BGjournal
Journal of Botanic Gardens Conservation International
Volume 6 • Number 1 • January 2009

Ecological restoration and the role of botanic gardens

BGCI
Plants for the Planet


Editors: Suzanne Sharrock and Sara Oldfield

Cover Photo: Foreground: native highland forest remnant; background: grassland vegetation following deforestation and continued 'slash and burn' practice. Northwest of Antananarivo, Madagascar. (BGCI).

Design: John Morgan, Seascape
E-mail: studio@seascapedesign.fsnet.co.uk

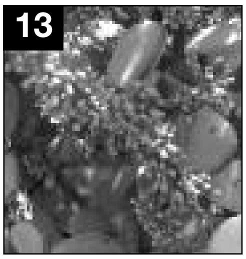
BGjournal is published by **Botanic Gardens Conservation International (BGCI)**. It is published twice a year and is sent to all BGCI members. Membership is open to all interested individuals, institutions and organisations that support the aims of BGCI (see inside back cover for Membership application form).

Further details available from:

- Botanic Gardens Conservation International, Descanso House, 199 Kew Road, Richmond, Surrey TW9 3BW UK. Tel: +44 (0)20 8332 5953, Fax: +44 (0)20 8332 5956 E-mail: info@bgci.org, www.bgci.org
- BGCI-Russia, c/o Main Botanical Gardens, Botanicheskaya st., 4, Moscow 127276, Russia. Tel: +7 (095) 219 6160 / 5377, Fax: +7 (095) 218 0525, E-mail: seed@aha.ru, www.bgci.ru
- BGCI-Netherlands, c/o Delft University of Technology Julianalaan 67, NL-2628 BC Delft, Netherlands Tel: +31 15 278 4714 Fax: +31 15 278 2355 E-mail: l.j.w.vandenwollenberg@tudelft.nl www.botanischetuin.tudelft.nl
- BGCI-Canarias, c/o Jardín Botánico Canario Viera y Clavijo, Apartado de Correos 14, Tafira Alta 35017, Las Palmas de Gran Canaria, Gran Canaria, Spain. Tel: +34 928 21 95 80/82/83, Fax: +34 928 21 95 81, E-mail: jmlopez@grancanaria.es
- BGCI- China, 723 Xingke Rd., Guangzhou 510650 China. Tel:(86)20-37252692. email: Xiangying.Wen@bgci.org www.bgci.org/china
- BGCI – South East Asia, c/o Registry, Singapore Botanic Gardens, 1 Cluny Road, Singapore 259569. E-mail: Bian.Tan@bgci.org,
- BGCI-Colombia, c/o Jardín Botánico de Bogotá, Jose Celestino Mutis, Av. No. 61-13 – A.A. 59887, Santa Fe de Bogotá, D.C., Colombia. Tel: +57 630 0949, Fax: +57 630 5075, E-mail: jardin@gaitana.interred.net.co, www.humboldt.org.co/jardinesdecolombia/html/la_red.htm
- BGCI-Deutschland, c/o Botanische Gärten der Universität Bonn, Meckenheimer Allee 171, 53115 Bonn, Germany. Tel: +49 2 2873 9055, Fax: +49 2 28731690, E-mail: biogart@uni-bonn.de
- BGCI(US) Inc, c/o Chicago Botanic Garden, 1000 Lake Cook Road, Glencoe, Illinois 60022, USA. E-mail: usa@bgci.org, www.bgci.org/usa

BGCI is a worldwide membership organisation established in 1987. Its mission is to mobilise botanic gardens and engage partners in securing plant diversity for the well-being of people and the planet. BGCI is an independent organisation registered in the United Kingdom as a charity (Charity Reg No 1098834) and a company limited by guarantee, No 4673175. BGCI is a tax-exempt (501(c)(3) non-profit organisation in the USA and is a registered non-profit organisation in Russia.

Contents



Guest editorial

Botanic gardens have long played a crucial role in documenting plant diversity and supporting efforts to protect it. Now, in the face of accelerating climate change and loss of biodiversity, it is clear that repair and restoration of damaged plant communities is needed more than ever before. With the unique combination of scientific and practical plant-based skills in botanic gardens, they are ideally placed to support a new surge in restoration science and management.

An international workshop was held at the Royal Botanic Gardens, Kew in June 2008 to identify the ways in which botanic gardens could do more to support the science of ecological restoration. The following important areas were among those identified.

A thorough understanding of the plant communities proposed for restoration is an essential starting point – their species and genetic composition, how they function ecologically and how they are likely to adapt to future climate change. The historical specimens and records safeguarded by most botanic gardens, along with leading expertise in botany, conservation genetics and computer modelling, can help to generate this vital information. On the practical side, increasing numbers of botanic gardens are now augmenting their living collections with seed banks, while developing storage, handling and germination protocols to enable the seeds to be put to use. Botanic gardens also commonly employ a wide range of horticultural techniques, from large-scale irrigation and weed control to the precision art of micropropagation, and staff members are well used to dealing with the diverse whims of the many species in their living collections – all experience which could prove valuable in restoring complex plant communities.

Restoration may be a slow process and research in this area calls for a commitment to research-based monitoring associated with adaptive management over considerable periods. Many botanic gardens can offer the level of stability and long term commitment required to undertake such a task, as well as having the necessary botanical skills.

Unlike most other research institutions, botanic gardens have their own estates, which will sometimes cover a range of habitats. This gives them the potential to carry out, experiment with or demonstrate various restoration techniques. The potential to show restoration in action is particularly exciting, offering the chance to inspire visitors to adopt methods they have seen.

Botanic gardens are globally dispersed, representing a broad spectrum of regions and floras. They have proven skills in the long term storage of diverse data, with specimen and collection records accumulated over centuries. Their information base also includes an impressive range and diversity of plant-related data generated through years of research and practice - an invaluable resource which can support the emerging science of restoration ecology. However, there is an urgent need to collate and share this information throughout the global network – a clear role for BGCI - which links botanic gardens worldwide and maintains global databases covering the work of botanic gardens and their plant collections.

If they are to assume an important role in restoration, the worldwide coverage of botanic gardens should be a strength. At a practical level, The Millennium Seed Bank Project provides a strong model of a cohesive network, involving partners in many countries around the world. We now need to build on this and to enhance the bonds of commitment and cooperation throughout BGCI's global botanic garden network. We need to agree on strategic priorities where the science of restoration ecology would be most usefully applied to achieve maximum benefit for all.

Kate A. Hardwick and
Stephen D. Hopper
Royal Botanic Gardens, Kew, UK.

Authors: Kingsley Dixon and Suzanne Sharrock

Botanic gardens in the age of restoration

Introduction

Storm Cunningham's latest book, provocatively entitled reWealth (McGrawHill), presents global restoration as a $2 trillion global industry. His mantra is that we can no longer exploit the planet in the belief that there is an inexhaustible supply of natural resources and that restoration of our natural capital assets (as well as the built and social capital of human societies) is critical if the planet is to be sustained. The question remains as to just how well botanic gardens are seizing the opportunity to be an effective and integral part of the global restoration challenge?

Building a common vision

For the past three decades or so, botanic gardens have been on a journey of discovery. The journey was a response to a world call-to-arms based on the pollution scares of the 1970's (the scene was set by Rachel Carson's Silent Spring) followed by the dire predictions of a global biodiversity melt-down and the Rio Summit in 1992, which culminated in the establishment of the Convention on Biological Diversity (CBD). While the CBD committed countries to conserve their biodiversity, it was still several years before a specific plan for conserving plant diversity at the global level emerged. Following concerted action by the world's leading botanists, the Global Strategy for Plant Conservation (GSPC) was adopted by the Parties to the CBD in April 2002, strengthening botanic gardens' connections globally. The GSPC includes 16 outcome-oriented targets to be met by 2010 and Target 8 focuses on *ex situ* conservation and restoration. This target provided botanic gardens for the first time with a united vision – avert plant extinction through *ex situ* conservation. Seedbanks, tissue culture, cryogenics and DNA fingerprinting emerged as charismatic technologies employed to save species.

> ***GSPC Target 8:*** *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.*

Today, the world's 2,500 botanic gardens have assembled a formidable scientific armoury in the fight against extinction. The scientific capacity of botanic gardens through such initiatives as the Millennium Seedbank Project has meant that '*…there is no technological reason why any species need go extinct*' (Paul Smith, Head, Millennium Seed Bank Project). Through their living collections and seedbanks, the world's botanic gardens and arboreta conserve a vast number of plant species. In an attempt to monitor progress towards Target 8, in 2004 BGCI launched its PlantSearch database, which provides information on plants in cultivation in botanic gardens, and links this information to threatened plant databases. At least 12,000 globally threatened species are maintained in botanic garden collections and some 100 plant species are now only found in botanic gardens! But where to next? Do seedbanks or artificially maintained populations in a botanic garden constitute conservation or do botanic gardens need to collectively take the next step in the conservation journey and restore species and habitats? If Target 8 of the GSPC is to be achieved, the answer is clearly the latter.

Above: For many species such as *Grevillea pythara* now reduced to a single individual in the wild, the only future for *in situ* conservation will rely on restoration of nearby landscapes and assisted migration to new safe-sites. (K. Dixon)

The restoration challenge

Although reintroduction of threatened species in the wild has so far been relatively restricted, recovery of wild

Right: Today, conservation and reintroduction strategies are as much about restoring habitat for threatened species as protecting their germplasm and genetic resources off-site. (Tony Scalzo, right and K. Dixon, far right)

populations of depleted species may be increasingly important in repairing damaged ecosystems and restoring connectivity at a landscape scale. However, for many of the world's threatened species, repatriation to nature is just not an option. With 60% of the land area of the planet now disturbed by humans, we can no longer rely on finding suitable and naturally resilient wild locations for all species; such areas just don't exist. For example, of the 2,814 conservation species in Western Australia (double the flora of the United Kingdom), at least half exist in highly disturbed habitats where invasive species, disease (particularly *Phytophthora*), salinity and pests mean that the critical ecological equilibrium needed to support long-term, self-perpetuating populations is not in place. Similar scenarios are now being played out in many countries.

The conservation mantra is therefore turning towards how habitats can be rebuilt, revitalised and restored, heralding a new era and new opportunities for botanic gardens as 'restoration hubs'. Restoration is inextricably tied to the global conservation challenge. Restoration takes a dysfunctional ecosystem and returns it to health and ecological equilibrium as a dynamic component of the conservation picture. In Cunningham's words, '..*restoration.. takes a dying, useless or ugly asset and returns it to health, value and beauty..*' What better ideal for botanic gardens than to engage in the reclamation of abandoned and seemingly 'useless' land while providing the ecological framework for repatriation of species. With over 200 million visitors annually, the capacity for botanic gardens to link active restoration to awareness within communities presents new opportunities for focusing education and extension programmes.

Restoration in a time of climate change

Climate change introduces an added complexity to ecosystem restoration. It is no longer 'simply' a question of restoring an ecosystem to its previous state by the reintroduction of species, but in the face of a changing climate, new species assemblages may also need to be considered. Restoration activities will also need to take into account the migration needs of plant species as they attempt to move into new climatically secure, safe havens. In ancient, stable floras such as those found in South Africa and temperate southwestern Australia, the prospect is particularly daunting as new research shows that many major plant groups lack capacity for long-distance, short-time frame dispersal. Iconic plants, such as *Banksia*, face the prospect of dwindling populations unable to effectively migrate to safe-sites by the 2050 date when climate change is expected to spell the end for a third or more of the world's plant species (Thomas *et al*., 2004; Fitzpatrick *et al*., 2008). For many plant species therefore, in today's highly fragmented and developed landscapes, assisted migration (see Box 1) may be the only way to secure species in environments where there will be some hope of sustaining populations outside of their 'protective custody' environments in botanic gardens.

The role of botanic gardens

Restoration ecology, the science of restoration, is an emerging and energetic discipline that brings into focus and play, an array of conceptual and technological tools. For botanic gardens, these tools represent challenges and opportunities to cross-cut science and operational areas for creating a 'one-stop-shop' in restoration. For example, botanic gardens invest substantially in horticultural science with living collections that represent many years

Box 1: Assisted migration

Assisted migration, or the establishment of plant species or communities in areas not presently within their 'native' ranges, is a contentious issue that places different conservation objectives at odds with one another. There are numerous examples where moving species beyond their current range into natural and agricultural landscapes has had significant negative consequences. However, the growing threat of biodiversity loss due to climate change means that if preventing climate-driven extinction is a conservation priority, assisted migration must be considered an option. Botanic gardens are well placed to contribute to the debate, which should include assessments of potential benefits and risks using lessons from natural succession dynamics, experimental introductions and restoration ecology.

Issues that will need to need taken into account include:

- The need for basic current distribution data;
- The accuracy of predicted future distribution based on modelling;
- The importance of community / inter-species interactions;
- Extent and type of intraspecific diversity in the source population;
- Potential for invasiveness in the new habitat.

of research and trial and error in developing horticultural excellence. Linking this capacity with the other research capacities in botanic gardens represent a unique opportunity for complimentary up-skilling for restoration activities. Few other organisations are so equipped to deliver such a potent combination of skills and ability linked to a strong and vibrant horticultural heritage.

Furthermore, the worldwide network of botanic gardens together holds a wealth of information and experience on cultivating plant species in different environments. In the face of rapid climate change, exchange of such information will be invaluable in developing efficient and sustainable restoration programmes. In support of this, BGCI has developed two new modules for its PlantSearch database, which will allow botanic gardens to share information on propagation methodologies and restoration efforts on a species-by-species basis.
At present these modules consist of a set of internal web pages on the BGCI website and a desktop application that allows institutions to enter data without being connected to the internet.
A working prototype will be developed following consultation with BGCI member gardens around the world and agreed initial data entry will be undertaken for *Magnolia, Acer, Quercus* and *Rhododendron* and for threatened plants of Russia. Information collected through this data entry will be used to provide case studies to plan the development of a manual on the restoration of endangered tree species.

Conclusion

Although important players in the global restoration challenge, it is clear that botanic gardens will not be able to tackle this alone. Restoration of nature has been aspired to for generations. The seamless transition from conservation to restoration as witnessed from the middle of the 20th century with the calls of Aldo Leopold (Sand County Almanac) to protect nature and natural resources ("*A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise*") to the ascendancy of the restoration ethic we see today in such books as reWealth, call upon integration – at the scientific, cultural/social, economic and political levels. For botanic gardens, linking within and beyond our institutional boundaries to embrace broader scientific, economic and social agendas will be fundamental for ensuring botanic gardens use their formidable capacity to deliver broadscale benefits in species and ecosystem restoration.

