Plants for life:

Medicinal plant conservation and botanic gardens

20 YEARS
1987-2007

BGCI

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Medicinal plant conservation and botanic gardens

Belinda Hawkins

*The Rosy periwinkle (*Catharanthus roseus*), extracts of which have helped increase the chance of surviving childhood leukaemia from 10% to 95%.*

Cover image: Echinacea *spp. used by Native American Indians and still popular today for stimulating the immune system and accelerating the healing of infections.*

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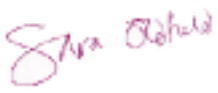
Foreword

Zingiber spectabile*. In addition to its use as a spice, ginger root has been used for centuries for an array of complaints; from stomach upset to rheumatism.*

Medicinal plants harvested from the wild remain of immense importance for the well-being of millions of people around the world. Providing both a relief from illness and a source of income, over 70,000 plant species are thought to be medicinal. Loss of habitat combined with over-harvesting threatens the survival of many of these plant species. Botanic gardens are important agencies for ensuring their conservation.

The original purpose of the earliest botanic gardens established in Europe in the sixteenth century was the cultivation and study of medicinal plants - at a time when medicine and botany were essentially the same discipline.
The tradition of cultivating and displaying medicinal plants has been retained by many botanic gardens. For example, a study by BGCI in 1998 highlighted the medicinal plant collections of 480 botanic gardens. Conservation of threatened medicinal plants has become an increasingly important role through *ex situ* conservation as an insurance policy against loss of resources in the wild, informing visitors about the values and conservation needs of these special plants and working with local communities to show how the plants they rely on can be cultivated or harvested sustainably. The multitude of ways in which botanic gardens support the conservation of medicinal plants is highlighted by this report. And yet much more needs to be done.

This report draws on a questionnaire survey of botanic gardens, experts and conservation organisations worldwide. The response has been extremely encouraging. Conservation organisations such as Plantlife International, TRAFFIC and the IUCN SSC Medicinal Plant Specialist Group have all highlighted the valuable skills and expertise of botanic gardens that can and should be made available to provide integrated conservation solutions for medicinal plants. We are very grateful for their practical suggestions and ideas for partnership. Botanic gardens have shared practical case studies and expressed their willingness to take on more conservation commitments. BGCI will now act on the findings presented in this report to fully develop and implement a medicinal plant programme that delivers the objective in our 5 Year Plan:
To enhance the conservation and sustainable use of threatened medicinal plants to address human well-being and livelihood issues as a contribution towards Targets 3 and 13 of the CBD Global Strategy for Plant Conservation.



Sara Oldfield
BGCI Secretary General
December 2007

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Magnolia denudata.
Flower buds and seeds used in Asia for headaches and sinusitis.

1. Introduction

Hibiscus *spp. Many species are used medicinally and as food across the globe.*

Botanic gardens around the world have been involved in the study and cultivation of medicinal plants for over 500 years. Collectively they provide an important repository for medicinal plants and the associated knowledge about these important species. Recognising this, BGCI has taken various steps to promote the conservation of medicinal plants by the botanic garden community since its establishment 20 years ago.

Currently, one of the aims of BGCI's 5-year plan (2007 – 2012) (available at www.bgci.org) is to enhance the conservation of threatened medicinal plants to address human well-being and livelihood issues as a contribution towards the Global Strategy for Plant Conservation (GSPC) (Annex 1). Though there are a range of resources directed at the conservation of medicinal plants, few of these have been specifically targeted for botanic gardens. BGCI's 'Safety Nets for Medicinal Plants' project, a one-year programme of work supported by the Rufford Maurice Laing Foundation, aimed to maximise the potential for skill-sharing within the medicinal plant conservation community, with a view to prioritising the practical medicinal plant conservation actions that botanic gardens and BGCI can take. Although botanic gardens have horticultural skills that can be disseminated to achieve a community benefit that is not necessarily a conservation benefit, the focus for this work was on threatened medicinal plants.

The project has involved updating BGCI's PlantSearch database (available at www.bgci.org/plant_search.php/) to include information on threatened medicinal plants for use as a planning tool. Some 3,000 key medicinal plant species are now included in the database, allowing botanic gardens to identify medicinal plant species within their collections and BGCI to build a picture of the *ex situ* status of priority species, at local, regional and global levels. This phase of the project has resulted in the collection of large amounts of data, which will be made available via the PlantSearch database and will serve as a basis for on-going work. Annex 2 records the sources of data used during this initial exercise.

Secondly, a medicinal plants workshop involving over 150 participants was held at the Third Global Botanic Gardens Congress in Wuhan, China in April 2007, at which a wider consultation exercise was begun. This involved a questionnaire survey (Annex 3), which was directed at various medicinal plant stakeholder bodies; from botanic gardens to NGOs, Government agencies and commercial enterprises. 80 questionnaire responses were received. Answers and commentary received have been woven into this report. Graphic results can be seen at Annex 4, suggested priority species can be seen at Annex 5.

Drawing on all of these inputs, this report compares the need for conservation of the world's medicinal plant diversity with the conservation resources provided by botanic gardens around the world and moves towards an action plan for prioritising conservation action, taking into account livelihoods and healthcare for an integrated approach.

2. Background

To begin simply, plants equal life. They are the primary producers that sustain all other life forms. They regulate air and water quality, shape ecosystems and control the climate. They provide food, medicine, clothes, shelter and the raw materials from which innumerable other products are made. These benefits are widely recognised but poorly understood. Thus plants are both a vital part of the world's biological diversity and an essential economic resource for human existence.

Yet plant extinctions are occurring at a rate unmatched in geological history, leaving ecosystems incomplete and impoverished. Current extinction rates are at least 100 to 1,000 times higher than natural background rates, with a quarter of the world's coniferous trees known to be in jeopardy (IUCN, 2006) and as many as 15,000 medicinal plants under threat (IUCN/SSC MPSG, 2007). Over 50% of cycads, used medicinally and the oldest seed plants on earth, are threatened with extinction. This makes them one of the most threatened groups of species currently on the IUCN Red List of Threatened Species. Whilst the extinction of a species is the ultimate loss, the process of extinction itself has serious consequences for local ecosystems. Plant to plant interactions effect both resource availability and habitat structure, and play an important role in mediating the responses of natural systems (Brooker, 2006). Thus the loss of any one species weakens an ecosystem's ability to adapt in a rapidly changing world.

Ginkgo biloba, *a 'living fossil' with a long history of use in China for improving the memory.*

"Exploitation pressures have increased with growing human population. Although sustainable exploitation of many species is theoretically achievable, many factors conspire to make it hard to achieve in practice, and overexploitation remains a serious threat to many species and populations. Among the most commonly exploited species or groups of species are plants and animals harvested for the medicinal trade" *(Millennium Ecosystem Assessment, 2005).*

Destructive harvesting practices coupled with the degradation of forests, agricultural expansion, grazing pressure and urbanisation all threaten the survival of medicinal plants. In short, we are asking more and more from natural ecosystems even as we reduce their capacity to meet our needs (Kazoora, 2002).

As we lose species, we lose vital components necessary to our own survival. Humans, with all their cultural diversity, are an integral part of ecosystems; ultimately one is entirely dependent on the other. Whilst we drive ecosystem change both directly and indirectly, changes in ecosystems cause changes in human well-being also. Adverse impacts on ecosystems have adverse impacts on cultures and communities, often affecting the world's poorest people with disproportionate severity. The ecosystem approach to conservation, which puts people at the centre of ecosystem management, is strikingly relevant to medicinal plants. Surely, **we should save the plants that save us?**

3. Medicinal plants for healing

Medicinal plants have been used by mankind for millennia; their use is as old as humanity itself. The range of species used and their scope for healing is vast. Cures as yet undiscovered may exist in plants as yet undescribed. Currently, it is estimated that the number of higher plant species used worldwide for medicinal purposes is more than 50,000 (Schippmann *et al*., 2002). This equates to approximately 20% of the world's vascular flora and constitutes the biggest spectrum of biodiversity used by people for a specific purpose (Hamilton *et al*., 2006).

Traditional medicine

"Traditional medicine is the sum total of the knowledge, skills and practices based on the theories, beliefs and experiences indigenous to different cultures, whether explicable or not, used in the maintenance of health as well as in the prevention, diagnosis, improvement or treatment of physical and mental illness"
(World Health Organisation (WHO), 2003).

In 1960, at the cave site of Shanidar in what is now north-eastern Iraq, the skeleton of an adult male was discovered, lying on his left side in a partial foetal position. He'd been buried some 60,000 years ago. Routine soil samples were gathered for pollen analysis in an attempt to reconstruct the site's palaeoclimate and vegetational history. In some of the samples concentrated clumps of pollen were found suggesting that entire flowering plants had been buried close to the man. Though the source of the pollen is hotly debated, a study of the particular flower types suggested that the flowers may have been specifically chosen for their medicinal properties. Yarrow (*Achillea* spp.), St. Barnaby's thistle (*Centaurea* spp.), groundsel (*Senecio* spp.) and rose mallow (*Hibiscus* spp.) amongst others were represented in the pollen samples, all of which have long-known curative powers as stimulants, astringents and anti-inflammatories.

- In China, Traditional Chinese Medicine (TCM) is largely plant-based (80%) and TCM preparations account for 30-50% of total medicinal consumption, rising to 90% in rural areas (WHO, 2003).
- In India, Ayurvedic medicine, a system more than 5,000 years old, is based on some 2,000 plant species (Zedan, 2002).
- In Sub-Saharan Africa, the ratio of traditional healers to the population is approximately 1:500, while medical doctors have a 1:40,000 ratio to the rest of the population (Richter, 2004).

In fact, of the total pharmaceutical drug supply available worldwide, only 15% is consumed in developing countries (Lydecker *et al*., 1992), supporting the

much-quoted WHO's estimate that 80% of people worldwide rely on traditional medicine for their primary healthcare. The majority of these people are in developing countries, where rapid population growth is expected to increase pressures on medicinal plant resources.

The greater part of traditional therapy involves the use of plants. With little or no access to modern pharmaceuticals and a strong cultural preference for traditional medicine, medicinal plants are therefore fundamental to the well-being of billions of people.

Demand for traditional remedies is also increasing in so-called developed countries, alongside growing environmental awareness and a desire for natural healing through natural products.

'Modern' medicine

Of course, allopathic or 'modern' medicine also owes a great deal to medicinal plants. *Catharanthus roseus* for example, treats leukaemia and Hodgkin's disease. Morphine and codeine are produced from cultivated opium poppy, *Papaver somniferum*. Aspirin was originally found in willow bark (*Salix* spp.). Quinine from the cinchona tree has been the primary treatment for malaria for centuries. Digitalin medicines,

Taxus *spp.*

Digitalis *spp.*

extracted from the leaves of the common foxglove (*Digitalis* spp.), are widely used for a variety of heart conditions. Topical steroids for eczema are produced from the yam (*Dioscorea* spp.) or from sisal (*Agave* spp.) and the alkaloid Galantamine, sourced from the bulbs of snowdrops (*Galanthus* spp.) is used to treat Alzheimer's disease, slowing down the progression of dementia.

In fact, as many as 50% of prescription drugs are based on a molecule that occurs naturally in a plant, with some 25% of prescription drugs derived directly from flowering plants or modelled on plant molecules (Foster and Johnson, 2006).

In many cases modern chemistry cannot offer viable alternatives to active botanical compounds. The compound paclitaxel (found in *Taxus* spp. and source of the anti-cancer drug, taxol) was described as the kind of molecule that no chemist would ever sit down and think of making;

"If contemporary chemistry is now allowing us to merely copy such molecules, one can imagine the near impossibility of designing from scratch a molecule with a comparable combination of form and biological function"

(Capson, 2004).

Predictions that advances in chemical sciences and synthetic material development would lessen the need for natural materials have proved to be wrong, and modern medicine depends on the continuing availability of biological materials as an incomparable source of molecular diversity.

4. Medicinal plants for livelihoods

Medicinal plants are clearly an important global resource in terms of healthcare but they are also an important economic resource, traded extensively on scales ranging from the local to the international.

Internationally, the trade in medicinal plants is estimated to be worth $60 billion per year (World Bank, 2004) increasing at a rate of 7% a year (Koul and Wahab, 2004).

Very little of the raw material to supply this demand is from cultivated sources. Of the 3000 or so species known to be in international trade (Schippmann *et al*, 2006) there are approximately 900 for which commercial cultivation is underway or in development (Mulliken and Inskipp, 2006). Putting it another way, about 70-80% of the medicinal plants being traded in the world's most important range countries for medicinal plants originate from wild-collection (WWF/TRAFFIC Germany, 2002). Many of these species are widespread and abundant but for naturally rare and heavily exploited species wild collection can be a major threat with local extinction the outcome. It is the collection for commercial trade rather than home-use that is overwhelmingly the problem (Hamilton, 2003).

Though notoriously poorly documented, and though our understanding of the biology, ecology and status in the wild of most medicinal plants is very fragmented, this level of wild harvest is said to be currently unsustainable.

We know this because herb-gatherers are having to go farther and farther afield to harvest the plant they want; they're experiencing a drop in harvest levels. Some species just aren't there anymore. Unfortunately, the motivation of short-term profit increase neglects all considerations of sustainability, but conservation intervention can occur at several points along the supply chain.

The consequences of unsustainable harvest are far-reaching, and not simply confined to a loss of healthcare or biodiversity. Many of the world's poorest people rely on the collecting and selling of wild medicinal plants for income generation. Though prices paid to gatherers tend to be very low medicinal plant collection provides a significant income for the often marginal, rural poor (World Bank, 2004).

Gentiana lutea

Gentiana lutea (Yellow gentian) is found in the mountains of central and southern Europe. Gentian root (which can be as thick as a person's arm) has a long history of use as an herbal bitter in the treatment of digestive disorders. An Egyptian papyrus from 1200 B.C. mentions gentian as an ingredient in medicines (Foster and Johnson, 2006).

The root contains one of the bitterest substances known to science (the bitter taste can still be detected at dilutions of herb to water 1:20,000) and it stimulates the taste buds and brain reflexes to promote the secretion of saliva and gastric juices. As such it has been used as an appetite stimulant in the treatment of anorexia (Foster, 2006). It is said to be especially useful in states of exhaustion from chronic disease and in cases of debility or weakness of the digestive system; strengthening the human system by stimulating the liver, gall bladder and digestive system (Plants for a Future, 2004).

Most imports of *G.lutea* originate from wild harvest and occasionally from cultivation in south east Europe (WWF/TRAFFIC Germany, 2002). The species is endangered or critically endangered over most of its range; it is included in the Red Data Books of Bulgaria, Albania and Transcarpathia; wild harvest is banned in Montenegro; the species is protected by law in Serbia and the Ukraine and it is considered threatened in Turkey.

Gentiana lutea is recorded in cultivation in 48 botanic gardens (PlantSearch database). The gathering of propagation data from these gardens and the exchange of this information will help to ensure the *ex situ* conservation of this species and will support restoration and reintroduction efforts. BGCI aims to facilitate this work though its medicinal plants programme.

- About 20,000 tons of medicinal and aromatic plants worth US$18-20 million are traded every year in Nepal alone, and about 90% are harvested in uncontrolled fashion by landless, resource-poor mountain farmers for whom the harvest and trade in medicinal plants constitutes their only form of cash income. The situation is similar in Bangladesh, Bhutan, India, and other countries of South Asia (MAPPA, 2007).

- In Namibia, there are an estimated 5,000 to 10,000 Devil's Claw (*Harpagophytum* spp.) harvesters, 50 to 100 middlemen and 17 Namibian exporters. The retail value in 2001 was some US$40 million, though Namibia captures at most 5% of the retail value of the trade (Cole and Stewart, 2006).

- Ethnoveterinary medicine is used by livestock raisers throughout the world to keep their animals healthy and productive, since modern treatments may be expensive and inaccessible in remote areas (Mathias, 2001).

Rows of ginseng and mushroom elixirs for sale in Seoul, Korea.

***Aconitum* spp.**

Aconitum heterophyllum (Patris) is endemic to the alpine and sub-alpine zones of the north-west Himalayas. It grows only in localised restricted ecological niches and is said to neither invade new areas nor survive at lower altitudes (Beigh et al, 2005).
The species has;

1 name in Arabic, 5 in Hindi, 2 in Kannada, 1 in Malayalam, 2 in Marathi, 3 in Persian, 70 in Sanskrit, 83 in Tamil, 3 in Telugu, 5 in Tibetan and 4 in Urdu (FRLHT, no date).

The dried root is commonly used to treat gastric disorders and high fevers, as a substitute for quinine and to treat toothache and scorpion or snake bites. It is a high value species; gatherers can expect to receive around Rs 1500/kg (approximately US$37) (Uniyal *et al*, 2006). Traditionally, it was harvested every two to three years. It is now harvested every year and subject to a lengthened harvesting season, placing the species under heavy pressure (Singh, 2006). The species shows poor seed germination and low seed survival therefore regeneration is low under natural conditions. This characteristic, combined with non-judicious exploitation, over-grazing and habitat destruction mean that the species is now hard to find and critically endangered.

