrana*) as well as all infraspecific taxa of these species. This listing also entered into effect on 12 January 2005.

Export from **China** of materials derived from native *Taxus* species originating from the wild is banned (ZHAI 2005); however, clarification is required to see if this also applies to confiscated materials that are subsequently supplied to manufacturers for extraction purposes. There do not appear to be similar restrictions on the export of materials derived from cultivated specimens or for re-export of material imported from other countries.

At present, there is no single law formulated specifically to implement CITES within China, however, certain laws contribute to the implementation of the Convention in this country. From 1 January 1998, China's regulatory system for the export of wild animals and plants was strengthened by the Endangered Species Import and Export Management Office (under the State Forest Administration), the designated CITES

Management Authority, and the Customs Authority. A wide range of animal and plant species are specified in an annex attached to a Joint Notification from the Management Authority and the Customs Authority. This annex is said to be compiled on the basis of the CITES Appendices and lists of key national protected animals and plants. The Notification was amended in February 1999 to include several medicinal plant species. Trade in live plants, parts in their raw form, and products made from them specified on the said list are controlled. Confirmation is required to see if the list has now been amended to include those *Taxus* species included in CITES Appendix II at CITES CoP 13 and to reflect the revised annotation for *Taxus* species. According to the Joint Notification, where applicable, import/export permits or certificates are required. Since September 2003, the Government of China has required export documentation for all *Taxus* species and subspecies (ANON. 2004b). Import licences are required for the import of *Taxus* from other countries. These are issued by the central CITES office in Bejing based on export permit documentation (ZHAI 2005).

In **India**, the export of wild specimens of *Taxus wallichiana* sourced from within India has been prohibited through the species' listing on the Negative List of Exports since March 1996 (TRAFFIC INDIA 1998), and possibly as early as March 1994 (LANGE & WÄCHTER 1996). This prohibition would not appear to have extended to cultivated specimens, TRAFFIC INDIA (1998) having noted that export prohibitions for products produced via cultivation were changed periodically. As will be explained below, it would also appear that this prohibition would not have extended to finished products, or possibly to chemical derivatives, e.g. paclitaxel.

CITES is implemented in **India** through a combination of the Wildlife Protection Act, 1972/1991/2002 and the Export and Import Policy (EXIM) of the Foreign Trade (Development and Regulation) Act, 1992 and the Customs Act, 1962. The Wildlife (Protection) Act prohibits export of a number of species, including all six CITES Appendix I plant species native to India, of which one, Kuth *Saussurea lappa*, is a medicinal plant.

Policy on trade in wildlife and wildlife products is established via the EXIM policy, which is revised periodically. The policy, as far as it concerns wildlife, is decided in consultation with the Director of Wildlife Preservation of the Government of India, who is the CITES Management Authority and oversees CITES implementation in the country. The Director has four Regional Deputy Directors and four sub-regional offices of wildlife preservation, these serving as assistant CITES Management Authorities. The EXIM policy is put into effect via the provisions of the Foreign Trade (Development and Regulation) Act 1992 and enforced via the Customs Act (CITES MANAGEMENT AUTHORITY OF INDIA in litt. 2004).

The EXIM policy was embedded within a broader Foreign Trade Policy for the period 2004-2009, this change coming into effect on 1 September 2004. The Foreign Trade Policy aims at doubling India's share of global trade and expanding employment opportunities, particularly in rural and semi-urban areas, and includes a Special Agricultural Produce Scheme, promoting the export of, *inter alia*, minor forest produce such as medicinal plants and their value-added products. The policy outlines that all export and import shall be "free", e.g. unrestricted, unless regulated under any legislation. Goods imported in accordance with this policy may be exported in the same form without a licence, provided that there is no import or export restriction for the items. Even goods restricted for import may be imported under Customs Bond for export without a licence provided that the items are freely exportable. Specific note is made in the policy that this does not preclude the application of other laws (DIRECTORATE GENERAL OF FOREIGN TRADE 2004).