Left: Community-based coastal restoration in the biodiversity hotspot of southwest Western Australia (K. Dixon)

References

➡ Thomas, C.D., Cameron, A., Green, R.E., Bakkenes, M., Beaumont, L.J., Collingham, Y.C. *et al*. 2004. *Extinction risk from climate change*. Nature, **427**, 145–147.

➡ Fitzpatrick, M.C., Gove, A.D., Sander, N.J. and Dunn, R.R. 2008. *Climate change, plant migration, and range collapse in a global biodiversity hotspot: the* Banksia *(Proteaceae) of Western Australia*. Global Change Biology, **14**(6): 1337-1352.

Kingsley Dixon
Director Science
Kings Park and Botanic Garden
West Perth, 6005
Western Australia;
Visiting Professor
The University of Western Australia.
Email: kdixon@bgpa.wa.gov.au

Suzanne Sharrock
Director of Global Programmes
BGCI
Descanso House
199 Kew Road
Richmond TW9 3BW
UK.
Email: Suzanne.sharrock@bgci.org

Below: The global restoration challenge is being embraced across all sectors of society (K. Dixon)

Authors: Joyce Maschinski, Scott Lewis, Don Walters, Jennifer Possley, Samuel J. Wright, Julissa Roncal and Caroline Lewis

The Connect to Protect Network: Botanic gardens working to restore habitats and conserve rare species

Above: Pine rocklands habitat (Metrozoo Pineland) (Jennifer Possley)

Introduction

Throughout the world, coastal habitats are gravely threatened by sea level rising. Focusing on the ecosystems and species at greatest risk of extinction in South Florida and the Caribbean, Fairchild Tropical Botanic Garden has begun a conservation initiative for globally endangered pine rocklands. Our efforts directly link ecological restoration to rare species conservation, while engaging the public to participate in the solution to a daunting conservation problem. We created The Connect to Protect Network that includes concentrated seed collections of common and rare pine rockland species, collaborations with the educational programme 'Fairchild Challenge' to engage community members in pine rockland restoration, and partnerships with private and public land owners to create pine rockland gardens as stepping stones between pine rockland fragments.

The Connect to Protect Network

Globally endangered pine rocklands occur only in South Florida, the Bahamas, and Cuba. Known by their South Florida slash pines (*Pinus elliotii* var. *densa*) and saw palmettos (*Serenoa repens*), they support over 400 native plant species, of which 31 are endemic, five are listed as federally endangered, and five are candidates for listing.

Rapid development in South Florida has endangered pine rocklands and their rare species. Once found extensively on limestone uplands in South Florida, today less than 2% remain as small fragments outside of the Everglades National Park. Many are protected by the Miami-Dade County, but some remain on unprotected public and private land.

When habitats become fragmented, plant populations become isolated and shrink in size. Fragmentation reduces the opportunities for pollinators to find flowers, which in turn may decrease seed production and the genetic health of these populations. Rare plants living in pine rocklands are particularly vulnerable to catastrophic events, such as hurricanes, and recovery from losses becomes more questionable. To help preserve and strengthen our remaining pine rocklands and to increase the numbers of pine rockland plants growing in Miami-Dade County, Fairchild Tropical Botanic Garden recently launched the Connect to Protect Network with funding from the U.S. Fish and Wildlife Service. Our objective is to create corridors and “stepping stones” to connect isolated pine rockland remnants and restore existing parcels to improve forest health. These corridors will serve to increase the probability that bees, butterflies, and birds can find and transport seeds and pollen across developed areas. Public and privately-owned pine rockland parcels may become part of the network. If degraded, parcels will be restored and planted with native pine rockland species. It is our hope that the interchange of seeds and pollen will improve gene flow and the likelihood that these species will persist over the long term. Threatened and endangered species planted in corridors will have increased numbers and reduced extinction risk.

Left: Students assist with crenulate leadplant habitat restoration by removing forest litter and dead leaves that accumulate due to fire suppression (Joyce Maschinski)

Pine rockland seed collections

Meeting the goals of the Connect to Protect Network will require planting many native pine rockland species that are not in the commercial trade. In preparation, we have collected seeds of pine rockland plants to learn about their germination, storage and cultivation requirements. *Ex situ* collections provide insurance against species extinction, plants for reintroduction or augmentation, and material to study the biology of rare species. Seed banks are a convenient and inexpensive way to conserve germplasm in a relatively small space. Although orthodox seed storage involving drying and freezing seeds generally works well for plants of temperate regions, it is unknown whether south Florida subtropical species will withstand drying or freezing. Therefore, we have begun testing seeds to determine optimal seed storage requirements for these species.

Left: *Liatris chapmanii* (Jennifer Possley)

To date we have collected over 50,000 seeds of 35 species for tests and long-term storage at The National Center for Genetic Resources Preservation in Ft. Collins, CO, USA (Table 1). Germination, desiccation and freezing trials indicate that most of the pine rockland species we have examined are capable of orthodox seed storage.

Collaborations with the Fairchild Challenge

Fairchild Tropical Botanic Garden’s environmental education outreach programme for middle and high school students is called the Fairchild Challenge. Comprised of a menu of multidisciplinary competitions, this free annual programme is designed for students of diverse interests, abilities, talents, and backgrounds and is open to all schools in the Greater Miami area. Successfully reaching a traditionally under-represented demographic group at botanical gardens, last year more than 40,000 students and 1,800 teachers from more than 100 middle and high schools participated in the programme.

Far left: The winning logo and slogan for the project was designed by Miami Palmetto High School student Yunxin Jiao.

With the Fairchild Challenge, we engaged students in diverse activities related to the Connect to Protect Network. As part of a 2007 Fairchild Challenge contest, Miami Palmetto High School student Yunxin Jiao designed the winning logo and suggested the slogan, “Connect to Protect” for our initiative.

Fairchild Challenge participating students have also helped us restore endangered species habitat. In October 2007 and February 2008, 100 students helped restore a fire-suppressed pine rockland that is home to the federally endangered crenulate lead plant (*Amorpha herbacea* var. *crenulata*). Because pine rocklands are adapted to periodic natural fires, which are infrequent in Miami-Dade County urban landscapes, conditions that are optimal for *Amorpha* growth and seedling recruitment are limited. In the absence of fire, shrubs and vines create dense shaded conditions and a deep layer of pine needles and palm fronds accumulate on the ground.

Above: *Lantana canescens* seeds are capable of orthodox storage and may hold the key to the species survival in Florida (Jennifer Possley)

Thanks to the efforts of students we removed 110 bags of leaf litter and stacked several large piles of vines and palm fronds! Miami-Dade County Natural Areas Management crews followed the students' efforts by thinning hardwood trees and shrubs to open the canopy. Fairchild will return to monitor *Amorpha* growth and seedling establishment. But in addition to the potential benefits of the restoration on the rare species, the enthusiasm of the students and their teachers was powerful. Many wanted to know when they could come back to continue the work, so we suspect that we have some committed conservationists to help with future projects.

Right: Corridors may improve pollinators visitation of pine rockland species like the U.S. federally endangered crenulate leadplant (*Amorpha herbacea* var. *crenulata*) (Jennifer Possley)

Several schools are also creating pine rockland gardens in their schoolyards. Schools located near corridors and natural areas serve as "stepping stones" between natural areas, increasing total space occupied by plants in the urban matrix and providing homes for the pollinators. In addition, these school gardens give students an opportunity to gain real experience in ecology, habitat restoration, and conservation. Fairchild facilitates the creation of these gardens by providing instruction to teachers, pine rockland plants and seeds, assistance with installation, and ideas about how gardens can be incorporated into maths and science instruction.

Experimental introductions of rare species

Unfortunately many South Florida rare species habitats are rapidly changing, such that they are becoming unsuitable for sustaining rare plant populations in the long-term. Surrounded by inhospitable matrices, migration and population expansion is prevented. Worse still, there may not be any suitable habitat remaining within their historic range into which they can disperse even if assisted by humans. Existing anthropogenic impacts leave few patches of land with natural vegetation of any sort, much less patches with special characteristics required by rare species.

Though the prospects are daunting, Fairchild has conducted experimental introductions of the regions' rarest species. After Fairchild scientists systematically review ecological, political and logistical criteria of potential reintroduction sites, we work closely with local land managers to restore habitats and introduce rare species. Initial findings of our studies suggest that it is possible to introduce species to novel habitats. By treating initial reintroductions as experiments to learn about the capacity of species to grow under current available conditions, we are hedging bets against uncertainty and improving chances for species persistence into the next century.

Conclusions

At Fairchild, we are concerned about the persistence of the rare and common plants in South Florida habitats that are predicted to be inundated by sea level rise within the next 100 years. Our proactive approach includes the following steps:

- ***Ex situ* conservation** through live collections and seed banking to increase options available for the future;
- **Connect forest fragments** with corridors to increase the probability of pollination and seed dispersal;
- **Decrease extinction risk** through restoring ecosystem health and reintroducing rare species;
- **Empower the community**, especially middle and high school students, to help be part of the solution.

Acknowledgments

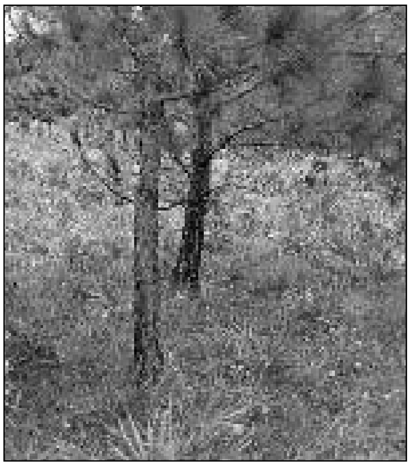
This work has been funded by the U.S. Fish and Wildlife Service, The Florida Dept. of Agriculture and Consumer Services, Division of Plant Industry and Miami-Dade County Natural Areas Management & Environmentally Endangered Lands Programs.

Key references:

➡ Guerrant, Jr. E. O., Havens, K., and Maunder, M. 2004. Ex situ *plant conservation: supporting species survival in the wild*. Island Press, Washington D.C.

➡ Maschinski, J. and Wright, S. J. 2006. *Using ecological theory to plan restorations of the endangered beach jacquemontia in fragmented habitats*. Journal for Nature Conservation **14**: 180-189.

➡ Maschinski, J., Possley, J., Bradley, K., Wright, S., Stolt, J., Walters, C., and Collins, M. 2007. *Developing corridors to alleviate problems of urban fragmentation on rare plant populations in South Florida*: March 2007. Report to U.S. Fish and Wildlife Service on Agreement No. 401816G137, South Florida Ecological Services Office, Vero Beach, FL.



Left: Pine rocklands habitat (K.S. Wendelberger)

➡ Maschinski, J. and Lewis, S. 2008. *Fairchild launches the Connect to Protect Network*. The Tropical Garden, Spring 2008.

➡ Myers, R.L. and Ewel, J. J. 1990. *Ecosystems of Florida*. University of Central Florida Press. Orlando, Florida, USA.

➡ Possley, J., Hines, K., Maschinski, J., Dozier, J. and Rodriguez, C. 2007. *A common passion: multiple agencies and volunteers unite to reintroduce goatsfoot passionflower to rockland hammocks of Miami, Florida, USA*. Native Plants Journal **8**:252-258.

➡ Possley, J., Maschinski, J., Rodriguez, C. and Dozier, J. 2008. *Alternatives for reintroducing a rare ecotone species: manually thinned forest edge versus restored habitat remnant*. Restoration Ecology online doi 10.111/j.1526-100X.2008.00395.x

➡ Roncal, J., Maschinski, J., Schaffer, B. and Gutierrez, S. M. 2008. *Introducing endangered species on a changing landscape: A case study of* Amorpha herbacea *var.* crenulata (Fabaceae) *in South Florida*. *In* Maschinski, J., Wright, S. J., Wendelberger, K., Pascarella, J., Schaffer, B. and Roncal, J. 2007. *Ongoing efforts to reintroduce and study two endangered plant species, beach jacquemontia and crenulate lead-plant*. Final report to U.S. Fish and Wildlife Service, South Florida Ecological Services Office, Vero Beach, FL.

➡ Wendelberger, K.S. and Maschinski, J. 2008. *Linking GIS, observational and experimental studies to determine optimal seedling microsites of an endangered plant in a subtropical urban fire-adapted ecosystem*. Restoration Ecology online doi:10.1111/j.1526-100X.2008.00422.x

➡ Wendelberger, K. S., Fellows M. Q. N. and Maschinski, J. 2007. *Rescue and restoration: Experimental translocation of* Amorpha herbacea *Walter. var.* crenulata *(Rybd.) Isley into a novel urban habitat*. Restoration Ecology online doi: 10.1111/j.1526-100x.2007.00325.x

➡ Wright, S. J. and Thornton, H. 2003. *A ranked list of restoration sites for* J. reclinata. *In* Maschinski, J., Wright, S. J., Thornton, H., Fisher, J., Pascarella, J. B., Lane, C., Pinto-Torres, E. and Carrara, S. *Restoration of* Jacquemontia reclinata *to the South Florida Ecosystem*. Final Report to the US Fish and Wildlife Service for Grant Agreement 1448-40181-99-G-173.

Correspondence to:
Joyce Maschinski
Fairchild Tropical Botanic Garden
Center for Tropical Plant Conservation
11935 Old Cutler Road
Miami, FL 33156, USA.
Email: jmaschinski@fairchildgarden.org

Table 1. Example of germination, desiccation and freezing tolerance of 14 pine rockland species.

