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Botanic gardens
and urban
biodiversity



BGCI

Plants for the Planet



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Cover Photo: Hoary plantain (*Plantago media*) inflorescence in a meadow in Germany. (A. Jagel / Still Pictures)

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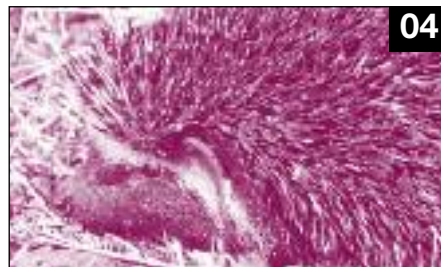
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Editorial – Urban botanic gardens – benefiting people and biodiversity

Opposite: Inner city children enjoying nature in Sao Paulo Botanic Garden (Brent Stirton / Getty Images / WWF-UK)

Over half the world's people live in urban areas. Increasingly cut off from the countryside how will their experiences of nature be shaped? Urban green spaces provide an increasingly important opportunity for people to connect with the natural world. Botanic gardens, generally located within cities, offer opportunities for people to enjoy and learn about a wide range of plant diversity - both native and exotic, wild and managed and to benefit from the relaxation and sense of well-being that botanic gardens - as a form of green space - provide. They form part of the spectrum from areas of natural vegetation through to sports grounds that are all managed as part of city ecosystems.

Botanic gardens attract a wide range of people from academic botanists, artists and city office workers enjoying a lunch break, to school children enjoying an open air classroom. It is not only plant enthusiasts that make a beeline for botanic gardens. This issue of BGjournal highlights the range of natural benefits that botanic gardens provide in an urban setting - both for people and for biodiversity.

Botanic gardens are rarely isolated entities but connect ecologically, culturally and socially with the surrounding locality and people. The article by Christopher Willis and Augustine Morkel highlights how some of the National Botanic Gardens in South Africa, even in urban areas, lie adjacent to natural habitats providing connectivity between urban centres and

the surrounding natural environment. The natural areas provide valuable biodiversity corridors and landscape linkages for the movement of animals into and out of the gardens. Professor Chin's paper explains how in Singapore, as in South Africa, the Botanic Gardens play an integral role in biodiversity conservation for the country as a whole linking administratively to the work of national parks and other protected areas. In both Singapore and South Africa the targets of the GSPC help guide plant conservation in an integrated fashion, incorporating *in situ* and *ex situ* aspects and the wide involvement of people.

The biodiversity found within cities generally can be overlooked but is a hugely important natural asset. Singapore, a densely populated small island city-state with 4.4 million people is in one of the most biodiverse regions of the world. Even the metropolitan region of New York with over 20 million people has a rich diversity of plant species as highlighted by Steven Clemants' article. Studying this biodiversity and involving local people in its care is clearly important. Over 70 botanic gardens recorded in BGCI's GardenSearch database are involved in research on biodiversity in urban environments. At least 200 botanic gardens maintain areas of natural vegetation within their grounds and thus directly conserve the local diversity.

The fauna associated with botanic gardens is often an attraction in its own right. Bird watchers travelling to new

destinations often visit botanic gardens as their first port of call. Leaflets highlighting the resident and migratory birds are produced by various botanic gardens, with recent examples being those produced by Caracas and Singapore botanic gardens. Bird conservation, has a massive, largely urban, support base in Europe and the US. Perhaps botanic gardens can help channel some of this interest into support for the less popular conservation of rare and threatened plants.

Combining urban recreational and biodiversity conservation needs is a success in many parts of the world and is something that is increasingly important in China with its rapidly urbanising population as described in Xiangying Wen's paper. One approach that has worked well for linking recreation and conservation is described in the paper on nature walks for conservation awareness in Mauritius. This shows how developing an area of degraded forest close to the city centre can provide an essential link for the urban dwellers with the remnant natural vegetation of the country. Providing appropriate interpretation and links with schools joins up the natural world with the everyday lives of people.

Interpreting and demonstrating the elements of nature is one of the common tasks of botanic gardens. The potential to build on these tasks and influence people's lives is enormous. With general ecological

awareness gaining ground, growing a garden is increasingly seen as the single most 'green' thing that people can do. However, collectively making the link between caring for garden plants, the conservation of plants in their natural habitats and the fundamental importance of plants at a time of rapid global change, is a major challenge when people's lives are generally divorced from the natural world. Botanic gardens are well-placed to take on this challenge and this will be a developing theme for the work of BGCI.

How can we engage more people in the common cause of plant conservation which is still too often viewed as a specialist, scientific task? BGCI's recent report *Plants and Climate Change: which future* sets out to act as a baseline for making the connections and from this we plan to develop an on-line information service, together with public awareness and educational materials that link the big themes relating to plants. Where better to deliver the messages about plants than in our major cities and through the global botanic garden network. I would be delighted to learn more about successful initiatives undertaken by botanic gardens that engage people directly in plant conservation. Please do share your experiences so that we can encourage more people to appreciate and become involved in caring for the world's plants.

Sara Oldfield
Secretary General, BGCI



National Botanical Gardens: South Africa's urban conservation refuges



Above: Many of the animals that occur in South Africa's NBGs, such as the South African Hedgehog, are nocturnal and normally not seen by visitors (Sharon Willcock)

Introduction

South Africa's National Botanical Gardens (NBGs) mean different things to different people. Traditionally, botanical gardens, as their name implies, have been viewed primarily through a botanical filter. Indeed, Botanic Gardens Conservation International (BGCI) has defined botanical gardens as 'institutions holding documented collections of living plants for the purposes of scientific research, conservation, display and education'. There is, however, much more to botanical gardens, particularly in South Africa, where all NBGs are classified as 'conservation gardens', each including an area of natural indigenous vegetation (with its associated wealth of biodiversity and biological interactions) as well as cultivated collections.

Up until 2007, SANBI managed eight urban-based NBGs mostly located in large towns or cities and bordered in part by urban and peri-urban developments that include roads, townhouse complexes and individual households as well as protected areas such as national parks (Kirstenbosch

adjacent to the Table Mountain National Park) and nature reserves (Harold Porter NBG adjacent to the Kogelberg Nature Reserve). In 2008, when the new garden in Nieuwoudtville was launched, SANBI established its first Nature or Wild Garden, with the aim of conserving a network of sites containing representative portions of indigenous vegetation unique to the Bokkeveld Plateau. This Garden faces its own unique challenges in that it is located in a predominantly agricultural area where sheep, wheat and rooibos tea are the main farming products.

South Africa's nine NBGs are currently spread across six provinces, and include over 7,000 ha of natural vegetation, ranging from savanna bushveld, highveld grassland to subtropical forest, mountain, coastal and renosterveld fynbos to arid succulent karroid vegetation. Based on a preliminary review of living collections in South Africa's NBGs, it has been estimated that the gardens together house some 8,500 indigenous plant species, 43% of South Africa's 19,581 indigenous species. The number of indigenous plant taxa per garden ranges between 350 in the Free State NBG to 5,506 in Kirstenbosch NBG (28% of South Africa's indigenous species). SANBI's gardens attract over 1.25 million visitors per year and, while the visitors to most gardens are largely local, Kirstenbosch in particular receives a significant portion (21%) of visitors as part of organised tour groups, both national and international.