Import and export restrictions for specific products are established via India's ITC (HS) classifications in accordance with the broader policy. Several categories relevant to CITES-listed species have been identified as goods allowed to be imported without restriction (i.e. free of import duties or quotas), e.g. "medicinal plants, fresh or dried, whether or not cut, crushed or powdered" (Schedule 1 Chapter 12), lac, gums, resins and other vegetable extracts (Schedule 1, Chapter 13), pharmaceutical products (Schedule 1, Chapter 30) and essential oils (Schedule 1, Chapter 33). Although instructions under the EXIM policy for 1997-2002 stipulated that imports of plants, products and derivatives were subject to CITES provisions (TRAFFIC INDIA 1998), the low levels of trade data for imports of CITES-listed species into India indicate that these provisions were not implemented effectively.

It does not appear that any CITES-related import controls were established via the policy for 2004-2009 until early 2006, nor that these existed under other legislation (with the exception of *Saussurea lappa*), with the effect that imports of CITES-listed medicinal plant species was uncontrolled. However, on 6 February 2006 the ITC (HS) Classifications of Export and Import Items were amended such that imports of *Rauvolfia* spp. (all species) are to be subject to CITES provisions (Ministry of Commerce & Industry Department of Commerce Notification No. 42 RE-2005/2004-09). Similar amendments were made for Kuth (*Saussurea lappa*) roots, cacti, agarwood and agar oil. This would seem to indicate that CITES trade controls are not required for imports of other CITES-listed plant species, however confirmation of this is required.

As stipulated in Chapter 12 of the ITC (HS) classifications, the export of plants, plant portions, their derivatives and extracts of species included in CITES Appendix I and II and obtained from the wild is generally prohibited. Further clarification is required to confirm whether this applies to wild specimens regardless of their country of origin, or to only those specimens obtained within India. An "Export Licensing Note" appended to Chapter 12 specifies 29 plant taxa for which export is generally prohibited. This list includes *Taxus wallichiana*. An exception for both CITES species and those listed in the Licensing Note is made for the export of "formulations", defined as including "products which may contain portions/extracts of plants on the prohibited list but only in unrecognizable and physically inseparable form" and "value added formulations as well as herbal Ayurvedic" (Chapter 12, Export Licensing Note 3). It is not clear whether the term "recognizable" is defined per the CITES interpretation of "readily recognizable" such that if the ingredients of a particular formulation of Ayurvedic medicine are listed on the packaging, then they are considered to be "recognizable". The instructions include a note that states that "no certificate from any authorities whatsoever shall be required for their [formulations] export", implying that no CITES permits would be required for such exports. This would appear to potentially allow for trade in *Taxus wallichiana* in violation of CITES trade controls, which were revised to apply to extracts, and subsequently also to finished products in forms other than packaged for final sale. Export Licensing Note 2 states that export permits are required, however it is not clear if this applies only to cultivated specimens, which are allowed to be exported (see below) or also to formulations. CITES Management Authority staff have advised that, if Customs staff refer a shipment of "formulations" containing CITES-listed species to the Management Authority for clearance, then issuance of a CITES export permit will be required (AARTI in litt. 2005).

A further exception is provided for exports of wild CITES-listed species on a case-by-case basis for "life saving drugs", which could presumably be applied to any medicinal species, and particularly *Taxus wallichiana*. However, in this case a CITES permit would be required, with such trade only allowed on recommendation of the Ministry of Environment and Forests.

Exports of plants produced via cultivation are allowed subject to obtaining a transit pass from the relevant Divisional Forest Officer if the plants were cultivated in sites within forests, or a Certificate of Cultivation from a District Agriculture, Horticulture or Forest Officer if cultivated at sites outside forests. Export Licensing Note 2 included in this schedule states that "…However, in respect of CITES species, a CITES permit of export shall be required". As noted above, it appears that this provision relates to all but formulations, however this requires further clarification.