Genus	Species	Date tested	Days to 1st germination	Duration of test (days)	# Seeds/ trial	Fresh	Desiccated	Stored 1 week at 20o C	Comments
Asclepias	*viridis*	9/15/2008	8	43	100	77%	87%	87%	
Brickellia	*mosieri*	3/24/2008	4	14	100	54%	50%	55%	
Chamaecrista	*deeringiana*	10/31/2008	2	4	100	88%	93%	90%	Seeds incised
Chamaecrista	*nictitans* var. *aspera*	9/26/2008	3	5	100	98%	97%	100%	Seeds incised
Crotalaria	*pumila*	2/14/2008	11	164	100	1%	2%	60%	Acid for 5 minutes
Echites	*umbellata*	2/15/2008	5	21	100	94%	96%	98%	
Gaura	*angustifolia*	2/15/2008	5	38	100	60%	62%	64%	
Melanthera	*parvifolia*	11/27/2007	6	38	100	21%	25%	33%	
Mimosa	*quadrivalis* var. *angustata*	9/5/2007	2	91	100	90%	12%	10%	With incision, frozen seeds germinated to 95% in 6 days
Morinda	*royoc*	8/7/2007	17	116	100	24%	23%	22%	With acid, frozen seeds germinated to 46%
Physalis	*walteri*	6/26/2007	9	56	100	52%	59%	55%	
Piloblephis	*rigida*	10/16/2007	3	22	100	36%	28%	33%	
Smilax	*havanensis*	11/27/2007	62	251	100	32%	34%	32%	Acid for 5 minutes
Trichostema	*dichotomum*	5/31/2007	6	50	100	50%	64%	71%	

Authors: Eric Bunn and Kingsley Dixon

Botanic Gardens: meeting the restoration challenge with critically endangered plants - a case history, *Symonanthus bancroftii* (Solanaceae)

A reintroduced male seedling plant in a restored population (E. Bunn)

Introduction

The wheat-belt region of Western Australia is one of the most extensively cleared landscapes in Australia with less than 2% of bushland remaining in some areas. The wheat-belt was underestimated in terms of biodiversity values and high levels of local and regional endemism and is now considered one of the most significant biodiversity melt-down regions in the biodiversity hotspot of southwest Western Australia (WA).

In the wheat-belt, many plant species are now restricted to small refugial habitats, often along roadsides and in small, scattered reserves sitting in a sea of wheat! *Symonanthus bancroftii* (Solanaceae) or Bancroft's Symonanthus - named after Dr Joseph Bancroft (1836-94, www.adb.online.anu.edu.au/biogs/A030084b.htm), is one of the rarest species in Western Australia and occurs in this region. The plant was thought to be extinct as the last known collection was in the 1940s. However the remarkable discovery of a solitary plant on a road-verge remnant in 1997 precipitated renewed interest in this species. The euphoria of the discovery was quickly dispelled when it was discovered that the plant was a male and that the impossible was needed – to find a female plant – and thus began a dedicated programme to locate more plants, a turning point for this species. Following intense searching in 1998 by local enthusiasts and a local LandCare group, another plant was found and with incredible good fortune this plant turned out to be a female! So the journey began to rebuild the entire species from the original 'Adam and Eve' for the species.

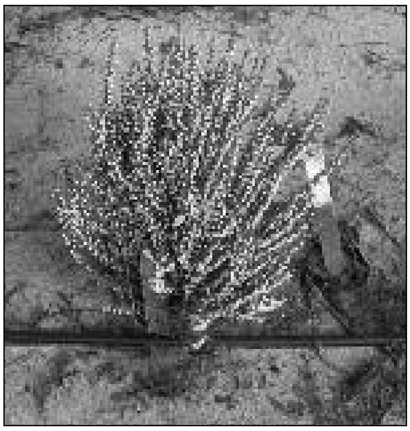
Both plants were found in disturbed and highly vulnerable habitats, one on a road-verge (the male plant) and the other (female) beside a railway track. Both sites were subsequently protected with fencing but are unfortunately still at risk to a variety of potentially lethal disturbances. For this reason urgent *ex situ* propagation was considered necessary. As the plants were widely separated it was considered unlikely that natural pollination could occur even if the plants were compatible, or that it would occur quickly enough to establish a seed bank before the plants perished. In addition, as these are very small plants, taking cuttings was deemed to be too risky. Tissue culture was therefore the logical choice for rapid propagation.

The Conservation Biotechnology research group at the Botanic Gardens and Parks Authority (BGPA) (Kings Park

Right: The original male plant of *Symonanthus bancroftii* (E. Bunn)

Left: Shoots of *S. bancroftii* growing in tissue culture (E. Bunn)

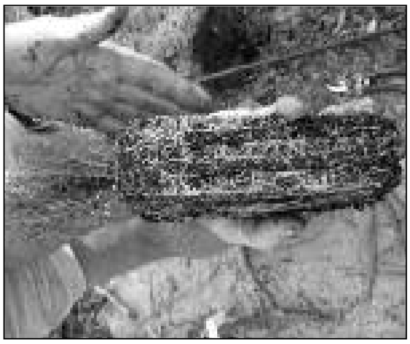
& Botanic Garden) are specialists in tissue culture of recalcitrant native plants, particularly rare and endangered species. The task of establishing a micropropagation method was begun in 1997 with the first collection of a small amount of shoot material from the male plant. Collection of this type of material (and indeed all such collections of rare and endangered plant material) is carried out by authorised Kings Park scientific staff with special permits from the relevant State Authority (in this case the Dept of Environment and Conservation or DEC). The initiation of material of the male plant into tissue culture was successful and a further study program was developed during 1998 to produce plants and overcome problems with the high mortality of shoots in the early stages of culture establishment. This study program resulted in a highly successful micropropagation procedure that was developed just in time to initiate shoot material of the second (female) plant found in 1998 (Panaia *et al*, 2000). In 2000-2001 micropropagated female plants were artificially pollinated with pollen from micropropagated male plants at Kings Park as part of a programme to study the reproductive biology of S. *bancroftii* (Ye *et al*, 2007) and resulted in production of the first seed of this species to be seen in over 50 years. Funding for setting up of field trials in 2002-4 was secured by the Bruce Rock LandCare group with assistance from BGPA and the Threatened Species Network – WWF Australia.



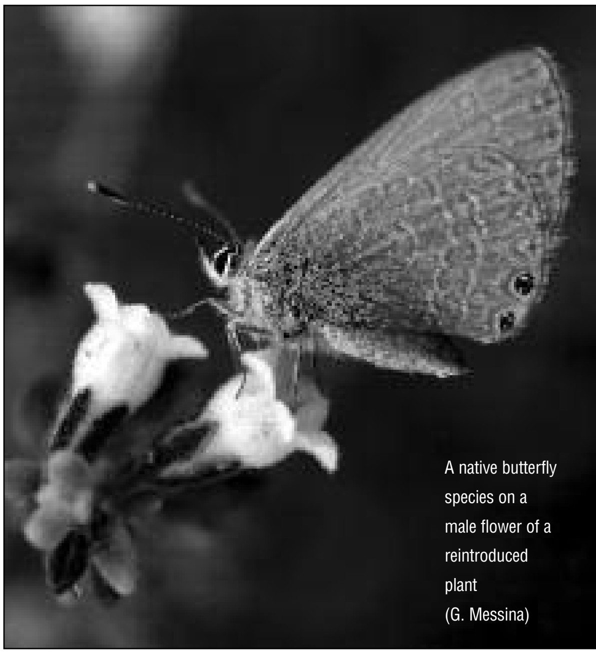
Bottom far left: Two-year old male plant in a restoration site (watering was found essential for at least the first year to maximise establishment of plants) (E. Bunn)

Over 2,400 plants (male and female) were produced from the micropropagation programme and planted in field sites from 2002-2006. Survival was low overall as many of these years saw below average rainfall accompanied by higher than average temperatures in summer, and in 2006 the driest June on record was experienced. Creating a watering system for the critical first season establishment also proved extremely difficult without a reliable water source (water needed to be carted to on-site tanks on a regular basis from nearby farm dams which were heavily drought-affected). Nevertheless, by 2004 in one field site approximately 25-30% of plants had survived two summers and these formed the basis of a stable reintroduced group of about 90 plants with a male:female plant ratio of approximately 1:3. Native insects were observed visiting flowers of both male and female plants in the field sites. From this sub-population seed was collected from female plants in 2006-2007. Utilizing the skills of the Seed Biology research group at Kings Park, a germination procedure was developed and seedlings were germinated for the first time in sufficient numbers to replace micropropagated plants in reintroduction trials. Although the first tentative seedlings transplants in 2006 were not particularly successful, follow up plantings in 2007 and 2008 are looking much more promising and a further 135 plants are now growing, spread over the two reintroduction sites. The change to a more reliable watering system (access to regional mains water for both restoration sites was made possible with assistance of WA Water Authority) for the early establishment of seedlings in 2007 has enabled much higher survival than was possible in the past. In addition, with the assistance of DEC and Bruce Rock Shire an automatic watering system is being developed. An existing manual pump system at the second site is run from a battery linked to a solar panel. It is likely that if micropropagated plants were used again, survival of these would also be much better than previously experienced. Although the cost of producing plants from seedlings is much cheaper than through tissue culture, the *in vitro* programme has enabled enough plants to be produced to create a stable reintroduced population capable of providing ample seed for further restoration, so has proved invaluable.

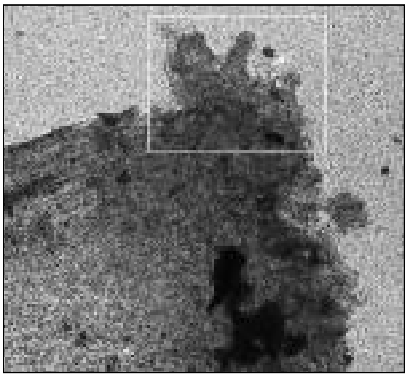
This project has also provided an opportunity to study the effects of extreme loss of genetic provenance on native species and the capacity of a species to rebound from such severe depletion. It is known that some plant species have undergone quite extreme genetic 'bottlenecks' in the past and were able to rebound and build up the species again (the much publicised Wollemi pine from eastern Australia had its origin in Jurassic times and is

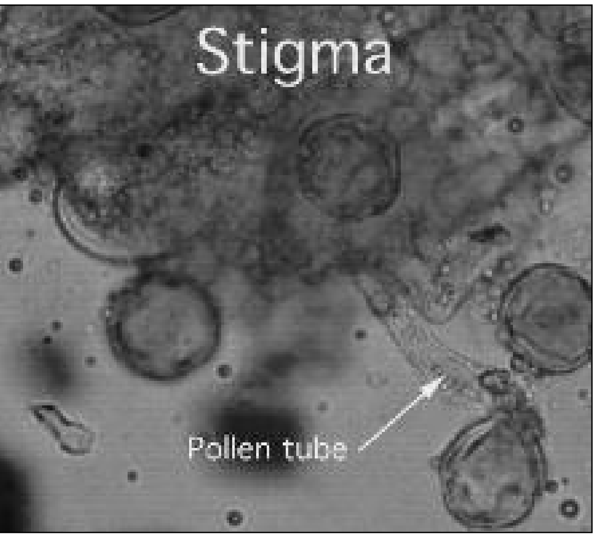


Left: Plants about to be transplanted to field (note well-developed root system resulting from specially modified slit 250 mm deep pots to encourage deep extensive root systems (E. Bunn)



A native butterfly species on a male flower of a reintroduced plant (G. Messina)

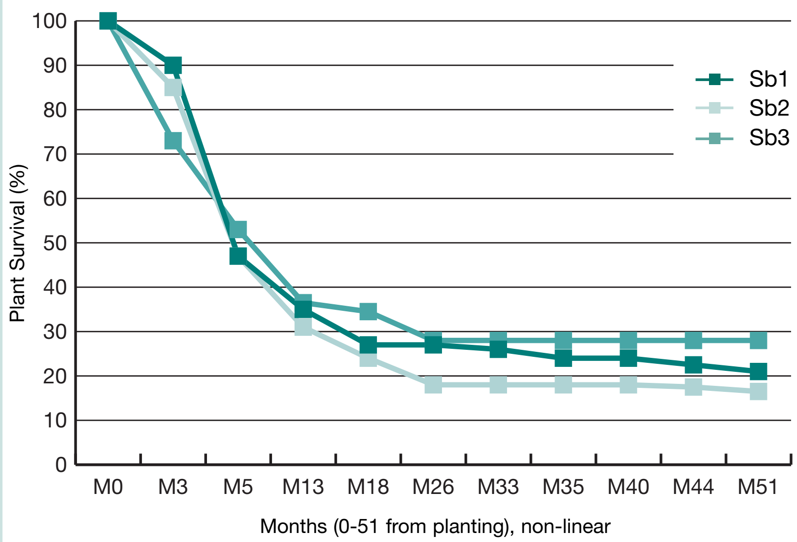




Top: Close up of *S. bancroftii* pollen grain on the stigma of a female flower (during artificial pollination) (E. Bunn)

Above: Germination of the pollen and pollen tube penetrating stigma tissue (E. Bunn)

Survival of micropropagated plants of three genotypes (Sb1 = original male plant, Sb2 = original female plant and Sb3 = daughter plant) of Symonanthus bancroftii *in a field site near Ardath, W.A. from original planting (M0 = June 2004) through to M51 (Sep 2008). Note the initial large loss of plants due to transplant shock M3-5) and again after the first summer (M13). By the second year after transplanting (M26) the population stabilized and losses in subsequent years (2007-8) have been minimal.*



now reputedly of very low genetic diversity but has still managed to survive!). The reintroduced populations of S. *bancroftii* represent a unique *in situ* 'laboratory' for these types of studies.

The continued survival of *Symonanthus* to the present day can be attributed to a partnership between conservation agencies and volunteer community groups who located the remaining plants, and the dedication of BGPA staff and research students. The programme illustrates the power and benefits of building 'citizen science' and partnerships for conserving rare and threatened species from a biodiversity hotspot.

Acknowledgements

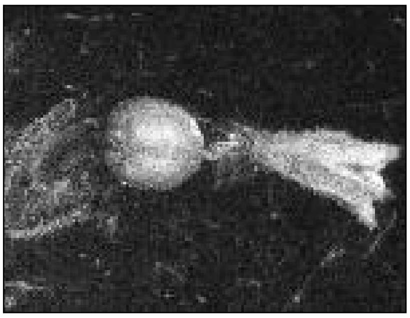
We would like to acknowledge staff and volunteers of DEC, Corrigin and Bruce Rock LandCare groups, Bruce Rock Shire, Water Authority of WA, the World Wildlife Fund, various BGPA staff (with special thanks to Bob Dixon and Keran Keys) and students, and volunteers from Friends of Kings Park who all assisted with this project over the years and made it possible.

References

➡ Panaia, M., Senaratna, T., Bunn, E., Dixon, K. and Sivasithamparam, K. 2000. *Micropropagation of the critically endangered Western Australian species* Symonanthus bancroftii *(F. Muell) L. Haegi (Solanaceae)*. Plant Cell, Tissue and Organ Culture **63**(1): 23-29.