SANBI: the biodiversity challenge

The formation of the South African National Biodiversity Institute (SANBI) in September 2004 through the proclamation of the National Environmental Management: Biodiversity Act (NEMBA) provided the ideal opportunity to showcase the total biological diversity held within South Africa's NBGs. However, since Kirstenbosch was established in 1913, the organisation's main focus has been on studying, documenting and conserving South Africa's indigenous plants. There are therefore many gaps in our knowledge and understanding of the faunal diversity conserved in our gardens. While in most cases there is a fairly comprehensive understanding of the avian diversity in the NBGs, our knowledge of the lesser known, and very often less visible, groups, such as insects, reptiles, amphibians and even mammals is still very restricted. Clearly, there are many opportunities for individuals to further study and document the faunal diversity associated with South Africa's NBGs.

Interpretation and courses

Although our knowledge of the gardens' faunal diversity is still at an embryonic stage, South Africa's NBGs have, for many years, been describing the interactions and dependencies between plants, people and animals through interpretive signage displayed in the gardens. This has been extended

Opposite: Orange-breasted Sunbird feeding on the flowers of *Erica verticillata* in Kirstenbosch NBG. While not threatened, it is adversely affected by invasion of alien woody plants (Mark Anderson)

to general visitors through guided tours and to learners through formal educational programmes presented in the gardens. Several gardens offer weekend talks and specialised natural history courses, and visitors are encouraged to make use of the opportunities that are provided to learn more about biological diversity present in and outside our NBGs.

Surveys and monitoring

Most of the available information on the biodiversity conserved in South Africa's NBGs has come from observations and *ad hoc* surveys completed by university staff and students, museums, and natural history societies and clubs. In recent years, natural history societies, museums and universities have been encouraged to monitor and survey the biodiversity within SANBI's conservation gardens. Faunal groups surveyed have included birds, mammals, spiders, scorpions, bats as well as a range of insect groups (from dragonflies and damselflies to butterflies). In the Walter Sisulu NBG, where a world-renowned resident pair of Verreaux's (Black) Eagles nests on the cliffs of the Witpoortjie Waterfall on the perennial Crocodile River, the breeding behaviour and movements of the eagles are regularly monitored by volunteers attached to the Black Eagle Project Roodekrans, a non-profit organisation dedicated to ensuring their survival.



Left: Resident Verreaux's (Black) Eagles are an important tourist attraction and play a valuable ecological role in the Walter Sisulu NBG (G. Heydenrych)

Biannual biomonitoring of the Crocodile River that runs through the Walter Sisulu NBG has been conducted over the past few years. Results from surveys conducted have shown that the quality of the water improves as it flows through the Walter Sisulu NBG, with the Garden having a positive effect on the biological integrity of the river reach under SANBI's management. Some 21 family representatives of aquatic macro-invertebrate taxa were recorded in the section of river that flows through the Garden. The Kitso-Ecocentre at the entrance of the Garden has an interesting live display of some of South Africa's indigenous fish. Natural history courses on a range of biodiversity topics have been arranged and hosted by several gardens and have proven very popular amongst members of the public.



Above: Dwarf Mongooses (*Helogale parvula*) are frequently seen in the Lowveld NBG. These small mammals are diurnal and live in packs of up to 30 in permanent holes, usually in termitaria. (Mark Anderson)

South Africa's NBGs house an impressive diversity of plants and animals, and it is only through regular inventory and monitoring of biodiversity and habitats in the gardens that we can evaluate the effectiveness of management interventions. Probably the most challenging part of managing NBGs is balancing human values and needs with ecosystem processes. The value of collaboration and partnerships in the management of South Africa's NBGs cannot be underestimated, and if we are to be successful in our management of the biodiversity within our gardens, there has to be close co-operation, facilitated by Garden Curators and their management teams, with local and provincial conservation agencies, universities, museums, natural history societies and volunteers. By sharing resources between agencies through partnerships and collaborative projects, funds and resources can be leveraged to achieve mutual conservation objectives.





Right: Darting Cruiser (*Phyllomacromia picta*) in the Lowveld NBG. Its range extends from the southwestern Cape northwards to East and West Africa (Christopher Willis)

various mammals in the gardens concerned. This policy will ultimately be extended to all NBGs as the conservation role of South Africa's NBGs in rapidly expanding urban centres becomes more important and valuable. One of the advantages of SANBI's gardens is that not all the gardens are functionally isolated but lie adjacent to natural habitats of varying sizes, providing connectivity between the gardens and their surrounding environment as well as valuable biodiversity corridors and landscape linkages for the movement of animals into and out of the gardens.

Biodiversity havens

SANBI's NBGs are home to a range of threatened and endemic fauna, from the endemic and Critically Endangered Table Mountain Ghost Frog, found only along forest streams on Table Mountain above Kirstenbosch, to the Marico Barb, a threatened indigenous fish found as recently as November 2007 in the Crocodile River that flows through the Walter Sisulu NBG in Roodepoort/ Mogale City. South Africa's NBGs in general serve an important role as refuges for many invertebrate taxa. A recent study conducted by the Department of Conservation Ecology and Entomology of Stellenbosch University has indicated that young forests and Kirstenbosch's cultivated gardens show the highest ground-living and flying invertebrate diversity on Table Mountain.

culminated in a dedicated Damselfly and Dragonfly Trail being developed inside the Garden in 2000. Repeated surveys conducted along the trail over a three-year period have indicated that from a list of 36 species (21 dragonflies and 15 damselflies) there are 24 'core resident species' that can be seen along the trail in the various habitats from January to May. It is possible therefore, on occasion, to account for all 24 during a single visit during this peak period. Academics from the University of KwaZulu-Natal have stated that 'botanical gardens are inherently valuable for drawing public attention to invertebrates, especially dragonflies which, like butterflies, have iconic value....to provide optimal conditions for a wide range of observable species, it is essential to maintain the natural heterogeneity of vegetation along reservoir and stream margins....removal of marginal vegetation for aesthetics or a sense of tidiness, can reduce local species diversity and abundance.'

