



# Saving plants, saving the planet

**Botanic gardens and the implementation  
of GSPC Target 8**

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## Target 8:

“60 percent of threatened plants in accessible *ex situ* collections, preferably in the country of origin and 10 percent of them included in recovery and restoration programmes.”

# Introduction

Plants are an essential part of the world's biodiversity. Healthy ecosystems, based on plant diversity, provide the conditions and processes that sustain life and are essential to the well-being and livelihoods of all humankind. Plants provide us with oxygen and remove atmospheric carbon dioxide, helping to regulate climates. They stabilize the soil, protect watersheds and provide food, medicine, fuel and shelter. Furthermore, plants provide inspiration and pleasure; in short – plants colour our world.

Despite the importance of plants, estimates suggest that up to 100,000 species may be in danger of extinction, and rates of loss are likely to increase as global temperatures continue to rise. Plants are endangered by a combination of factors: over-collection, intensive agriculture and forestry, urbanisation and other land use changes, pollution, the spread of alien invasive species, and increasingly, climate change.

In 2002, in the face of the global plant extinction crisis, the *Global Strategy for Plant Conservation* (GSPC) was adopted by the Parties to the Convention on Biological Diversity (CBD). The 16 output-oriented targets of the GSPC were the first internationally agreed targets for biodiversity conservation, and the *Strategy* was therefore seen by many as a valuable pilot exercise towards the eventual wider adoption of targets in other areas of the CBD's work. Implementation of the GSPC requires action at both the species and habitat level. The targets address the conservation needs of wild plants as well as those of cultivated crops, pastures and forests. Targets on the sustainable use of plant genetic resources link the GSPC to human livelihood issues and the achievement of other targets and goals, such as the Millennium Development Goals, while other targets focus on education, public awareness, capacity building and networking. Achievement of the GSPC requires action by a broad range of stakeholders across sectors as well as implementation both nationally and internationally.

Botanic Gardens Conservation International (BGCI) played a key role in the development and subsequent promotion and implementation of the GSPC. We have acted as lead facilitating agency for the targets related to *ex situ* conservation (Target 8) and education and public awareness (Target 14). Over the last eight years, the botanic garden community as a whole has embraced the GSPC and it has provided a clear focus for conservation action at all levels. Botanic gardens are helping to implement all the GSPC targets, although as they retain a particular interest in the *ex situ* conservation of wild plant resources, special efforts



have been made towards the implementation of GSPC Target 8. This report aims to evaluate the extent to which Target 8 has been achieved at the global level and to identify the impact of the target itself on the botanical community.

With the adoption of the GSPC, it is clear that international plant conservation has undergone a remarkable transformation over the past few years (Wyse Jackson and Kennedy, 2009). However, as work has progressed, changes in the external environment have meant that the task to safeguard the world's plant diversity has become even more demanding. Nevertheless, the botanical community has demonstrated genuine and enthusiastic support for the GSPC; new initiatives, programmes and partnerships have been developed and, if this can be sustained in the coming decade, we believe we can secure the world's plant diversity. By saving plants, we will save the planet.

# The importance of *ex situ* conservation

Ever since the 1992 Rio Earth Summit, *in situ* conservation has been recognised as the dominant strategy for biodiversity conservation. Following the direction of the CBD, in 2002 the GSPC notes that it will “employ *in situ* conservation measures as the primary approach for conservation...” *Ex situ* conservation has therefore been relegated to a supportive role, with the main focus being to facilitate the rehabilitation and reintroduction of threatened species into their native habitats. However, with the threats to biodiversity increasing and action on the ground being inadequate, a re-assessment of the role and importance of *ex situ* conservation is now due.

## The implications of climate change

Recent studies predict that a temperature rise of 2-3°C over the next century could result in as many as half of the world’s plant species being threatened with extinction (Bramwell, 2007). Ecosystems are already rapidly and demonstrably shifting as individual species respond differently to environmental changes and the range areas of species move (Hawkins *et al.*, 2008). Given this, a number of protected areas may soon no longer harbour the species for which they were originally designated and the fixed concept of ‘natural habitats’ may be approaching meaningless for a number of species (Pritchard and Harrop, 2010). Moreover, migration processes are jeopardised by ongoing habitat fragmentation which inhibits the ability of species to re-colonise in new ranges, or even adjoining areas. Given this, conservation strategies, predominated as they are on the management of habitats and species within specific geographical locations, need to be reviewed. As well as protecting and restoring ecosystems, increased efforts should also be focused on ensuring that all wild plant species are backed-up in well-documented *ex situ* collections as an insurance against extinction, and that such material is available for use in research, restoration and adaptation to climate change.