➡ Ye, Q., Bunn, E., Krauss, S.L. and Dixon, K.W. 2007. *Reproductive success in a reintroduced population of a critically endangered Western Australian shrub,* Symonanthus bancroftii *(Solanaceae)*. Australian J. Botany **55**:428-432.

Eric Bunn and Kingsley Dixon
Kings Park and Botanic Garden
West Perth, 6005
Australia;
and
Faculty of Natural and Agricultural Sciences
School of Plant Science,
University of Western Australia
Nedlands, 6009
Australia.
Email: ebunn@bgpa.wa.gov.au; kdixon@bgpa.wa.gov.au



Right: Developing fruit on a female plant (E. Bunn)

Authors: Shirley Pierce, Richard Cowling, Anthony Mills,
Mike Powell and Ayanda Sigwela, R3G*

Restoring valuable spekboomveld using the international carbon market

One of the biggest restoration trials in the Southern Hemisphere aims to re-establish badly degraded spekboomveld and investigate carbon-trading opportunities

Left: Flowering spekboom (A. Mills)

Introduction

Think of the south-eastern Cape, South Africa, and an image that springs to mind is a stately kudu browsing gracefully in dense, tangled foliage. Or contented elephants in Addo Elephant National Park, placidly foraging on thorny branches and succulent leaves. The supporting vegetation is known as Thicket, (or more formally, the Subtropical Thicket Biome) which has its heartland near Addo, and is distributed as far as Riversdale in the west and the Great Fish River in the east. It is an ancient and complex vegetation type, expressed in different forms, ranging from low noorsveld at its inland margins, to the dense bush with emergent tree euphorbias and aloes characteristic of valley slopes. But what few are aware of is the extent of devastation of thicket vegetation wrought by poor farming practices.

Forms of thicket vegetation that have been especially ravaged by overgrazing in the past century, are those rich in spekboom or igwanishe, *Portulacaria afra*. There is evidence that even in the short space of a decade, heavy browsing, especially by mohair-producing angora goats, can convert dense shrubland into a desert-like state. Of some 16,000 square km formerly covered in spekboom-rich thicket, some 46% has undergone severe degradation and 34% moderate disturbance. Unfortunately, removing livestock and resting the veld does not lead to natural recovery of the vegetation, as seedling establishment is constrained by the exposed soil's temperature extremes and reduced water-holding capacity. Essentially, to restore this thicket type requires active intervention, which is what this article is about.

Degradation of thicket has negative socio-economic repercussions. Reductions in diversity, soil carbon, soil quality, and plant productivity all lead to lower livestock productivity (Mills and Fey, 2004; Mills *et al*., 2007). Decreases in availability of wood, wild fruits and medicinal plants used by rural communities also result in lowered income – approximately $150 per annum per household – which is a significant amount for struggling rural people (Cocks and Wiersum, 2003).

Restoration is expensive, and the active restoration of thousands of hectares of formerly healthy thicket, rich in spekboom plants, appears at first sight to be unfeasible. But there is compelling scientific evidence that spekboom - with its rather special characteristics, together with the possibilities of earnings via the carbon market, and the creation of jobs in the economically depressed rural areas - may provide an all-round solution (Mills and Cowling, 2006; Mills *et al*., 2007).

How grazing affects spekboom

It is interesting that, although spekboomveld evolved under the grazing of hulking megaherbivores - elephant and black rhino - it is especially vulnerable to heavy grazing by goats. The explanation for this anomaly is that indigenous animals feed from above, promoting the natural umbrella-shaped canopy. In contrast, goats tend to feed from underneath, with the result that overgrazing destroys this canopy. With indigenous browsing, the shrub forms a 'skirt' of branches which are able to root and proliferate on contact with the ground, while broken branches are able to re-establish, much like planted cuttings. The theory is that the plant's unique umbrella-shaped canopy maintains a cool, drier microclimate conducive to accumulating carbon-rich ground litter, which may also explain the rates of carbon sequestration which are extraordinarily high for an arid environment (Mills and Cowling, 2006).

Carbon storage in spekboom

Currently, there is an initiative which is building on the sound scientific evidence that spekboom is something of a 'superplant' when it comes to its extraordinary carbon storing capabilities. Data gathered over the last seven years show that carbon storage in intact spekboom thicket in the arid south-eastern Cape exceeds 20 kg of carbon per square metre of vegetation, which is equivalent to that of moist subtropical forests (Mills *et al*., 2005; Mills *et al*., 2005). In addition, the plant's ability to sprout from re-planted truncheons, without irrigation or cultivation in a nursery, makes it a very good candidate for large-scale restoration of degraded land. Furthermore, spekboom is thought to be especially efficient in capturing carbon as it is among those special arid plants which can switch from using the 'normal' photosynthetic pathway (C_3) to another water-conserving (CAM) pathway when conditions are dry. The ability to use the C_3 pathway when the soil is moist means it is more productive than those succulents that use only CAM.

Below: Mike Powell in front of a healthy stand of spekboom, *Portulacaria afra* (A. Mills)

The Restoration Research Group (R3G) is a group of scientists who are currently evaluating the feasibility of massive-scale restoration of thicket. Their project includes possibly one of the biggest restoration trials in the southern hemisphere. Spanning the entire Thicket Biome, a distance of about 800 km, this investigation aims to determine areas for 'optimal survivorship' and best growth from cuttings of the succulent-leaved shrub, spekboom, as well as variation in rates of carbon sequestration.

One aim of this trial is to determine the potential for re-planting to earn carbon credits on the international market as a future means of funding land restoration on freehold and communal land. R3G is working in close partnership with the Department of Water Affairs and Forestry's *Working for Woodlands* Project and supported by poverty-alleviation funds from the government's Expanded Public Works Project. The actual re-planting is being supervised by the Gamtoos Irrigation Board (GIB), the implementing agency which has been managing large-scale plantings over the last three years, restoring close to 400 ha in the Baviaanskloof Nature Reserve (a World Heritage Site), the Addo Elephant National Park and the Great Fish River Reserve.

Data on the remarkable rates of carbon storage under re-planted spekboom were collected on the farm Krompoort, between Uitenhage and Steytlerville, inland of Port Elizabeth. Over the last 30 years, the far-sighted farmer, Mr Henry Graham Slater, has systematically restored a degraded hillslope using spekboom truncheons. Now, the oldest spekboom plants stand more than 2 m tall and cover 90% of the planted site, an impressive growth from truncheons planted in bare ground under a rainfall of only 250-350 mm per year. The different-aged plantings enabled estimates of potential rates of carbon sequestration, with the oldest stand having sequestered 11 kg of carbon per square metre over 27 years, indicating an average rate of 0.42 kg of carbon per square metre per year (Mills and Cowling, 2006). This rate of carbon sequestration is comparable to many temperate and subtropical forests, and potential earnings through carbon credits are likely to rival forest-planting schemes.

Impressive results

The biome-wide trial commenced in January 2008, and already more than 100 of the planned 300 plots have been established. Farmers have been keen to participate in allowing trial plots to be located on their land, and many are going ahead with their own plantings. The trial plots (50 x 50 m each) are located in degraded thicket, and each plot is fenced off and manually planted with spekboom truncheons by trained teams under the supervision of GIB. Increments in carbon (above and below ground) are then monitored to determine rates of carbon storage.

Preliminary observations suggest that as the productive and water-efficient spekboom shrubs establish sufficiently to shade the soil surface and produce litter, the quality of the soil starts improving. This enables other flora and fauna to re-establish, and biodiversity begins to return. There is still much scope for horticultural research within our project to increase the survivorship of cuttings and to determine effects of soil properties (both biological and inorganic) on growth rates. Botanic gardens are well positioned to play a role in this critical part of restoration projects. Our project would welcome collaboration on this front.

Concurrent with the field trials, R3G is investigating the complex requirements to qualify for carbon credits. Trade in carbon in afforestation and restoration operates via two main paths: the formal compliance market (controlled by the Clean Development Mechanism, an arrangement under the Kyoto Protocol), or via the informal, voluntary market (Bumpus and Liverman, 2008). The spekboom project may well be best

suited to the latter market, which follows many of the formal procedures of the formal compliance market but relies on individuals who care about climate change, or else is dependent on those corporate companies with social responsibility programmes. The voluntary market also takes into account the sustainable development of rural livelihoods and benefits for biodiversity. A critical aspect for either market is accurate quantification of carbon stocks in landscapes before and after the restoration. These carbon stocks include carbon in soils, litter and biomass. In order to earn the carbon credits, auditors need to be contracted to validate the project and certify that the carbon quantification is scientifically rigorous. This adds large transaction costs to a restoration project aiming to earn carbon credits and a rule of thumb is that any project less than 10,000 hectares is unlikely to earn sufficient credits to warrant the transaction costs. Seeing projects of this size implemented across the Eastern Cape is the ultimate goal of the Working for Woodlands programme. Green investors who back the carbon market are, however, at this stage still required to make this vision a reality.

Ultimately the potential benefits of restoration to degraded thicket landscapes are enormous from an environmental, social and economic perspective, leading to: increased wildlife carrying capacity, reduced soil erosion, improved water retention and infiltration in the soil, and the return of biodiversity, while earning carbon credits on international markets which can provide employment and income to rural communities. Surely a win-win-win situation!

Amended from an article published in Veld & Flora, the Journal of the Botanical Society of South Africa.

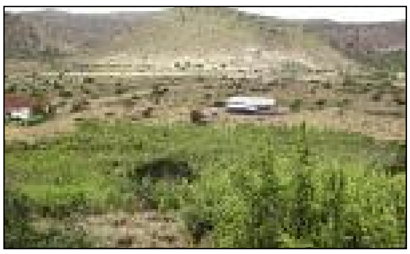
*R3G –the Restoration Research Group - comprises a group of scientists whose strength lies in a unique partnership, applying their scientific expertise with the practical implementation of the South African Government's Department of Water Affairs and Forestry's *Working for Woodlands* Project, which trains and employs contracting teams funded by the Expanded Public Works Programme (EPWP) under the supervision of the Gamtoos Irrigation Board. The scientists are based at Rhodes University, Stellenbosch University and Nelson Mandela Metropolitan University. See www.r3g.co.za.

References

- Bumpus, A. G. and Liverman, D. M. 2008. *Accumulation by decarbonization and the governance of carbon offsets*. Economic Geography **84**(2): 127-155.
- Cocks, M. L. and Wiersum, K. F. 2003. *The significance of plant diversity to rural households in Eastern Cape province of South Africa*. Forestry, Trees and Livelihoods **13**: 39-58.
- Mills, A. J. and Cowling, R. M. 2006. *Rate of carbon sequestration at two thicket restoration sites in the Eastern Cape, South Africa*. Restoration Ecology **14**: 38-49.
- Mills, A. J., Cowling, R. M., Fey, M. V., Kerley, G. I. H., Donaldson, J. S., Lechmere-Oertel, R. G., Sigwela, A. M., Skowno, A. L. and Rundel, P. 2005. *Effects of goat pastoralism on ecosystem carbon storage in semi-arid thicket, Eastern Cape, South Africa*. Austral Ecology **30**: 797-804.
- Mills, A. J. and Fey, M. V. 2004. *Transformation of thicket to savanna reduces soil quality in the eastern Cape, South Africa*. Plant and Soil **265**: 153-163.
- Mills, A. J., O'Connor, T. G., Donaldson, J. S., Fey, M. V., Skowno, A. L., Sigwela, A. M., Lechmere-Oertel, R. G. and Bosenberg, J. D. 2005. E*cosystem carbon storage under different land uses in three semi-arid shrublands and a mesic grassland in South Africa*. South African Journal of Plant and Soil **22**: 183-190.
- Mills, A. J., Turpie, J., Cowling, R. M., Marais, C., Kerley, G. I. H., Lechmere-Oertel, R. G., Sigwela, A. M. and Powell, M. 2007. *Assessing costs, benefits and feasibility of subtropical thicket restoration in the Eastern Cape, South Africa. In*: Restoring Natural Capital Science, Business and Practice: 179-187. Aronson, J., Milton, S. J. and Blignaut, J. (Eds.). Washington DC: Island Press.

Left: Spekboom, *Portulacaria afra* (M. Powell)

Corresponding author:
Anthony Mills
Department of Soil Science
Stellenbosch University
Western Cape, South Africa.
Telephone and Fax:
+27-21-7151560
Email: mills@sun.ac.za



Left: A restored slope (foreground) (A. Mills)

Authors: David A. Burney and Lida Pigott Burney

Inter situ conservation: Opening a "third front" in the battle to save rare Hawaiian plants

Anyone who has taken a course in conservation biology, or even read a book on the subject, knows that there are fundamentally two kinds of conservation: *in situ* and *ex situ*. The former, aimed at preserving species where they presently occur naturally, will perhaps always rightly be the front line of conservation. The latter, however, has become increasingly important as botanical gardens, zoos, and other cultural institutions strive to save the rarest species by growing them under intensive care in living collections and backing this effort with seed banks, tissue culture, and other relatively expensive high-tech methods.

Each strategy has its advantages and disadvantages (Table 1). In places like Hawaii, where approximately half the native flora is considered at risk of extinction in the next few decades, scientists and conservationists have begun asking themselves how they can do more for these roughly 500 species, through innovative and more cost-effective strategies that aim to bridge the gap between these two methodologies. Although the term has been around for over a decade, the concept of "*inter situ*" conservation first came to the attention of the public in Hawaii through a radical experimental plan that was hatched by paleoecological researchers whose focus was originally on the past, not the future, of rare plants and animals.

Right: *Hibiscus waimeae* is a favourite among the over 100 native species used in the *inter situ* restorations on Kaua`i (Alec Burney)

Listening to the fossils

Since 1992, our group has been excavating a remarkable fossil site, at Makauwahi Cave on Kaua`i's south shore. It is generally acknowledged as the richest in the Hawaiian Islands. This ancient limestone feature, a large cave system complete with stalactites and highly endangered blind cave organisms that live their entire lives in complete darkness, contains a large open sinkhole in the center that was actually a lake inside the cave for thousands of years. Soft sediments there are filled with splendidly preserved seeds, pollen, bird bones, snail shells – even fossil DNA and a thousand-year record of human activity. From artifacts of not just stone but wood, gourd shell, and plant fibers we have been able to learn how Hawaiians used plant resources for many centuries. The site provides a continuous record of all that happened on the landscape for 10,000 years or more.