Aconitum heterophyllum is recorded in cultivation in only 4 botanic gardens (PlantSearch database). BGCI will therefore support the *ex situ* conservation of this species by alerting gardens to the conservation needs of the species, gathering species-specific data and facilitating knowledge share between gardens.

The world's greatest concentration of medicinal plant wealth is found in tropical developing countries that are beset by acute poverty. In these regions, the loss of biodiversity and land degradation is accelerating as poverty is increasing. The loss of livelihood is a very real concern given that approximately 1 billion people, a fifth of the world's population, live on less than US$1 a day (World Bank, 2007).

A common definition is that a livelihood is the financial means whereby one lives; for example, collecting wild medicinal plants for sale. However, this does not necessarily mean that the plants collected are sufficient to satisfy an individual's needs or to lift them out of poverty. Such a livelihood cannot therefore be sustainable. A sustainable livelihood is one that can cope with and recover from stresses and shocks whilst maintaining or enhancing its capabilities for the future and not undermining the natural resource base (Kazoora, 2002). Sustainable use meets the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland, 1987).

5. Approaches to medicinal plant conservation

Medicinal plant conservation is challenging, since the taxa occur in a wide range of habitats and geographic regions. Their conservation threats and ultimate use are diverse and users are not only local rural communities but also far away urban citizens. However, it is widely agreed that the conservation of medicinal plants (and biodiversity in general) can be achieved through an integrated approach balancing *in situ* and *ex situ* conservation strategies.

Medicinal plant conservation must therefore operate within several spheres; drawing together disparate groups and mutually acknowledging different stakeholder interests in order to succeed.

The policy context

A policy trend positively linking biodiversity conservation with human development is gaining momentum and people's access rights to natural resources necessary for their survival have improved with policy provisions.

- **The Convention on Biological Diversity** (CBD) was ratified in 1992 at the Rio Earth Summit. The 190 Parties have agreed to commit to protect biodiversity, develop sustainably and engage in the equitable sharing of benefits from the use of genetic resources. The conservation of biodiversity is acknowledged as the cornerstone of sustainable development. For more information on the CBD go to www.cbd.int.
- The World Trade Organisation's (WTO) agreement on **Trade-Related Aspects of Intellectual Property Rights** (TRIPS), 1994, sets out how to deal with the commercial use of traditional knowledge and genetic material by those other than the communities or countries where these originate, especially when these are the subject of patent applications. More information on the WTO and TRIPS Agreement is available at www.wto.org.

The Chiang Mai Declaration of 1988 led to the publication of the first Guidelines on the Conservation of Medicinal Plants (currently being updated), recognising the "urgent need for international co-operation and co-ordination to establish programmes for the conservation of medicinal plants to ensure that adequate quantities are available for future generations" *(WHO, 1993)*.

The guidelines detailed the experts most needed for a programme of conservation and sustainable utilisation of medicinal plants, though terms may have changed in the almost 20 years since, the roles remain just as current.

Agronomists:	To improve techniques for cultivating medicinal plants
Conservation campaigners:	To persuade the public of the need to conserve medicinal plants
Ecologists:	To understand the ecosystems in which medicinal plants grow
Ethnobotanists:	To identify the use of plants as medicines in traditional societies
Health policy-makers:	To include conservation and utilisation of medicinal plants in their policy and planning
Horticulturists:	To cultivate medicinal plants
Legal experts:	To develop effective legal mechanisms that ensure that collection of medicinal plants is at levels that are sustainable
Park managers:	To conserve medicinal plants within their parks and reserves
Park planners:	To ensure the park and reserve system contains the maximum diversity of medicinal plants
Pharmacologists:	To study the application of medicinal plants
Plant breeders:	To breed improved strains of medicinal plants for cultivation
Plant genetic resource specialists:	To assess the genetic variation in medicinal plants and maintain seed banks of medicinal plants
Plant pathologists:	To protect the cultivated medicinal plants from pests and diseases without using dangerous chemicals
Religious leaders:	To promote a respect for nature
Resource economists:	To evaluate the patterns of use and the economic values of medicinal plants
Seed biologists:	To understand the germination and storage requirements of the seed of different medicinal plants
Taxonomists:	To identify the medicinal plants accurately
Traditional health practitioners:	To provide information on the uses and availability of medicinal plants

- The **UNCTAD BioTrade Initiative** (launched in 1996) promotes the sustainable use of goods and services derived from biodiversity, in support of the objectives of the CBD (www.biotrade.org/).
- The eight **Millennium Development Goals** (MDGs) were agreed by world leaders in 2000, providing an agenda for reducing poverty and improving lives through environmental sustainability by the target date of 2015. Any measures which enable the sustainable use of natural resources to improve livelihoods will contribute to the MDGs. The MDGs can be viewed at www.un.org/millenniumgoals/.
- The **Millennium Ecosystem Assessment** (MEA) assessed the consequences of ecosystem change on human well-being, gathering data from 2001 to 2005 and providing a scientific appraisal of the condition and trends in the world's ecosystems and the services they provide, as well as the scientific basis for action to conserve and use them sustainably (www.millenniumassessment.org).
- The **Doha Declaration** of 2001 aimed to ensure that the TRIPS agreement and the CBD support each other; *"allowing for the optimal use of the world's resources in accordance with the objective of sustainable development, seeking both to protect and preserve the environment and to enhance the means for doing so in a manner consistent with their respective needs and concerns at different levels of economic development"*.
- In 2002 the CBD adopted the **Global Strategy for Plant Conservation** (GSPC), which specifies 16 outcome-orientated targets for delivery by 2010. See Annex 3 and www.plants2010.org.
- The 2002 **World Summit on Sustainable Development** aimed to promote a global commitment to sustainable development, improving the lives of the world's poorest people as well as reversing the continued degradation of the global environment. For the latest developments see http://www.un.org/esa/sustdev/index.html.
- The WHO launched their **Traditional Medicine Strategy** in 2002, discussing the role of traditional medicine in health care systems. View at http://www.who.int/medicines/publications/traditionalpolicy/en/.
- In 2004, the **Addis Ababa Principles and Guidelines** to the CBD detailed 14 interdependent practical principles and operational guidelines that govern the uses of components of biodiversity to ensure the sustainability of such use. These can be viewed on the CBD website, as before.
- Also in 2004, a new paragraph was added to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (**CITES**) Resolution Conf.8.3 stating that the Conference of the Parties recognizes that implementation of CITES listing decisions should take into account potential impacts on the livelihoods of the poor. See www.cites.org for further information.

Homalanthus nutans

Access and benefit sharing (ABS)

One of the three fundamental objectives of the CBD is to promote the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources. One way of doing this is by confirming the sovereign rights of the State over its biological resources. The bioprospecting of plants for potential new drugs raises issues about the protection of traditional knowledge and the mechanisms to ensure that indigenous peoples benefit from uses of their resources.

- *Homalanthus nutans* (the mamala tree) is native to the rainforests of the South Pacific island of Samoa. It has traditionally been used to treat a number of conditions; from back pain to hepatitis, diarrhoea and yellow fever. Researchers at the University of California, Berkeley, in the US identified a promising AIDS drug (Prostratin) in the bark of the tree. Samoa therefore declared sovereign rights over the species, including the actual gene sequences, and signed an ABS agreement with the University in 2004 (picture above). The agreement gives Samoa and the University equal shares to any commercial proceeds resulting from the genes. Samoa's 50% share will be allocated to the government, to villages and to the families of traditional healers. Another facet of the agreement is a requirement that any subsequent commercialised drug must be supplied to developing countries free, at cost or at very nominal profit.

- In October 1991, the Costa Rican Asociacion Instituton Nacional de Biodiversidad (INBio), a private, non-profit, scientific organization and Merck, a U.S. multi-national pharmaceutical corporation, signed a two year agreement. In the agreement, INBio would supply Merck with samples among the plants, insects and microorganisms collected from Costa Rica's protected forests. Merck then would have the right to use these samples to create new pharmaceutical products. Merck paid one million dollars to INBio for the right to analyze an agreed-upon number of indigenous plant and animal samples. Merck (it is believed) will pay INBio between one to three percent royalties for any product developed through the agreement. Ten percent of the initial one million dollars and fifty percent of any royalty will be invested in biodiversity conservation through Costa Rica's Ministry of Natural Resources. (Trade and Environment Database, no date).

Clearly such agreements are beneficial in many ways to countries rich in biodiversity but without the capacity to develop these resources. However, there are concerns that such legislative measures may restrict access to plant resources for non-commercial use such as research, conservation, education and display. Considering the key role that botanic gardens play in educating the public about medicinal plant use, access to medicinal plants for education and display purposes as well as for conservation and research activities, is important. Botanic gardens have in recent years been working to develop harmonised approaches to implementing the ABS provisions of the CBD. Two voluntary approaches have been developed, the Principles on Access to Genetic Resources and Benefit-Sharing (the Principles) and the International Plant Exchange Network (IPEN).

- The Principles provide a framework to help guide gardens when developing their own individual policies.
- IPEN establishes a system of facilitated exchange for a network of gardens that have signed up to a Common Code of Conduct. The IPEN system only covers non-commercial use of living collections.

Non-monetary benefits resulting from plant exchange can include knowledge transfer, technical support, staff exchange and capacity building to strengthen conservation work in the country of origin of the plant material.

Further information can be found at www.bgci.org/abs.

Cultivation versus wild harvest

Cultivation has long been suggested as a possible mitigation to the unsustainable wild harvest of medicinal plants, simultaneously taking the pressure off wild stock whilst boosting commerce. Along an agronomic model, modern methods of plant breeding, propagation and post-harvest processing techniques

Panax quinquefolius

Panax quinquefolius (American ginseng) has been heavily traded in North America for over a century;

"We were down in the Tennessee mountains when there came slowly down the mountain trail a dilapidated specimen of humanity, slouch hat, bare foot, coat hung on one shoulder, and a sack, of unknown origin, in his hands. He saw us, heard us as we greeted – but without turning the head slunk on like some phantom creature into the forest labyrinth. 'Humph', said the guide. 'You might a' known. You can't expect nothin' of a ginseng-digger.'"

(Koch, 1910).

It is highly prized as a universal remedy in east Asia, where more than 95% of harvested roots end up. Traded ginseng types include wild, wild-stimulated, cultivated woods-grown and cultivated fields-grown. Field-grown ginseng roots reach a size in three years that can only be attained by 15-30 years of growth under natural forest conditions, and are very pale in colour compared to wild-grown roots.

Wild ginseng root has the greatest perceived medicinal value of all the ginseng types and this is reflected in price – from as much as US$1300/kg for wild roots to as low as US$44/kg for field-cultivated roots (Pierce, 2002). Though there is a move towards grading the roots according to the quantity of active chemical content, buyers primarily grade roots according to physical characteristics; size (the bigger the better), shape (the more 'man-shaped' and thicker the better), age (the older the better) and colour (the darker the better) (Sinclair, 2005).

Illegal wild harvest is known to occur; 10,515 illegally harvested roots were seized between 1991 and 1999 in the Great Smokey Mountain National Park alone (Pierce, 2002). Conservation efforts have therefore included employing marker technology to enable distinction between cultivated and wild root, as well as research into the active compound content. *P .quinquefolius* is widely cultivated commercially, and recorded in eight botanic garden collections (PlantSearch database).

Harvesting Prunus africana.

allow medicinal plant products to be engineered to a consistent and high standard, infinitely more appropriate for standardised pharmaceutical use. The cultivation, management and enrichment planting of high value plants is therefore an important strategy to meet consumer demands and reduce the impacts of markets on biodiversity.

However, cultivation often requires major inputs for a far-off return in a fluctuating market characterised by 'fads'. Though several medicinal plants are cultivated on a large scale (*Arnica montana, Hamamelis virginiana, Panax quinquefolius* and *Catharanthus roseus* to name a few) it is not economically feasible to commercially cultivate all of the medicinal plants that are threatened in the wild. (It should be noted that, despite cultivation, several of these species were also considered as priorities for further conservation attention in the wild, see Annex 5). There is little incentive to bring into cultivation species that are required in relatively small volumes, are slow growing, are believed to be more potent in their wild form or do not command sufficiently high prices.

Moreover, there are social, economic and ecological benefits to wild harvest. As mentioned, since wild collection is mostly carried out in low-wage countries and by low-income, underprivileged groups it's a chance for the poorest of people to get at least some income, despite having no land.

Wild harvest also gives an economic value to ecosystems and habitats and thus provides an incentive for the protection of something much larger than just the medicinal plant. Though the consequences of collecting activity are still very little understood, the involvement of local people in sustainable management practices increases both their desire and ability to protect wild populations from over-exploitation. Of course, the assumption here is that stocks are sufficient, demand will remain constant and the structures and dynamics within local communities will remain stable.

Rauvolfia serpentina

Rauvolfia serpentina (Indian snakeroot, Sarpaghanda) is member of the dogbane family, found in India, Pakistan and south east Asia.

"The primary folk use for the extract was as a means of attaining states of introspection and meditation, and Indian holy men, including Mahatma Ghandi, were habitual users of the drug"

(Mann, 1992).

But the plant is also an important healer, used for stomach disorders, snakebite and epilepsy. *R. serpentina* is also the source of the alkaloid resperine, which revolutionized the treatment of hypertension in the 1950s and is still commonly prescribed today. Chemically similar to serotonin, resperine was also used to treat severe mental illnesses due to its powerful sedative properties.

Once found in most of tropical India, by 1998 it was confined to a range of less that 5,000km^2; with an area of wild population occupancy said to be less than 500km^2 (Mamgain *et al*. 1998). Export was banned by the Indian Ministry of Commerce in 1994, and in Nepal in 2001 (Aryal, no date) and trade is now less than it was in past decades (CITES, 2005). However the rapid decline and isolated nature of snakeroot populations means that wild genetic stock is severely depleted.

On a small scale India has successfully cultivated snakeroot for many decades, for example in hospital gardens, and continues to invest in this area. It is not clear how successful this has been however, given that the species requires at least two years before bearing marketable product. Further experiments have shown that net returns are higher when *Rauvolfia* is inter-cropped than when grown alone, in this way yielding a year round harvest and down-playing the slow early growth of the species (Maheshwari, 1985).

Rauvolfia serpentina is recorded in cultivation in 22 botanic gardens (PlantSearch database). However, little is known about the genetic diversity of such cultivated stock and accessions in genebanks. A genetic study of the plants in botanic garden collections will be encouraged by BGCI with a view to developing a strategy for the restoration of wild populations.

It should be noted that both large-scale cultivation and unsustainable wild harvest lead to genetic erosion. When cultivated, artificial changes (to intensify the concentration of certain compounds) often occur very quickly, unlike in nature. In the short term the desired results are achieved but, in terms of genetic diversity, there may be long term negative consequences. It is a diverse gene pool that contributes to the ability of species or populations to maintain resistance to diseases and to adapt to a changing climate. Environmental conditions at every level are constantly changing, and only diversity can ensure that some individuals will be able to adapt to these changes.

CITES and medicinal plants

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) provides varying degrees of protection to more than 33,000 plant species. Of these, about 240 are medicinal (Schippmann, 2001) even though only approximately 30 have been listed specifically because of concern over their trade as medicine. The intention of CITES is to promote a sustainable trade in listed species.

Hoodia spp.

Hoodia spp. are slow-growing, perennial, spiny succulent plants. They occur in a wide range of arid habitats in southern Africa, typically on arid gravel plains. Detailed information on the distribution and population status of individual taxa is limited but ten of the16 taxa assessed have been classified as threatened according to IUCN Red List categories, with four taxa classified as Vulnerable in 2002.

Traditionally used by the San bushmen of South Africa, strong, global commercial interest in the genus has resulted from the isolation and patenting of an active ingredient (P57) which acts as an appetite suppressant and is claimed to help weight loss; **"Amazing, most effective safe weight loss with no side effects advanced appetite suppressant available!" "HoodiThin™ - Feel full faster and stay full longer!" "*Hoodia* diet pills are guaranteed to work for you or it costs absolutely nothing!"**

The active ingredient has been isolated from *H. gordonii* which only occurs in Namibia and South Africa. This species is considered to be abundant and widespread. However, some of the other taxa in the genus exist in fragmented populations (some with as few as 250 individuals) and cannot easily be distinguished from *H. gordonii*. These species are therefore under threat from over-collection for trade. All *Hoodia* species were listed on CITES Appendix II in 2005, but illegal trade is known to occur.

Species	No. of botanic garden collections
Hoodia bainii	2
Hoodia barklyii	2
Hoodia currori	1
Hoodia dregei	5
Hoodia gibbosa	1
Hoodia gordonii	10
Hoodia juttae	3
Hoodia langii	1
Hoodia macrantha	7
Hoodia parviflora	1
Hoodia pilfera	4
Hoodia pillansii	1
Hoodia ruschii	3

There is significant commercial attention on this genera, given the lucrative nature of its promise. The species should only be grown or collected with a permit and plantations have been in development for several years. Demand however, remains a threat to certain populations. As a suggested species for priority conservation action, *Hoodia* will be included in BGCI's wider medicinal plant conservation programme.