**In the face of an uncertain future, an urgent priority must be conservation through seed-banking and living collections for as many plant species as possible, by way of an insurance policy.**

## The status of *ex situ* conservation

*Ex situ* conservation of plants – in the form of seed banks, *in vitro* collections, field gene banks and the living collections of botanic gardens and arboreta – has proliferated in recent years. For example, in the area of plant genetic resources for food and agriculture, a mere half million samples of plant genetic material were stored in less than ten genebanks in the 1970s. This has risen to more than 7.4 million samples

in more than 1,750 gene banks in the present day (FAO, 2009). In relation to the conservation of wild plants, the main institutions involved are botanic gardens, and the number of such gardens has more than doubled in the last 50 years. Today their collections include nearly 105,000 species, almost one third of all known flowering plants.

## The value of living collections

*Ex situ* collections are vitally important as an insurance policy against extinction in the wild. Furthermore, species held as well-documented, genetically-representative living collections have additional value, providing material for:

- Horticultural and field-based research (propagation, growth requirements etc.);
- Propagation to remove or reduce pressure from wild harvesting;
- Taxonomic and systematic research and reference for identification;
- Display, education and community engagement activities;
- Species reintroduction and habitat restoration activities;
- Identification of taxa for introduction into the nursery trade, local agriculture and crop breeding programmes, amenity planting, local forestry etc.



# Monitoring GSPC Target 8

## Botanic garden collections

Target 8 of the GSPC calls for 60% of threatened plants to be conserved *ex situ*, preferably in the country of origin. Botanic gardens are recognised as the institutions most concerned with the *ex situ* conservation of wild plants. However, in 2002, a global review of *ex situ* conservation, noted that “*Botanical gardens maintain the largest assemblage of plants species outside nature, but no overall assessment of the diverse array has been conducted. Even though they contain a large proportion of the world’s flora, the gardens have traditionally not been integrated, and their holdings have been known only locally*” (Keller *et al.*, 2002).

During the development and adoption of the GSPC, BGCI was invited to become one of the two lead facilitating agencies for Target 8, focusing specifically on wild plant species. In response to this, as well as to address the concerns raised by Keller *et al.*, the PlantSearch database was developed to record plants in cultivation in botanic gardens. BGCI has also worked with national and regional botanic gardens to promote the target and support its implementation.

## A moving target

In 2002, when the GSPC was adopted, a consolidated list of the world’s flora did not exist, but it was believed that the number of known flowering plants stood at around 270,000. Similarly, information on the number of threatened plants was also lacking, but this was estimated at around one third of all species, or some 90-100,000 species. It was therefore predicted that in order to meet Target 8, around 60,000 threatened species would need to be included in *ex situ* collections, from an estimated baseline of 10,000 species. Today, the number of known flowering plants is estimated at 350,000 (Paton *et al.*, 2008), meaning that some 120,000 species could be under threat, and to meet the target, 72,000 threatened species would need to be in *ex situ* collections. However, as the IUCN Red List for plants still only includes 10,174 threatened species (IUCN, 2010), it is impossible to know which are the globally threatened species that should be conserved. Furthermore, as the effects of climate change start to have an impact on plant species survival in the wild, the estimate of 30% of plants being under threat may also need to be adjusted. Against this backdrop, measuring progress presents a challenge.

## PlantSearch as a monitoring tool

BGCI’s PlantSearch database is an on-line, publically accessible searchable database of the living collections of botanic gardens around the world. Data is provided by the participating gardens and is compiled into a single list linked to a range of other relevant databases.