It does not appear that export restrictions on wild specimens of CITES-listed species apply to imported specimens, however this requires confirmation, nor does it appear that there are any specific provisions made for controlling re-exports of CITES-listed species, other than as may be required to prove that re-exports do not involve wild-collected stock from within India. No reference could be found to an earlier (2003) provision requiring exporters of value-added formulations made out of imported species from the list of "prohibited plants" to provide an affidavit to Customs authorities at the time of export that the specimens were legally imported (NTF NO. 03/2003 31/03/2003). However, CITES Management Authority staff state that proof of import is required prior to granting re-export permission, and that they take into account, for example, the amount of unprocessed product that would have been required on import to produce a given export quantity (JAIN in litt. 2005). CITES Re-export Certificates are issued for such shipments (AARTI 2005).

According to India's CITES Management Authority staff, the export of paclitaxel and 10 DAB manufactured from imported *Taxus baccata* is permitted with issuance of a "No Objection Certificate" by the CITES Management Authority after scrutinizing import documents and taking an affidavit from the exporter that the exported derivatives have in fact been manufactured from imported *T. baccata*. Such exports are not being recorded in India's CITES annual reports as they do not involve CITES-listed species (JAIN in litt. 2005).

Exports are required to be limited to the following ports: Mumbai, Nhava Sheva, Kolkata, Cochin, Delhi, Chennai, Tuticorin, Amritsar, Calicut and Thiruvananthapuram (DIRECTORATE GENERAL OF FOREIGN TRADE 2004). It is not clear if this relates to all plants covered under this Customs classification, or only to CITES-listed species and other medicinal species for which export is prohibited.

All violations of the EXIM policy constitute an offence under the Customs Act and are dealt with by Customs officials, who alone have the responsibility to enforce compliance with CITES at border posts. Inspection of consignments by Wildlife Inspectors, co-operating with Customs staff, may also be carried out at border crossings, but such specialist investigations are few. Enforcement of any violations detected is the responsibility of the Customs authorities (PANDA in litt. 1998).

There is no specific CITES-implementing legislation in **Nepal**, however legislation to promote more effective CITES implementation has been under consideration since the late 1990s. If agreed, the Rare (Endangered) Wildlife and Plants Trade Control Act 2057 (2002), which includes a number of CITES-relevant

provisions, would provide a more powerful legal tool for CITES implementation within Nepal (HEINEN & CHAPAGAIN 2002).

Nepal's CITES Management Authority for plants is the Department of Forests, Ministry of Forests and Soil Conservation. The CITES Scientific Authority for plants is the Department of Plant Resources, Ministry of Forests and Soil Conservation. The Management Authority issues export permits for plants covered by CITES and/or the Forest Act.

The Management Authority also maintains liaison with the Departments of Customs, Intelligence, Police and other agencies. The Ministry of Commerce (Customs) and the police assist in the enforcement of import and export controls. However, it was noted in 2000 that Customs officers had not been trained in the identification of medicinal plants (BISTA in litt. 2000); it is not known if training has been provided since that time. Personnel from the Department of Forests and District Forest Offices have been posted at the Customs points in the Terai to examine consignments containing wild flora (ARYAL 2000).

The Government of Nepal banned export of *Taxus* spp. by publishing a notification in the Nepal Gazette under the power conferred by rule 12 and 13 (2) of Forest Regulation 1995 on April 3 1995, which was amended per Clause 2 of Nepal Gazette vol. 3, Section 51 No. 36, dated 31 December 2001 issued by Ministry of Forests and Soil Conservation. The Government allows the export of *Taxus* spp. in processed form with permission from Department of Forests on the recommendation of Department of Plant Resource and Herbs Production and Processing Co. Ltd (AMATYA in litt. 2005). According to PANDIT & THAPA (2004), the ban on export of raw materials of certain medicinal species has been misinterpreted by some District Forest Office staff as relating to trade from one District to another, rather than to export from Nepal, increasing the incentive for illegal trade by village collectors.