CITES regulates international trade between signatory countries. It is not applicable to domestic or non-signatory traffic. Monitoring of the trade under the terms and conditions of the Convention is complex and only partially successful. It is thought that a huge amount of trade in medicinal plants goes unrecorded and unregulated, for example that within China or between Nepal and India.

Even trade movements covered by CITES are poorly understood, hampered by identification problems, under-resourced enforcement and inconsistent national interpretations of the international statute. Most medicinal plant species are not traded under their scientific name, and come in a variety of parts and derivatives. *Aquilaria malaccensis*, for example, has at least 50 trade names (Lange and Schippmann, 1999); an import of woodchips can be listed as 'bark' with no species name.

Seized cycads, said to have various medicinal qualities and one of the most endangered living things on the planet.

"It is indisputable that monitoring the trade in wild collected plants is only useful if carried out at species level and that without such, analysis of the trade and its impact on populations cannot be carried out effectively"

(Schippman, 1994).

However, CITES is an important mechanism for trade regulation and to highlight critical issues. Botanic gardens can be involved in the success of CITES in a number of ways.

For more information on CITES and botanic gardens go to www.bgci.org/cites or see *A CITES manual for botanic gardens* (Oldfield and McGough, 2007).

The IUCN Red List of Threatened Species

Policy frameworks and legislation are informed by essential data such as the endangerment assessments made by the Species Survival Commission (SSC) of the IUCN, which produces a Red List of Threatened Species. Using a network of thousands of scientists the Red List provides taxonomic, conservation status and distribution information on globally evaluated species according to specific categories and criteria (Annex 6). It is essentially a framework for classifying species according to their extinction risk. So far, almost 40,000 species have been assessed, of which some 12,000 are plants. It is difficult to specify what proportion of threatened medicinal plant species have been evaluated using the IUCN Red List categories and criteria but it is generally recognised to be a low proportion.

For more information on the IUCN SSC and the IUCN SSC Medicinal Plants Specialist Group (MPSG) go to www.iucn.org/themes/ssc/ and www.iucn.org/themes/ssc/sgs/mpsg/.

6. Medicinal plants and botanic gardens

Some 5,000 years ago, a botanic garden said to have astounded the Spanish conquistadores existed in the city of Texcoco, the second most important city in the once majestic Aztec empire. Approximately 370 species of plants still grow there in a confined geographical area, though the city and the civilisation have long since disappeared. Research conducted at the sight has resulted in the identification of all the plants that would have been cultivated in the garden, all of which have either medicinal properties or other economic uses (Montúfar, 2007).

The Botanical Garden of Padua, founded in 1545 and one of the oldest botanic gardens in the world, was created by the Vatican Republic purposely for the cultivation of medicinal herbs. The institution enabled students to use the garden to learn how to distinguish between and use medicinal plants, improving both local healthcare and scientific understanding. Similarly, the Chelsea Physic Garden was founded in England in 1673 by the Worshipful Society of Apothecaries to train apprentices to identify plants and to help in the cultivation of exotic plants for medicine. These gardens thus met a research, economic and health goal.

These days, there are over 2,500 botanic gardens in 150 countries around the world, holding over six million accessions of living plants representing around 80,000 species. They are therefore major repositories of species diversity and collectively represent many, many years of learning.

As institutions, their work remit occupies several spheres; from scientific research to education to informing legislation to running community-based projects – and it's a remit that's widening in both scope and importance alongside global population increase, rapid urbanisation and relentless pressure on our collective wild resources. Increasingly, botanic gardens are more than just 'pretty places'.

Whilst conservation has not been a traditional garden activity, it is becoming more so, as demonstrated by the International Agenda for Botanic Gardens in Conservation (Wyse Jackson and Sutherland, 2000) launched in 2000 to provide a common global framework for garden policies and signed by 432 botanic gardens so far, as well as the involvement of botanic gardens in the development of the GSPC.

Botanic gardens have a long-standing connection to medicinal plants in particular, since the sole purpose of all early botanic gardens was to grow and study medicinal plants. They are inherently well-placed to respond to the very specific local conservation needs of medicinal plants and the people who rely on them for health and livelihood in a particular region. Moreover, they are probably the most important agencies for the conservation of native medicinal plants, since plants are not often the priority of other conservation bodies and government agencies related to agriculture pay little attention to those species of undetermined economic use.

Using botanical and cultivation knowledge there are a number of key ways in which botanic gardens can contribute towards medicinal plant conservation and sustainable use.

Questionnaire responses illustrated the wide range of areas in which botanic gardens are involved with medicinal plant conservation, the positive effects of this work and the linkages between botanic gardens and other conservation agencies.

Ex situ conservation

Ex situ conservation remains the main remit and area of expertise of botanic gardens. It provides an important 'insurance' against the loss of plant genetic resources, with a key role to play in terms of preservation and species re-introduction programmes, education and research.

This role has been defined by the GSPC, specifically Target 8, which calls for 60% of threatened plant species in accessible *ex situ* collections, preferably in the country of origin, and 10% of them included in recovery and restoration programmes.

Living collections

The conservation of plant resources can be achieved through different methods such as seed banks, *in vitro* storage methods, pollen banks and DNA banks as well as the maintenance of living collections. This is particularly important with threatened medicinal plants where protection in the wild may not be realistic in the short-term, or where *ex situ* work cannot yet be directly linked to *in situ*. The resources provided by these collections are important for *in situ* recovery programmes.

Target 9 of the GSPC calls for 70% of the genetic diversity of the major socio-economically important plants conserved.

Wuhan Botanic Garden, China has developed a medicinal plant garden with over 800 species for education, research and preservation (Z. Jiang, pers.comm.).

A medicinal plant seed bank and herbarium has been developed at Al-Quds University Botanic Garden in Palestine, to preserve wild native medicinal plants (K. Sawalha, pers.comm.).

In China, the Shangri-La Alpine Botanical Garden in Yunnan province is designing a Tibetan Medicinal Plants Garden, collecting those species most commonly used (Liu, pers.comm.).

Chicago Botanic Garden maintains both an outdoor collection and a seed bank of local medicinal plant species, for detailed evaluation of active plant compounds. The identification of useful medicinal compounds should not only promote public health but also underscore the importance of protecting native flora.

Jardin Botanico de Bahia Blanca in Argentina maintains a display of medicinal plant species used on a local scale (Villamil, pers.comm.).

Plant records

An essential, defining feature of a botanic garden is the maintenance of plant records on the living collection. Each record typically records the scientific name of the plant and its origin (whether of known wild origin or cultivated source). Many botanic gardens hold collections of medicinal plants – see for example the BGCI Directory of Medicinal Plant Collections in Botanic Gardens (Wyse Jackson and Dennis, 1998) but the value of these has never been fully assessed.

BGCI maintains the PlantSearch database which records data on plants in botanic garden collections. As of August 2007 the PlantSearch database held details on over 2,540 botanic gardens, 681 of which have uploaded their species data, totalling 505,000 records of approximately 140,000 different taxa. The database is available for public use, although garden addresses are only accessible after requesting further information from the garden itself, due to the valuable nature of some of the plants held.

As part of the 'Safety Nets for Medicinal Plants' project, BGCI has updated PlantSearch to include information on some 3,000 medicinal plants species as well as all plants listed on CITES. We have obtained over 40 lists of key species including almost 1,000 species threatened in the wild due to unsustainable harvesting and habitat destruction (see Annex 2). Work is currently underway on a detailed gap analysis of key medicinal plant species in botanic garden collections and the conservation work being done with them, if any.

Since botanic gardens hold the largest assemblage of plants outside of nature, it makes sense to work towards a global inventory of medicinal plants held in botanic gardens. BGCI is working towards this aim.

Research

Botanic gardens provide a permanent location around which an infrastructure can develop. Around the world, they have become centres for the research and study of disciplines as diverse as taxonomy, ecology, agronomy, horticulture, ethnobotany and habitat restoration, all of which inform medicinal plant conservation.

Xishuangbanna Tropical Botanic Garden in China has begun a research programme into the propagation and re-introduction of local Dendrobium *species, used extensively in TCM. This will include field work to assess the status of populations in the wild and research into cultivation techniques (Y.Shouhua, pers.comm.).*

*Leiden Botanic Garden in the Netherlands has begun researching ways of distinguishing between legally produced and illegally wild harvested agarwood (*Aquilaria *and* Gyrinops *spp.) using DNA markers in plantation crops (van Uffelen, pers.comm.). This research work aims to assist the control of illegal wild harvest and trade in threatened medicinal plants.*

In 2006, the Pfizer Plant Laboratory was opened in New York Botanic Garden, systematically screening plants in the search for active medicinal compounds, and studying the efficacy of these compounds. This is not as simple as it sounds. Normally, all medicinal plants have one or two primary compounds and a number of secondary compounds. The efficacy of the plants in medicinal use depends on the interaction of all roughage, secondary and mucous compounds with the primary active compounds. If primary compounds are isolated, they may have completely different effects than in combination with the cocktail of secondary compounds of the respective plant (WWF/TRAFFIC Germany, 2002). Efficacy also depends, to a certain extent, on abiotic factors of the environments and on collection methods. It differs from location to location (soil quality, mineral content, moisture content, temperature, intensity of light) and depends on the weather conditions at the time of collection.

The Jodrell Laboratory at RBG, Kew in the UK is dedicated to ethnobotany and runs numerous research projects into the chemistry, bioactivity and taxonomy of medicinal plants (Olwen, pers.comm.). This scientific research can be used to inform legislation and policy development.

Turpan Desert Botanic Garden has constructed an Ethnic Medicinal Plant Garden, researching the use of medicinal herbs used by the Uygur people of Xinjiang (Tan, pers.comm.).

At Reading University in the UK the Faculty of Pharmacy is developing a University Botanic Garden for use as a medicinal plant resource (V. Heywood, pers.comm.). Work is also underway in affiliation with the Foundation for the Revitalisation of Local Health Traditions (FRLHT) in India on developing DNA markers for medicinal plants. (J. Hawkins, pers.comm.).

Education

Rightly hailed as a way of inspiring and motivating action and public support, education about medicinal plants takes many forms; from educating end consumers about the sources of their medicines to educating farmers and herb gatherers about the value of sustainable harvest. Botanic gardens have a key role to play in educating the public about the value and conservation needs of medicinal plants.

Target 14 of the GSPC calls for education and awareness about plant diversity to be promoted.

Marie Selby Botanic Garden in Florida is creating information profiles for the medicinal plants in the garden, to include the conservation status of the species in the wild, geographical information, botanical characteristics and ecology, uses to humans and parts of plants used, chemical compounds, history and folklore, re-affirming the links between plants and people (Tieghem, pers.comm.).

Seven of the eight botanic gardens in the South African National Biodiversity Institute's (SANBI) network of botanic gardens have demonstration gardens that are used for education, display and research on indigenous traditional use (Xaba, pers.comm.).

Several botanic gardens in the US for example, Denver, Brooklyn, North Carolina and New York as well as the Royal Botanical Gardens in Canada offer training courses in horticultural therapy. It has been well established that people respond positively to green plants and colorful flowers. Gardening offers relief from physical and cognitive limitations, reduces stress, gently exercises aging or arthritic joints, and stimulates memory.

Krishna Mahavidyalaya Botanic Garden in India grows approximately 130 species of medicinal plants in pots, emphasizing those used in indigenous systems of medicine. The plants are accompanied by display notes including the common name in various languages as well as its use as medicine and scientific data. Since the plants are in pots, a mobile exhibit has traveled extensively, creating awareness and educating people about their shared medicinal plant resource (Salunkhe, pers.comm.).

The IB-UNAM Botanic Garden, Mexico runs courses whereby ethnobotanists share their technical and botanical expertise while traditional healers share their knowledge on the indigenous and ritual use of plants. The information is disseminated by the botanic garden to other healers, housewives, professionals and alternative health practitioners.

In the UK, the Botanic Garden of Wales has a 'Physicians of the Myddfai' exhibition and displays traditionally important medicinal plants whilst Bristol Zoological Gardens provides the locale for a series of courses and lectures on medicinal plants.

Networking

No single sector, public or private, can undertake the conservation of medicinal plants alone and the neutral nature of botanic gardens puts them in a good position to act as intermediaries between various commercial and scientific interests.

The importance of enhanced communication and knowledge exchange between concerned parties has also been recognised by the GSPC, which states that networking can avoid duplication of conservation effort, enable the development of common approaches, help strengthen links between different sectors and ensure the co-ordination of policy development at all levels.

Target 16 of the GSPC calls for the establishment and strengthening of plant conservation networks.

Working with local authorities, Oaxaca Botanic Garden in Mexico has recommended Guiacum coulteri *be planted in local parks and public gardens, as well as making seeds available to local schools and community organizations (A.de Avila, pers.comm.).*

The Tasmania Herbarium in Australia used its living collections to support screening by a large pharmaceutical company searching for active medicinal compounds, in accordance with access and benefit sharing regulations (Papworth, pers.comm.).

The Jardin Botânico da Fundaçâo Zoobotânica de Belo Horizonte in Brazil partners with universities to study the chemical composition and biological activites of local medicinal plants (Nogueira, pers.comm.).

The Botanic Gardens of Adelaide in Australia, as well as developing education programs for schools based around indigenous knowledge and the traditional uses of plants, work closely with hospitals on harmful plants and toxicology (Christensen, pers.comm.).

Botanic garden display including various aloes, which are commonly used for skin conditions.

In situ conservation

As recognised by the CBD, *in situ* conservation is the preferable methodology, since *ex situ* conservation tends to take place outside the range state of the target species. The preservation of species *in situ* offers all the advantages of allowing natural selection to act, which cannot be recreated *ex situ*. Unless plants can be conserved in their natural habitats, in variable breeding populations, they run the risk of extinction.

In reality, many species exist only as part of ecosystems and cannot survive unless their ecosystems are preserved along with as much as possible of the biodiversity they contain. *Cistanche deserticola*, for example, an important plant in TCM, is dependent on two fungi; *Mycena osmundicola* (to draw nutrients from the soil and allow seed germination) and *Armillaria mellea* (which must be incorporated into the tuber to maintain growth to maturity). Similarly, *Cistanche deserticola* is parasitic to the roots of the desert shrub *Haloxylon* spp. The *Haloxylon* genus is notoriously difficult to cultivate, and is also know as 'coal of the desert' because of its firewood properties. The conservation of these species cannot be removed from the habitats they exist within.

Traditionally, *in situ* conservation has involved the protection of species within their natural habitats in various forms of land set aside as nature reserves or other protected areas. This approach cordons off certain areas and restricts their use. Though often hampered by weak enforcement capacity, protected areas are of critical importance since we have yet to master the sustainable use of medicinal plant resources in the wild.

Botanic gardens are involved in the management of natural habitats in this way, as well as carrying out field-work, such as wild population surveys.
A priority for medicinal plant conservation is the carrying out of ecogeographical surveys, followed by proper targeted *in situ* species conservation with as many samples of genetic (therefore chemical) variation as possible preserved (Heywood, pers.comm.).

NGO representatives but most importantly the rural populations of people living near wild medicinal plant populations. Preferable methodologies will improve the understanding of impacts on the livelihoods of the poor of both harvesting medicinal plants and of measures to ensure the conservation and sustainable use of medicinal plants.

Community-based conservation work

Botanic gardens are increasingly involved in the development, implementation and support of local, community-based projects, for example using collections to support local initiatives in primary healthcare.

Medicinal plant conservation is about plant resources, hence emphasising the idea of conservation not for conservation's sake but for the conservation of resources for use (Hamilton, pers.comm.). Community-based conservation emphasises the things about these plants that give people drive to do something about them i.e. concerns about health, money (income generation) and cultures (important religious elements, heritage protection). Recent forestry research has shown that, when their rights are recognised, communities are more effective at protecting forests than national parks (Rights and Resources Initiative, 2007).

However, response strategies designed to provide incentives for biodiversity conservation by ensuring that local people benefit from one or more component of biodiversity (such as products from a single species) have proved very difficult to implement (MEA, 2005).

Lophophora williamsii, *used ritually in Mexico for thousands of years.*

Community-based conservation must therefore be integrated with development at every level; from village to region to world. A wide range of stakeholders must be engaged from the start; from scientists to traders to government and

The Etnobotanica Paraguay project, run by the Conservatoire et Jardin Botaniques de la Ville de Geneve, is researching the use of local medicinal plants and running targeted education campaigns to encourage the use and protection of appropriate species, as well as setting up community gardens and looking at the best application of the plants.

Malabar Botanic Garden in India is promoting the cultivation of the state's native medicinal plants, by giving training in relevant techniques to local farmers. Guidance is given on the medicinal plants' cultivation, storage and trade. In the last two years over 200 farmers have been trained, and a farmer's society has been formed to share knowledge and to promote the mass cultivation and trade of medicinal plants. This has provided a valuable opportunity for these farmers to expand and diversify their crops, safeguarding their incomes.