PlantSearch linkages:

- **IUCN Red Lists** (1997 and 2010);
- **International Plants Names Index** – a database of the names and associated basic bibliographical details of all seed plants, ferns and fern allies;
- **Google images**;
- **Tropicos** - the world’s largest database of plant information, containing publicly accessible searchable records for millions of plant specimens, images, and bibliographic references, maintained by Missouri Botanical Garden;
- Lists of **medicinal plants** (BGCI’s compilation of medicinal plant species lists, 2007) and **crop wild relatives** (UNEP-WCMC unpublished crops wild relative genera table);
- **Alpine plant species** list – provided by the Global Observation Research in Alpine Environments (GLORIA) project;



- **CITES** lists – Plants listed on the Appendices of the Convention on International Trade in Endangered Species of Wild Fauna and Flora;
- **Plants of the World** bibliographic database provided through the Australian New Crops Web Site, supported by the Rural Industries Research and Development Corporation.

PlantSearch therefore provides an efficient and publically accessible tool to monitor the cultivation of plants – including those of conservation concern - in botanic garden collections. While the user can rapidly determine if a particular species is included in the combined botanic garden collections and how many gardens hold that species, public access does not allow the actual garden location of species to be identified.

### PlantSearch data

There are presently around 2,800 botanic gardens in existence around the world. Although many of these gardens were not originally developed as conservation organisations, the GSPC has provided a valuable focus for developing conservation action. Since 2002, with the launch of the PlantSearch database, BGCI has gathered information on the living plant collections of botanic gardens. To date 855, or nearly one-third of all botanic gardens, from over 110 countries have contributed data to PlantSearch. The database now includes records for 261,000 taxa, related to nearly 105,000 species in cultivation in botanic gardens. Plant lists included in the database range from lists of many thousands of species cultivated

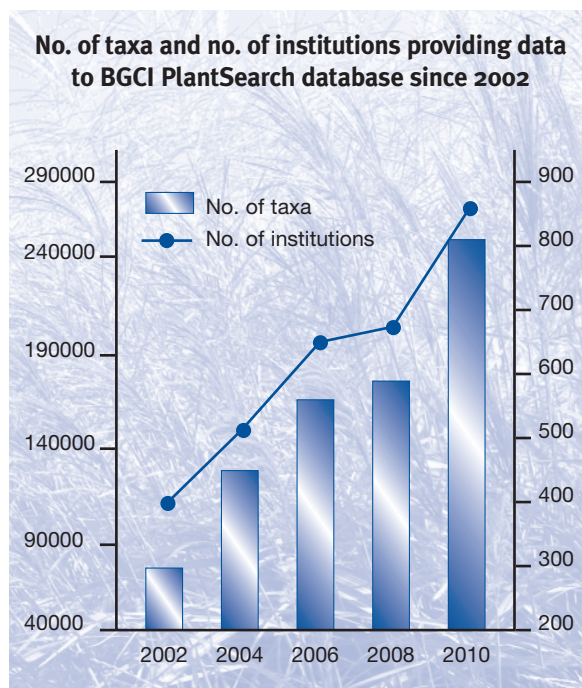


Figure 1: Increase in the amount of data and number of data providers to PlantSearch since 2002

in the large diverse gardens of the USA and Europe to small, but equally valuable lists provided by gardens with collections of local and often highly endangered species and other specialized collections.

**Thanks to PlantSearch, we now have accurate information on the location in conservation of almost one-third of the world's plant species.**

While the total number of species records in PlantSearch is impressive (647,532), collecting data remains a challenge. Despite the anonymity of data in PlantSearch, some gardens are still reluctant to share information on the location of rare plants in cultivation, in case these become a target for collectors or thieves, or because of issues related to intellectual property. Furthermore, many of the smaller, less well-resourced gardens do not have the electronic data management systems in place to allow them to generate plant lists in a format compatible with PlantSearch. For others, language remains a major barrier to contributing data to a database which is presently only available in English.

Collating the data also presents a challenge and over recent years, BGCI has devoted increasing efforts to removing duplicate and misspelt plant names and liaising with botanic gardens to clarify plant nomenclature issues.