Treaty of Trade between Nepal and India

In an effort to expand trade between their two countries, the Governments of India and Nepal entered into a bilateral trade agreement in 1991. The treaty provides for preferential treatment (exemption from Customs duty and quantitative restrictions) for trade in certain "primary products", which include forest produce that has not undergone processing, and Ayurvedic and herbal medicines (Article IV) (ANON. 2002c). Under this treaty, a certificate of origin issued by the Government of Nepal is the only document required for presentation to India's Customs authorities at the time of import (MULLIKEN 2000). Trade in conjunction with the treaty is required to take place via one of the 22 border crossings designated in Annex A of the treaty. During the late 1990s, border officials were unaware that CITES documentation might also be required for export (as noted above, under India's current CITES implementing legislation and the EXIM Policy, CITES export permits would not be required to accompany shipments into India in any event). The treaty contains provisions for stronger domestic measures on the part of national governments, and provides a list of articles not allowed preferential treatment (e.g. cigarettes and alcohol) as an annex. It appears that this Annex could be amended to reflect CITES requirements (MULLIKEN 2000).

TRAFFIC India informed Government authorities in both India and Nepal of the apparent relevance of this treaty with respect to CITES trade controls. Initial research results from this study were communicated to the second Indo-Nepal Trans-border Meeting in February 1999. As a result, the final resolution of that meeting called for bringing the bilateral treaty in line with CITES requirements (MULLIKEN 2000).

The treaty was extended for a further five years in 2002 and remained in effect until 5 March 2007 (ANON. 2002d). Although some amendments were made, these did not reflect the concerns raised regarding CITES implementation (AMATYA in litt. 2005). The treaty has been extended for a further five years, and will remain in effect until 5 March 2012.

Pakistan's CITES Management Authority is the National Council for the Conservation of Wildlife (NCCW), under the authority of the Ministry of Environment, Local Government and Rural Development, in Islamabad. CITES permits are issued by the NCCW, which is also responsible for formulating countrywide legislation for regulating harvest, national and international trade of CITES-listed species. It issues directives to various provincial Forest Departments to control the harvest and trade of medicinal plants and intervenes wherever a violation of CITES is reported. It is also responsible for inter-provincial and international coordination of CITES implementation. Enforcement officials interviewed at border posts were generally unaware of CITES requirements.

Conclusions

Taxus wallichiana is a multipurpose tree species valued through much of its range as a source of timber, fuelwood, fodder, tea, traditional medicine and, since the early 1990s, paclitaxel and other taxanes used in anti-cancer medications. Slow growing, slow to regenerate and sensitive to canopy disturbance and fire, it appears that this species was declining in some parts of its range even before harvest for production of taxanes began. However, high demand for bark and leaves for paclitaxel production resulted in a significant increase in the rate of harvest leading to population declines in China, India and Nepal, and potentially elsewhere in the species' range. Cultivation has been promoted in each of these countries, but as yet does not appear to be making a major contribution to *T. wallichiana* supplies. International trade in *T. wallichiana* and other Asian *Taxus* species involves a combination of leaves, bark and extracts in various stages of processing. Much of the preliminary processing appears to take place within the three range States named above, while the final pharmaceutical products are more likely to be produced and consumed in the USA, and, increasingly, in Europe. There has also been an increasing trade in raw materials from European and North American *Taxus* species to China in recent years to support processing facilities in that country.

Although the species has been listed in CITES Appendix II since 1995, there is relatively little information available regarding current rates of harvest and trade of *T. wallichiana*. This reflects a combination of factors, including:

- Varying interpretations and confusion regarding the taxonomy of *T. wallichiana* and other *Taxus* species;
- Generally low levels of CITES implementation for medicinal plant species;
- The exclusion of chemical derivatives (extracts) from CITES trade controls from 2000-2005; and
- Difficulty in visually identifying the main products in trade (leaves, bark, extract), including with regard to discriminating between parts and derivatives from *T. wallichiana* and those from other *Taxus* species.