At Nature Palace Botanic Garden in Uganda the Poverty Alleviation and Health Promotion through Conservation project engaged 50 subsistence farmers who are now cultivating rare medicinal plants for income generation. The farmers have formed an Association (the Kasanje Conservation and Development Association), which is now engaged in a drive to recruit more farmers (D. Nkwanga, pers.comm.).

North Carolina Botanic Garden and the North Carolina Department of Agriculture collaborated on a project to mark Dionea muscipula *plants growing in the wild. Roots are painted with a dye that glows under ultra-violet light, enabling the identification of wild harvested specimens. This is proving a deterrent to would-be poachers, who plucked thousands of Venus fly-traps from the protected Green Swamp area in a single afternoon in 2005 (Nature Conservancy, 2006).*

Aburi Botanical Garden in Ghana in partnership with BGCI, the UNEP World Conservation Monitoring Centre, the Royal Botanic Garden Edinburgh and the University of Ghana ran the Conservation and Sustainable Use of Medicinal plants in Ghana project. This project aimed to improve communities' access to medicinal plants, and to encourage their sustainable use. It set up a 50 acre model Medicinal Plant Garden, based on community ethno-botanical surveys, which was planted with 1,361 medicinal plant seedlings, and also set up a plant nursery to hold 5,000 medicinal plant seedlings for distribution to herbalists.

The National Botanic Garden of Belguim works closely with Kisantu Botanic Garden in the Congo both on community education and the propagation of medicinal plants for distribution (Rammello, pers.comm).

7. Recommendations for medicinal plant conservation by botanic gardens

The questionnaire survey has provided a wealth of information on the ways botanic gardens can support medicinal plant conservation. These echo the points made in the previous section, in which case studies from questionnaire responses have already been highlighted. A strong majority of respondents emphasised the role that botanic gardens play in conservation education, and the continued importance of raising awareness about medicinal plant resources. Also particularly highlighted was the role of research and the need for botanic gardens to develop collaborative ventures, working with partner NGOs and local communities.

Rescuing Aloe castanea *from granite mining.*

Encephalartos ghellinctii*, vulnerable in the wild, slow-growing and rare in cultivation.*

Prioritise species

Taking into account the sheer number of medicinal plant species around the world (c.70,000) and the number which may be threatened (c.15,000) comprehensive and consistent information on the threat status of medicinal plants at a global level is not yet available. This limits the extent to which a rational prioritisation can be undertaken for medicinal plant conservation.

Logically, the information required for such a prioritisation exercise is: i) which species are most threatened; ii) which species are most valuable in terms of healthcare and of livelihoods and iii) our ability to conserve the species in question.

Botanic gardens are well placed to define local priorities. Globally, BGCI can assist by assessing the extent to which plants are already in cultivation by botanic gardens, what their threat status is and (through collaboration with other organisations) what the priorities for practical action are.

Annex 5 lists all the species that were suggested to us as priority species for conservation action over the next 5 years, as well as their IUCN and CITES status. In most cases the information provided reflects species of national concern as provided by the respondents.

We have also indicated whether these species are held in botanic garden collections. Several species were mentioned more than once, and these 35 priority species are presented first. BGCI will pay particular attention to work with its member gardens to conserve these species (See Section 8 and Annex 7).

Prioritise actions

1. Research

It is widely recognised that medicinal plant conservation is hampered by a lack of good quality information. It is therefore essential to collect accurate data regarding plant population density in the wild in the past and present, the current commercial demand and future projections, methods of collection and threats to these plants. Botanic gardens are well placed to undertake research to determine the taxonomy, propagation and management techniques for medicinal plants.

Specifically, the following research areas were highlighted in questionnaire responses;

- Regionally up-to-date lists of species used for medicinal purposes would enhance the opportunity to use them sustainably.
- Locally used medicinal plants can then be categorised according to their use, value, ecological characteristics and management, by way of prioritising species for conservation action.
- Species-specific baseline data on the status of populations in the wild and on what entails a sustainable harvest limit, both culturally and commercially, is required for priority species (to include harvesting techniques which are suitable for village level use).

2. Educate

It has often been argued that a major reason for our failure to conserve natural ecosystems is that we do not realise how valuable they are. In fact, a country's ecosystems and its ecosystem services represent a capital asset. The benefits that could be attained through better management of this asset are poorly reflected by conventional economic indicators, so this must be clearly demonstrated in different ways. For medicinal plants; why should wild harvest be curtailed when it will always be the easiest option? Why should consumers re-visit their consumption habits and make a decision on which products they will use and which they won't? An educated public can influence both the pattern of trade and, optimistically, governmental decisions.

Practical suggestions for educational initiatives included the following;

- Botanic gardens should be aware of the medicinal properties of plants within their collections. Interpretation panels can illustrate both the values and vulnerability of medicinal plants and promote an understanding of medicinal plant conservation, effecting an attitudinal change about the use of natural resources and medicinal plants. Botanic gardens can pro-actively improve people's access to this information.
- Model gardens can be created to be demonstration areas for people living near to threatened species for conservation knowledge. Stakeholders can be taught appropriate *ex situ* management techniques such as domestication, management and value adding. Booklets can be prepared and circulated on the latest cultivation methods and post-harvesting processes for key species.
- Targeted education campaigns can also be linked to outreach programmes, for example to health care workers dealing with first line medicinal aid, or with school botanic projects. Mobile exhibits have been shown to be particularly useful.

3. Collaborate

Much mentioned in questionnaire responses was the need for a collaborative approach to medicinal plant conservation and the recognition that botanic gardens are well placed to facilitate this and add both key botanical knowledge and key knowledge about local people, industries and landscapes.

Key messages for botanic gardens were to:

- Joint plan rather than work in isolation, check who else is doing what before deciding priorities.
- Diversify working partners, for example work with forestry, agriculture and health industries, as well as NGOs.
- Develop regional approaches to the management of species occurring in neighbouring countries.
- Develop joint outreach and extension programmes and contribute to these by bringing botanical expertise on specific taxa.
- Inform legislation and policy development and assist with national implementation and interpretation of international statutes. For example, training Customs officials on the identification of CITES listed medicinal plant parts and derivatives.
- Encourage private sector support for sustainable and ethical sourcing.

4. Conserve

The role of plant and seed collections as a conservation resource was widely acknowledged as an important piece of the conservation jigsaw puzzle. It was emphasised that *ex situ* methods are made more relevant when they feed directly and specifically into targeted *in situ* conservation, and that this should become a normal partnership. Seed banking was frequently cited in questionnaire responses as a vital back-up to other conservation methodologies, and one that should be supported and expanded for medicinal plants specifically, since most efforts have been directed to crops thus far. Further, climate change science is turning its attention to the predicted effects of temperature rise on individual plant species. The alteration of a species' environmental niche will in turn affect whole ecosystems; habitats will shift and their composition change. *Ex situ* collections that attempt to recreate habitats become even more relevant in this light.

Botanic gardens should therefore:

- Maintain and develop living collections of local medicinal plants and make them available for teaching and research use.
- Set-up and maintain seed and germplasm banks, specifically for local medicinal plants and those critically endangered. Ensure that the best and most current seed conservation technologies are used, to ensure long-term preservation.
- Foster ecological and floristic studies in sites of origin of plants.
- Maintain familiarity and compliance with regulations, for example CITES, and with the conservation status of medicinal plant holdings via, for example, the IUCN Red List.
- Contribute to the development and testing of conservation methodologies.

5. Preserve indigenous knowledge

In 2004 the United Nations Conference on Trade and Development (UNCTAD) warned that a biodiversity crisis is being accompanied by a cultural diversity crisis and the weakening of the customary laws that traditionally regulated the use of natural resources. The growing awareness of loss of indigenous knowledge and the implications of this was reflected in questionnaire responses.

- Target 13 of the GSPC calls for the decline of plant resources and associated indigenous knowledge that support livelihoods to be halted, since both physical habitat and ancient knowledge, once lost, will be gone forever.
- There are inherent conservation values in the way plants were collected for traditional healing, many of which have now fallen out of use. In Zimbabwe, for example, the collecting of bark, roots, branches etc. from a plant that showed signs of having been collected from by another n'anga (traditional healer) was prohibited. It was believed that when a n'anga used a plant to treat a patient, the patient's disease was transferred into that plant. When another n'anga subsequently used the same plant to treat a patient, the disease of the previous patient would be transferred to the new patient. This belief ensured that the plant recovered from the effects of collection (Mavi and Shava, 1997).
- There have been clashes between traditional healers and external organisations, based around the ownership of indigenous knowledge. Botanic gardens are likely to have detailed specific knowledge about the landscapes, people and flora of an area and are well-placed to build community links and to help with the documentation of traditional knowledge on medicinal plants that is available in the public domain.
- There are simple ways botanic gardens can collect and promote indigenous knowledge. For more information on the collection of indigenous knowledge go to www.kew.org/ethnomedica/.

6. Develop alternatives to wild harvest, technology transfer

Another key questionnaire response, emphasised again and again, was the role of community involvement in conservation. This is imperative at all stages of project development and implementation. At a local level botanic gardens can provide communities with valuable horticultural expertise and market information. The transfer of cultivation methodologies to farmers and other stakeholders via training initiatives should be encouraged, as should the development of harvester organisations and best practice horticultural knowledge shared between these. Additionally, investments in technology transfer, research, training and capacity building, can make the private sector voluntarily respond to environmental management.

- A recent study of 150 traditional healers in South Africa found that 72% said they would appreciate proper training on how to domesticate frequently used medicinal plants (Manzini, 2005).
- During storage considerable amounts of medicinal plants are wasted due to humidity, insect attacks, inappropriate storage facilities and lack of awareness on the part of collectors. (Hamuyan *et al*., 2006).

Prunus africana

Prunus africana (Pygeum, African cherry) is found in mountain tropical forests in central and southern Africa and Madagascar and has been used for centuries for its hard and durable timber as well as for the medicinal properties of its bark, which is used to treat malaria, fevers, kidney disease, urinary tract infections and more recently prostate enlargement (benign prostatic hyperplasia). Overall, the medicinal retail trade for *P .africana* is estimated to be US$220 million/year (WWF, 2001).

As long as the tree is not completely girdled it can bear repeated harvests. These limits should be relatively easy to determine. After all, the tree has been used sustainably for hundreds of years. Indigenous knowledge maintained that, post-harvest, bark grows back more quickly on the side of the tree that faces the sunrise. Since the tree heals faster this side, medicine made from this east-facing bark will heal a patient faster. Thus only one side was stripped.

When harvested sustainably, each batch of bark amounts to about 55kg which currently returns US$10 - 20 to the collector. When completely stripped, a large tree may yield up to a metric ton of bark worth US$200 (Future Harvest, 2000). Harvest limits and protective folklore have therefore given way to market demand. *Prunus africana* was listed on CITES Appendix II in 1995, is assessed as Vulnerable on the IUCN Red List of Threatened Species and mentioned most frequently in questionnaire responses, despite being abundant in parts of its range, for example in South Africa (van Jaarsfeld, pers.comm.).

Cordoba Botanic Garden has produced guidelines for a Pygeum management plan in Equitorial Guinea and Limbe Botanic Garden is involed in teaching techniques for the sustainable harvesting of *Prunus* bark as well as providing seedlings for local nursery initiatives.

Prunus africana is recorded in cultivation in only 3 botanic gardens (PlantSearch database). However, it is likely that this species is in fact being cultivated much more widely. As part of our east African medicinal plants programme, BGCI will gather further information on the distribution in cultivation of this species and share this information with relevant partners.

- Micro enterprises that add value through simple on-site techniques like drying, cleaning, grading and packaging can strengthen the position in the market of collectors and farmers.
- Local, small-scale cultivation provides an alternative to wild harvest, though there is a distinction between cultivation for self-medication and cultivation for income generation.
- Medicinal plants in particular have very specific requirements concerning soil and environment that affect the active compounds in the plants. They are often more difficult to cultivate than other crop species, therefore interventions are needed to reduce cultivation risks and increase the dependability of inter-cropping as a way to supplement the opportunity cost of wild harvest.
- Small home gardens where plants can be cultivated for self-healing have been shown to be successful and deliver multiple benefits.

7. Sustainable wild harvest

Wild collection is sustainable as long as the amount of medicinal plant material of a given species collected each year in a certain region does not exceed the annual, natural increase of the species in the same location. If collection exceeds the natural increase over several consecutive growing seasons the species may become regionally threatened (WWF/TRAFFIC Germany, 2002).

The International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants (ISSC-MAP) has been developed by the IUCN/SSC MPSG. It has six principles and 18 criteria, addressing ecological, social and economic requirements for sustainable wild collection of medicinal plants.

Compliance will maintain wild medicinal plant resources, prevent negative environmental impacts, ensure compliance with laws, regulations and agreements, respect customary laws and apply responsible management and business.

Botanic gardens can play a valuable role in promoting the ISSC-MAP.

Our survey showed the growing recognition of the importance of sustainable wild harvest as a conservation response.

- Data on the natural ecological distribution of a species compared with good data on volume harvested is needed in order to develop sustainable use regulations and management measures, such as an annual harvest quota.
- Along the market chain, mechanisms must be in place to ensure a better price for those who have observed sustainable harvest limits and good collection practice, such as certification along the lines of the FSC (Forest Stewardship Council) and MSC (Marine Stewardship Council) Standards.

For more information on the ISSC-MAP go to www.floraweb.de/map-pro/.

Whatever the conservation action, projects must be appropriate to the organisation and set realistic, achievable targets not removed from reality considering the area you are working in.

Expect slow progress; an inherent problem in conservation is that it is given low priority compared to the day to day activities of people going about their lives.

However, considering the scale and urgency of the problem there is little room for reticence.

"You must be the change you want to see in the world"
(Mahatma Ghandi).

8. Towards an action plan for medicinal plant conservation by BGCI

The role of BGCI is to support and enable botanic gardens to act on the recommendations made for medicinal plant conservation in the previous section of this report. The questionnaire survey and consultation during this project resulted in a very wide range of suggestions of activities BGCI could undertake. These suggestions, together with discussions between BGCI staff, member gardens and other medicinal plant conservation agencies have led to the development of an action plan for BGCI's medicinal plant conservation work, as well as the identification of key partners for future activities, such as TRAFFIC, the IUCN/SSC MPSG and Plantlife International, as well as various national and local organisations and stakeholders.

Activities at the global level

1. Information gathering and awareness raising for over 400 suggested priority species (at Annex 5)

- Collect detailed information on the *ex situ* conservation status of these species and work towards ensuring that all are secure in *ex situ* collections (at least 5 botanic gardens), with well-documented, diverse genetic representation.
- Link this data to the PlantSearch database and make available via an information portal. Continue to develop PlantSearch as a means of monitoring and recording medicinal plants in botanic garden collections, as well as identifying regions where this is a priority.
- Coordinate the collection of case studies, analysis of best practice and sharing of lessons, helping to improve both collection management and conservation practice.

Use the information available for educational purposes (see below).

2. Provide education and training materials on medicinal plants and their conservation

- Identify and publish case studies about success in medicinal plant conservation.
- Provide information and educational materials about relevant policy and scientific issues, for example the ISSC-MAP and CITES and ABS requirements.
- Develop models and outreach materials for 35 priority species relevant to all levels of botanic garden visitors, staff and volunteers, as well as for donors and decision makers.

Develop education materials that inform key stakeholders about the need for botanic gardens and their role in medicinal plant conservation.

3. Promote the role of botanic gardens in CITES

Questionnaire responses to CITES issues favoured the promotion of appropriate cultivation of CITES listed species and local community participation in this, incentivising compliance and conservation without threatening livelihoods. It was felt the focus of capacity building should be on

developing countries, rich in biodiversity but poor in resources, for whom implementation of CITES is harder. There was also a strong case for developing better identification and authentification tools to enable better trade practice and enforcement. Education and training across all stakeholder levels was thought necessary. BGCI will:

- Publish and distribute an updated CITES Manual for botanic gardens, making this available in English, Spanish and Chinese.
- Distribute CITES information to all stakeholders. The PlantSearch database now includes information on all CITES listed plants, so that botanic gardens can be aware of the CITES status of plants in their collections. Go to www.bgci.org/plant_search.php/.
- Help botanic gardens to develop identification and authentification tools for plant materials so that CITES can be implemented effectively for those species that are listed.
- Help botanic gardens to help local communities to build their capacity to comply with CITES.
- Collect and compile information so that local species that do fulfill listing criteria can be included in CITES and to aid with the proper development of non-detriment findings.

Activities at the regional/national level

BGCI's action plan for medicinal plant conservation at regional and national levels draws on its ongoing work and global partnerships to secure plant diversity.

In its initial phase (based on BGCI's *Five Year Plan 2007-2012*) the action plan includes the development and implementation of a series of new projects and programmes for selected priority medicinal plant species in the regions and countries where they naturally occur, as identified in this report.