Like most lowland areas of the state, the surrounding acreage has been dominated by a handful of invasive plant species introduced to the island since the arrival of Europeans in the late 18th century. A few years ago, our group decided to enlist the aid of the large contingent of community volunteers that had helped us with the fossil dig to attempt to recreate, to the

Left: View of the rare native plants growing in the sinkhole at Makauwahi Cave, as seen from the darkness of the large cave on the south end (Alec Burney)

extent possible, the plant communities that the fossils showed us grew there for thousands of years before the recent human transformation of the landscape through deforestation and the introduction of a host of invasive animals and plants.

By this time we had obtained a lease on the cave and surrounding property from the owners, Grove Farm Company. In addition to an array of limestone sea cliffs, rolling dunes, and the largest limestone cave in Hawaii, the property also contained some abandoned farmland covered in a tangle of thorny non-native bush. That was in 2004. By now, thanks to the efforts of nearly everybody on the island from school classes, Boy Scouts, and native Hawaiian groups, to the numerous retirees and tourists on Kaua`i, much of the land surrounding the site features the native plants that we have inferred, from the fossil record, to be the ones that existed there before.

This was no easy process. Techniques were developed to use heavy equipment, such as mowers, tractors, and rotary tillers, to convert the weedy farmland back to bare soil and start over, planting native species, including many quite rare ones, where we knew they once had grown. We soon found that, in this dry leeward habitat, native plants could best outstrip the aggressive invader plants if we put them on an automated drip irrigation system, similar to the ones used for maize and other crops by our farmer neighbours nearby, until they were thoroughly established – generally through two of the long, intensely dry summers. After that, many natives had gained a sufficient head start on the weeds to hold their own.

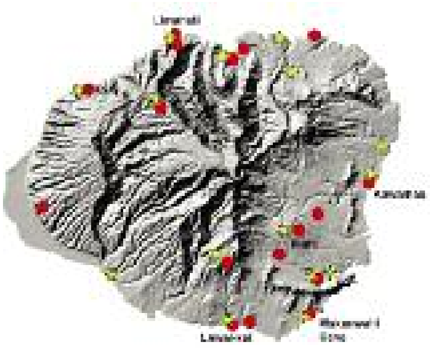
Because the site is on top of and adjacent to the habitat of three species of endangered blind cave invertebrates and a potential breeding and foraging site for endangered birds and invertebrates, we have developed techniques for controlling the weeds and insect pests that avoid the use of herbicides and pesticides. The challenges have been great, but the Makauwahi Cave Reserve, as we have come to call it, now hosts nearly 100 native plant species and provides habitat for rare Hawaiian animals. For several extremely rare plant species, we can now say that the largest "wild" populations in existence are thriving there, planted by thousands of willing hands.

So what kind of conservation is it?

So what is it, *in situ* or *ex situ* conservation? Well, both, and neither. As this idea has caught on and spread to other sites on Kaua`i and elsewhere here in the islands, we have come to refer to this as *inter situ* to signify its intermediate status. The basic idea is to conserve rare species by reintroducing them to sites where they once grew, but have been eliminated in recent decades or centuries by human agencies such as, here in Hawaii, the highly destructive impact of introduced goats, pigs, and rats.

One of the first places that this idea has caught on is on the properties of the National Tropical Botanical Garden (NTBG) and those of collaborating landowners. At Läwa`i-kai, the uniquely beautiful coastal property managed by NTBG as part of the historic Allerton Gardens on Kaua`i's south shore, just a few kilometers from Makauwahi Cave, invasive vegetation has been removed from the beach strand and coastal forest and replaced with not just the three hardy native plant species that had persisted there, but dozens of other natives that cores collected from the adjacent marsh as well as the detailed record from other sites along the south shore such as Makauwahi shows were there when the Polynesians arrived a little more than a millennium ago.

Other natives have been reintroduced to the restoration sites NTBG maintains along nearby Lawai Stream, on the cliffside in Lawai Valley, and on the upper edge of McBryde Garden.



Above: Map of Kaua`i showing location of Makauwahi Cave and other sites mentioned in text. Asterisk symbol shows sites that have yielded useful paleoecological information, and dots show restoration sites that have been able to use this information

The Lawai Forest Restoration is near NTBG's *ex situ* collection of native plants from throughout the state of Hawaii, the largest living collections of this flora found anywhere. To supply all the plants needed for these and other restoration efforts, NTBG's Conservation and Horticulture Center has stepped up production in its state-of-the-art micropropagation, greenhouse, shadehouse, and sunny nursery facilities to the point that the organization has planted out nearly 12,000 specimens in the past year, and currently has over 18,000 plants in pots awaiting their "turn."

One of the most spectacular conservation projects of NTBG is the beautiful Limahuli Garden and Preserve on Kaua`i's north shore. The nearly 1000-acre property contains a massive archaeological site and cultural restoration, featuring centuries-old stone terraces and pondfields for growing taro (*Colocasia esculenta*) and other traditional Polynesian crops.
A key effort here, as well as at NTBG's Kahanu Gardens near Hana, Maui, is to grow not only native plants in contexts that span the full range of *in situ, ex situ*, and now, *inter situ* techniques, but also to collect and propagate the rapidly disappearing old Hawaiian varieties of Polynesian crops such as breadfruit, banana, coconut, kava, and – of course – for the mainstay of Polynesian diet, more than 50 varieties of taro.

Watch out, it's spreading!

The *inter situ* approach has spread rapidly to other properties throughout Kaua`i, notably Grove Farm's Iliahi project, near our Kilohana Crater coring site, where the fossil pollen record reaches back all the way to the late Pleistocene, more than 27,000 years ago. Another is Kawaihau Wetland, a collaboration between NTBG, Ducks Unlimited, the US Fish and Wildlife Service, and the USDA Natural Resources Conservation Service that has been creating new habitat for endangered endemic waterfowl and native wetland plants on property owned by singer/actress Bette Midler. Plant choices there were guided by the results of a sediment core from the wetland containing a 7,000-year record of fossil pollen and spores.

With only 0.2% of the land area of the United States, and 43% of the endangered plant species, the challenges to conservation in Hawaii continue to be daunting. Classic *in situ* and *ex situ* methods of conservation will continue to be major "fronts" in the eleventh-hour battle to stem the tide of extinction. They need all the support they can get from government and private sources, far more than they are getting now. But opening a "third front" in the struggle makes a lot of sense, to fill the many gaps in coverage of our conservation efforts, particularly in reclaiming the abundant lands available for conservation but not currently being used because of their state of degradation and commitment to other purposes. By blending advanced agricultural techniques such as conservation tillage, mulching, integrated pest management, and drip irrigation with large-scale conservation efforts on marginal lands – using the records from sedimentary fossils, archaeological sites, historical evidence, oral traditions, and old herbarium sheets as a guide to what was growing there just moments ago in evolutionary and ecological time – we can bring resources and people into the fray that can never reach the last *in situ* stand of a rare plant, and extend the reach of *ex situ* botanical gardens to larger land areas, more diverse habitats, more people, and a longer list of species. As our meticulous record-keeping has shown, this approach is cheap and efficient, with a low per-plant cost and high survival rate.

Conserving more than we thought

One realization that has emerged from this expanded *inter situ* effort is that, by preserving these plants, we are also helping preserve native Hawaiian culture. Many native plants and rare Hawaiian cultivars are integral to local culture, but the lore is slipping away because the plants are otherwise just too rare and inaccessible — perhaps even illegal — for cultural practitioners to use them, and most young people will never even see them. At Makauwahi Cave and at Limahuli, McBryde, and Kahanu Gardens of NTBG, young and elderly Hawaiians, as well as persons of other backgrounds with an interest in preserving traditional cultures, frequently come together to grow and use these nearly-forgotten plants in ways they could never do in an *in situ* context. In *inter situ* projects, subsequent generations of these

Right: Girl Scouts from Kaua`i plant natives at Iliahi, the Grove Farm Ecological Restoration Project. Over 1000 young people from the island have assisted in planting several thousand native plants at this site, not far from Kilohana Crater (David Burney) restored plants, now reproducing on their own in places where they were once abundant, then extirpated, and now re-established, hold out the possibility that subsequent generations of people will still know about these plants, their lore, and uses both past and future. With this increased accessibility, even the most endangered plants can potentially be studied and understood, so that precious *in situ* populations are not impacted, but better management can potentially be applied through research focused on rare species' biology, ecology, and ethnobotany.

One of the most heartening triumphs of our *inter situ* experiments is that, for the first time, some rare plants are now being made available for restoration on a larger scale. A current NTBG project in collaboration with the State Department of Forestry and Wildlife and the US Fish and Wildlife Service is a good case in point. We are reintroducing native plants to the remote uninhabited Lehua Islet just

Left: Aerial view of an *inter-situ* restoration site at Makauwahi Cave, where rare native plants are being grown on abandoned farm land (Matthew Bell)

north of Kaua`i's neighbour island of Niihau, guided by fossil pollen and charcoal identified from deposits there – since rabbits and rats now being eradicated had driven most native plants to extinction years ago. Producing enough seeds to restore a 300-acre (122 ha) island is a tall order. Recently NTBG interns and volunteers have been able to gather, under the guidance of NTBG field botanist Natalia Tangalin, huge quantities of fully accessioned weed-free native plant seeds for the restoration effort. So, in the space of a few years of *inter situ* efforts, we can now say that our restoration sites are restoring other sites!

Key references:

➡ Burney, D.A. and Burney, L.P. 2007. *Paleoecology and* "inter-situ" *restoration on Kaua`i, Hawai`i.* Frontiers in Ecology and the Environment **5**(9): 483-490.

➡ Burney, D.A., and Kikuchi, W.K.P. 2006. *A millennium of human activity at Makauwahi Cave, Maha`ulepu, Kaua`i.* Human Ecology **34**:219-247.

➡ Burney, D.A., and Flannery, T.F. 2005. *Fifty millennia of catastrophic extinctions after human contact*. Trends in Ecology and Evolution **20**:395-401.

D. Burney
Director of Conservation
National Tropical Botanical Garden
3530 Papalina Road
Kalaheo, HI 96741, USA.
Email: dburney@ntbg.org

L.P. Burney
Manager, Makauwahi Cave Reserve
P.O. Box 1277
Kalaheo, HI 96741, USA.

Table 1. Comparison of three "fronts" in conservation.

DEFINITION	ADVANTAGES	DISADVANTAGES
In situ: Conservation efforts applied to species in a pre-existing wild condition in their current range.	Species is presumably adapted to the site already. Co-evolution with other species in the community may be critical to survival and ecological function.	Site may be remote, expensive to maintain, and undergoing degradation. Problems leading to rarity may be unabated. Stochastic events such as storms, disease outbreaks, and human over-utilization are difficult to factor into planning
Ex situ: Efforts based on intensively human-controlled environments such as botanical gardens, zoos, genebanks, and propagation facilities.	Provides a second line of security for rare species by allowing specimens to be grown in the absence of challenges faced in nature. Gives people a chance to see biodiversity up close and near home.	Stops or even diverts evolution. Species may become "domesticated" and no longer suitable for reintroduction. Per unit cost may limit number of species and/or individuals that can be managed with this intensity.
Inter situ: The establishment of a species by reintroduction to locations outside the current range but within the recent past range of the species.	In effect bridges the gaps between *in situ* and *ex situ*. Species can be more accessible and better protected than former, and produced at much lower unit cost than latter. Evolutionary processes can be retained to varying degrees. New populations can be controlled or manipulated to enhance or preserve genetic diversity	Insufficient knowledge of community and ecosystem function limits our ability to reconstruct complex biotic webs. Some follow-up care is required to effect most successful reintroductions. Legal obstacles may inhibit innovative conservation efforts for rarest species. Long-term persistence of reconstructed communities needs evaluation through long-term monitoring.

Author: Paweł Kojs

The Silesian Botanical Garden as a natural habitat garden

Above: The ponds present a wonderful living environment for numerous plant species in the garden

Right: Fruits of *Prunus spinosa* and other species are an important source of food for birds and other animals during the long winter

Introduction

Poland is facing a dramatic loss of biodiversity and this is thought likely to continue through the coming decades. Of particular concern are various types of grassland habitats (such as hay meadows) as these are considered to contain the highest numbers of rare and endangered plant species per square metre in Poland. While these habitats are protected under the EU Habitats Directive, habitats influenced by agricultural activity must be used, otherwise with the passing of time natural succession will change the character of plant associations and thus in most cases negatively influence biodiversity. But when used improperly the biodiversity of these agriculturally-influenced associations will also be lost. The area of these grasslands has decreased dramatically throughout the past decade (especially after EU accession), as farming has become more and more intensive.

Protected areas are not the only means of conserving biodiversity. Sometimes, quite incidentally, managed habitats can offer refugia for species that are in decline in protected areas. Managed landscapes can and do support biodiversity, and a big challenge for researchers is to consider how to best integrate biodiversity conservation in both strictly protected and in managed areas. Here is an opportunity for 'habitat' botanical gardens. Botanical gardens are professionally managed areas, where besides high botanic diversity habitats for considerable numbers of invertebrates and small vertebrates can also be found.

Natural conditions of the Silesian Botanical Garden

The Silesian Botanical Garden is one of the youngest botanical gardens in Poland. Although it has been existence for 9 years, it was officially established as a union of associations in 2003. The Garden is located close to Mikołów City, south of Katowice City – capital of the Silesian Province, the most industrialized part of Poland. The Silesian Botanical Garden covers an area of about 100 hectares and is part of a bigger landscape complex. This landscape complex of 524 ha also includes a special forest farm for forestry management (70 ha), an ecological landscape park (182 ha) and arable lands with field margins (172 ha). The area reserved for the Silesian Botanical Garden includes a variety of habitat types suitable for both aquatic and terrestrial flora and fauna (Szendera *et al*. 2005). Over 650 species of vascular plants, including over 100 rare and 30 legally protected taxa can be found in the garden, as well as many natural land types unique to Upper Silesia.

Right: Fruits of *Pyrus communis*

Forty nine plant communities have been identified in the Silesian Botanical Garden, of which 8 are communities of unknown syntaxonomical position. These plant associations reflect a range of habitat types: woodlands, water, swamps, muddy banks, temporarily flooded swamps, meadows, grasslands, nitrophilic forest margins, clearings and disturbed land (Wilczek *et al*. 2005). Six communities occur on the Red List of Upper Silesian Plant Communities (Celiński *et al*., 1997).