The listing of the remaining Asian *Taxus* species in CITES Appendix II effective January 2005 should facilitate CITES implementation for *T. wallichiana* by requiring CITES documentation for any trade in native *Taxus* species from range States. The revised annotation for *T. wallichiana*, which also applies to these other species, should also improve the role of CITES in controlling and monitoring trade. However, CITES implementation will continue to be complicated by the factors above, and the increased trade in paclitaxel and other compounds produced from non-CITES *Taxus* species.

Ongoing research and developments in the technology for extracting and synthesising paclitaxel and other taxanes has widened the range of *Taxus* species from which these compounds can and are being extracted. These include European Yew *T. baccata*, a widely distributed species and also a common ornamental plant, and the North American species *T. canadensis*, for which commercial propagation trials for taxane production are underway. Paclitaxel is also now being produced via plant cell fermentation technology, although the rights to this technology were apparently initially licensed to a single company. These developments, along with significant investment in cultivation of *Taxus* species, suggest that demand for wild-harvested *T. wallichiana* will decrease at some stage in the future. In the near term, however, it seems likely that a strong economic incentive for wild harvesting and the purchase by manufacturers of wild-harvested products will remain, even within range States that do not allow such harvests such as China. There is no indication that demand for local use as a medicinal plant and tea within Himalayan range States will decrease in the near future. Use of raw materials in Ayurvedic and Unani medicines also seems likely to persist.

Most key range States have placed strict restrictions on harvests and/or trade. China bans both harvests and export, although does allow products to be manufactured, and presumably exported, from wild-harvested materials that have been confiscated. Based on available information, it appears that wild harvest continues to be legal in some states within India, and national export laws allow for the export of "formulations" made from wild-harvested material. However, no such exports have been permitted in recent years according to CITES Management Authority staff. India's trade controls similarly allow for the import and re-export of wild material from other countries outside of CITES trade controls. There was no information to indicate that this was a widespread practice, however, with imports of materials for processing said to involve *T. baccata*. Wild-harvest is allowed within Nepal, as is export of value added products (e.g. extracts). No permits have been issued for harvest in or export from Myanmar, and harvest (and presumably export) is banned in Pakistan.

Further information is required to determine how CITES authorities within those countries that allow export of raw materials or extracts maintain chain of custody controls in order to discriminate between CITES and non-CITES species. Further information is also required with regard to the making of non-detriment findings when trade involves wild-harvested specimens. Unlike cultivation, it seems that relatively little emphasis has been placed thus far on making such findings, or on developing sustainable harvest rotations for bark and leaves of *T. wallichiana* or other Asian *Taxus* species. Increased emphasis on sustainable harvest methods in Asian range States could serve multiple purposes, including securing income for rural (and potentially landless) producers and increasing the sustainability of *Taxus* harvests for other purposes, e.g. fodder and local production of traditional medicines and teas. Given the slow growth of the species, it seems unlikely that a similar approach would be successful with regard to timber harvests. However it might be that the promise of long-term cash income from needles and bark could outweigh the short-term benefits to be gained from use and sales of timber.

Possible next steps

Range States for Asian *Taxus* species might consider

- increasing domestic chain of custody controls for *Taxus* parts, derivatives and products; and
- investing in sustainable forest management and associated forest tenure approaches for *Taxus* species, and cross-sharing of lessons learned at the local, national and regional levels.

Range, consumer and intermediary processing States for Asian *Taxus* species might consider

- Developing and distributing improved identification materials for Asian *Taxus* parts and derivatives likely to be in trade;
- Developing a standardized CITES labelling system for chemical derivatives and extracts;
- Developing of a notification system to report the issuance and/or acceptance of CITES export permits for raw as well as processed materials; and
- Greater sharing of information regarding national harvest and trade controls, including the making of CITES non-detriment findings.