Management challenges

NBGs are managed with the aim of maximising their biodiversity display, conservation, education and research functions. While the natural areas of the gardens perform important roles as refuges for many different animals and plant species, these areas, with the exception of the Hantam NBG in Nieuwoudtville (which comprises 6,200 ha and is mainly a natural or wild garden), are relatively small compared with many other nature reserves and national parks. There are also, in most cases, no large natural predators (e.g. large cats, pythons, raptors) to control populations of some species. This requires management intervention to keep some kind of balance. For example, the population of Rock Hyraxes in the Pretoria NBG has grown significantly over the past few years because of the absence of their natural predators, Verreaux's Eagles, from the eastern suburbs of Pretoria. In

Right: Scorpion talks in SANBI's NBGs are always popular events (Lou-Nita le Roux)



Studies in the KwaZulu-Natal NBG, where 120 butterfly species have been recorded, have shown that the KwaZulu-Natal NBG is important not only for introducing butterfly conservation to the general public, but also acts as a valuable refuge for many butterfly species in the urbanised area of Pietermaritzburg. Surveys completed in the Garden by staff and students of the University of KwaZulu-Natal

The banning of dogs from several NBGs has resulted in a significant increase in the number and visibility of



Right: Tree Workshop in the Pretoria NBG (Linette Ferreira)

collaboration with Tshwane Nature Conservation, a relocation programme was initiated by which hyraxes were trapped in cages and then released in other nature reserves in and around Pretoria. Since the project started, 82 hyraxes have been captured and relocated to the Groenkloof and Wonderboom Nature Reserves. Other challenges include the introduction of feral animals (such as cats and dogs) or the introduction of rabbits by some members of the public who may unfortunately mistakenly perceive NBGs as places of refuge for their unwanted pets and associated litters. Domination by certain naturalised birds, such as the Common (Indian) Myna, can also cause disturbance to the natural populations of birds in certain gardens; they also compete with indigenous birds and mammals for nesting cavities. Common Mynas have now become a pest in many urban areas in South Africa, particularly in Gauteng and KwaZulu-Natal. They are now considered by the World Conservation Union (IUCN) as one of the world's 100 worst invasive species and do not warrant protection. Mynas compete aggressively with many indigenous species and tend to replace them in areas where Myna populations are well established. Other alien species that are a potential threat to South Africa because of their aggression towards indigenous species include the House Crow and the Common (European) Starling. Maintaining a cultivated garden in association with wildlife can also be frustrating, particularly when certain mammals take a preference to plants that horticulturists are attempting to cultivate and display for visitors. This includes the activities of cane rats, moles, baboons and porcupines in several gardens, as well as the effect of alien invasive grey squirrels on strelitzias cultivated for their seed in Kirstenbosch.



Biodiversity management systems

With the promulgation of the NEMBA in 2004, SANBI has renewed its focus on the conservation of all forms of life in its NBGs, with the ultimate aim that biodiversity and ecological processes within the boundaries of the Gardens will be conserved for both present and future generations. The effective management of the biodiversity housed within South Africa's NBGs requires the development of biodiversity information management systems that include databases, threatened status categorisation, annual indicator surveys, preparation of GIS maps and significant research projects. A need exists to consolidate and standardise a dynamic biodiversity information system, linked to horticultural databases, for South Africa's NBGs. There is also a need to be able to document and evaluate the conservation effectiveness of garden management practices, using indicators such as land alteration, edge effect, riparian buffers, spatial configuration and connectivity, effectiveness of land management for ecological conservation and effectiveness of restoration efforts.

Conclusion

SANBI's ultimate aim is to conserve and celebrate biodiversity and educate members of the public about its value and importance, both inside and outside the boundaries of South Africa's NBGs. The underlying assumption is that people with more exposure to nature are more interested in conserving it. It has been shown that direct experience with the natural world, especially during childhood, appears to be the most important source of environmental sensitivity. As human populations shift to cities, people will experience nature primarily through contact with urban nature. If it is true that conservation will increasingly depend on the ability of people in cities to maintain a connection with nature, then South Africa's NBGs as urban refuges for biodiversity, and places that allow people to connect with natural habitats and ecosystems, will become increasingly more valuable for future generations.



References

- ➔ Honig, M., 2000. *Making your garden come alive!—Environmental interpretation in botanical gardens*. Southern African Botanical Diversity Network Report No. 9. SABONET, Pretoria, South Africa. 92 pp.
- ➔ Willis, C.K., 2005. *National Botanical Gardens: embassies of South Africa's biodiversity and culture*. BGjournal **2**(2): 9-12.
- ➔ Willis, C.K., 2006. SANBI: *Institutional response to implementing the International Agenda*. BGjournal **3**(1): 11-13.
- ➔ Willis, C.K. & Huntley, B.J., 2004. *Establishing National Botanical Gardens in South Africa*. SABONET News **9**(1): 5-13.
- ➔ Willis, C.K. & Morkel, A.T., 2007. *National Botanical Gardens: havens of biodiversity*. Supplement to: Veld & Flora **93**(4). Published by Botanical Society of South Africa and SANBI.

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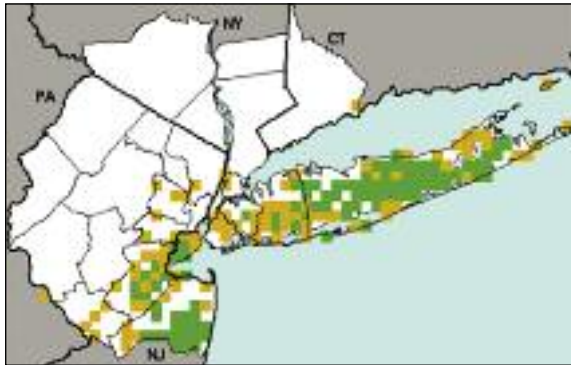
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Above:
 Grysbok have become more visible in the Kirstenbosch NBG over the past few years (Alice Notten)

Left:
 The Table Mountain Beauty or Mountain Pride (*Aeropetes tulbaghia*) is the only known pollinator of the Red Disa (*Disa uniflora*), but it also visits other flowers as seen here (Alice Notten)

Plant conservation in New York City

Right: *Lyonia mariana*, an example of the decline of an Ericaceae. Orange squares indicate where the species was seen up until 1980 and green are where the species is found today (NYMF)



Far right: The seed bank for the city Parks Department (Edward Toth)

**“Abandon hope,
all ye who enter here.”**
Dante’s *Divine Comedy*

The immortal words over the gates of hell might also signify the thoughts of many who consider plant conservation in major urban areas. Why try? Surely there is no hope? For the past two decades Brooklyn Botanic Garden (BBG) has entered this realm and found it hopeful and rewarding. Conservation in urban areas involves much more than habitat or population preservation. The changes to the urban environment are profound and far-reaching. They include changes to the climate, air, soils, and water. Without understanding these changes and developing ways of overcoming or adapting to them it might indeed seem hopeless.

Brooklyn Botanic Garden is uniquely situated to act as a centre for plant

conservation in the New York City area. Its scientists have long studied the flora of the region, and it possesses the first native flora garden in the country, where plants that grow native within 100 miles of the city are presented. Furthermore, and most importantly, the garden is located in the centre of the urban matrix.

The New York metropolitan region is home to nearly 20,000,000 people, one of the largest urban areas in the world. Yet even in this densely populated area we have over 2,000 native plant species. BBG has developed a multifaceted approach to conserving this biodiversity. The New York Metropolitan Flora project was developed to identify and inventory the plants of the region. We are now developing a programme together with the City of New York Office of Parks and Recreation to carry out *in situ* and *ex situ* rare plant conservation within New York City (NYC). Ten years ago

we developed the Center for Urban Restoration Ecology (CURE) together with Rutgers University to improve and promote ecological restoration in the NYC region as well as other urban areas. Through our journal, *Urban Habitats* we are compiling and publishing information on the urban environment for all to use. Through these intersecting projects we believe we can protect and preserve the botanical biodiversity of the region.