The action plan at regional and national levels (which also feeds information into our global activities) pursues an integrated, four-step approach of both *ex situ* and *in situ* conservation action:

1. Conservation status assessments

- Training and capacity building for red listing on medicinal plants through regional and national workshops and working with IUCN/SSC MPSG.

2. National *ex situ* collection surveys and gap analysis

- Development of species-specific action plans for botanic gardens, with focus on endemic medicinal species under severe threat.

3. Enhancing *ex situ* cultivation matching local needs

- Compiling and promoting local traditional knowledge in medicinal plant management for enhancing sustainable use.
- Establishing community-based medicinal plant nurseries suitable for alternative income generation, including the development of propagation and harvesting techniques which combine traditional and scientific knowledge.

4. *In-situ* conservation and reintroductions into the wild

- Enhancing *in situ* conservation through the establishment and protection of important medicinal plant areas managed by local communities, as well as reintroductions into the wild of medicinal plant species that are extinct in the wild, or critically endangered.

At Annex 7 is our tabular, project and species specific regional action plan for medicinal plant conservation.

9. Conclusions

This work has aimed to gather information from a wide stakeholder base to identify the issues to be addressed, viewing the problem from different angles and priority perspectives.
Typically of conservation debate, complex sustainability issues are at play, in this case surrounding a widely misunderstood resource whose population and trade is notoriously hard to measure.

The wide range of habitats and plant types, as well as the variety of cultural, social and economic conditions which affect the use of medicinal plants present substantial challenges to their conservation.

Indeed, medicinal plants conservation can be viewed as a microcosm for plant conservation as a whole;

"It speaks of supply, it speaks of demand, and it speaks of competition and control. Humankind's use of species and ecosystems is critically determined by these variables"

(Murphree, 2003).

Against this backdrop, and in the face of multiple threats from trade, habitat loss and climate change, botanic gardens have an important role to play in securing medicinal plant diversity for people and planet.

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Acronyms

ABS	Access and benefit sharing
BG	botanic garden
BGCI	Botanic Gardens Conservation International
CBD	Convention on Biological Diversity
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
FAO	Food and Agriculture Organisation
FRLHT	Foundation for the Revitalisation of Local Health Traditions, India
FSC	Forest Stewardship Council
GSPC	Global Strategy for Plant Conservation
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
ISSC-MAP	International Standard for the Sustainable Wild Collection of Medicinal and Aromatic Plants
IUCN	World Conservation Union
IUCN/SSC MPSG	IUCN Medicinal Plants Specialist Group
IPEN	International Plant Exchange Network
MDG	Millennium Development Goals
MEA	Millennium Ecosystem Assessment
MSC	Marine Stewardship Council
NCARTT	National Center for Agricultural Research and Transfer of Technology, Jordan
NGO	Non-government Organisation
PIINTEC	Pyongyang International Information Center for New Technology and Economy, Korea
PROTA	Plant Resources of Tropical Africa
RGB	Royal Botanic Garden
SANBI	South Africa National Biodiversity Institute
SSC	Species Survival Commission
spp.	species
ssp.	subspecies
TAM	Traditional African Medicine
TCM	Traditional Chinese Medicine
TRAFFIC	Wildlife monitoring network, joint programme of WWF and the IUCN
TRIPS	Trade Related Aspects of International Property Rights
UK	United Kingdom
UNCTAD	United Nations Conference on Trade and Development
UNEP	United Nations Environment Programme
US	United States of America
WHO	World Health Organisation
WTO	World Trade Organisation
WWF	World Wildlife Fund

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Central Council for Research in Ayurveda and Siddha, India
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Chinese Academy of Sciences, China
CITES, Switzerland
Delft University Botanic Garden, Netherlands
Dunedin Botanic Garden, New Zealand
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Nature Palace Botanic Garden, Uganda
NCARTT, Jordan
Nordic Gene Bank, Sweden
Pakistan Museum of Natural History, Pakistan
Philodassiki Botanic Garden, Greece
PIINTEC, Korea
Plantlife International, UK
PROTA, Kenya and the Netherlands
Quarshi Research International, Pakistan
Reading University, UK
Regenerations International Botanical Garden, US
Royal British Columbia Museum, Canada
SANBI, South Africa
Shangri-la Alpine Botanic Garden, China
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Annexes

Annex 1 – The Global Strategy for Plant Conservation: 2010 Targets

A) Understanding and Documenting Plant Diversity

Targets in this theme are:

(i) A widely accessible working list of known plant species, as a step towards a complete world flora;

(ii) A preliminary assessment of the conservation status of all known plant species, at national, regional and international levels;

(iii) Development of models with protocols for plant conservation and sustainable use, based on research and practical experience.

B) Conserving Plant Diversity

Targets in this theme are:

(iv) At least 10 per cent of each of the world's ecological regions effectively conserved;

(v) Protection of 50 per cent of the most important areas for plant diversity assured;

(vi) At least 30 per cent of production lands managed consistent with the conservation of plant diversity;

(vii) 60 per cent of the world's threatened species conserved in situ;

(viii) 60 per cent of threatened plant species in accessible *ex situ* collections, preferably in the country of origin, and 10 per cent of them included in recovery and restoration programmes;

(ix) 70 per cent of the genetic diversity of crops and other major socioeconomically valuable plant species conserved, and associated indigenous and local knowledge maintained;

(x) Management plans in place for at least 100 major alien species that threaten plants, plant communities and associated habitats and ecosystems.

(C) Using Plant Diversity Sustainably

Targets in this theme are:

(xi) No species of wild flora endangered by international trade;

(xii) 30 per cent of plant-based products derived from sources that are sustainably managed.

(D) Promoting Education and Awareness About Plant Diversity

The target for this theme is:

(xiv) The importance of plant diversity and the need for its conservation incorporated into communication, educational and public –awareness programmes.

(E) Building Capacity for the Conservation of Plant Diversity

Targets in this theme are:

(xv) The number of trained people working with appropriate facilities in plant conservation increased, according to national needs, to achieve the targets of this Strategy;

(xvi) Networks for plant conservation activities established or strengthened at national, regional and international levels.

Annex 2 – Source data for list of medicinal plants included in BGCI's PlantSearch database

(number of species shown in brackets)

Africa:

- Useful medicinal plants of Africa (494)
  Source: http://database.prota.org/search.htm
- Threatened South African medicinal plants (146)
  Source: Wendy Foden, SANBI
- Medicinal plants that are of common use in Africa and Madagascar (83)
  Source: Safowora, 1996.
  (www.conserveafrica.org.uk/herbal_industry.pdf)
- Medicinal plants used by majority of the population and frequently cited by most traditional healers in Tanzania (10)
  Source: www.conserveafrica.org.uk/herbal_industry.pdf
- Commonly used African medicinal plants for which a standard would be useful (53)
  Source: http://www.aamps.org/aamps%20specieslist.pdf
- Medicinal plants used in Uganda (7)
  Source: http://www.plantlife.org.uk/international/plantlife-med-plants-projects-allachy-uganda.htm
- Investigations on West African medicinal plants (8)
  Source: http://www.iupac.org/publications/pac/1986/pdf/5805x0653.pdf
- Threatened Kenyan medicinal plants (96)
  Source: Stella Simiyu
- East and Southern Africa: TRAFFIC evaluation of priority plant species in the region (110)
  Source: Marshall, N.T. (1998) Searching for a Cure: Conservation of Medicinal Wildlife Resources
- Indigenous plants that are harvested as a source of active ingredients for export purposes (19)
  Source: Cunningham, A.B (1993) African Medicinal Plants
- Cameroon Medicinal Plants (62)
  Source: http://www.africaphyto.com/eng/plantes.htm
- Selected African Medicinal Plants (155)
  Source: Iwu, M.M (1993) Handbook of African Medicinal Plants
- Drug candidates from African Forests (12), African Medicinal Plants with Oral Health implications (12) and African Medicinals on the World Market (8)
  Source: http://www.africanethnomedicines.net/i.elujobaetal.pdf

India:

- Medicinal plants of Northern Areas of Pakistan (109)
  Source: http://www.wwfpak.org/nap/dnap_medicinalplants_survey_na_ibrahim.php
- Medicinal plants that are easily cultivated (22)
  Source: State Forest Research Institute, Arunachal Pradesh, India (http://www.arunachalpradesh.nic.in/med-plant.htm)
- A-Z Catalogue of Indian Medicinal plants (500)
  Source: http://www.sbepl.com/medicinal-plants-10.html
- Ethno-medicinal Plants Used by Gond Tribe of Kukrakhapa, District Chhindwara, Madhya Pradesh, India (32)
  Source: (http://www.naturalhealthweb.com/articles/acharya1.html)
- Medicinal plants of India (39)
  Source: http://www.bsienvis.org/medi.htm
- Medicinal plants of South India (4)
  Source: http://www.rosneath.com.au/ipc6/ch02/brooks2/index.html
- Traditional use of medicinal plants among the tribal communities of Chhota Bangal, Western Himalaya (35)
  Source: www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1435742
- Medicinal plants of the Chamoli district, West India (11)
  Source: http://www.plantlife.org.uk/international/plantlife-med-plants-projects-allachy-India-Chamoli.htm
- Critically endangered and vulnerable species (110) List of species banned from export (27)
  Source: Suma Taqadur, FRLHT
- FRLHT Red List (104)
  Source: http://envis.frlht.org/iucnlist.php
- FRLHT list of 7,637 Medicinal Plant Species
- 930 Traded Plants of Conservation Concern
  Source: http://envis.frlht.org/digital_herbarium_930.php

US:

- Threatened medicinal plants of the US (208)
  Source: Patricia de Angelis, Chair MPWG, PCA
- American Medicinal Plants of Commercial Importance (133)
  Source: http://www.hort.purdue.edu/newcrop/HerbHunters/hhunters.html
- Medicinal Plants and Herbs of Eastern and Central North America (500)
  Source: A Field Guide to Medicinal Plants and Herbs: Of Eastern and Central North America (Duke, Foster, Peterson, 2000)
- Medicinal plants of the South West (48)
  Source: http://medplant.nmsu.edu/plantindex.htm
- NatureServe list of US medicinal species and their conservation status (538)

Europe:

- Europe's threatened medicinal plant species (20)
  Source: http://www.traffic.org/plants/executive-summary.html and http://www.traffic.org/plants/recommendations.html
- Cultivated Species of Bulgarian Wild Medicinal Plants (268)
  Source: http://www.worldwildlife.org/bsp/publications/europe/bulgaria/bulgaria20.html
- Main threatened Turkish medicinal plants (8)
  Source: http://www.fao.org/docrep/005/Y4496E/Y4496E44.htm
- European Cooperative Programme for Plant Genetic Resources Medicinal and Aromatic Plants Working Group: 10 priority species
  Source: http://www.ecpgr.cgiar.org/Workgroups/Med_aromatic/AppendixI.doc
- 16 target species for SEED net MAP project
  Source: http://www.ecpgr.cgiar.org/Workgroups/Med_aromatic/MAP2_draft_Jan2005.pdf
- Main European Medicinals (83)
  Source: http://www.phyto-lexikon.de/liste/liste.html
- Mediterranean Medicinal Plants (1404)
  Source:http://medusa.maich.gr/query1/?genus=&species=&use=medicine&Major_Parts=Any&Major_Chemistry=Any&country=Any

China:

- Medicinal Plants in China: List of 150 commonly used species
  Source: World Health Organisation
  http://www.wpro.who.int/internet/files/pub/69/toc.pdf
- Herbal Pharmacology of the People's Republic of China (243)
  Source: The Southwest School of Botanical Medicine
  http://www.swsbm.com/Ephemera/China_herbs.pdf

South America:

- Amazon Medicinal Plants (233)
  Source: http://www.rain-tree.com/plistbot.htm (Tropical Plant Database)
- Important medicinal plants in Bolivia (8)
  Source: http://www.positivehealth.com/permit/Articles/Herbal/lunny22.htm
- TRAFFIC priority species (2)
  Source: http://www.traffic.org/dispatches/archives/september98/medicinal-projects.html
- 10 South American plants screened for anti-viral properties (10)
  Source: http://www3.interscience.wiley.com/cgi-bin/abstract/55001305/ABSTRACT?CRETRY=1&SRETRY=0
- Iracambi medicinal plants project in Minas Gerais (Brazil) and the international standard for sustainable wild collection of medicinal and aromatic plants (ISSC-MAP). (12)
  Source: Gullia and Franz, IUCN/SSC MPSG Newsletter Vol. 11.

General:

- Medicinal and Aromatic Plants included in the CITES Appendices (229)
  Source: Schippman, U. (2001) Significant Trade study
- IUCN species where main threat is over-harvesting for medicinal use (26)
  Source: IUCN
- Plants for a Future Database of Medicinal plants (7,500)
  Source: http://www.ibiblio.org/pfaf/database/latinA.html

Annex 3 – Medicinal plants questionnaire

Safety Nets for Medicinal Plants Project Questionnaire

Linking more than 800 botanic gardens in 118 countries BGCI (www.bgci.org) forms the world's largest plant conservation network, with a mission to mobilise botanic gardens and engage partners in securing plant diversity for the well-being of people and the planet. One of the specific aims of our 5 year plan (2007 – 2012) is to enhance the conservation of threatened medicinal and nutritious plants to address human well-being and livelihood issues as a contribution towards Targets 3 and 13 of the GSPC.

To this end, we have begun to identify the threatened plant species held in botanic gardens according to the BGCI PlantSearch database and we are working to improve the information held so that it can be used as a planning tool. We have also identified several successful models of medicinal plant conservation work undertaken by botanic gardens. They include:

- Working with communities to document and use indigenous knowledge
- Educating on the value and used of sustainably harvested medicinal plants
- Collecting and developing gene pools of wild stock plants
- Research to discover and investigate medicinal plant properties
- Using collections to support local initiatives in primary healthcare, particularly in developing countries
- Using collections to support screening programmes for pharmaceutical companies, in accordance with guidelines on access and benefit sharing, and to assay the value and safety of particular medicines
- Improving the agronomy of cultivated medicinal plants
- Cultivating medicinal plants, to tackle unsustainable harvest and improve ease of harvest
- Practice of horticultural therapy, using plants and gardening to treat mental and physical disorders
- Educating end consumers and supporting standard setting for medicinal plant production

Now, in order to successfully match medicinal plant conservation needs with the capabilities of gardens we would greatly value your input. This will help to define priorities for both in situ and ex situ conservation programmes and to facilitate best practice and priority activities for implementation.

1. Out of the thousands of threatened medicinal plant species, which, in your opinion, are outstanding priority species for conservation action over the next 5 years?

2. In your opinion, what are the immediate priorities for medicinal plants in relation to CITES?

3. In your opinion, what are the priority methodologies for medicinal plant conservation?

4. How do you think botanic gardens can best complement the medicinal plant conservation being undertaken by other NGOs or agencies?

5. We want to help botanic gardens help medicinal plants. Where do you think BGCI should focus our capacity building over the next 5 years?

There are a range of resources available on medicinal plants and conservation programmes but little specifically targeted at botanic gardens. We want to maximise the potential for skill, best practice and knowledge sharing.

Your input will help focus conservation efforts and feed into the production of a new report and action plan containing case studies and best practice to utilise the skills of botanic gardens in conserving threatened medicinal plant species.