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ANNEX 1. LIST OF ISO COUNTRY CODES AND COUNTRY NAMES

This list provices country names (official short names in English) in alphabetical order as given in International Standards Organisation 3166-1 and the corresponding ISO 3166-1-alpha-2 code elements. The list is updated whenever a change to the official code list in ISO 3166-1 is effected by the ISO 3166/MA. It lists 240 official short names and code elements.

Afghanistan	AF
Åland Islands	AX
Albania	AL
Algeria	DZ
American Samoa	AS
Andorra	AD
Angola	AO
Anguilla	AI
Antarctica	AQ
Antigua and Barbuda	AG
Argentina	AR
Armenia	AM
Aruba	AW
Australia	AU
Austria	AT
Azerbaijan	AZ
Bahamas	BS
Bahrain	BH
Bangladesh	BD
Barbados	BB
Belarus	BY
Belgium	BE
Belize	BZ
Benin	BJ
Bermuda	BM
Bhutan	BT
Bolivia	BO
Bosnia And Herzegovina	BA
Botswana	BW
Bouvet Island	BV
Brazil	BR
British Indian Ocean Territory	IO
Brunei Darussalam	BN
Bulgaria	BG
Burkina Faso	BF
Burundi	BI
Cambodia	KH
Cameroon	CM
Canada	CA
Cape Verde	CV
Cayman Islands	KY
Central African Republic	CF
Chad	TD
Chile	CL
China	CN
Christmas Island	CX

Cocos (Keeling) Islands	CC
Colombia	CO
Comoros	KM
Congo	CG
Congo, The Democratic Republic of the	CD
Cook Islands	CK
Costa Rica	CR
Cote D'ivoire	CI
Croatia	HR
Cuba	CU
Cyprus	CY
Czech Republic	CZ
Denmark	DK
Djibouti	DJ
Dominica	DM
Dominican Republic	DO
Ecuador	EC
Egypt	EG
El Salvador	SV
Equatorial Guinea	GQ
Eritrea	ER
Estonia	EE
Ethiopia	ET
Falkland Islands (Malvinas)	FK
Faroe Islands	FO
Fiji	FJ
Finland	FI
France	FR
French Guiana	GF
French Polynesia	PF
French Southern Territories	TF
Gabon	GA
Gambia	GM
Georgia	GE
Germany	DE
Ghana	GH
Gibraltar	GI
Greece	GR
Greenland	GL
Grenada	GD
Guadeloupe	GP
Guam	GU
Guatemala	GT
Guernsey	GG
Guinea	GN
Guinea-Bissau	GW

Guyana	GY
Haiti	HT
Heard Island and Mcdonald Islands	HM
Holy See (Vatican City State)	VA
Honduras	HN
Hong Kong	HK
Hungary	HU
Iceland	IS
India	IN
Indonesia	ID
Iran, Islamic Republic of	IR
Iraq	IQ
Ireland	IE
Isle of Man	IM
Israel	IL
Italy	IT
Jamaica	JM
Japan	JP
Jersey	JE
Jordan	JO
Kazakhstan	KZ
Kenya	KE
Kiribati	KI
Korea, Democratic People's Republic of	KP
Korea, Republic of	KR
Kuwait	KW
Kyrgyzstan	KG
Lao People's Democratic Republic	LA
Latvia	LV
Lebanon	LB
Lesotho	LS
Liberia	LR
Libyan Arab Jamahiriya	LY
Liechtenstein	LI
Lithuania	LT
Luxembourg	LU
Macao	MO
Macedonia, The Former Yugoslav Republic of	MK
Madagascar	MG
Malawi	MW
Malaysia	MY
Maldives	MV
Mali	ML
Malta	MT
Marshall Islands	MH
Martinique	MQ
Mauritania	MR
Mauritius	MU
Mayotte	YT
Mexico	MX
Micronesia, Federated States of	FM