Special attention is paid to the communities of unidentified syntaxonomical position, composed of strictly protected plants: communities with *Equisetum telmateia* and communities with *Gentianella ciliata*.

What conditions must be fulfilled to establish a collection of living plants of rare or endangered species significant for biodiversity conservation?

To have an endangered plant in a botanic garden does not necessarily mean that it is in a conservation programme. In botanic gardens even a diverse population of an endangered species without its natural environment will systematically lose its ability to compete and survive in its "normal" habitat. In botanic gardens it is the gardener, not nature, that provides the most significant factors that influence the direction of the micro-evolution of such a population. By modifying (simplifying) the environment, we may unintentionally eliminate the processes of co-evolution of plants, fungi, animals, bacteria or viruses and thus reduce the ability of certain population to adapt to the much more complex natural ecosystem. This may result in the reintroduction of species into their natural habitats being unsuccessful.

Goals and aims of the Silesian Botanical Garden

The main aim for this new botanical garden is the conservation of the local flora in Upper Silesia and neighbouring areas, merging *ex situ* and *in situ* conservation methods. The large area of the Silesian Botanical Garden provides a good opportunity for the conservation of many plant communities (woodland, wetland and xerothermic associations) in semi – natural habitats (secondary habitats). It also paves the way for research on secondary habitats e.g. to establish the minimal effective area for a given habitat or procedures for the best practice in management of secondary as well as natural habitats (Loreau *et al*., 2001). The key research task may well be to develop our understanding of how managed interventions can mimic natural disturbance processes and patterns, and how these can contribute to the conservation of biodiversity. Climate change will be an important factor influencing future land use change (Thomas *et al*., 2004). Land use change, in turn, will influence the distribution of habitats and species in a warmer world. More research is needed to develop an understanding of future land use and landscape change as well as the effects on nature conservation networks.

Other aims of the Silesian Botanical Garden are the following:

1) to create appropriately large habitats which would be identical or similar to natural habitats and to provide the best possible conditions for regeneration of populations of protected, endangered or rare plants – the main focus of our conservation activities;

2) to establish secondary habitats for priority habitats (Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora) occurring in the province of Silesia;

Forest communities	Threat categories
Ass: Circeo-Alnetum Oberd. 1953	V
Ass: Luzulo pilosae-Fagetum Mat. 1973	V
Ass: Tilio-Carpinetum Tracz. 1962	V
Others	
Ass: Filipendulo-Geranietum Koch 1926	R
Ass: Aegopodio-Petasitetum hybridi R. Tx. 1949	R
Ass: Cirsietum rivularis Ralski 1931	I

Table 1: Associations of endangered plants occurring in the wild in the Silesian Botanical Garden listed in Red List of Upper Silesian Plant Communities (Celiński et al., 1997)

Above: The extensively used meadows, featuring an abundance of vanishing and protected species, are a slowly disappearing element of our landscape.

Left: Abandoned limestone quarries are secondary habitats rich in rare species of flora. Mikolow Limestone is one of the highest viewpoints in Silesia Province (340 m a. s. l.)

Above far left: The winter aspect of water meadows and rushes in the Silesian Botanical Garden. The last few winters in the Silesian Botanical Garden were snowless

Above: Fruits of *Rosa canina* appear in the autumn

3) to provide additional habitats (not listed in Annex 1) suitable for all species that are fully or partly protected by law currently occurring in the Silesian District (there are 136 such species of vascular plants);

4) to organize a local seed bank for rare and endangered plants in the Upper Silesian region.

Methods

Firstly we developed the natural potential of the Silesian Botanical Garden to recreate habitats which have been negatively affected by human activity during the last few hundred years. This process is based on the method of enriching chosen plant associations by planting appropriate species of herbaceous plants, trees and bushes. There are also activities aimed at restoring the plant communities associated with agricultural land. The aim is to create habitats that are as similar as possible to the natural conditions in order to protect the future generations of plants from biased selection caused by the change of environmental conditions and genetic erosion caused by too small a population in a small area.
The main source of seeds and habitats (parts of habitats) for the recreation of habitats are areas outside the garden presently being influenced by infrastructural development (mainly roads, new factories, new settlements, etc.).

Right: Field margins in the Silesian Botanical Garden provide and enhance wildlife habitats across arable farms. Field margins are also thought to act as corridors for the movement of fauna and flora. The flowering plant is *Crategus monogyna*

Photo credits: Wieslaw Włoch

Activities and plans

Because of its convenient location in the centre of the Silesian conurbation, the diversity of accessible habitats and its relatively large area, the Silesian Botanical Garden has particular opportunities to protect large populations of plants which are headed for extinction in Silesia, in natural and semi-natural environments.

We also think of the Silesian Botanical Garden as the interface between humans and nature. The garden acts as a node, from which impacts radiate out into the surrounding areas. We aim to help the general public to understand the need to conserve habitats and communities, thereby conserving species more effectively. We hope this would not only address today's threatened species but would slow the decline of common species, preventing them from becoming tomorrow's threatened species. This is especially important in view of climate change scenarios.

Conclusions

The proposed solution refers to part of our "genetic heritage" which should be protected. That is, collections of native plants growing wild. The important element of this solution is a good knowledge of the natural position of protected, endangered and rare plants in a particular region, taking into account nature reserves and ecological arable lands for seed collection as well as strengthening wild populations by planting good specimens from *ex situ/in situ* cultivation. The advantages of the Silesian Botanical Garden allow many species of vascular plants to be brought under protection in appropriate habitats in their natural or semi-natural associations.

References:

➡ Celiński F., Wika S., Parusel J., (Eds.). 1997. *Red List Of Upper Silesian Plant Communities In*: Parusel J.B., (ed.) Centrum Dziedzictwa Przyrody Górnego Śląska Raporty i opinie. Tom **2**: 39-68, Katowice

➡ Habitats Directive COUNCIL DIRECTIVES 92/43/EEC, 21 May 1992. *On the conservation of natural habitats and of wild fauna and flora*.

➡ Loreau, M., Naeem, S., Inchausti, P., Bengtsson, J., Grime, J. P., Hector, A., Hooper, D. U., Huston, M. A., Raffaelli, D., Schmid, B., Tilman, D. and Wardle, D. A. 2001. *Biodiversity and ecosystem functioning: current knowledge and future challenges*. Science, **294**: 804-808.

➡ Southwood, T. R. E. 1977. *Habitat, the template for ecological strategies*. Journal of Animal Ecology **46**: 337-365.

➡ Szendera, W., Włoch, W., Kojs, P., Jura, J. and Wilczek, A. 2005. *Natural potential of the Silesian Botanical Garden in conservation of wild plant and crop plant diversity.* Biul. Ogr. Bot., Muzeów i Zb., **14**: 9-18

➡ Thomas, C.D., Cameron, A., Green, R.E., Bakkenes, M., Beaumont, L.J., Collingham, Y.C., Erasmus, B.F.N., Ferreira de Siqueira, M., Grainger, A., Hannah, L., Hughes, L., Huntley, B., van Jaarsveld, A.S., Midgley, G.F., Miles, L., Ortega-Huerta, M.A., Townsend Peterson, A., Phillips, O. L. and Williams, S.E. 2004. *Extinction risk from climate change*. Nature **427**: 145-148.

➡ Wilczek, A., Jura, J., Włoch, W., Kojs, P. and Szendera W. 2005. *The significance of the field shrubs and hedges in biodiversity conservation. The old field shrubs and hedges of Silesian Botanical Garden*. Biul. Ogr. Bot., Muzeów i Zb., **14**: 49-54

Pawel Kojs
Botanical Garden - Center for Biological Diversity Conservation, PAS Warsaw,
Silesian Botanical Garden, Mikolow, Poland.
Email: pkojs@op.pl

Authors: Antonina Shmaraeva and Irina Ruzaeva

Reintroduction of threatened plant species in Russia

Introduction

The conservation of individual species and plant communities *in situ* is preferable to preservation *ex situ*. However, in many regions the scale of ecological degradation does not allow the conservation of plants under natural conditions. In such cases, the introduction of threatened species into conservation areas for future recovery and the reconstruction of entire communities may be regarded as a potential measure for saving plants threatened with extinction.

A number of projects and programmes involving species recovery and restoration have been carried out over the last 40 years in Russia and the former USSR. In recent years however, interest in reintroducing rare and threatened plants has considerably increased and the number of related publications has also grown. Despite this, the basic methodological principles for plant reintroduction, especially related to threatened species are underdeveloped. There is also a lack of coordination of reintroduction activities with respect to selecting priority species for urgent conservation and fundraising for implementing plant restoration and recovery programmes.

Left: Seed collection of *Stipa pulcherrima*

In 2007, BGCI organised two workshops to evaluate the current situation of threatened plant reintroduction in Russia as well as to train botanic garden staff in developing and implementing recovery programmes. A pre-meeting survey carried out by BGCI revealed that more than 100 plant species are included in recovery and restoration programmes implemented by Russian botanic gardens and nature reserves. However, only 28 of these species are listed in the National Red Data Book, equivalent to about 4% of the total number of threatened species in Russia. Thus restoration activity should be increased significantly to reach 10% of threatened species, as proposed in Target 8 of the *Global Strategy for Plant Conservation*.

Following the two workshops, a manual providing detailed guidance for plant reintroduction was published in

Left: *Crambe tataria*

Right: *Stipa pulcherrima*

English and Russian by BGCI (Gorbunov *et al*., 2008) and two pilot threatened species reintroduction projects were launched in 2008. These projects are located in the southern part of the European territory of Russia: Samara Region in the middle region of the Volga River and Rostov-on-Don Region close to the delta area of the Don River. Historically these are regions where extensive agriculture covered vast areas of vulnerable steppe landscapes. Both projects are targeted at restoring the steppe flora in areas that are in a serious stage of degradation due to anthropogenic pressure. This degradation is having a disastrous effect on landscape and biological diversity and due to this, the concept of steppe landscape restoration is becoming increasingly popular in Russia.

Reintroduction of rare species of steppe flora in Rostov-on-Don region

The first project is being implemented by the Botanical Garden of the Southern Federal University which is located in Rostov-on-Don - one of the major cities in the south of Russia. The ecological situation in the Rostov-on-Don area is described as critical due to the practically complete extinction of zonal steppe vegetation. In most of the territory the natural vegetation is already destroyed: 60 % of the area is under arable land, about 9% is covered with water, roads and settlements and the remainder is under severe development pressure.

Below: Near-Azov steppe – the natural vegetation for creation of artificial communities in the Botanical Garden

The vascular flora of the Rostov-on-Don area includes more than 1,900 species of which 46 are included in the Red Data Book of the Russian Federation and 217 are in the local Red Data Book of Rostov-on-Don region. Rare species mainly include obligate steppe plants of genera such as *Stipa, Crambe, Tulipa* etc. Two ecologically important steppe species, which form plant communities of Don River steppes were selected as the objects for the reintroduction experiment. The area and population of both of these species is declining due to habitat disturbance and destruction. *Stipa ucrainica* P. Smirn. is endemic to the Black Sea coast and is listed in the Red Data Book of the Russian Federation (2V category). It is the main indicator species of the dry steppes of the Don River basin. *Stipa pulcherrima* C. Koch is a vulnerable species also included in the Red Data Book of the Russian Federation (2V category). It is a dominant plant of mixed pastures and stony steppes.

The specific goal of the project was to create sustainable artificial populations with *Stipa ucrainica* and *Stipa pulcherrima* as dominant species in an area of 30,000 sq.m in a specially protected natural steppe landscape within the boundary of the botanical garden. In addition to *Stipa* spp., populations of some rare herbaceous plants typical for the Don River steppe were also included in the artificial communities: *Iris pumila* L., *Eremurus spectabilis* Bieb., *Salvia austriaca* Jacq. and *Crambe tataria* Sebeok.

Establishment techniques

The method is based on sowing seed mixtures of numerous species, including seeds of rare plants collected from natural communities, into a ploughed soil (Dzybov, 2001). It provides the model environmental conditions necessary for the stable growth of introduced mixtures of rare and endangered steppe species. The seed preparation includes hand cleaning which is labour intensive and time consuming, but it provides significant similarity in species composition and abundance between natural and experimental communities. The mixture includes seeds of not less than 50 plant species. It consists of 30% grasses (dominating species), 10% leguminous plants and 60% other herbaceous species.

Seed collecting

Field trips to 7 administrative districts of Rostov-on-Don region were organized to evaluate natural populations of rare species and to

collect seeds of steppe plants. Two - three populations of species such as *Stipa ucrainica, Stipa pulcherrima, Crambe tataria, Iris pumila, Eremurus spectabilis, Salvia austriaca, Bellevalia sarmatica, Centaurea ruthenica, Hedysarum grandiflorum, Hyacinthella pallasiana* and *Linum hirsutum* were described in each location. These communities were not significantly disturbed and were thus used as the basis for the creation of artificial populations in the botanical garden.

Seeds of 98 typical steppe species from 28 families and 71 genera were collected in order to provide floristical and taxonomical diversity of created communities and to conform to the natural analogues. Two plots of artificial steppe (15,000 sq.m. each) were established at the end of October. *Stipa pulcherrima* is the dominant species for one plot, with a total of 88 species included in the seed mixture, 12 of which are rare. *Stipa ucrainica* is the dominant species for the other plot, where the seed mixture includes 87 species with 9 rare species. The seeds of *Stipa pulcherrima*, *Stipa ucrainica* and some other rare species where collected from different parts of Rostov-on-Don region to provide genetic heterogeneity and thus stability, in the reintroduced populations. These two newly established plots add to a fragment of artificial steppe dominated by *Stipa dasyphylla* which had already been created in the botanical garden.

If the weather conditions of winter–spring 2009 are favourable, then the mass germination of seeds will take place during the next year of the experiment. If there is some loss of seeds, additional sowing during the next 2 years will be provided.

Long-term perspectives of the project

The work implemented so far is just the first stage of the reintroduction experiment. During the next 2 years the development of the artificial communities and the rare plant populations will be closely observed and the plots will be appropriately managed. After 4-5 years, seeds of these populations should be ready for use in restoring *Stipa ucrainica* and *Stipa pulcherrima* populations in other specially protected natural territories of Rostov-on-Don Region. The plots of artificial steppe created through the project will be included in the ecological path which is currently being developed in the garden as the part of the programme for environmental education. The artificial steppe area will be a good example of regional vegetation recovery and plant diversity conservation.