Optional contact details:

Your name:
Your institution:
Email:
Does your institution currently run any projects with medicinal plants? Please give brief details:

Many thanks for sparing the time to help! Please return any comments to Belinda Hawkins at BGCI at:

belinda.hawkins@bgci.org

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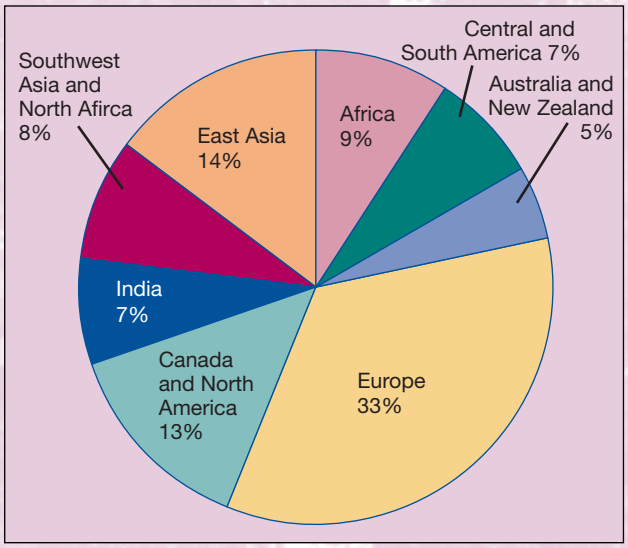
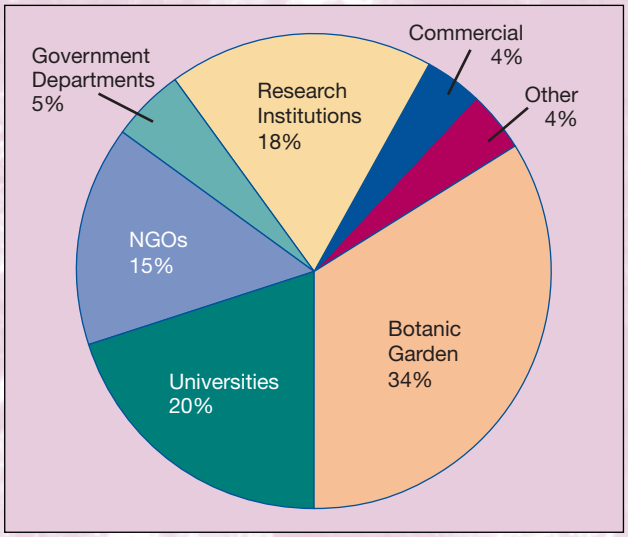
BGCI
Plants for the Planet

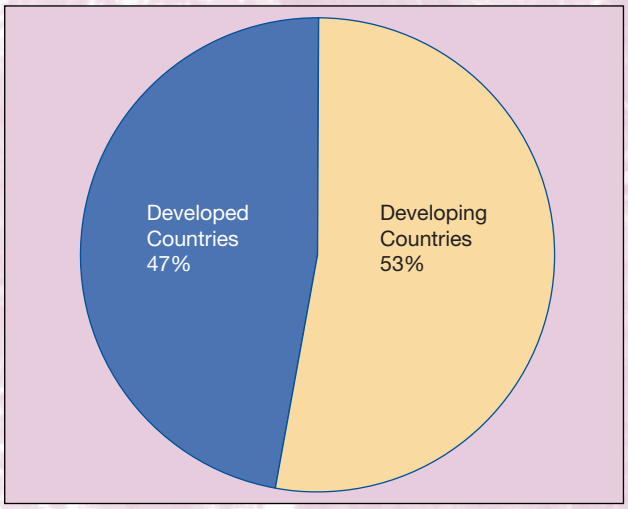
The Rufford Foundation

Annex 4 – Analysis of questionnaire responses

79 questionnaire responses were received from a wide range of individuals and organisations. The first three pie charts show the range of participants in the questionnaire survey, by geographical region and by institution type.

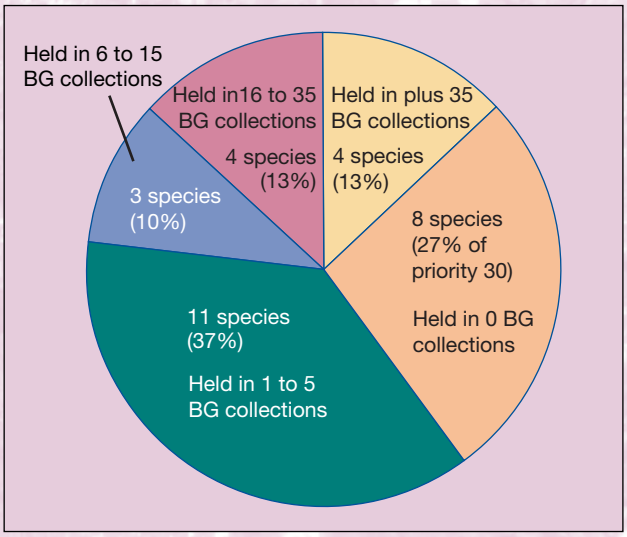




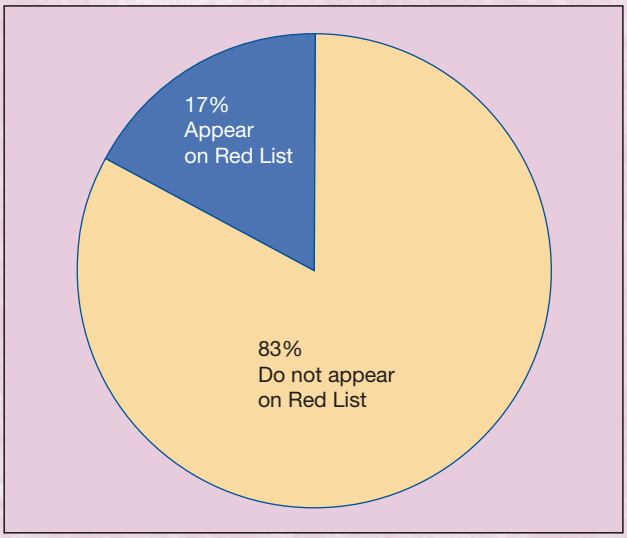


The following pie charts and table relate to the suggested priority species; their status within botanic garden collections and whether they have been assessed using the IUCN categories and criteria, either on the 1997 Red Data List or the 2007 Red List of Threatened Species.

Number of species from priority 30 (discounting the 5 genera suggestions) that are held in botanic garden collections (according to PlantSearch)



Percentage of suggested species (out of total 428 species mentioned) that are either on the 1997 IUCN Red List of Threatened Plants or the 2007 IUCN Red List of Threatened Species



Within the 35 priority list 5 genera were suggested: *Aloe* spp., *Aquilaria* spp., *Cinchona* spp., *Hoodia* spp. and *Panax* spp. These have been discounted from the above graph and looked at separately. For *Aloes*, *Aquilarias* and *Cinchonas* only those species that have been assessed as CR, EN or VU on the 2007 Red List of Threatened Species have been screened against the PlantSearch database. For *Panax* spp. we have used both the 2007 Red Listed species and those specifically suggested to us as of conservation priority. Only 3 *Hoodia* spp. appear on the 2007 Red List and all are classified as LC.

Number of species from priority 5 genera that are held in botanic garden collections

Other species and IUCN Red List status	**Number of BG collections (PlantSearch)**
***Aloe* – 21 spp. on 2007 Red List, 740 BG records**	
Aloe ballii (EN)	6
A.ballyi (VU)	11
A.erinacea (EN)	11
A.helenae (CR)	9
A.peglerae (EN)	32
A.pillansii (CR)	16
A.ramosissima (VU)	19
A.squarrosa (VU)	17
A.suzannae (CR)	34
***Aquilaria* – 9 spp. on 2007 Red List**	
Aquilaria banaensae (VU)	0
A.beccariana (VU)	1
A.crassna (CR)	1
A.cumingiana (VU)	0
A.hirta (VU)	2
A.malaccensis (VU)	3
A.microcarpa (VU)	0
A.sinensis (VU)	6
***Cinchonas* – 4 spp. on 2007 Red List**	
Cinchona lucumifolia (VU)	0
C.mutisii (EN)	0
C.rugosa (VU)	0
***Hoodia* spp. – 3 spp. on 2007 Red List**	13 species held in 41 BG collections (see *Hoodia* spp. box in section 5)
***Panax* – 1 spp. on 2007 Red List**	
Panax zingiberensis (EN)	1
P. quinquefolius (not assessed)	8 (see *P. quinquefolius* box in section 5)
P. ginseng (not assessed)	13
P. stipuleanatus (not assessed)	0
P. vietnamensis (not included on 2006 Red List, EN on 1997 IUCN Red List of Threatened Plants)	0

Annex 5 – Suggested priority species for conservation action

This list presents the species that were suggested to us as priorities for conservation action over the next five years in answer to Question 1 of the medicinal plants questionnaire. Some of the species are only of local conservation concern, whilst others may be globally threatened. It is a compilation of all the answers suggested to BGCI and represents multiple and varying stakeholder priorities.

428 species or genera were mentioned, some more than once. Therefore, at the beginning of the table are the top 35 species, mentioned several times in questionnaire responses and suggested as key priority species for immediate conservation action.

*A * next to species name indicates some conservation work already undertaken or supported by BGCI*

The 35 most frequently mentioned species or genera

Species	Region	CITES (Appendix)	IUCN (2007 categories at Annex 6)	BGs	Of interest
Aconitum ferox	E.Asia, Himalaya, N.India		1997 Indeterminate	9	very poisonous plant, used for leprosy, choleras, rheumatism and fevers
•*Aconitum heterophyllum*	E.Asia, Nepal/western Himalaya, India			4	very poisonous,simple contact has caused numbness in some people, but is anti-inflammatory, aphrodisiac and astringent.
Aloe spp. Particularly *Aloe turkanensis*	tropical Africa	II (except *A.vera*) 890 species listed	21 species listed 2006, of which 9 are CR, EN or VU. 158 species listed 1997	n/a	gel from leaves used for burns, wounds and skin disorders whilst sap is a digestive stimulant and laxative
Aquilaria spp	Indomalaysia	II (31 species)	2006 9 species listed, 8 of which are CR or VU	n/a	fragrant resin-impregnated heartwood of the tree used for incense and as an imporant medicine in TCM
Balanites aegyptiaca	N tropical Africa to E Med			10	medicinal bark, roots contraceptive, fruit pulp used against worms in drinking water
**Cinchona* spp.	Andes to Costa Rica		2006 4 species listed, 3 of which are EN or VU. 1997 6 species listed	n/a	source of alkaloids especially antimalarial quinine, still not completely superceded by synthetics
**Cordyceps sinensis*	Asia			0	a form of parasitic fungus that grows on insect larvae, eventually consuming the whole caterpillar. Said to have good 'yin yang balance' in TCM because of it's half-animal, half-plant appearance.
Coscinium fenestratum	Southern India, Sri Lanka		1997 Rare	1	widely used in traditional medicinal systems of Ayurveda and Siddha to treat diabetes
Dactylorhiza hatagirea	Himalaya, India, Pakistan, Nepal, Tibet	II		0	extract from the tuber used to treat wounds ad as a tonic for fevers
**Eucommia ulmoides*	China		2006 LR:nt, 1997 Rare	97	possibly not known in wild, TCM tonic for arthritis and tooth fillings
Gastrodia elata	SE Asia	II	2007 VU	4	dried and powdered a common TCM cure for headaches
Gentiana lutea	Europe, W Asia			48	contains some of the bitterest compunds known to science
**Hoodia* spp. Particularly *H.gordonii*	southern Africa	50 species listed on II	2006 3 species listed as LC, 1997 5 species listed as VU or Rare	n/a	traditionally used as an appetite supressant by the San bushment of South Africa, now used to treat obesity
**Magnolia officinalis*	China	II	2007 LR/nt 1997 VU	39	bark and flowers important in TCM
Nardostachys grandiflora (syn*: Nardostachys jatamansi)*	Nepal/Himalaya	II		3	rhizomes with oil formed prized salves in Roman times
**Neopicrorrhiza scrophulariflora (syn: Picrorhiza scrophulariflora)*	Nepal/Himalaya	II		0	rhizomes anti-bacterial and anti-inflammatory and have been shown in clinical trials to boost the immune system. Often used to treat scorpian and snake bites
**Nothapodytes nimmoniana*	southern India			0	yields Camptothecin, important anti-cancer alkaloid. Destructive harvesting and habitat loss has led to species decline of 50-80%.
Oroxylum indicum	Nepal/Himalaya, southern India	II		16	bark used to treat ulcers and for animal de-worming, potential anti-cancer drug with several claims
Osyris lanceolata	E Africa			1	East African sandalwood, known for it's scent and medicinal qualities, can fetch as much as US$15,000 a tonne.
Paris yunnanensis (syn: Paris polyphylla var.yunnanensis)	China			2	used in TCM said to 'reduce heat, resolve toxicity, reduce swellings and stop pain'
**Panax* spp. Particulalry *P. vietnamensis* and population specific *P.ginseng*	N America, E Asia	2 species on II	P.zingiberensis 2006 EN, 1997 2 species listed as EN	n/a	long history of use going back some 5,000 years, regarded as a cure all
**Podophyllum hexandrum* (syn*: Sinopodophyllum emodi)*	Nepal/western Himalaya	II		45	contains podophyllin, which interferes with cell growth and has been used to treat ovarian cancer
Prunus africana	tropical and S Africa	II	2007 VU	3	common treatment for prostitis
Rauvolfia serpentina	Southern India, Vietnam	II		22	source of resperine, reduces blood pressure and used to treat mental illness
**Rhoicissus revoilii*	tropical and S Africa			5	the Bushveld Grape, given to livestock to expell worms
Saraca asoca	Southern India		2007 - VU	1	the tree under which the Buddha was born
**Saussurea costus* (syn*: S.lappa)*	E Himalaya	I	1997 EN	6	considered one of the 50 fundamental herbs in TCM, also used in Ayurvedic and Tibetan traditional medicine systems
**Sideritis raeseri*	Europe			1	Greek Shepherd's tea, siad to have a positive effect on all ailments, particularly colds, respiratory problems and the immune system
Swertia chirayita	Himalaya, India			0	extensively used plant, used as a bitter tonic and for the treament of fever and for curing skin diseases
Taxus wallichiana	Nepal/Western Himalaya	II	2007 DD	19	used in Ayuvedic and TCM to treat fever and muscular pain but also as a source of the best-selling anti-cancer drug Taxol
Toddalia asiatica	Africa			0	fruit used as a cough remedy, roots for indigestion, leaves for lung diseases and rheumatism and to treat fever.
Warburgia salutaris	E Africa		2007 EN 1997 VU	1	bark a purgative, active against worms, leaves eaten in curries
Withania somnifera	Africa, India			26	narcotic and diuretic
Zanha africana	E Africa			0	a local 'cure all'
Zanthoxylum chalybeum	Africa			0	roots used to treat malaria

Other medicinal plant species suggested as being of conservation concern

Species	Region	CITES (Appendix)	IUCN (2007 categories at Annex 6)	BGs	Of interest
Acacia elatior ssp. elatior	Africa			0	
Acacia nilotica	tropical Africa, natur.India			16	important tanbark and gum arabic substitute
Acacia tortilis	Africa and Middle East			8	
Acanthopanax gracilistylus (Elutherococcus)	Vietnam			4	
Acanthopanax rufinerve	Korea			0	
Achillea fragrantissima	Arabian peninsula			2	
Acokanthera oppositifolia	Tropical, E and S Africa			9	digitalin-like, used as arrow poison
Aconitum balfourii	Himalaya		1997 Indeterminate	1	poisonous and drug source including cough medicines
Aconitum spicatum	China, India, Nepal, Bhutan			2	
**Acorus calamus*	temperate North; from India to New Guinea			57	rhizome used in TCM since Hippocrates, found in Tutankahmun's tomb, mentioned in bible, used in Sumatra to keep evil spirits away from children at night
Adansonia digitata	tropical Africa			67	the baobab tree, lives up to 2000 years, many med and othe uses, dried fruit rich in citric acids, inner bark used as rope,
Adenia gummifera	South Africa			2	outer as cloth, seeds as fuel
Adenia hondala	southern India			0	
Adiantum capillus- veneris	Europe			0	
Adonis vernalis	C and S Europe	II		37	a local 'cure-all'
Ageratum conyzoides	tropical America, now pan-tropic			17	digitalin-like
Agrimonia eupatoria	Europe			52	folk medicine e.g diarrhoea, and insecticide - causes precocious metamorphosis of insects
Albizia anthelmintica	tropical and southern Africa			0	folk medicine e.g live disease, source of yellow dye
Albizia coriaria	N and C Africa			4	
Albizia suluensis	South Africa		2006 VU	1	
Albuca fastigiata	South Africa			3	
Allium stracheyi	western Himalaya		1997 VU	1	
Aloe calidophila	tropical Africa	II	1997 Rare	2	
Aloe elgonica	tropical Africa	II	1997 VU	18	
Aloe linearifolia	South Africa	II		3	
Aloe secundiflora	tropical Africa	II		39	
Aloe turkanensis	tropical Africa	II		3	
Aloysia triphylla	South America			32	fragrant sedative tea also used extensively as a cheap lemon flavouring/scent for washing up liquid, lemon sherbert
Amsonia elliptica	Japan, Chin, Korea			2	
Anabasis ophyila	Europe			0	
Anemarrhena asphodeloides	N.China and Japan			7	
Anogeissus leiocarpa	tropical Africa			1	chewing sticks, vermifuge for stock, termite-proof wood, source of yellow dye
Ansellia africana	South Africa	II		26	
Aquilaria crassna	Vietnam	II	2007 CR	1	
Aquilaria malaccensis	Indonesia and Malaysia	II	2007 VU	3	
Aquilaria sinensis	South China and Hong Kong	II	2007 VU	6	
Aralia continentalis	W and N China, Korea, Siberia			17	
Arctostaphylos uva-ursi	N.America, N.Euope, N.Asia			53	used in tanning, in smoking mixtures, as urinary antiseptic
Ariocarpus bravoanus	Mexico	I	2007 VU	6	slow growing
Ariocarpus kotschoubeyanus	Mexico	I	2007 NT	25	slow growing
Arisaema convolutum	Asia			0	
Arisaema peninsulae	Asia			4	
**Aristolochia tuberosa*	Vietnam		2007 EN	1	
**Arnebia benthami*	western Himalaya			1	
Arnica montana	C and N Europe			44	
Artemisia alba	Europe			25	
Artemisia siberi	Palestine			0	
Arum spp.	Europe			n/a	
Asarum balansae	Vietnam			0	
Asarum heterotropoides var. seoulense	E Asia, N Japan			0	