## Implementing Target 8



### The importance of having a target

Progress towards the implementation of any target can be monitored not only in terms of the degree to which the target itself has been met, but also in assessing the impact the existence of the target has had on stimulating and catalysing action. In the case of Target 8, it is clear that major progress has been made and advances achieved that were unlikely without the adoption of the target. Setting the target has brought botanic gardens together around a common cause at both global and national levels. It has provided a framework for action at various levels, as well as a reference point for monitoring progress. It has also helped to shape expectations and to stimulate a more focused approach to plant conservation, highlighting those species that require urgent action. It has stimulated botanic gardens to think critically about their plant collections and examine the conservation value of such collections, and has resulted in the development of a range of tools, manuals and best practice examples to guide *ex situ* conservation practice in the future (e.g. ENSCONET, 2009; Offord and Meagher, 2009). Finally, it has provided a much-needed entry-point for botanic gardens to engage with the wider biodiversity conservation agenda and for their work to be recognised as an important contribution to the implementation of the CBD as a whole.

### The botanic garden response to Target 8

While the GSPC targets are set globally, primary responsibility for implementation is at the national level. A number of countries have developed national responses to the GSPC, with national targets, including for Target 8, set at a level to reflect national needs and capacities. However in a number of countries, responses to Target 8 have been developed by national botanic garden networks even in the absence of national plant conservation strategies.

**Botanic gardens have embraced Target 8 and it has empowered them to work together nationally and globally, developing their own targets and strategies for *ex situ* conservation.**

### Meeting the target – global assessments

Monitoring progress towards Target 8 at the global level is constrained by the lack of progress in plant conservation assessments. Less than 4% of the world's known plant species have been assessed using the internationally accepted criteria established by the IUCN in 2001 (IUCN, 2010) although a somewhat larger number had previously



## Examples of botanic garden responses to Target 8:

Argentina and Brazil	The Argentine and Brazilian Botanic Garden Networks both agreed a target for at least 50% of critically endangered native plants to be included in botanic garden collections. This to be achieved by 2013 in Argentina and by 2014 in Brazil.
Australia	Australian botanic gardens are active participants in 130 threatened species recovery and restoration programs. Australia has 21 per cent of its threatened plant species in <i>ex situ</i> conservation and 11 per cent (135 species) are the subject of restoration work.
Austria	Austrian botanic gardens started documenting their <i>ex situ</i> collections of Austrian rare and endangered plant species in 2003 in order to establish a coordinated approach to secure all Austrian threatened species <i>ex situ</i> in botanic gardens (in living collections as well as in seed banks). Recent results show that 779 of the 1,798 endangered species are present in <i>ex situ</i> collections, 406 of those with documentation of their origin (Kiehn, 2010).
Japan	The Japanese Association of Botanic Gardens agreed a target to conserve 50% of threatened plant species by 2012. Recent surveys of Japanese botanic garden collections have shown that they contain 1,058 Japanese Red Listed plant taxa (approximately 50% of the total). The survey also looked at how many of these taxa were held in more than one garden and this revealed that 417 taxa (39%) were present in the collections of only one garden. 281 taxa were included in the collections of four or more gardens (Yukawa, 2007; JABG, 2010).
Northern Europe	The Association of German Botanic Gardens has launched a website to document information on native German plant species in cultivation in German botanic gardens; Dutch botanic gardens have adopted a plan to increase the number and quality of Dutch Red List species in botanic gardens and use these to raise public awareness; The National Botanic Garden of Belgium aims to include all the critically endangered plants of Belgium in its seed bank.
North America (USA, Canada and Mexico)	Botanic garden associations set a target that by 2010, 75% of threatened plant species in the US and Canada and 40% of Mexican 'at risk' species will be represented in botanical garden <i>ex situ</i> collections.
UK	Plant Network (The Plant Collections Network of Britain and Ireland) adopted a 'Target 8 project' which aimed to use member gardens to grow the threatened plants of Britain and Ireland <i>ex situ</i> and to link them to conservation work <i>in situ</i> . Target 8 also provides a major focus for the Millennium Seed Bank Project of the Royal Botanic Gardens, Kew which had banked 10% of the world's plant species by 2010, including 96% of the UK native flora.





been assessed (Walter and Gillett, 1998). In the absence of a comprehensive list of globally threatened plants, measurements of progress towards Target 8 are necessarily based on estimates and extrapolation.