Left: *Hyacinthella pallasiana*

Below: *Centaurea ruthenica*

Left: Sowing the seed mixture

Rare plant reintroduction in natural habitats

The second project is being implemented by the Botanical Garden of the Samara State University. The flora of Samara Region is abundant and diverse; it comprises more than 2,500 species of higher plants. Intensive agriculture has led to the devastation of most steppe plant communities, which nowadays are only preserved in remote areas. However, there has been a recent trend towards the reduction of intensive agriculture and the transformation of some areas into fallow lands. Here we see a gradual succession replacement of early coloniser species by the common steppe and meadow plants. But the most valuable and rare

Right:
Iris pumila

components of plant communities that were already lost cannot reappear without special intervention (reintroduction of seeds or plants).

The following plant species listed in the Red Data Books of the Russian Federation and Samara Region were selected for this project: *Paeonia tenuifolia* L. – considered extinct in Samara Region for the last 50 years but which has recently started to reappear in some remote areas; *Juniperus sabina* L. - a very rare species which is gradually decreasing in number and which grows on limestone soils in stony steppes and in pine forests; *Iris pumila* L. – a rare species with a stable population. It is an ornamental plant and grows in various parts of Samara Region. Its populations are highly damaged by human interference and especially by steppe fires. Its reintroduction to natural ecosystems is considered to be easier than for the first two species. The specific goal of the project is to optimise rare plant reintroduction techniques for various plant communities of forest-steppe and steppe in the Middle Volga River area.

Results

Four reintroduction sites have been selected using the following criteria:

- environmental conditions that meet the needs of a plant (type of community, quality of soil, microrelief and microclimate);
- intensity of anthropogenic pressure (cattle grazing, recreation intensity, distance from villages and towns etc.);
- accessibility to conduct periodical observations.

Below:
Eremurus spectabilis

Photo credits: Antonina Shmaraeva

Preparation of experimental material
Juniperus sabina cuttings were obtained from 3 small populations in the Zhigulevskiy State Reserve and propagated vegetatively at the botanic garden. 150 cuttings were successfully rooted and will be ready for planting in spring 2009. The botanic garden nursery has also prepared more than 150 plants of *Iris pumila* from plants that are growing in the botanical garden. In spring 2009 *Iris pumila* will be planted in the Krasnosamarsky forest and *Juniperus sabina* will be planted in Zhigulevskiy State Reserve in order to create populations and increase the number of plants of these species.

Planting of experimental material in reintroduction sites
170 plants (sprouts with 3-5 buds) of *Paeonia tenuifolia* were obtained by splitting mother shrubs from the collection of the botanical garden. Reintroduction was conducted in autumn (September-October) 2008, with the prepared plants being planted in model plots in the reintroduction sites at Chubovskaya steppe and in Krasnosamarsky forest (specially protected natural territories of Samara Region). Planted specimens were protected from the influence of adjacent plants by partial removal of competitors. In addition seeds of the species were also planted in both plots.

Long-term perspectives

Intensive research on the reintroduced plants will be conducted at the model plots by students, postgraduate students and professors at the Polygon for Monitoring Studies of Samara State University. The main focus of these activities will be the monitoring of the established reintroduction sites and the creation of new sites. The work of creating a network of reintroduction plots (which was launched in 2003) will also continue in different areas of Samara Region.

Conclusion

Plant reintroduction activities in Russia have been enhanced due to BGCI's reintroduction programme initiated in

2007 and two pilot projects on the restoration of threatened steppe species have been successfully launched. However much work remains to be done in sustaining and monitoring the artificial communities that have been created, as well as expanding reintroduction activities in Russia.

References

➡ Dzybov, D.S. 2001. *Metod agrostepej. Uskorennoe vosstanovlenie prirodnoj rastitel'nosti. Metodicheskoe posobie*. Saratov. 40 pp.

➡ Gorbunov, Yu. N., Dzybov, D. S., Kuzmin, Z. E. and Smirnov, I. A. 2008. *Methodological recommendations for botanic gardens on the reintroduction of rare and threatened plants* BGCI, BGCI, Russian Botanic Gardens Council, Main Botanic Garden of Russian Academy of Sciences. Moscow, Russia. 52 pp.

Antonina Shmaraeva
Senior Research Scientist
Laboratory of Natural Flora
Botanical Garden of the Southern Federal University
Botanical slope 7
Rostov-on-Don, Russia, 344700.
Email: botsad@rsu.ru

Irina Ruzaeva
Head of the Flora Department
Botanical Garden of Samara State University
Moscow highway 36
Samara, Russia, 443086.
Email: sambg@ssu.samara.ru

Author: Matt Bare

Short communication:

Restoring threatened plants of the Amazon

Situated in the upper reaches of the Ecuadorian Amazon, the Orchid Botanical Garden of Puyo, Ecuador finds itself in the unique position as a center of restoration for threatened and endangered tropical plants. While small in size at merely seven hectares, the Garden has been working for almost 30 years restoring a degraded pasture land and serving as a refuge for plants threatened by deforestation.

While preserving intact primary forests clearly has a higher ecological value, significant emphasis is also being placed upon reforestation programmes in Ecuador. However, many of these reforestation programmes lack local botanical knowledge and in the 20th century, much of the deforested sierra (mountain) region of Ecuador was reforested with non-native pine and eucalyptus. These trees, planted in monocultures, do not encourage the growth of understorey plants. Furthermore, the poor quality of rainforest soil means that many deforested lands are only profitable for cattle ranching for 5-10 years. After this time high rainfall has eroded the soil, nutrients have been leached from the soil that remains, and lack of tree cover has dried up springs and soil moisture. For this reason, ecological restoration in the rainforest is not a simple process. In the Orchid Garden, local, non-chemical materials, such as sawdust, animal manure and compost derived from food waste were used to improve the soil. With time, trees began to grow again, springs that had dried up began flowing again and pollinating insects returned to the forest. In the 21st century, as deforestation continues, reserves and gardens such as the Orchid Botanical Garden of Puyo are crucial as a seed bank and reference for restoration efforts.

The Orchid Botanical Garden is working to meet the targets of the Global Strategy for Plant Conservation by maintaining populations of locally rare rainforest species such as Guyacan (*Tabebuia guayacan*), Ceibo, and Canelo (*Ocotea* spp.). It has also recently opened a visitor center, complete with thousands of individual photos documenting the insect colonization that has occurred throughout the nearly thirty-year history of the garden. While about 80% of the Ecuadorian Amazon remains forested, most residents live in urban centers far removed from primary forest. With this in mind, the garden is planning on initiating education programmes to teach school children about local endangered species and their role in the timber trade.

As a small reserve with an even smaller staff, the Garden puts a strong emphasis on capacity and network building with regional and international partner organizations. The Garden works with U.S. Peace Corps volunteers in the Puyo region to assist with outreach activities. The reserve is a member of the Orchid Conservation Coalition's 1% for Orchid Conservation Program, a project which uses charitable proceeds to purchase and conserve endangered orchid habitat. The garden also works with the Society for Ecological Restoration to coordinate volunteer and student programmes involving reforestation in local communities. These restoration activities include a combination of community education along with practical techniques such as soil fertilization and transplanting.

Recently the Orchid Botanical Garden has developed a web site: www.jardinbotanicolasorquideas.com. In the coming year the Garden plans to expand its educational activities and further develop the potential of its visitor center. The Garden is looking for assistance to create a database detailing the orchid species and corresponding pollinators of the zone, which it can then contribute to the BGCI plant search database. The Garden is also looking for student groups to help us facilitate restoration and reforestation efforts with neighboring communities.

Matt Bare
Jardin Botanico Las Orquideas
Casilla 16-01-710
Puyo
Ecuador.
Email: mattbare03@gmail.com

Top: *Pleurethalis* spp., one of the orchids being conserved in the Orchid Botanical Garden

Above: Degraded pasture land adjoining the Botanical Garden shows how the Garden looked before restoration

Credits: Matt Bare

Notice:

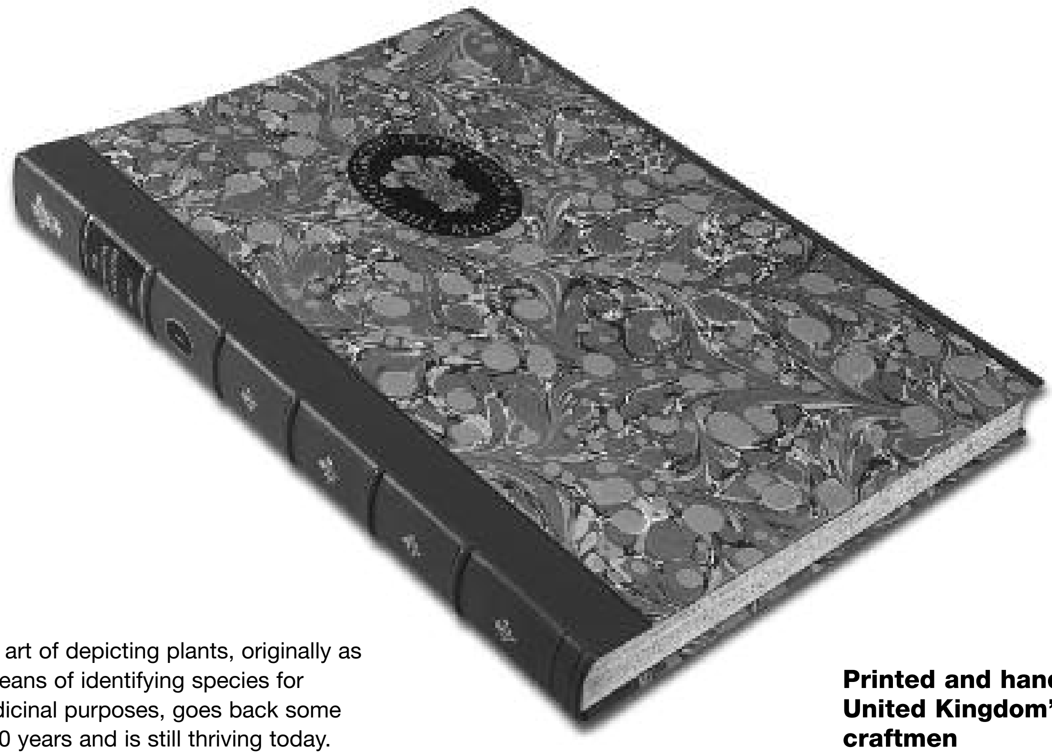
The Highgrove Florilegium

Throughout history, "the patron has been an important figure in the publication of many florilegia. With The Highgrove Florilegium*, The Prince of Wales is continuing that tradition but also breaking new ground in that, this is the first florilegium of a garden belonging to a member of the British Royal Family…Today the term is also frequently emblematic of a group of artists who are specifically drawing plants with a particular association or from a certain location, such as the groups working at Hampton Court or the Chelsea Physic Garden. This is the spirit in which The Highgrove Florilegium has been compiled, a work that promises to be one of the most significant of the 21st century.*

The history of the florilegium is not so much titles and dates but more one of passion, dedication and determination."

Taken from The Preface by Christopher Mills from *The Highgrove Florilegium*. Addison Publications 2008.

Right: *Cosmos atrosanguineus*



The art of depicting plants, originally as a means of identifying species for medicinal purposes, goes back some 2000 years and is still thriving today. It is widely acknowledged that there is now a renaissance of contemporary botanical art. The great period of botanical painting was from 1740–1840 and coincided with the voyages of discovery when new plants were introduced to Europe. The celebrated Franz and Ferdinand Bauer, Pierre-Joseph Redouté and Georg Dionysius Ehret (1708-70) were all producing magnificent flower paintings during this time.

A record for posterity of a royal garden

It is out of this European tradition of botanical painting that *The Highgrove Florilegium* is being created. Anne-Marie Evans founded the diploma course at the English Gardening School at London's Chelsea Physic Garden and it was here that, with one of her students, her idea 'to record for posterity a collection of plants from a chosen garden' came into being. The proposal was discussed with His Royal Highness The Prince of Wales who welcomed the suggestion that his Gloucestershire garden, Highgrove, should be the subject of a florilegium.

Seven years in the making

Lists of plants were drawn up by the head gardener David Howard, with additional suggestions from other botanists including Professor Christopher Humphries at the Natural History Museum. To this end the plants depicted are classified according to recent molecular phylogenetic studies. Artists were approached by Anne-Marie who, through her teaching, has contacts around the world. Artists suggested other artists and botanical gardens made recommendations. To administer the project and its growing number of artists, *The Highgrove Florilegium* Committee was established. Visits to the garden were arranged and sometimes plant specimens were provided for the artists to work from in their own studios. The finished paintings were submitted to a selection committee with representatives from the worlds of art, botany and design which has ensured a consistent and high standard throughout.

Printed and hand-bound by United Kingdom's leading craftmen

As with many other collections of botanical paintings it was decided to publish the Highgrove watercolours, and in a manner appropriate for England's first royal florilegium. There was a long series of proofing trials on a variety of specially made papers to find the most appropriate finish. The images are accompanied by the Natural History Museum's text giving the formal Latin name and a brief history of their discovery or creation, distribution, ecology and uses. *The Highgrove Florilegium* is presented as a two-volume work, half-bound in red goatskin with hand marbled paper sides.

Edition limited to 175 sets
The Highgrove Florilegium is available to purchase in a in two-volume set from a limited edition of just 175. Each copy is signed by HRH The Prince of Wales and all royalties go to The Prince's Charities Foundation. If you would like to know more about how to acquire one of these sets containing 120 plates in total, please call Amanda on +44 (0) 207 602 1848 or email THF@addisonpublications.com

Resources

Books and journals

Ecological restoration. Principles, values and structure of an emerging profession

Clewell, A.F. and Aronson, J.

This book is a concise reference document that will be valuable to all interested in or involved in ecological restoration. Fundamental principles such as the important selection of a reference model and the recognition of people as ecological influences are addressed in general introductory chapters. The underlying importance of plant species composition is stressed as, "it is the plant community that gives an ecosystem its structure and provides habitat." The book's later chapters are aimed at more experienced practitioners of ecological restoration. Case studies of ecological restoration projects around the world are included as "virtual field trips". Included as an Appendix are the Society for Ecological Restoration International's, *Guidelines for developing and managing ecological restoration projects*, 2nd Edition.