Other medicinal plant species suggested as being of conservation concern

Species	Region	CITES (Appendix)	IUCN (2007 categories at Annex 6)	BGs	Of interest
Asparagus racemosus	China, Japan, India			7	
Asteropeia labatii	Madagascar		2007 EN	0	
Asteropeia mcphersonii	Madagascar		2007 VU	0	
**Atropa acuminate*	Himalaya	II		0	used to dilate the pupil in surgery and eye exams
Azadirachta indica	pan tropical			19	Neem
Ballota kaiseri	Egypt			0	
Begonia homonyma	South Africa		1997 Rare	11	
**Berberis aristata*	Nepal			24	bitter tonic for fevers
Berberis koreana	Korea			44	
Bergenia ciliata	W Pakistan to SW Nepal			28	garden plant
Bergenia pacifica	far east Russia			4	
Bistorta amplexicaulis (Persicaria)	Himalaya			4	
Bletilla striata	China, Japan	II		46	
Boschniakia rossica	Russia, China, Japan			0	
Boswellia neglecta	Africa			2	relative of Frankinsence
Bowiea volubilis	S and E Africa			36	bulb toxic and locally medicinal
Brachystelma pulchellum	South Africa			0	
Bridelia micrantha	Africa			5	
Brucea antidysenterica	Africa			1	
Bulbine latifolia	South Africa			17	
**Bunium persicum*	Himalaya			0	
**Butea monosperma*	Nepal/Himalaya			7	astringent, vermifuge, said to be one of the most beautiful flowering trees, sacred to the Brahmins in India
Buxus koreana	Korea			0	
Caesalpinia volkensii	Africa			1	
**Canarium strictum*	southern India			0	
Capparis spinosa	Mediterranean Europe			35	
Caragana chamlagu	N China, Korea			3	relative of Ylang Ylang and supposedly an aphrodisiac
Caragana koreana	Korea			0	
Carica papaya	C and S America			52	papaya
Carissa edulis	Africa			11	
Carissa spinosa	Australia			1	
Cassia abbreviata	S Africa			4	one of the world's most popular natural laxatives
Catharanthus roseus	Madagascar			50	
Celastrus paniculatus	southern India			5	
Centella asiatica	South Africa but pan tropical to Chile, New Zealand			16	used in skin treatments and to treat leprosy
Centropogon pilalensis	Ecuador		2007 CR	0	
Cetraria islandica	Europe, especially Arctic regions			0	iceland moss, highly prized lichen used as a cough medicine
Changium smyrnioides	China			7	
Chenopodium opulifolium	Europe			8	
Chuanminshen violaceum	China			0	
Cibotium barometz	India, S China, W Malaysia	II		9	
Cimicifuga racemosa	E N America			33	
**Cinnamomum spp.*	E to SE Asia, Australasia, tropical America		24 species assessed 2007, of which 20 are CR, EN or VU	n/a	
Cissus aphyllantha	Africa			0	
Cistanche tubulosa	W India to NW China		1997 Endangered	3	
Clausena anisata	Africa			4	
Cleome gynandra	Africa			7	
Clerodendrum incisum	Africa			0	
Clerodendrum eriophyllum	Africa			0	
Clerodendrum myricoides	Africa			4	

Other medicinal plant species suggested as being of conservation concern

Species	Region	CITES (Appendix)	IUCN (2007 categories at Annex 6)	BGs	Of interest
Clivia nobilis	South Africa			44	common houseplant
**Colchicum luteum*	Western Himalaya			7	
Colchium autumnale	Europe to N Africa			54	pain killer and used in lots of genetic engineering work. Colchicine is used to make sterile hybrids fertile, acting on chromosomes. Also used as a poison by the Greeks
Commiphora africana	Africa			9	
Commiphora holtziana	Africa			2	
Commiphora myrrha	Africa			2	
**Commiphora wightii*	Arabia to Indian desert		2007 DD	1	resin important local medicine for arthritis
Convallaria majalis	N Europe			58	rhizomes used in scent and snuff also posionous
Coptis chinensis	Vietnam			8	
Coptis chinensis var. brebisepala	E Asia			0	
Coptis quinquesecta	Vietnam			0	
Coridothymus capitatus	Meditterranean Europe			3	
Corydalis humosa	Asia			0	
Corylus sieboldiana	East Asia, Japan			0	
Cotoneaster integerrima	Europe			0	
Craterostigma nanum	tropical and southern Africa			0	
Crocosmia paniculata	South Africa			13	common garden plant
Crocus sativus	Europe			32	richest known source of vitamin b2, source of saffron, reduces arteriosclerosis poss. Explaining low levels of cardiovascular disease in spain where consumption is high
Croton membranaceus	Africa			0	
Cycas beddomei	tropical Asia	I	2007 CR 1997 EN	7	
Daphne genkwa	China			7	used clinically as a safe and efficient abortifacient
**Decalepis hamiltonii*	Southern India			0	
Delphinium himalayai	Nepal/Himalaya			0	
**Dendrobium spp.*	tropical to warm Asia to Australia and Pacific	1365 species, cruentum - I, all II	2007 12 species listed of which all are CR, EN or VU 1997 66 species listed	n/a	
Dialium guineense	Africa			7	
Diaphananthe millarii	South Africa	II	1997 Rare	1	
Digitalis lanata	Europe			52	used as a cardiac stimulant since 1785
Dionea muscipula	SE N America	II		2	the Venus Flytrap, under research as a possible treatment for HIV
**Dioscorea deltoidea*	western Himalaya			6	
Dioscorea dregeana	South Africa			2	
Dioscorea nipponica	Asia			15	
Diphylleia sinensis	W China		2007 EN	4	rhizomes locally medicinal
Dovyalis abyssinica	Africa			4	
Drosera rotundifolia	global in wet places			46	
Drosera spp.	global in wet places			n/a	
Dryopteris filix-mas	N Europe			51	one of the oldest known vermifuges
Dysosma versipellis	E Asia		2007 VU	7	
Dysoxylum malabaricum	southern India			0	
Echinocodon lobophyllus	China			0	
Elaeodendron buchananii	Africa			3	
Embelia schimperi	Africa			4	
Encephalartos aemulans	South Africa	I	2007 CR	3	
Encephalartos cerinus	South Africa	I	2007 CR	4	
Encephalartos friderici-guilielmi	South Africa	I	2007 NT	16	
Encephalartos ghellinckii	South Africa	I	2007 VU	11	
Encephalartos lebomboensis	South Africa	I	2007 EN	28	
Encephalartos msinganus	South Africa	I	2007 CR	1	
Encephalartos ngoyanus	South Africa	I	2007 VU	11	

Other medicinal plant species suggested as being of conservation concern

Species	Region	CITES (Appendix)	IUCN (2007 categories at Annex 6)	BGs	Of interest
Encephalartos nubimontanus	South Africa	I	2007 EW	1	
Encephalartos senticosus	South Africa	I	2007 VU	1	
Ephedra distachya	Europe			38	used as a 'miracle' weightloss drug, mimics the effect of amphetamines
**Ephedra gerardiana*	Himalaya			16	
Epimedium truncatum	China	II	2007 VU - add to iucn pie	0	
Eremostachys superba	western Himalaya			0	
Eriosema populifolium	South Africa			0	
Eriospermum mackenii	South Africa			2	
Erythrina abyssinica	Africa			17	
Euadenia eminens	tropical Africa			7	
Euclea divinorum	tropical Africa to Arabia			5	
Eucomis autumnalis	South Africa			0	common garden plant
Eugenia hastilis	Mauritius		2007 CR 1997 Rare	0	
Eulophia petersii	South Africa	II		10	
**Euphorbia ambovombensis*	Madagascar	I	2007 VU 1997 EN	5	
Euphorbia antisiphilitica	SW N America			1	
Euphorbia bupleurifolia	South Africa			12	
Euphorbia candelabrum	Africa			18	
Euphorbia franksiae	South Africa	II		2	
Euphorbia matabelensis	Africa			0	
Euphorbia woodii	South Africa			10	
Fagaropsis hildebranditii	tropical and NE Africa			0	
Ferula fukanensis	central Asia			0	
Ferula sinkiangensis	China			0	
Fritillaria roylei	western Himalaya			5	bulb medicinal in TCM
Fritillaria walujewii	China			7	
Funtumia africana	tropical Africa			0	
Garcinia gummigutta	southern India			0	
Gardenia volkensii	Africa			7	
Gasteria croucheri	SA		1997 VU	10	
Gentiana kurroo	western Himalaya			7	
**Ginko biloba*	E China			0	older than the dinosaurs, a 'living fossil' now confined to one mountain slope in China, used to treat Alzheimers disease.
Gleditsia japonica	East Asia, Japan			28	
Gloriosa superba	South Africa			33	common garden plant
Glycyrrhiza spp.	Eurasia, Australia, N America and temperate S America			n/a	licorice
Gonolobus saraguranus	tropical America	II	2007 VU	0	
Guaiacum spp.	warm America	18 on II	2006 3 species listed of which 2 EN	n/a	
Gymnadenia conopsea	northern Europe			16	
Gynostemma pentaphyllum	China			2	
Habenaria intermedia	western Himalaya			0	
Hagenia abyssinica	E Africa			6	
Harpagophytum procumbens	SA			5	
Harrisonia abyssinica	tropical Africa			5	
Haworthia limifolia	South Africa			19	
Helichrysum odoratissimum	South Africa			1	
Hippophae rhamnoides (location specific)	Europe to N China			57	
Horsfieldia spp.	Indomalaysia to Australia		2007 68 species listed of which 44 CR, EN or VU, 1997 6 species listed	n/a	
Hoslundia opposita	tropical Africa			4	
Hovenia dulcis	E Asia			54	Japanese raisin tree

Other medicinal plant species suggested as being of conservation concern

Species	Region	CITES (Appendix)	IUCN (2007 categories at Annex 6)	BGs	Of interest
Huernia hystrix	South Africa			10	
Huperizia saururus	Argentina			0	
Huperzia serrata	China			0	
Hydrastis canadensis	C and E N America	II		17	
Hydrostachys polymorpha	South Africa			0	
Hymenaea courbaril	eastern Amazonia			20	
Hyoscyamus niger	temperate Europe, natur.N America			49	source of alkaloidal drugs used as hypnotic and narcotic, highly toxic
Hypericum perforatum	Europe to C China, natur W N America			63	St John's wort but poisonous to stock through photosensitisation
Hypoxis hemerocallidea	South Africa			11	
Juniperus communis	N temperate		2007 DD	1	used to flavour Gin
Justicia capensis	South Africa			1	
Kedrostis foetidissima	Africa			4	
Kigelia africana	tropical Africa			0	locally purgative
Kleinia squarrosa	Africa			0	
Knipofia spp.	Arabia, tropical and S Africa, Madagascar			n/a	
Knowltonia bracteata	South Africa			3	
Lannea schweinfurthii	E and S Africa			2	
Laurus nobilis	Europe			78	bay, used in veterinary medicine and aromatherapy
Leptolaena abrahamii	Madagascar		2007 EN	0	
Leptolaena cuspidata	Madagascar		2007 LC	0	
Leptolaena multiflora	Madagascar		2007 EN	0	
Leptolaena raymondii	Madagascar		2007 CR	0	
Linum usitatissimum	Europe			38	flax, linseed, not known in wild
Loesenera kalantha	tropical Africa		2007 VU	0	
Lonicera bournei	Vietnam			0	honeysuckle
Lophophora willamsii	Mexico			0	used for over 7000 years , contains over 30 alkaloids, mescaline the leading one
Lophora diffusa	N Mexico		2007 VU	0	
Lophophytum leandri	S America	II		0	
Lycoris aurea	China and Japan			6	
Maerua decumbens	tropical and S Africa to India			0	
Maesa lanceolata	tropical and S Africa, Madagascar			6	fruit is an effective bactericide
Magnolia hodgsonii	SE Asia	II		0	
Magnolia officinalis ssp. Biloba	China	II		46	bark used as tonic in TCM
Magnolia officinalis ssp. officinalis	China	II		0	
Markhamia lutea	tropical Africa			10	
Maytenus senegalensis	Spain and N Africa to Bangladesh			4	locally medicinal, extracts have cytoxic effect on some cancers
Meconopsis aculeata	western Himalaya		1997 EN	4	common garden plant
Menyanthes trifoliata	circumboreal			40	rhizome a traditional cure for arthritis in Europe
Minthostachys mollis	Argentina			0	
Monarrhenus salicifolius	Mauritius		2007 CR	1	
Mondia whytei	tropical Africa			3	
Monsonia natalensis	South Africa			0	
Morchella spp.	global			n/a	
Morinda officinalis	China			4	
Myrica salicifolia	Africa			0	
**Myristica dactyloides*	southern India		2007 LC/cd	0	used as flavouring (mace) and oil for toothpaste, excess is toxic, hallucinatory and addictive with reputation as aphrodisiac
Myrsine africana	Africa			43	
Mystacidium capense	South Africa			1	
Napeta binaludensis	Iran			0	
Nervilia aragoana	southern India	II		1	
Obregonia denegrii	N E Mexico	I	2007 VU 1997 Rare	30	
Ochrosia borbonica	tropical Africa		2007 EN 1997 VU	5	

Other medicinal plant species suggested as being of conservation concern

Species	Region	CITES (Appendix)	IUCN (2007 categories at Annex 6)	BGs	Of interest
Ocimum americanum	Africa, Asia			11	basil
Ocimum gratissimum	tropical and S Africa			13	traditional medicine, louse remover
Ocimum kilimandcharicum	E Africa			0	
Ocotea bullata	South Africa			0	
Ocotea usambarensis	E Africa			0	
Olinia rochetiana	E and S Africa			0	
**Opuntia megarrhiza*	Mexico	II	2007 EN	0	
Orbea woodii	South Africa		1997 Rare	1	
Orchis spp.	N temperate zones to S W China and India	218 species - II		n/a	
Origanum syriacum	near Eurasia			3	used against rheumatism, a painkiller
Origanum vulgare	Europe to C Asia			55	
Ornithogalum longibracteatum	South Africa			18	
Orobanche coerulescens	Asia			0	
Osyris abyssinica	Africa			0	like sandalwood, oil used in scentmaking
Ozoroa insignis	tropical Africa			3	
Paederia scandens	S E Asia, Malaysia			15	
**Paeonia anomala*	Russia			31	common garden plant
**Paeonia emodi*	Himalaya			18	
Paeonia japonica	E Asia, Japan			13	
Panax ginseng	Korea, N E China	II		13	
Panax quinquefolius	N America	II		8	
Panax stipuleanatus	Vietnam			0	
Panax vietnamensis	Vietnam		1997 EN	0	
Pappea capensis	tropical E to S Africa			0	
Paullinia pinnata	tropical America, Africa			7	caffine high drink, (3 to 4 times that of coffee), locally medicinal, used in chewing gum, arrow poison, chewing-sticks
**Pelargonium (South African spp.)*	South Africa	II		n/a	
Pentaphylloides fruticosa	Russia			4	
Peucedanum caffrum	South Africa			1	
Phellodendron amurense	E Asia			58	
Phellodendron sachalinense	E Asia			21	
Picrorhiza scrophulariiflora	western Himalaya			0	
Pimpinella caffra	South Africa			0	
Pinus gerardiana	NW Himalaya		2007 LR:nt 1997 Rare	10	
Pinus sibirica	Russia		2007 LR:lc	27	
Pistacia chinensis	Himalaya			29	
Plectranthus barbatus	Africa, tropical and warm Old World			11	lice-remover, potential drug for hypertension, glaucoma, asthma
Plectranthus grallatus	South Africa			1	
Plectranthus pseudomarrubioides	Africa			2	
Plumbago zeylanica	SE Asia			24	
Polygonatum multiflorum	India			48	
Polystachya ottoniana	South Africa			3	
Prestonia rotundiflora	tropical America		2007 EN	0	
Primula boveana	Egypt			9	
Primula elatior	Europe			40	
Primula veris	Europe			55	
Prinsepia sinensis	Himalaya to N China and Taiwan			44	
Psammosilene tunicoides	Himalaya		1997 Rare	1	
**Pterocarpus santalinus*	southern India	II	2007 EN 1997 EN	3	
Ptychopetalum olacoides	Eastern Amazonia			0	
Rapanea melanophloeos (Myrsine)	tropical and S Africa			2	
Raphia australis	South Africa		2007 DD 1997 Rare	10	
Reynoutria sachalinensis	temperate Asia			5	