Using the data that is available however, we can at least develop a reliable baseline for moving forward. Some 40,000 plant species have so far been recorded as globally threatened (Walter and Gillett, 1998 and IUCN, 2010). Of these, just over 9,000 are recorded in cultivation in botanic gardens. This means that at the global level, at least 23% of globally threatened plant species are known to be in the *ex situ* collections of the world's botanic gardens, clearly indicating that Target 8 has not yet been achieved globally. However, as noted above, this figure must be treated with caution and it is possible that significantly more of the species recorded in PlantSearch may prove to be globally threatened when further assessments are carried out. Furthermore, a much more encouraging picture emerges when national and regional efforts are taken into account. Mega-diverse countries such as China, Brazil and Mexico have set national targets for *ex situ* conservation which reflect Target 8, and are progressing well towards these targets. These three countries collectively hold at least 25% of the world's plant diversity, and many of their species are endemic. Little of the data for *ex situ* collections in these countries is so far included in PlantSearch. Once this data is combined with the global list, the figure for globally threatened plant species in *ex situ* collections will be much higher than 23%.

Increasing the amount of data provided by botanic gardens to PlantSearch is also an important factor in being able to accurately assess progress towards the target. A recent focus on North America by BGCI resulted in a 5-fold increase in the number of institutions providing data. Similar initiatives in other countries, such as Russia and Indonesia, where BGCI has worked closely with botanic garden networks, have also yielded further increases in data.

## National and regional experiences in implementing Target 8

### Saving Europe's threatened flora

The European flora consists of around 14,000 species and includes a wide range of domesticated and economically important species and their wild relatives. Despite being amongst the most studied flora in the world, the continuing loss of plant diversity in Europe remains a major concern. Although various estimates have been made for the number of threatened plant species in Europe, an up-to-date European plant Red List does not presently exist. To address this gap BGCI developed a consolidated list of European threatened species as a step towards a formal Red List. To generate the list, a database consisting of national Red List data from 28 European countries was developed. This included distribution and threat status information for over 11,000 taxa. A list of 1,917 regionally threatened species was extracted from the database and screened against BGCI's PlantSearch database and ENSCONET's (European Native Seed Conservation Network) database of plants conserved in European seed banks. This analysis revealed that 42% of European threatened species are in *ex situ* conservation programmes within Europe (Sharrock and Jones, 2009).

### *Ex situ* plant conservation in China

China is home to approximately 10% of the world's plant diversity and more than half of its 33,000 species are endemic (MEP, 2008). This unique flora is increasingly under threat, with some 4-5,000 species considered to be at risk of extinction. However, China's botanic gardens have prioritised the conservation of rare and threatened species and are progressing rapidly towards Target 8. The combined living collections of the ten Chinese Academy of Sciences (CAS) botanic gardens include some 24,667 species (Huang, 2010). It is estimated that approximately 80% of the species in these collections are native Chinese plants and that all the 388 species categorised for national protection (Fu, 1992) are included. However, extensive *ex situ* collections have not yet taken place for the 4,404 species included on a more recently published Red List (Wang and Xie, 2004). In addition to the living collections of the botanic gardens, wide scale seed-banking is also given priority and China's first national seed bank for wild plants, the Germplasm Bank of Wild Species at the Kunming Institute of Botany in Yunnan Province now contains some 30,000-plus seeds.

### Plant conservation in Russian botanic gardens

In 2002-2005, an inventory of Russian botanic garden collections was carried out to identify threatened plants in cultivation in botanic gardens. This revealed that in 2005, 249 of the 461 (54%) species of higher plants included in the Russian Red Book were cultivated in the botanic gardens of Russia. 20 species were represented in collections of three and more botanic gardens (i.e. they had

sufficient numbers in cultivation to provide an insurance for the future). Efforts are now focused on the creation of a new database of rare and threatened plants. Results of the preliminary analysis show that between 2005 and 2010, there was significant growth in the number of botanic gardens in Russia maintaining collections of rare species, as well as a marked increase in the overall number of conserved species. According to this data, the living collections of botanic gardens now contain about 64% of the threatened species of the Russian flora. Thus, Russian botanic gardens have already achieved Target 8 at the national level (Gorbunov and Smirnov, 2010).