Moldova, Republic of	MD
Monaco	MC
Mongolia	MN
Montserrat	MS
Morocco	MA
Mozambique	MZ
Myanmar	MM
Namibia	NA
Nauru	NR
Nepal	NP
Netherlands	NL
Netherlands Antilles	AN
New Caledonia	NC
New Zealand	NZ
Nicaragua	NI
Niger	NE
Nigeria	NG
Niue	NU
Norfolk Island	NF
Northern Mariana Islands	MP
Norway	NO
Oman	OM
Pakistan	PK
Palau	PW
Palestinian Territory, Occupied	PS
Panama	PA
Papua New Guinea	PG
Paraguay	PY
Peru	PE
Philippines	PH
Pitcairn	PN
Poland	PL
Portugal	PT
Puerto Rico	PR
Qatar	QA
Reunion	RE
Romania	RO
Russian Federation	RU
Rwanda	RW
Saint Helena	SH
Saint Kitts and Nevis	KN
Saint Lucia	LC
Saint Pierre and Miquelon	PM
Saint Vincent and the Grenadines	VC
Samoa	WS
San Marino	SM
Sao Tome and Principe	ST
Saudi Arabia	SA
Senegal	SN
Serbia And Montenegro	CS
Seychelles	SC
Sierra Leone	SL

Singapore	SG
Slovakia	SK
Slovenia	SI
Solomon Islands	SB
Somalia	SO
South Africa	ZA
South Georgia and the South Sandwich Islands	GS
Spain	ES
Sri Lanka	LK
Sudan	SD
Suriname	SR
Svalbard and Jan Mayen	SJ
Swaziland	SZ
Sweden	SE
Switzerland	CH
Syrian Arab Republic	SY
Taiwan, Province of China	TW
Tajikistan	TJ
Tanzania, United Republic of	TZ
Thailand	TH
Timor-Leste	TL
Togo	TG
Tokelau	TK
Tonga	TO
Trinidad And Tobago	TT
Tunisia	TN
Turkey	TR
Turkmenistan	TM
Turks And Caicos Islands	TC
Tuvalu	TV
Uganda	UG
Ukraine	UA
United Arab Emirates	AE
United Kingdom	GB
United States	US
United States Minor Outlying Islands	UM
Uruguay	UY
Uzbekistan	UZ
Vanuatu	VU
Venezuela	VE
Viet Nam	VN
Virgin Islands, British	VG
Virgin Islands, U.S.	VI
Wallis And Futuna	WF
Western Sahara	EH
Yemen	YE
Zambia	ZM
Zimbabwe	ZW

Source:
http://www.iso.org/iso/country_codes/iso_3166_code_lists/english_country_names_and_code_elements.htm

ANNEX 2. LIST OF ISO LANGUAGE CODES AND CORRESPONDING LANGUAGES

This list provices three-digit language codes referred to in this report in alphabetical order as given in International Standards Organisation 639.2 and the corresponding languages.

Code	Language
asm	Assamese
ben	Bengali
bhu	Bhutanese
bod	Tibetan
bur	Burmese
chi	Chinese
eng	English
fre	French
gar	Garhwal, Garwhali
ger	German
guj	Gujarati
hin	Hindi
ita	Italian
kan	Kanarese/Kannada
kas	Kashmiri
kha	Khasi
mal	Malayalam
mar	Marathi
mik	Mikir
mun	Mundari
nep	Nepali
new	Newari
nld	Dutch
ori	Oriya
pha	pharmaceutical name
por	Portuguese
pun	Punjabi
pus	Pushto
san	Sanskrit
spa	Spanish
tam	Tamil
tel	Telugu
tha	Thai
tib	Tibetan
urd	Urdu

Source: http://www.loc.gov/standards/iso639-2/php/English_list.php.