New York Metropolitan Flora Project

For nearly 20 years BBG has been studying the flora of the New York metropolitan region. The New York Metropolitan Flora (NYMF) project studies the plant life in the twenty five counties within 50 miles of New York City. This project includes many integrated components including extensive field studies, detailed literature and herbarium studies,

development of a comprehensive database and website, and publication of manuals and research articles. To find out more please visit our web site (www.bbg.org/sci/nymf/).

One of the critical components of NYMF is to understand the changing nature of the regional flora. We have identified over 3,000 species native and naturalized in the tri-state region. Using over 300,000 records of plant occurrences in the metropolitan region we can now suggest which native species have declined, which have resisted the urban influence and which have flourished. This data comes from a variety of sources but particularly from herbarium specimens housed at eleven herbaria in the Northeast United States, extensive published and unpublished lists from literature, and nearly twenty years of field work in the region.

Recently we analyzed nearly 100,000 non-duplicated records of woody plants (trees, shrubs and vines) collected over the past century. As one might expect, over this period we see a general decline of the native species and replacement of these species with introduced, often invasive, species. But more interesting and valuable are the changes happening to specific species or groups, because we can analyze characteristics of these species to determine what aspects of the urban environment are influencing them.

For instance *Celastrus scandens* (American bittersweet) a native species has declined dramatically over the past century, while at the same time as *Celastrus orbiculata* (Asian bittersweet) has spread just as dramatically. This suggests that the later species is out competing and replacing the former species.

Furthermore we are seeing a decline of nearly all members of the heath family (Ericaceae). This change is probably due to changes in the soils of the region. Species of the Ericaceae are highly mycorrhizal and acid-loving but urban soils are generally inhospitable to many soil organisms and more alkaline.

Yet other species appear to be declining because of the dramatic increase of white-tailed deer as the region has become suburbanized.

Clearly the impacts of urbanization are as varied as the biodiversity. Conservation will need to use a variety of measures in order to succeed. We cannot assume a “forever wild” or hands-off approach where we preserve the land and let nature take its course. The environmental changes in the region are too profound and far reaching for that.

New York City Parks Rare Plant Initiative

New York City, The Big Apple, even with a botanical moniker most people do not think of plants when they think of the city. Yet the city was once home to 1,370 native plant species of which 818 still exist in the 50,000 acres of open space. Recently BBG and the City of New York Office of Parks and Recreation have begun work to conserve this botanical resource.

Most of the native plants in the NYC region are not rare elsewhere. But NYC is a prime habitat for a few extremely rare species that grow within the city limits. On New York City beaches can be found some of the largest populations of the federally threatened seabeach amaranth (*Amaranthus pumilus*) found anywhere in the world. Continued efforts of the city will probably keep these populations stable. Similarly, the federally threatened swamp pink (*Helonias bullata*) once grew wild on Staten Island and this has recently has been reintroduced into suitable habitats in the city.

However, we want to preserve all the plant species we can in the city. Even though they grow in the surrounding areas, the populations in the city may have unique characteristics, and they are a part of our legacy. Although two-thirds of the native flora still exist in the city, in many cases they are represented by fewer than five populations. Therefore BBG is entering into a partnership with the New York City Office of Parks & Recreation (including the Greenbelt Native Plant Center and the Natural Resources Group). Included in this project will be: an assessment of the status of all native plants in the city; a programme to seed bank native plants of the city and the immediately surrounding area;



a programme to manage, reintroduce and restore species into the city's parks; and a research programme using molecular techniques to analyse the genetic consequences of fragmenting plant populations.

Last summer we launched this initiative with a three-way partnership to develop an urban seed bank. BBG and the Green Belt Native Plant Center joined with RBG Kew's Millennium Seed Bank project as part of the Atlantic Flora programme of the Millennium Seed Bank. This summer we are continuing with pilot projects to examine the genetics of some plant populations in the city.

Center for Urban Restoration Ecology

Ten years ago BBG and Rutgers University founded the Center for Urban Restoration Ecology (CURE). CURE has four major goals:

- (1) to understand patterns of urban biodiversity,
- (2) to provide protocols for successful restoration projects,
- (3) to encourage urban restoration, and
- (4) to train students and professionals in urban restoration.

Through our New York Metropolitan Flora project we are beginning to understand the patterns of urban plant diversity.

Above: Gerry Moore, Director of Science at BBG, collecting in Northern New Jersey (Tracy Delius)



Above and right:
Flushing
Meadow, shots
of planting
(right) in 1995
and the grown
out condition
(above) in 1998,
of a wetland
restoration in
Queens (Steven
Handel)

One of our most important research objectives is to understand the constraints to successful restoration. These may be biotic (mutualists, pollinators, soil biota, dispersers, invasives, competition, genetics), abiotic (soil physical and chemical effects, heat, light, edge effects, air quality) or social (lack of long term management, human traffic, attitudes).

One of the more pervasive constraints to urban ecological restoration is the abundant non-native species surrounding many projects. BBG has worked for many years to stem the tide of invasive plants in the region. Through our publications we have highlighted the threat of invasive plants, and for example using data from our New York Metropolitan Flora, we can actually quantify that threat. We are now working with local and state groups to identify the most invasive species and determine what we can do to eradicate, manage or mitigate the harm caused by these species.

Some of our research is very practical. For instance, we have started analyzing what is the optimal source of plant material for use in urban restoration. Is it better to get the material from other sites within the urban matrix where the plants have weathered the numerous urban challenges? Or can we use material from outside, where it is easier to get plants and grow them? So far our studies have indicated that getting seed from outside the urban matrix, but nearby, works as well as material from within.



Through our better understanding of the urban environment, its biodiversity, the constraints to urban restoration and practical knowledge we have successfully restored habitats in various urban regions of the world.

Urban Habitats

We are not alone in wanting to conserve plants in the urban area. People throughout the world are seeing the challenge and trying to change it. However, there are few resources devoted to understanding the urban environment. So five years ago CURE co-founded the open-access journal Urban Habitats (www.urbanhabitats.org). We have published numerous articles on plants and animals in urban areas, various habitats, and how people relate to nature in urban areas. We can all learn from each other.

Conclusions

Plant conservation in urban areas is not for the weak at heart. There are immense obstacles and setbacks but we need not abandon the biodiversity of our cities. With concerted efforts, new understanding and new tools we can achieve.

References

- ➔ Galbraith-Kent, S. & Handel, S., 2007. *Lessons from an urban lakeshore restoration project in New York City*. *Ecological Restoration*, **25**(2) 123-128.

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Urban habitats

An electronic journal on the biology of urban areas around the world
<http://www.urbanhabitats.org>

Urban Habitats is a peer-reviewed, open-access electronic journal that focuses on current research on the biology of urban areas. Papers cover a range of related subject areas, including urban botany, conservation biology, wildlife and vegetation management in urban areas, urban ecology, restoration of urban habitats, landscape ecology and urban design, urban soils, bioplanning in metropolitan regions, and the natural history of cities around the world. The broad reader-contributor base of Urban Habitats includes city planners, urban historians, and naturalists as well as scientific researchers and practicing ecologists.