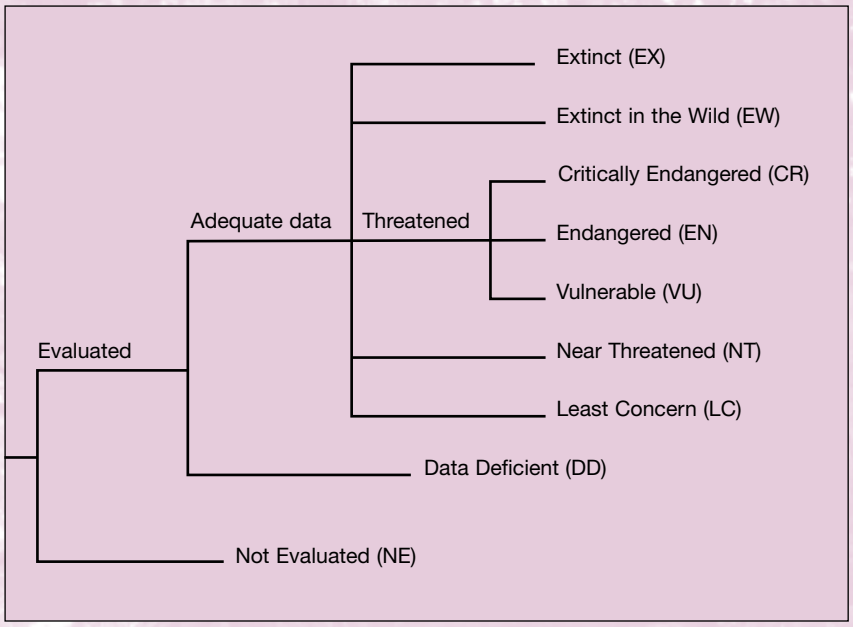
Other medicinal plant species suggested as being of conservation concern

Species	Region	CITES (Appendix)	IUCN (2007 categories at Annex 6)	BGs	Of interest
Rhamnus prinoides	Africa			4	
Rhamnus staddo	Africa			2	
Rheedia aristata (Garcinia)	Cuba, Brazil		2007 EN 1997 Rare	1	
**Rheum australe*	Nepal/Himalaya			13	rhubarb
Rheum coreanum	E Asia, Korea			0	
Rheum emodi	western Himalaya			1	
Rheum webbianum	western Himalaya			10	
Rhodiola elongata (Sedum)	Korea			0	
Rhodiola heterodonta	western Himalaya			13	
Rhodiola rosea	Arctic regions of Europe, Asia and N America			42	
Rhododendron brachycarpum	Japan			35	
Rhododendron chrysanthum	E Asia		1997 VU	5	
Rhoicissus tridentata	tropical and S Africa			2	
**Rosa arabica*	Egypt		1997 EN	3	
Roylea cinerea	western Himalaya			0	
Ruscus aculeatus	Europe			69	
Ruscus spp.	Macronesia and W Europe			n/a	
**Salacia oblonga*	southern India			1	
Salvadora persica	tropical Africa to Asia			9	known as the toothbrush tree
**Salvia officinalis*	S Europe and Mediteranean			68	sage
Sambucus nigra	Eurasia			74	elderberry, associated with superstition, Romans used as a hair dye, medicinal and pith still used for holding specimens when sectioning botanical material
Saracca indica	India			14	
Sarcolaena delphinensis	Madagascar	II	2007 EN	0	
Sarcophyte sanguinea	E tropical and South Africa			0	
Saruma henryi	NW to SW China	II	2007 EN	10	
Sasa coreana	Korea			0	
Satureja montana	S Europe			51	
Sceletium tortuosum (Phyllobolus)	Namibia, W and C S Africa			0	
Schizobasis intricata	South Africa			4	
Schlechterina mitrostemmatoides	tropical E Africa			0	
Scilla natalensis	South Africa			14	
Sclerocarya birrea	tropical and S Africa			8	
Scutellaria baicalensis	Siberia to Japan			18	
Scutia myrtina	Africa			4	
Secamone gerrardii	South Africa			0	
Securidaca longipeduculata	tropical Africa			4	
Senna didymobotrya	tropical Africa, natur. Asia and America			11	
Senna singueana	Africa			6	
Shorea talura	Southern India			2	
Sideritis spp.	N temperate Old World and Macronesia			n/a	
Silene leucophylla	Egypt			0	
Siphonochilus aethiopicus	South Africa		1997 Indeterminate	3	
Solanum incanum	Africa			3	
Solanum lyratum	E Asia			2	
Sorbus sambucifolia	N hemisphere			22	
Stapelia gigantea	South Africa			32	flowers smell of rotting flesh
Steganotaenia araliacea	Ethiopia to S Africa			3	
Stellera chamaejasme	C Asia, Himalaya			4	
Stephania cepharantha	Vietnam			0	
Strophanthus hispidus	tropical Old World			10	arrow poisons and cardiac drug
Strychnos henningsii	Africa			3	

Other medicinal plant species suggested as being of conservation concern

Species	Region	CITES (Appendix)	IUCN (2007 categories at Annex 6)	BGs	Of interest
**Tabebeuia impetiginosa*	N Mexico to Argentina			0	
Tamarindus indica	origin tropical Africa			50	tamarind
Taxus chinensis	S China to Malaysia	II	2007 LR:lc	13	
Taxus cuspidata	E Asia	II	2007 LR:lc	66	
Teclea simplicifolia	tropical Africa			2	
Telosma procumbens	Vietnam			0	
Thalictrum ichangense	Vietnam			2	
Thymus quinquecostatus	E Asia			5	
Tilia cordata	Europe			62	
Tragopogon collinus	Israel			0	
Treculia africana	tropical Africa			8	
Trichilia emetica	Africa			0	
Tridactyle bicaudata	South Africa			8	
Tulbaghia ludwigiana	South Africa			5	
Turbina oblongata	South Africa			2	
Tylosema fassoglensis (syn: Bauhinia fassoglensis)	pantropical			5	
Urginea altissima (Drimia)	South Africa			0	
Urginea delagoensis	South Africa			0	
Usnea barbata	South Africa			0	
**Utleria salicifolia*	southern India			0	
Uvaria scheffleri	Africa			0	
Vaccinium myrtillus	Europe			44	
Valeriana jatamansi	Asia			2	
Valeriana officinalis	Eurasia			58	
Vateria indica	southern India		2007 CR	1	
Veronica spp.	Europe, Turkey, N America, Africa and Australia		2007 1 species LR/nt	n/a	
Vinca spp.	Europe to N Africa and C Asia			n/a	
Viola canescens	India			0	
Viscum album	Europe, W Asia			20	mistletoe
Vitex rotundifolia	Indomalaysia			13	used for flu, colds and sore eyes in TCM
Voacanga africana *Warburgia salutaris*	tropical Africa southern Africa		 2007 EN	11	 the 'pepper bark' tree, widely traded and in high demand, bark in various forms is used for many ailment; from common colds to malaria
Warburgia ugandensis	E Africa			1	
Withania somnifera	Africa, Mediteranean to India			26	narcotic and diuretic
Ximenia americana	Africa			3	
Zanha africana	E Africa			0	said to be a 'cure all'
Zanthoxyllum gillettii	western Himalaya			0	
Zanthoxylum armatum	A Asia			0	
Zanthoxylum chalybeum	Africa			0	
Zanthoxylum piperitum	E Asia			0	
Zanthoxylum usambarense	Africa			0	
Zanthoxylum xanthoxyloides	W Africa			0	

Annex 6: The 2007 IUCN Red List of threatened species categories (basic definitions)



The structure of the categories (2001 Categories and Criteria, version 3.1)

EX – Extinct

A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

EW – Extinct in the wild

A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

CR – Critically Endangered

A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria for Critically Endangered and it is therefore considered to be facing an extremely high risk of extinction in the wild.

EN - Endangered

A taxon is Endangered when the best available evidence indicates that it meets any of the criteria for Endangered and it is therefore considered to be facing a very high risk of extinction in the wild.

VU - Vulnerable

A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria for Vulnerable, and it is therefore considered to be facing a high risk of extinction in the wild.

NT – Near threatened

A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

LR – Lower risk (from the 1994 Categories and Criteria, version 2.3)

A taxon is Lower Risk when it has been evaluated, does not satisfy the criteria for any of the categories Critically Endangered, Endangered or Vulnerable. Taxa included in the Lower Risk category can be separated into three subcategories:

1. Conservation Dependent (cd). Taxa which are the focus of a continuing taxon-specific or habitat-specific conservation programme targeted towards the taxon in question, the cessation of which would result in the taxon qualifying for one of the threatened categories above within a period of five years.
2. Near Threatened (nt). Taxa which do not qualify for Conservation Dependent, but which are close to qualifying for Vulnerable.
3. Least Concern (lc). Taxa which do not qualify for Conservation Dependent or Near Threatened.

LC – Least concern

A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.

DD – Data deficient

A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and a threatened status. If the range of a taxon is suspected to be relatively circumscribed, and a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.

Annex 7: BGCI regional action plan for medicinal plant conservation

Region / Country	General description	Ongoing and planned activities	Potential partners
EAST ASIA • China	Medicinal plants are of immense importance in China. Some 11,164 species are reported in China's National Strategy for Plant Conservation (CSPC, 2007) as used in TCM. The CSPC, recently produced in response to the GSPC, reflects the values and conservation needs of native medicinal plants. The development and implementation of BGCI's medicinal plants conservation activities in China is coordinated by its office in Guangzhou, South China, and supports a number of national targets, particularly; Target 3 – Research and exploration of application models for plant conservation and sustainable use. Target 7 – *In situ* conservation of threatened species Target 8 – *Ex situ* conservation and recovery plans for threatened species Target 11 – No species of wild flora endangered by international trade Target 12 – Strengthening sustainable use and management of plant-based products Target 13 – Halting the decline of plant resources that support livelihoods and associated traditional knowledge.	• Magnolia *ex situ* collection survey: - gap analysis with special reference to medicinal Magnolias (e.g. *M. officinalis* and *M. denudata*) - strengthen *ex situ* collections and *in situ* conservation, and - reintroduction into the original habitat. • Undertake *Quercus ex situ* collection surveys and explore the potential to strengthen *ex* and *in situ* conservation of threatened oaks. Examples of Chinese oaks with medicinal properties include: *Quercus acutissima, Q.dentata, Q.glauca, Q.semecarpifolia*. • Explore *ex situ* and *in situ* conservation initiatives for other threatened species, notably: *Aristolochia tuberosa, Eucommia ulmoides, Dactylorhiza hatagirea, Cordyceps sinensis*, *Paris polyphylla* var. *yunnanensis, Gastrodia elata, Eremosparton songoricum* and *Cinnamomum mairei.* • Pursue conservation assessments of Rhododendrons in China to include medicinal species such as *Rhododendron molle, R. aureum, R. anthopogon* and *R. arboreum*.	Chinese Academy of Sciences State Forestry Administration State Environmental Protection Administration Global Trees Campaign
SOUTH EAST ASIA • Vietnam, Laos, Cambodia, Indonesia	Taxa of primary attention for BGCI in this region include *Aquilaria* spp., *Cibotium barometz, Stephania* and *Ardisia* spp. Over-harvesting in the wild has led to serious declines of populations of *Cibotium barometz* in Indonesia, and of various species of *Aquilaria, Stephania* and *Ardisia* in Vietnam, Laos and Cambodia. The development of recovery programmes for these taxa will serve as BGCI pilot initiatives for reintroduction of threatened medicinal plants in South East Asia into their habitat of origin.	• The initial phase of the project development will include: a) Detailed target species and population assessments; b) Assessment of the potential for conservation of remaining populations *in situ* and identification of suitable areas for reintroductions; c) *Ex situ* conservation: collection of plant propagation material, and multiplication in botanic and home gardens – involvement of local communities; d) Production of public awareness materials and policy guidelines for recovery of threatened medicinal plants for decision makers; e) Reintroduction into the original habitat.	Research Institute of Science, Lao PDR Hanoi University of Pharmacy, Vietnam Department of Nature Conservation and Protection, Ministry of Environment, Cambodia Cibodas Botanic Gardens, Indonesia

SOUTH ASIA • India, Sri Lanka	It is estimated that 10% of all plant species in India are currently endangered (Pandey *et al.*, 2007). There are estimated to be 8,000 species of medicinal plants used in different systems of Indian medicine. Some 930 of these are known to be traded extensively, with at least 100 of these Red Listed (FRLHT, no date). There is a gap of 40,000 tonnes in the demand and supply of medicinal plants. The major source is the forest, and about 90% are collected from the wild (Kala and Sojwan, 2007). BGCI has supported medicinal plant conservation projects in India ranging from awareness raising and environmental education on medicinal plants in schools to the establishment of medicinal plant gardens. In Sri Lanka, BGCI is currently working jointly with IUCN on the assessment and conservation of Important Plant Areas.	• Development of medicinal plant conservation education programmes (e.g. for high school students in Karnataka). • Enhancing the establishment of community-based nurseries and provision of training in nursery management for selected medicinal plant species. • Focus attention on key medicinal plant species such as: *Aconitum ferox*, *A.heterophyllum, Nothapodytes nimmoniana, Oroxylum indicum, Rauvolfia serpentina, Saraca asoca, Swertia chirayita and Coscinium fenestratum* and *Cinnamomum* spp. in Sri Lanka.	FRLHT PRAGYA IUCN National Botanic Gardens, Sri Lanka Ministry of Environment and Natural Resources, Sri Lanka
EAST AFRICA • Kenya, Tanzania, Uganda SOUTHERN AFRICA • Namibia	Perhaps more than anywhere, Africa's socio-economic profile dictates reliance on traditional medicine. Native plants are the main constituent of traditional African medicines (TAM) (Cunningham, 1993). Unlike the systems of Ayurveda and TCM, TAM is an oral tradition and there are few, if any, written records of its methods and materials. Estimates of the number of species used and the number threatened within Africa as a whole are therefore almost impossible. BGCI is working with the National Museums of Kenya and other partners from Kenya, Tanzania and Uganda on conservation assessments of and management plans for medicinal plants in the region. A similar assessment is proposed for Southern Africa, in particular in collaboration with the National Botanical Research Institute in Namibia.	• Pursue conservation status assessments. • Development of village-specific home herbal health kits and home gardens with medicinal species for self healing, to include plants both of conservation concern and those under no perceived threat. • Develop *ex situ* and *in situ* conservation initiatives for other threatened species, notably: *Aloe* spp., *Hoodia* spp., *Osyris lanceolata, Rhoicissus revoilii, Toddalia asiatica, Warburgia salutaris, Withania somnifera, Zanha africana* and *Zanthoxylum chalybeum*.	Plantlife International National Botanical Research Institute, Namibia SANBI
• Madagascar	Madagascar possesses some 80% endemic biodiversity and is known to contain a wealth of medicinal plant species and indigenous knowledge. However, over 70% of its inhabitants live on less than US$1 a day, making it one of the poorest countries in the world. The natural wealth of the island is therefore threatened by the extreme poverty of the human population, and some 90% of the forest has now gone (Azafady, 2007). As part of its joint initiative with IUCN – The World Conservation Union, BGCI is working on the assessment of Important Plant Areas in Madagascar.	• Convene a series of stakeholder workshops to identify project interventions addressing immediate *ex* and *in situ* conservation needs building on the results of the IPA assessment and focussing on species such as: *Aloe suzannae, Asteropeia labatii, A.mcphersonii, Euphorbia ambovombensis, Leptolaena abrahamii, L.cuspidata, L.multiflora, L.raymondii* and *Sarcolaena delphinensis*.	University of Antananarivo Madagascar Plants Specialist Group IUCN

MESO AMERICA • Mexico, Costa Rica	The traditional medicinal systems of this region are highly localised, with plant species known to be of importance in providing healthcare. There is little in the way of an official catalogue of medicinal plants. The IUCN MPSG is currently working on a regional Red List of medicinal plant species. BGCI is supporting the establishment of the Mexican Strategy for Plant Conservation. In this framework, a number of issues for medicinal plant conservation will be addressed. In Costa Rica, BGCI is currently working jointly with IUCN on the assessment and conservation of Important Plant Areas.	• Convene a series of stakeholder workshops to identify project interventions addressing immediate *ex* and *in situ* conservation needs and focussing on species such as: *Cinchona* spp., *Ariocarpus bravoanus, A.kotschoubeyanus, Centropogon pilalensis, Euphorbia antisyphilitica, Guiacum* spp., *Obregonia denegrii* and *Opuntia megarrhiza*.	Mexican Association of Botanic Gardens INBio

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BGCI
Plants for the Planet

Botanic Gardens Conservation International is a worldwide membership organisation working on an international scale to safeguard tens of thousands of plant species from extinction. Its mission is to mobilise botanic gardens and engage partners in securing plant diversity for the well-being of people and the planet. BGCI brings together the world's botanic gardens, forming a community working in partnership to achieve conservation, education and development goals.

Enhancing the conservation of threatened medicinal plants to address human well-being and livlihood issues is one of the aims of BGCI's current 5-year plan. BGCI believes that the global network of botanic gardens can play a key role in ensuring the sustainable use and protection of this vital resource. For more information visit www.bgci.org or email medicinalplants@bgci.org.

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