### Assessing North American collections

The North American Collections Assessment<sup>1</sup>, a joint project of BGCI-US, the Arnold Arboretum and the United States Botanic Garden, is identifying how many rare taxa native to North America (including Canada, Mexico, and the United States) are maintained in collections at North American institutions. For this, information on taxa held in living plant collections, seed banks, tissue culture and cryopreservation facilities was collected from 217 institutions, and a list of 9,619 rare taxa (critically imperiled, imperiled, vulnerable, historical, or extinct in the wild) was compiled from NatureServe Global ranks, the IUCN 2010 Red List, and Mexico's NOM-059-SEMARNAT-2001 (including an updated but unpublished NOM-2010 list). More than 35% of these known rare taxa are maintained in collections at institutions on the continent. Of these, over 1,850 taxa are maintained in seed banks or other germplasm storage facilities (with 22 institutions or conservation networks contributing data) while nearly 1,900 (20%) taxa are in cultivation at North American botanic gardens. Over half of the rare taxa in cultivation are recorded from only one institution, and additional work is needed to identify how genetically diverse and representative these collections are. While a majority of the rare taxa in seed banks or other germplasm collections are recorded in only one or two locations, they often include multiple accessions of genetically diverse collections and therefore have direct application to reintroduction efforts. An upcoming report *Conserving North America's Threatened Plants* will provide detailed results of this assessment, including ongoing reintroduction efforts being carried out across the continent.

### Conserving South Africa's unique flora

Since the world-renowned Kirstenbosch National Botanical Garden was established in 1913, ongoing efforts have been made to conserve threatened South African indigenous plants within botanic gardens (Willis, 2006). South Africa has a network of nine national botanic gardens (NBGs) that are managed by the South African National Biodiversity Institute (SANBI) and the conservation of South African indigenous plants is included in the mandate of these gardens. A survey of the *ex situ* collections of the NBGs was carried out in 2002 and this showed that some 8,500 indigenous plant taxa were grown in these gardens, or 39% of South



Africa's 21,721 indigenous plants. At this time a total of 813 Red List plant species were represented in the NBG collections. A more recent assessment (2009) indicated that the number of threatened plant taxa in the NBGs stands at 775, representing just over 30% of South Africa's 2,577 threatened taxa (van Wyk, pers. comm.). A further 160 South African Red Listed plants are in cultivation in botanic gardens outside South Africa, raising the percentage of threatened plants in cultivation to 36%.

### Taking a species-based approach

In the absence of a comprehensive global plant Red List, BGCI, working with the IUCN/SSC Global Tree Specialist Group and in partnership with Fauna and Flora International (FFI), has taken a lead on red listing tree species. To date, Red Lists of Magnolias, Oaks and Maples have been published (Cicuzza *et al.*, 2007; Oldfield and Eastwood, 2007; Gibbs and Chen, 2009) and a Red List of Rhododendrons is in preparation. With the Red List data as a basis, BGCI has carried out in-depth surveys of botanic garden collections to identify threatened species not yet in cultivation and has highlighted, encouraged and supported action to address the gaps. In the case of magnolias, only 37 of the 89 Critically Endangered and Endangered species were found in cultivation and BGCI therefore initiated work in the two main centres of Magnoliaceae diversity – China and Latin America to ensure the conservation and restoration of priority threatened species. The situation is similar for oaks, with more than half of the Critically Endangered or Endangered taxa not currently known in cultivation and therefore at great risk of extinction if the threats they are facing in the wild are not addressed.

## Conclusions

There is clearly still much work to be done to achieve Target 8 at the global level. However, our review indicates that despite this, Target 8 has been successful in many ways, most notably in mobilizing botanic gardens and stimulating conservation action at the national level in many countries.