The theme of the latest issue, (Volume 5, May 2008) is 'What is local' and it includes papers on: Genetics and plant selection in the urban context; Practical seed source selection for restoration projects in an urban setting; and a call for the establishment of a National System of Regional Seed Banks and Seed Networks. Previous issues have covered topics such as 'Green roofs and biodiversity', 'Birds in the urban environment' and 'Urban floras'.

Urban Habitats is published by the Center for Urban Restoration Ecology (CURE), a collaboration between Brooklyn Botanic Garden and Rutgers University.



Biodiversity conservation in Singapore

Introduction

Singapore is a small island city-state in one of the most biodiverse regions of the world. The land area of Singapore is about 697 sq km with about 10% of this, a result of land reclamation. With a population of 4.4 million, it is also one of the most densely populated cities in the world. The gross domestic product of over S\$243 billion in 2007 (www.singstat.gov.sg) indicates robust economic activities. The combination of limited land, high population and significant industrial activities means that major planning efforts are constantly required to manage

competing land use. Singapore has executed this adroitly. While material improvements and economic benefits have driven planning and decision making, biodiversity conservation has been given due importance.

The founding of modern Singapore in 1819 by the British, led to rapid colonization and population growth with extensive agricultural activities. The primeval rainforest that covered virtually all of the island was felled for cash crops that included gambir (*Uncaria gambir*) for the production of catch (or catechu) used in tanning leather, pepper (*Piper nigrum*) and



Left: Mandai Road, a Heritage Road with overarching Rain trees (*Samanea saman*) (Singapore National Parks Board)

nutmeg (*Myristica fragrans*). Gambir was ecologically the most damaging, as a great deal of firewood, obtained by cutting more forest, was required to boil down the leaves. Land under rainforest cleared of vegetation loses its fertility very quickly. After a few years of cropping when both fertility and firewood were depleted, the farmers moved to new forest sites. By the 1880s only 7% of the original forest remained (Cantley, 1884). Current estimates indicate that 2,053 species of vascular plants were native to Singapore and some 1,454 species are still surviving (Tan *et al*, 2008).

The green spaces

Today the public green areas of Singapore are mostly under the management of the National Parks Board (NParks). These exceed 9,500 ha or about 13.6% of the total land area of Singapore (www.nparks.gov.sg). Of this, about 3,326 ha (almost 5%) are classified under Nature Reserves. These are the Bukit Timah Nature Reserve, a lowland dipterocarp forest, Central Catchment Nature Reserve, a

Left: Sungai Buloh Wetland Reserve is a popular place to learn about mangrove ecology (BGCI)





Above:
One of
Singapore's two
remaining
patches of
coastal forest
vegetation on
sandstone cliffs,
Sentosa Island
(BGCI)

lowland dipterocarp and freshwater swamp forest, Sungei Buloh Wetland Reserve, a mangrove habitat and Labrador Nature Reserve, a coastal hill forest. The last two were only gazetted in 2002, a significant achievement for conservation, in land-scarce Singapore. Other green areas forming a part of the 9,500 ha include parks, park connectors, playgrounds, and roadside gardens and vacant state lands.

Biodiversity and conservation

Singapore's geographical location and its equable tropical climate support lush natural vegetation. Despite having lost more than 90% of its original forest cover, it is still home to a huge diversity of plants and animals. Apart from the over 1,400 species of native vascular plants still extant, 376 species of birds, 282 species of butterflies, 102 species of reptiles, 58 species of mammals and 27 species of amphibians, have been recorded.

In the marine environment there are 200 species of hard corals, 111 species of reef fish and 11 species of sea grasses.

A far-reaching decision was made in 1963 that a green Singapore was a competitive factor in attracting foreign investment and would be a more attractive and comfortable home for its people. The first tree planting campaign the same year, symbolized this. In the years that followed a number of specific initiatives were put in place to ensure that adequate provisions would be made for urban greenery. Concept Plan Reviews are held periodically to better implement a Master Plan that guides the development of Singapore. A guiding principle of 0.8 ha of park space per 1,000 population was adopted, meaning that additional parkland would need to be provided as the population grows. Road codes were developed so that planting verges along major and minor roads were provided. Car parks must be designed with planting areas and structures like traffic flyovers and pedestrian overpasses clothed with climbers or creepers or screened by shrubs and trees.

Singapore is committed to conserving and ensuring the sustainability of its natural heritage. It is a signatory to the international Convention on Biological Diversity (CBD) resulting from the Rio Earth Summit in 1992. In the same year, the Singapore Green Plan was launched to provide a framework on biodiversity conservation. Nineteen nature areas (terrestrial and marine) were recommended. In 2003, the Singapore Green Plan 2012 was launched to better address conservation issues. In 2006, the National Biodiversity Reference Centre, under NParks, was established as a focal point for biodiversity conservation.

NParks has an active programme of biodiversity surveys and monitoring of its nature areas. In the last several

years, 35 species of plants and animals new to Singapore have been discovered and seven species thought to be extinct have been rediscovered. These and other updates are highlighted in the second edition of the Singapore Red Data Book (Tan *et al*, 2008).

In the built up environment, NParks is committed to creating rich plant diversity in its parks, gardens and streetscapes. Trees and shrubs are planted intensively and extensively and NParks now manages about 1.3 million trees and many more million shrubs. It is estimated that the urban landscape now has been planted with over 3,000 taxa. Of the total, 70-75% are introduced species. It is likely that Singapore has the most biodiverse urban landscape, by far, of any city in the world. Satellite imagery showed that the estimated green cover of Singapore has increased significantly from 35.7% in June 1986 to 46.5% in August 2007 (See Table 1). To a large extent this increase is likely to be due to urban planting and the growth of the planted vegetation providing increasing ground cover.

Introduced species have so far not managed to invade and alter the composition and ecology of Singapore's matured natural vegetation. This perhaps is an indication of the resilience and dynamism of the mature tropical rain forest. The most aggressive introduced species include: *Acacia auriculiformis* from the Australian region, *Paraserianthes falcataria* from east Malesia to the Solomons, *Cecropia peltata* from tropical America and *Spathodea campanulata* from Africa. These are able, though not very successfully, to invade open secondary forest areas as pioneers. The tropical American shrub, *Clidemia hirta*, penetrates old growth forest but only along more exposed trails. However, in time, primary lowland rain forest species introduced from the region, can be expected to invade matured native habitats.

In Singapore, a bold proposal is for a park connector network designed as green corridors that will connect parks, nature areas and open spaces to population centers. It is proposed that the network will cover the entire island,

Table 1: Green cover of Singapore

June 1986	June 1997	August 2007
35.7%	43.1%	46.5%

(information from CUGE Research, NParks, 2008)

providing a matrix of vegetated links accessible only to pedestrians and cyclists. It is anticipated that the corridors will also facilitate bird life and bird movements and encourage other animal life. When completed in 2015, there would be a network of 300 km; currently, 100 km are opened for use.