The book builds on and develops the Society for Ecological Restoration International's *Primer of Ecological Restoration* (http://www.ser.org/content/ecological_restoration_primer.asp), of which Clewell and Aronson were among the three principle authors.

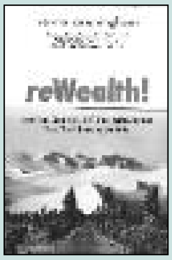
Available from Island Press as part of the book series "The Science and Practice of Ecological Restoration."
ISBN: 978-1597261692. 2007.
Details of other publications published for the Society of Ecological Restoration International can be found at the website: www.ser.org

*re*Wealth

Storm Cunningham

Restorative development is the largest, fastest-growing new source of prosperity in today's global economy. *Re*Wealth unveils the astonishing growth of this trend, presenting the context and strategies for taking advantage of the tremendous wealth of restorable assets - while renewing and revitalising the world around us.

In an age of climate change, destructive development and species extinction, this book points to a new paradigm of restoration and redevelopment. The author suggests a definition of *re*Wealth as "living in a way that leaves both us and the world healthier and wealthier with each passing day", and proposes that a 5,000 year legacy of depletion and destruction can be turned into a $100 trillion worldwide inventory of restorable assets. The author argues that leaving the world better than we found it is a very different proposition from merely slowing the rate of depletion and pollution. Conservation is essential but it doesn't address the needs of wildlife whose habitat has already been destroyed. Sustainability is certainly a worthy goal, but what about the vast majority of the planet that is already badly damaged? Is protecting it from further damage good enough? Why not restore it?



In *re*Wealth, redevelopment expert Storm Cunningham reveals a vast new realm of fast-growing, highly profitable opportunities to revitalise our communities and our planet. He outlines new practices and strategies that achieve rapid, resilient renewal, and shows how wealth can be generated by replenishing natural resources, rebuilding communities, redeveloping polluted land, restoring structures and revitalising economies.

ISBN 978-0-07-148982-9. McGraw-Hill. 2008. 398 pages.

Methodological recommendations for botanic gardens on the reintroduction of rare and threatened plants.

Yu. N. Gorbunov, D.S. Dzybov, Z.E. Kuzmin and I. A. Smirnov.

This manual, published in Russian and English, describes methodological approaches for the reintroduction of rare species of plants into natural habitats. Problems of terminology and the selection of species for reintroduction are discussed. The manual also focuses on issues related to preliminary studies, selection of initial starting material, determination of natural habitats and

processes for the creation and monitoring of reintroduced populations. Special attention is paid to the necessity of providing genetic diversity within created populations and the need for thorough documentation of the work carried out. A separate section is dedicated to the method of reintroduction of plant communities (agrosteppe creation) and examples of practical experience of reintroduction of rare species in various regions of Russia (Bashkortostan, the Far East, Irkutsk and Vladimir regions) are given.

Published by BGCI, the Russian Botanic Gardens Council and the Main Botanic Garden of the Russian Academy of Sciences named after N.V. Tsitsin. 2008. Tula: Grif & Co. 52 pages. ISBN 978-1-905164-28-8. Copies available from BGCI.

Guidelines for the translocation of threatened plants in Australia - Second Edition

L. Vallee, T. Hogbin, L. Monks, B. Makinson. M. Matthes and M. Rossetto.

The Australian Network for Plant Conservation first established guidelines for the translocation of threatened plants for conservation purposes as a result of resolutions from the Australian Network for Plant Conservation conference in Hobart, 1993. The need for revision was recognised as the number of translocations being carried out grew, bringing to light new information on techniques and approaches. This second edition puts more emphasis on evaluating whether translocation should go ahead, monitoring and evaluation, and involving local communities. The main points are brought together in useful case studies from across Australia. Written by people experienced in threatened plant translocations, this 80 page colour publication includes information on: definitions and objectives; deciding whether translocation is a viable option; the translocation process from project proposal, development, through to monitoring; community participation and case studies.

ISBN: 0 9752191 0 3. 2004. Copies available from the Australian Network for Plant Conservation Inc, GPO Box 1777, Canberra, ACT, 2601, Australia.
Email: anpc@anpc.asn.au
Web site: www.anpc.asn.au

Handbook of Ecological Restoration
Martin Richard Perrow, A. J. Davy

The two volumes of this handbook provide a comprehensive account of the rapidly emerging and vibrant science of the ecological restoration of both habitats and species. Ecological restoration aims to achieve complete structural and functional, self-maintaining biological integrity following disturbance. In practice, any theoretical model is modified by a number of economic, social, and ecological constraints. Consequently, material that might be considered as rehabilitation, enhancement, reconstruction, or re-creation is also included. *Restoration in Practice* provides details of state-of-the-art restoration practice in a range of biomes within terrestrial and aquatic (marine, coastal and freshwater) ecosystems. Policy and legislative issues on all continents are also outlined and discussed. The accompanying volume, *Principles of Restoration* defines the underlying principles of restoration ecology. The *Handbook of Ecological Restoration* will be an invaluable resource to anyone concerned with the restoration, rehabilitation, enhancement or creation of habitats in aquatic or terrestrial systems, throughout the world.

Published by Cambridge University Press. 2002. ISBN: 978-0521791298. 618 pages

Journals

Ecological restoration
Ecological Restoration is a forum for people interested in all areas of ecological restoration. The technical and biological aspects of restoring landscapes are featured, as well as emerging professional issues, the role of education, evolving theories of post-modern humans and their environment, land-use policy, the science of collaboration, and more. The quarterly publication offers original feature articles, short notes, and book reviews as well as abstracts of pertinent work published elsewhere. Published since 1981, (originally as Restoration & Management Notes) *Ecological Restoration* is the oldest publication to deal exclusively with the subject of restoring ecosystems. *Ecological Restoration* is published for the University of Wisconsin-Madison Arboretum by the University of Wisconsin Press and in association with the Society for Ecological Restoration International. *Ecological Restoration* is available as a stand-alone subscription or at a discounted rate for members of SERI or the Friends of the Arboretum.

Further information: www.ecological restoration.info/firstpage.html

Websites

Centre for Plant Conservation
Genetic considerations in ecological restoration: an annotated bibliography
Land managers often face the need to plan and implement re-vegetation or restoration work for disturbed or degraded habitats. Often there is relatively little background information to provide the context about a focal species or the greater plant community. A common concern, particularly for larger scale restoration, centres on how to make decisions about the selection of wild source material to be used. Managers need information about the importance of local genetic adaptation in restoration work, and how to maximize the chances for success and minimize the possibility of any deleterious effects. However, most biologists and land managers are not genetic experts and have limited time to devote to in-depth study of the issues.

The Center for Plant Conservation (CPC), with the assistance of a number of population geneticists, conducted a literature review to explore some of the key issues and has made that bibliography available on their website. While initially intended to present available literature on the topic of ecotypes, the scope of the bibliography was expanded as a result of discussions with numerous authorities on the subject. The current bibliography now presents literature on topics broadly relevant to genetic considerations in ecological restoration. Inclusion of literature is not limited to peer-reviewed scientific articles, but also includes grey literature, including book chapters, papers from meetings and symposia, and reports.

www.centerforplantconservation.org/Education.html

Global Partnership on Forest Landscape Restoration
The Global Partnership is a network of governments, organisations, communities and individuals who recognise the importance of forest landscape restoration and want to be part of a coordinated global effort. The partners will learn from one another's experiences and identify, undertake and support forest landscape restoration activities. The Forest Restoration Information Service (FRIS) plays a critical role as an information resource and in promoting information sharing among partners and other restoration practitioners. The partnership will serve as a model of how the international forest community can move constructively from dialogue to action by linking policy and practice.

www.unep-wcmc.org/forest/restoration/globalpartnership/

Conferences

19th Conference of the Society for Ecological Restoration (SER) International
Making Change in a Changing World
Perth, Western Australia, 23-27 August 2009.

SER International meetings provide important international fora for scientists and practitioners who look to restoration as a means to conserve declining biodiversity and failing ecosystems.

The following sessions are likely to be of particular interest to BGCI members:

The Role of Botanic Gardens and Seed-banks in Ecological Restoration: Next Steps
Principal Organizer: Kate Hardwick, Royal Botanic Gardens, UK

Native Plant Materials Development and Use in a Changing World
Principal Organizer: Kayri Havens, Chicago Botanic Garden, USA

Sourcing Seed in a Changing World: Genetic Implications for Restoration Success
Principal Organizers: Siegy Krauss, Kings Park and Botanic Garden, Australia
David Coates, Department of Environment and Conservation, Australia

Doing Restoration: A Practitioners Practical Guide to Restoration Techniques and Technology
Principal Organizer: Kingsley Dixon, Kings Park and Botanic Garden, Australia

For more information on this meeting visit www.seri2009.com.au or email seri2009@bgpa.wa.gov.au

Please register your contributions to the *International Agenda for Botanic Gardens in Conservation*

International Agenda for Botanic Gardens in Conservation Registration Form

Name of Institution	

Type of Registration			*Please Tick*
	Formal	Board Resolution or other form of approval from relevant governing bodies (e.g. university authorities, local, regional or national government	
	Informal	E.g. by Director/Senior staff.	

BGCI would welcome copies of any formal resolution, motion or other form of endorsement.

Name of responsible person	
Position	
Address	

Email		**Date of Registration**	

Declaration

This institution welcomes the International Agenda for Botanic Gardens in Conservation as a global framework for the development of institutional policies and programmes in plant conservation for botanic gardens.

Without imposing any obligations or restrictions (legal or otherwise) on the policies or activities of this institution/organisation, we commit ourselves to working to achieve the objectives and targets of the ***International Agenda for Botanic Gardens in Conservation.***

Signed		**Date**	

Please sign and detach this registration form and send it to The Secretary General, Botanic Gardens Conservation International, Descanso House, 199 Kew Road, Richmond, Surrey TW9 3BW, U.K.

Thank you for registering with the ***International Agenda for Botanic Gardens in Conservation***.

Please keep a duplicate copy of this form for your records.

How to join Botanic Gardens Conservation International and help us to save plants from extinction

Established in 1987, BGCI links more than 500 botanic gardens and conservation organizations in 115 countries, working together to save PLANTS FOR THE PLANET.

BGCI's INSTITUTION members receive numerous benefits:
- Opportunities for involvement in joint conservation and education projects
- Tools and opportunities to influence global conservation policy and action
- Botanic Garden Management Resource Pack (upon joining)*
- Regular publications:
  - Cuttings – newsletter on botanic gardens and plant conservation (2 per year)
  - BGjournal – an international journal for botanic gardens (2 per year)
  - Roots - Environmental Education Review (2 per year)
  - A wide range of publications and special reports
- Invitations to BGCI congresses and discounts on registration fees
- BGCI technical support and advisory services

	Institution Membership	£ Stlg	US $	€ Euros
A	BGCI Patron Institution	5000	8000	7500
B	Institution member (budget more than US$2,250,000)	750	1200	1000
C	Institution member (budget US$ 1,500,000 - 2,250,000)	500	800	650
D	Institution member (budget US$ 750,000 - 1,500,000)	350	550	450
E	Institution member (budget US$ 100,000 - 750,000)	185	300	250
F	Institution member (budget below US$100,000)*	85	130	115
	**Generally applies to institutions in less developed countries*			

INDIVIDUAL members and donors support BGCI's global network for plant conservation, and are connected to it through our publications and events. Membership categories include:

- Regular publications:
  - Cuttings – newsletter on botanic gardens and plant conservation (2 per year)
  - BGjournal - an international journal for botanic gardens (2 per year)
  - Roots - Environmental Education Review (2 per year)
- Invitations to BGCI congresses and discounts on registration fees

	Individual Membership	£ Stlg	US $	€ Euros
J	Conservation donor (*BGjournal*, *Roots* and *Cuttings* reports and more)	250	400	350
K	Associate member (*Cuttings* and *BGjournal*)	40	65	50
L	Associate member (*Cuttings* and *Roots*)	40	65	50
M	Friend (*Cuttings*) available through online subscription only (www.bgci.org)	10	15	15

Corporate Membership is available; please contact BGCI at info@bgci.org for further details.

**Contents of the Botanic Garden Management Resource Pack include: Darwin Technical Manual for Botanic Gardens, A Handbook for Botanic Gardens on the Reintroduction of Plants to the Wild, BGjournal - an international journal for botanic gardens (2 past issues), Roots - Environmental Education Review (2 past issues), The International Agenda for Botanic Gardens in Conservation, Global Strategy for Plant Conservation, Environmental Education in Botanic Gardens, additional recent BGCI reports and manuals. BG-Recorder* (a computer software package for plant records) available on request.

Payment may be made online at www.bgci.org/worldwide/members/, or by cheque (payable to Botanic Gardens Conservation International) or VISA/MasterCard sent to BGCI, Descanso House, 199 Kew Road, Richmond, Surrey, TW9 3BW, U.K or Fax: +44 (0) 20 8332 5956.

❑ **I wish to apply for BGCI's INSTITUTION / INDIVIDUAL membership (circle one).**

Institution Name (if applicable) ....

Contact Name ....

Address ....

....

Telephone ....

Fax ....

E-mail ....

Website ....

Membership category (A-M) .... Annual rate ....

VISA/Mastercard number ....

Credit card expiry date .... Security code/CSV number (last 3 digits) ....

Signature .... Print name ....

❑ **I would like to make a donation to BGCI.** Amount ....

Please clearly state your name (or the name of your institution) on all documentation. Please contact info@bgci.org for further information.
Individuals in the U.S. can make tax-deductible contributions online at www.justgive.org or by contacting usa@bgci.org.
BGCI is a registered charity and company, limited by guarantee, in England and Wales, and in the U.S. as a 501(c)(3) non-profit organization.

This publication is supported by the
Rufford Maurice Laing Foundation

The Rufford Maurice Laing Foundation
www.rufford.org

BGCI
Plants for the Planet

Botanic Gardens Conservation International

Descanso House, 199 Kew Road,
Richmond, Surrey, TW9 3BW, U.K.

Tel: +44 (0)20 8332 5953
Fax: +44 (0)20 8332 5956
E-mail: info@bgci.org
Internet: www.bgci.org

Printed on 100% recycled paper

ISSN 1811-8712