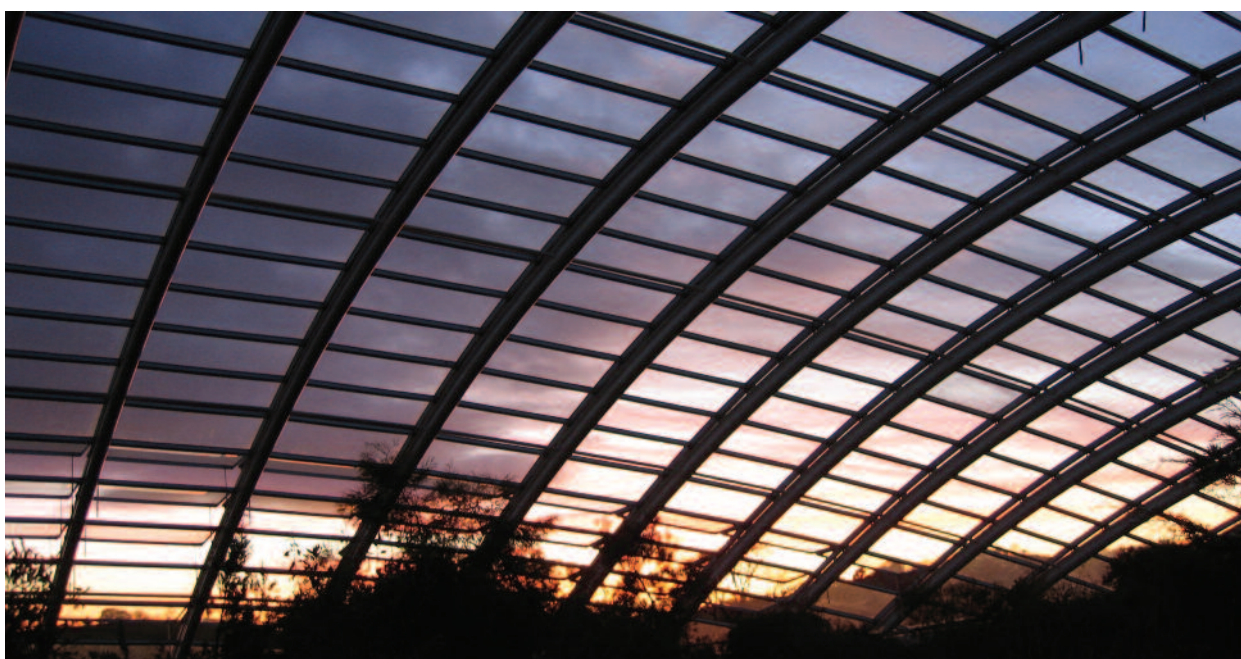
BGCI's PlantSearch database, developed as a direct response to Target 8, is now in place and increasingly being used in a variety of ways. It has been shown to provide an efficient tool for measuring progress towards Target 8 with respect to the living collections of botanic gardens. Resources are now being sought to further develop the database, improving its compatibility with regional and national databases and to increase the capacity of individual gardens to exchange data through BGCI. Furthermore, seed bank data is presently not routinely included in PlantSearch and this needs to be addressed to ensure such collections are included in future *ex situ* assessments.

Without knowing how many and which species are under threat, monitoring progress towards Target 8 at the global level will continue to be challenging. There is therefore a need to accelerate the process of plant red listing – with particular attention being paid to socio-economically important plants, such as medicinal plants and crop wild relatives, as well as woody species necessary for forest restoration and carbon sequestration projects around the world. Moreover, as the impacts of climate change accelerate, priority for *ex situ* conservation should also be given to species that are potentially vulnerable, even if these are not yet considered threatened.

Target 8 consists of two elements – “60% of threatened species in *ex situ* collections” and “10% of these in recovery and restoration programmes”. Monitoring the second part of Target 8 has proved to be a greater challenge than the first part, and relatively little progress has been made to date. However, as the GSPC enters its second phase and greater attention is focused on the urgent need to restore the world's degraded ecosystems, BGCI will be giving priority to promoting and monitoring this vitally important component of the target.

Furthermore, an analysis of the data indicates that of the 9,000 or so globally threatened species that are in botanic garden collections, around one-third are to be found in only one garden. If *ex situ* collections are considered an ‘insurance policy’, questions must be asked if single-location collections are sufficiently secure. In these cases particularly, it will be important to know how genetically diverse and representative these collections are.

The proposed updated Target 8 for 2020 calls for “At least 75% of threatened plant species in *ex situ* collections, preferably in the country of origin, and at least 20% available for recovery and restoration programmes”. Genetically representative collections are essential if they are to be used for recovery and restoration work. The focus and challenge for the coming decade must therefore surely be not only to increase the number of threatened plants in *ex situ* collections, but also on assessing and ensuring the conservation value of such collections. Working collectively, botanic gardens are stepping up their efforts to ensure a future for the world's plant diversity.



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