Another two schemes initiated by NParks in 1991 are highlighted here. These are the Heritage Tree and Heritage Road Schemes. The former was designed to identify, recognize and conserve individual trees of historical, aesthetic, cultural, social or educational value. The public can participate in this scheme by nominating individual trees for consideration as a heritage tree. Currently 171 trees have been given this status. A plaque identifies each of them. The Heritage Road scheme, on the other hand, identifies and conserves specific roads with outstanding treescapes. Currently 5 roads totaling about 10 km have been gazetted as Heritage Roads

Public sentiments and life-style choices in Singapore are evolving to favour environment and conservation. A classic example is the way Chek Jawa; a tidal flat at the eastern tip of Pulau Ubin, an island to the northeast of Singapore was saved. This shallow shelf was identified for land



Left:
The Treetop
Walkway at the
Central
Catchment
Nature Reserve
provides a
unique
opportunity for
nature watching
at the canopy
level (Singapore
National Parks
Board)

reclamation in 1991, with work to begin in December 2001. However, over time nature enthusiasts discovered that this tidal habitat was exceptionally rich in marine life. In addition, the beach had both rocky and sandy components with a mangrove in the vicinity and a patch of coastal hill forest on the landward side. From mid 2001, lobbying to save the tidal flats intensified. The Government responded swiftly by calling for a study on the biodiversity and reclamation options. By January 2002, the Government

decided that the proposed reclamation be deferred indefinitely. It has since funded the development of visitor facilities and conservation initiatives at Chek Jawa. This unique habitat has now become a popular visitor destination and an important outdoor educational resource.

The role of Singapore Botanic Gardens

In its early decades, the Singapore Botanic Gardens played important roles in recreation, research and forest conservation. From its founding in 1859, the Gardens staff began collecting and documenting plants. A journal, now *The Gardens' Bulletin Singapore*, was started in 1881 to record the results of research in the Gardens. In 1883 when the first forest reserves were established in the Straits Settlements (the territories of Malacca, Penang and Singapore), they were placed under Director of the Gardens who was also the Conservator of Forests.

The Forest Department was to remain under the Gardens' administration until 1895 when forest matters were officially transferred to the Land Office. By this time 35,776 ha had been designated as Forest Reserves in the Straits Settlements, a significant achievement in forest conservation. In 1939 the forest reserves in Singapore reverted back to the control of the Director of the Gardens.

Left:
Schools find the
Singapore
Botanic Gardens
a very
accessible place
to teach
children about
plants and the
environment
(BGCI)





Right:
Sungai Buloh
Wetland Reserve
(BGCI)

The other major and continuing role of the Gardens was botanical exploration and documentation of the flora of the region, providing the baseline information for conservation decisions. Until the 1960s, nearly all significant publications on the flora of the Malay Peninsula resulted from the efforts of the Gardens' staff.

It is interesting to note that in the 1880s, staff of the Gardens supervised tree planting in the city of Singapore. This was a role that the Gardens was to revisit in a major way almost a hundred years later when the Gardens focussed on the greening of Singapore in the 1970s and 1980s.

In 1990, the Gardens, under the National Parks Board, redefined its roles and goals and forged a new vision as a botanical institution with a focus on research, conservation, education and recreation. Together with other partners, it initiated a 6-year project in 1991 to survey the biodiversity of the nature reserves of Singapore. Today, the targets of the Global Strategy for Plant Conservation guide its efforts in conservation. The Botanic Gardens' activities are focused

on taxonomy and floristics of the region, capacity building and promoting education and awareness about plant diversity and conservation.

Conclusion

Since independence in the 1960s, the policy to green Singapore was implemented with dedicated effort and political will. It has resulted in an island almost 50% vegetated with its existing biodiversity managed and conserved and increasingly made accessible and interpreted. Its key botanical institution, the Singapore Botanic Gardens, has played leading roles in plant diversity conservation since its establishment almost 150 years ago.

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References

- Cantley, N., 1884. *Report on the forests of the Straits Settlement*. Singapore Printing Office. Singapore

- CUGE Research, NParks, 2008. Manuscript.

- Tan, H. *et al.*, 2008. *Checklists of Threatened species: Plants*. In, Davison, G., Ng, P. & Ho, H. 2008. *The Singapore Red Data Book: Threatened Plants and Animals of Singapore*. 2nd edition, Nature Society, Singapore. Singapore.

Websites

www.nparks.gov.sg
www.singstat.gov.sg

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Diversity in amenity planting

Introduction

Botanic gardens form part of the continuum of open spaces available to the public in urban areas. As well as their more specialised roles in research and biodiversity conservation they provide recreational areas for exercise and relaxation. The planting and pathways are important as in any urban green area. But how important is diversity in planting when the plants are seen as one part of the amenities available to the general public in our city spaces? And what is meant by amenity planting? In its broadest sense, amenity planting is a wide-ranging subject. It covers planting in parks and gardens, roadside flower beds, roundabouts and cemeteries, and extending to supermarket car parks, motorway verges and public visitor attractions. It is in fact any planting in a public



Left:
Bedding plants are planted in their thousands in amenity landscapes every year

space. Those responsible for amenity planting include local authorities, trustees of private gardens and museums and tenants organisations.

Amenity planting – the traditional view

Amenity planting in any context including within botanic gardens, encompasses trees; both as specimens

and in woodlands; shrubs, perennial planting in herbaceous borders and seasonal bedding. All of these types of planting embellish mown grass which has itself always been the dominant vegetation type in the amenity setting. The preferred landscape choice of many involved in the amenity sector is mown grass, along with seasonal bedding (annual flower planting). This is monoplanting and has been described

Left:
A single species or very limited number constitutes monoplanting

Right:
Beds at the
Sheffield Botanic
Garden



Above:
Naturalistic
herbaceous
vegetation -
Primula meadow
(James
Hitchmough,
Sheffield
University)

by sceptics as 'green concrete' and is the antithesis of diversity in amenity planting. The reason it is so widespread is the minimal maintenance required to keep it neat (predictable, repetitive and mechanised) and its more physical qualities such as robustness and long season of 'interest'. In the UK at least, much is made by local authorities of the cheapness per hectare of gang mown grass: in economy of scale it is unparalleled.

Annual plants used to complement mown grass are planted in their thousands in every country that has the resources to do so - from Egypt to Mexico. These provide 'colour and drama' now understood to be an essential requirement of the average tax payer who provides budgetary support for amenity planting. Thousands of bedding plants are planted every summer to decorate the streets and parks. The Royal Borough

of Kensington and Chelsea in London, for example plants at least 300,000 bedding plants every year for 100 or so sites around the borough. The resource intensity of this is considerable as these plants need a ready supply of water and nutrients in order to complete their swift, intense lifecycle. Mobile watering vehicles regularly irrigate the flowers that are planted during a hectic month in late spring and again in late autumn.

The managers in the parks departments would also see that planting 300,000 exotic flower cultivars...from Dahlia 'Roxy' to Fuschia 'Maybe Baby', tightly together in rows and shapes and creating a riot of colour that lasts just three months, to be replaced in autumn with pansies and bulbs, as very diverse. They are right from an artistic point of view, but this kind of landscape management is a far from sustainable from an ecological perspective and is expensive. Local authorities would argue that this kind of planting bolsters 'civic pride' despite the fact that it is economically and environmentally costly. Does civic pride have to come at this cost?