ANNEX 3. GUIDE TO INFORMATION WITHIN TABLES ON CITES-REPORTED TRADE

Data on international trade reported by CITES Parties (CITES annual report data) were obtained from the UNEP-World Conservation Monitoring Centre, which maintains this information on behalf of the CITES Secretariat. These are presented in the form of "comparative tabulations", which allow comparison of trade reported by exporting/re-exporting Parties with that reported by importing Parties. When considering these data it is important to bear in mind that discrepancies in trade reporting by different countries, for example reporting of the source of specimens in trade, may give the appearance that different shipments are involved when this is not the case. In addition, Parties often report exports based on the date of permit issuance; however, CITES export permits can be valid for up to six months, with the result that they may be issued and reported on in one year by the exporting Party, but not reported on until the following year by the importing Party. A guide to interpretation of CITES annual report data prepared by UNEP-WCMC, UNEP-WCMC *A Guide to Interpreting Outputs from the CITES Trade Database*, can be found on the UNEP-WCMC website at www.unep-wcmc.org/citestrade/docs/Guide_v.6.0.pdf.

The format for the CITES data tables in this document is provided below:

Year	Country of Export	Country of Import	Origin	Export					Import				
				Quantity	Unit	Term	P	S	Quantity	Unit	Term	P	S

Country codes used by the International Standards Organization are used to designate countries of export, origin (where this differs from the exporting country) and import. See Annex 1 for a list of these codes in relation to the country names. The code "??" is used where the country is unknown.

The following descriptions of the information contained within the individual columns have been extracted from *A Guide to Interpreting Outputs from the CITES Trade Database*:

Year year in which trade occurred
Country of Import (where exports are reported, this is the declared country of destination)
Country of Export (where imports are reported, this is the declared country from which the specimens were consigned)
Country of Origin (this column is blank if the country of export is the country of origin or if the country of origin is not reported)

Export - Exports Reported by the Exporting Country
Quantity of specimens reported as imports
Unit e.g. kg. If no unit is shown, the figure represents the total number of specimens
Term description of specimens traded
P purpose of the transaction
S source of the specimen

Import - Imports Reported by the Importing Country
Quantity of specimens reported as (re-)exports
Unit e.g. kg. If no unit is shown, the figure represents the total number of specimens
Term description of specimens traded
P purpose of the transaction
S source of the specimen

Purpose and Source Codes

The preferred purpose and source codes to be used in annual reports and therefore appearing in the data, as specified in Notification to the Parties No. 2002/022, are as follows:

The reported **purpose** of the transaction is shown as a one-letter code:

B Breeding in captivity or artificial propagation
E Educational
G Botanical Gardens
H Hunting trophies
L Enforcement (e.g. evidence in court, specimen for training)
M Bio-medical research
N Reintroduction or introduction into the wild

P Personal
Q Circuses and travelling exhibitions
S Scientific
T Commercial Trade
Z Zoos

The reported **source** of the transaction relates to the original source of the species being traded and again is shown by a one-letter code:

A Plants that are artificially propagated in accordance with Resolution Conf. 11.11, paragraph a), as well as parts and derivatives thereof, exported under the provisions of Article VII, paragraph 5, of the Convention (specimens of species included in Appendix I that have been propagated artificially for non-commercial purposes and specimens of species included in Appendices II and III).

C Animals bred in captivity in accordance with Resolution Conf. 10.16 (Rev.), as well as parts and derivatives thereof, exported under the provisions of Article VII, paragraph 5, of the Convention (specimens of species included in Appendix I that have been bred in captivity for non-commercial purposes and specimens of species included in Appendices II and III).

D Appendix-I animals bred in captivity for commercial purposes and Appendix-I plants artificially propagated for commercial purposes, as well as parts and derivatives thereof, exported under the provisions of Article VII, paragraph 4, of the Convention.

F Animals born in captivity (F1 or subsequent generations) that do not fulfil the definition of 'bred in captivity' in Resolution Conf. 10.16 (Rev.), as well as parts and derivatives thereof. **I** Confiscated or seized specimens (may be used with another code)

O Pre-Convention specimens (may be used with another code)

R Specimens originating in a ranching operation

U Source unknown **(must be justified)**

W Specimens taken from the wild