The influence of the 'gardenesque'

Historically the influence of the 'gardenesque' underpins all of our thinking about planting. During the

second half of the nineteenth century global influences and the greater availability of many types of flowers made it possible for parks to aspire to have the features of the great botanic gardens and private estates of the day. Many public parks had indeed been private gardens themselves before being taken over for the enjoyment of the public. Herbaceous borders, 'parkland', annual displays of bedding plants, Japanese gardens, Alpine gardens, Rhododendron borders... the list of features that constitute gardenesque is considerable. In their time, parks were very successful at maintaining and introducing these elements for the enjoyment of the public. Today however most parks departments are no longer the repositories of horticultural skill they once were, and they no longer have the resources to implement and maintain the highly formulaic garden features they formerly aspired to.

Stripped down and simplified ideas from the gardenesque seeped out into amenity planting, hence the expanses of monoplanting that adorn our streets and roundabouts; monoplanting of shrubs, annual flowers and bulbs. This type of *gardenesque 'lite'* still forms the majority of our amenity planting outside our parks and, to some extent, within them.

Introducing diversity into amenity planting

Let's consider this matter of diversity in amenity planting. What is it and why is it better than the traditional alternative? Diversity means a large number of plant species creating a variety of habitats thereby allowing numbers of species to thrive in balanced, permanent ecosystems. And why is it good? From an *ecological* point of view a range of co-existing species is considered able to exploit more resources than can a single species on its own thereby producing a greater biomass and the environmental benefits that ensue. A range of species is also said to be better able to cope with change, as an ecosystem, than a single species.. There are two theories as to why this might be so: firstly, at a *community* level, the greater the number of species, the greater the number of responses to different



environmental stresses, which smooths out variation at the community level; the second theory being that a large number of species in a community means that there are enough species to *functionally* replace those that are adversely affected by external pressures. (Dunnett 2004). It is true that a range of species planted in an ornamental setting is certainly less vulnerable to pathogens and environmental extremes than one sole taxon. Pansies planted *en masse* all with mildew are not an uncommon site on London's Streets, as are rose beds blighted by black spot.

From an *aesthetic* point of view, despite evidence suggesting that people like things to be tended, peoples' perception of landscape is favourable if there is a degree of 'complexity' to a setting (as well as coherence). Managed complexity, or diversity, is therefore what people want to see. Wildness is acceptable if the edges are neat...mixed plantings are accepted if they look planned rather than random. This requires skill at the management level to make wild and managed meet seamlessly. Spontaneous vegetation (also known as weeds) in an urban setting, left to colonise abandoned land does not necessarily constitute diversity as too often it is one or two highly competitive (normally exotic) species that dominate.



Environmental concerns, which now underpin every area of public life, have started to have an influence on amenity planting. Parks departments and others in the landscape planting sector have been and continue to think about how to make planting both diverse as well as resource-efficient. They have approached this in various ways. Many of the more forward-thinking managers of public spaces have experimented with sowing flower mixes redolent of annual meadows. Organisations such as Landlife International based in the UK receive a lot of public funding to involve the community in sowing wildflower meadows in an urban setting. These mixes can, however, be very vulnerable to annual weeds and a short (but often spectacular) burst of poppies, cornflowers and ox eye daisies cedes to three months of weeds that self seed and so the cycle continues. It can take many years (and much commitment) to restore the balance in favour of a natural succession of annual flowers in grasses. The reason for this is two fold....the soil in the amenity setting is more often than not much richer in nutrients than many of our soils that occur naturally. A small group of exotic plants exploit these nutrients and self seed very successfully making it difficult for introduced annual flower seeds to get a toehold.

Another very successful way of introducing diversity is simply not to mow the grass; differential mowing is a common practice in most amenity grassland management. Over time new species self seed and the unmown grass becomes a habitat in its own right with other species slowly establishing in the grassland. On the planting side, local authorities such as the new Potters Hill Park by Tower Bridge in London, UK have employed forward thinking landscape architects who are specifying swathes of tall perennial plants and grasses such as those pioneered by the Dutch architect Piet Oudolf. These are wildlife-friendly and easy to maintain. Oudolf uses a limited palette of tall perennial plants and grasses planted in swathes.... his is the herbaceous border re-examined with grasses playing a major role.

Using perennial plants again the University of Sheffield has done much research over the last twenty years to develop the use of *naturalistic herbaceous* vegetation in an amenity setting. This presents a middle ground between meadow-like planting and herbaceous planting and as well as being a resource-efficient way of introducing diversity into amenity

Left: Palms are used to punctuate and alleviate the flatness in amenity planting

Far left: Single species amenity planting

Below: Naturalistic herbaceous vegetation sown from seed (James Hitchmough, Sheffield University)



Right: Perennial plants used with grasses are wildlife friendly and provide a very long season of interest, as well as being drought resistant and minimal in maintenance requirements



Right: Bedding plants are resource intensive and often not particularly wildlife friendly. They do however, provide colour



planting. Using a large number of species of perennial flowers, or forbs as they are known, 'prairie' type planting is established; a site is sprayed with a graminicide weed killer and seeds are sown into a thick mulch of sand or compost which acts as a weed suppressant. Germination and establishment is generally very successful. Mixes can be tailored to damp or dry soil, they require very little maintenance and the resulting growth is very attractive to birds and invertebrates.

Right: Mesotrophic meadow in Brandon Hill Park, Bristol. This was formerly mown grass

Management is the key to increasing diversity in amenity planting. For local authorities that do not have the resources to achieve nature-friendly management, wildlife trusts sometimes step in and take over the management. Such is the case of Brandon Hill Park in Bristol. Half of this park has been given over to the Avon Wildlife Trust, who are restoring it to a mesotrophic grassland, introducing native trees and shrubs and allowing nature to take its course. Botanic gardens and other parks, often have 'conservation areas' that are encouraged to be wildlife friendly habitats. Management is kept to a minimum - just enough to keep species diversity fairly balanced. These areas are accepted by the park users as long

as all of their other needs are catered for, such as sport, dog walking, flower displays, benches, cafes and toilets.

Conclusions

Encouraging diversity in amenity planting is often constrained by the reluctance of those in charge of amenity landscapes to experiment. This is an area in which botanic gardens, most of which are in cities, could play a major role. Botanic gardens have always taken the lead in encouraging the conservation of plant diversity, and there is a growing focus on local habitats and vegetation types in their displays. They have in the main however, been slower to adopt some of the management practices discussed above - differential mowing of grass, sowing ornamental seed mixes or even using perennial plants experimentally.



Botanic gardens are repositories of increasingly rare horticultural skills and accumulated knowledge. They also have a history of plant-based experimentation - whether it be trialling tropical crops for agriculture or growing plants for medical research. This experimental approach could be extended to include to the wider amenity environment, notably the area of ornamental planting. There is no reason why botanic gardens could not aim to move away from the immaculate seasonal bedding laid on for the visitor and experiment to make seasonal ornamental planting less resource-intensive, with a greater focus on seed sowing - educating visitors and the wider greenspace community thereafter. Taxonomic order beds are often maintained by re-sowing every year, with seed being collected and phenological information noted; there is no reason why these practices cannot be applied to some of the seasonal ornamental plantings, to create diverse and suitable seed mixes with a long season of colour.

References

➔ Dunnett, N. & Hitchmough, J., 2004. *The Dynamic Landscape*, Spon Press, London, UK.

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The importance of botanic gardens in Chinese cities

Introduction

China has around 234 botanic gardens and arboreta generally designated by the Government as research and development centres for plant diversity conservation and sustainable utilisation. Most botanic gardens are located in central city locations or in the suburbs forming an integral part of the city environment. The number of Chinese botanic gardens is increasing with major new gardens being developed or planned (e.g. Chen Shan Botanical Garden in Shanghai, Nan Shan Botanical Garden in Chongqing and Dong Guan Botanical Garden). It is estimated that there are 1-5 new botanic gardens built each year in China. The rapid development of botanic gardens and the resurgence of interest in their potential within China is mainly due to the rapid recent development of the country's economy and the growth of external and internal tourism. Botanic gardens are seen as prestigious urban development projects and, at the same time, they



Left: Children enjoy the Wuhan Botanic Garden (BGCI)



continue to play an important function delivering Chinese development policy, particularly an Ordinance issued by the Ministry of Construction covering the building of Ecological Gardening Cities, which emphasizes that all cities should build botanic gardens to conserve their local biodiversity.

China has 31,000 species of vascular plants accounting for 10% of the world total, making it one of the richest countries in terms of plant diversity. However, China's rapid economic development in the last thirty years and continuous population growth seriously threatens this abundant biodiversity.

Left: Signage in the medicinal plant garden at Wuhan Botanic Garden (BGCI)



Above:
Gateway to the
Xishuangbanna
Tropical
Botanical Garden
(BGCI)

Nearly 4,000 to 5,000 higher plants are considered at risk of extinction, accounting for 15-20 % of the total number of plants in China. Biodiversity conservation is fundamental to support ecologically sustainable development in both urban and rural areas.

Right:
Chinese pavilion
in the Wuhan
Botanic Garden
(Zhang Li)

The biodiversity conservation role of botanic gardens is therefore essential, and the responsibilities of botanic gardens include plant conservation advocacy, species protection and research. In addition, botanic gardens have important experience and expertise in the control, research, management and utilisation of alien invasive plants, which are a major ecological problem in China and one that cities will face increasingly in the future (He Shan'an, 2007).

Furthermore, as the standard of living improves, more and more people recognise the broader importance of botanic gardens for horticulture, environmental improvement and leisure and increasing foreign exchange in China is encouraging a growing interest in botanical gardens (Zhang Zuoshuang, 2007).

Differing roles of botanic gardens in China

Botanic gardens in China - as elsewhere in the world - are multifunctional. However in China, gardens have different emphases according to the branch of Government that oversees them.

For example, the botanic gardens under the leadership of the Chinese Academy of Sciences (CAS) focus on botanical research and the collection and cultivation of Chinese wild plants.

The arboreta of the Forestry Department focus on forestry research, mainly collecting and cultivating tree species. The botanic gardens of the Urban Construction Department focus

on horticultural research, collecting extensively ornamental plants both from home and abroad. These have a particularly key role in promoting diversity in urban planting. The botanic gardens of the Educational Department focus on research, and the collection and cultivation of plants for the purpose of teaching (Xu Zaifu, 1996).

The fourteen CAS botanic gardens, especially the three core gardens (Xishuangbanna Tropical Botanical Garden (XTBG), South China Botanical Garden (SCBG) and Wuhan Botanic

Garden (WBG)), have collected and conserve *ex situ* about 20,000 vascular plant species, accounting for approximately 90% of all plant species maintained by all Chinese botanical gardens. This indicates that CAS has achieved the target of conserving at least 60% of Chinese native plants and providing an important reserve of plant resources for sustainable economic development in China.

China has a long history of using traditional Chinese medicine (ca. 11,000 medicinal plant species) and



Right:
Exploring
bryophytes at
Fairy Lake
Botanical Garden
(BGCI)

Government that oversees them. For example, the botanic gardens under the leadership of the Chinese Academy of Sciences (CAS) focus on botanical research and the collection and cultivation of Chinese wild plants.

The arboreta of the Forestry Department focus on forestry research, mainly collecting and cultivating tree species. The botanic gardens of the Urban Construction Department focus



Far right:
Interpretation
panels in Wuhan
Botanic Garden
(BGCI)



many Chinese botanic gardens play an active role in medicinal plant research, cultivation and conservation. The gardens provide extensive plant resources to meet the growing healthcare demands of the increasingly urbanised Chinese population. For example, the Herbal Medicinal Garden of SCBG in Guangdong, has a collection of more than 2,000 medicinal plant species with Lingnan characteristics (i.e. species common in the Lingnan region of China and frequently used by Cantonese people in Guangdong, including Guangdong Chinese herbal tea 'Wang Lao Ji' and other types of Chinese herbal teas).

With the rapid development of science and technology, living standards have improved and energy consumption increased. Enhancing the research and development of bio-energy sources in China is one of the effective means of resolving the impending energy crisis. SCBG has established an industrial bio-energy plant garden that conserves germplasm of potentially useful plants and provides effective support for research into energy from biomass and related areas. China has around 15,000 economic plant species of which ca. 4,000 species have value for bio-energy development. Approximately 100 species, including oil plants, fuel plants and crops are conserved *ex situ* in SCBG's energy plant garden. This also provides a potentially important education resource.

Plant diversity in urban ecosystems in China

Rapid economic development has resulted in the pace of urbanization accelerating dramatically in China. Currently about 50% of China's population reside in urban areas.



By 2030, this is expected to rise to 75%. With the process of urbanization and increasingly dense construction, urban biodiversity is drastically decreased, which seriously affects the stability of the ecological environment of cities and directly impacts on the loss of plant species. In today's cities, the original vegetation has all but disappeared and the existing green vegetation is almost all secondary. Wild native plants are losing out to introduced plants and coupled with natural disasters and human destruction, the available habitat for native species in urban area is getting smaller and smaller, while the threats are increasing.

Plants are a vital component of urban ecology and the city landscape. Plant diversity underpins the sustainable and stable development of city economies and helps to regulate the local climate, reduce noise, and beautify the urban environment - all of which impact on human well being. Urban landscape ecosystems built up with few species are highly dependent on artificial maintenance. Increasing green spaces and improving the productivity of communities and eco-efficiency cannot be realized without the diversity of plants (Lu Dongmei, 2005). Botanic gardens are well placed to help maintain the stability of the urban

ecosystem. In China, botanic gardens can contribute significantly to improving city planting schemes by providing both new plant resources appropriate for local conditions and ecological expertise.

Public education for enhancing environmental awareness

Botanic gardens are ideal places to capture the attention of the public and inspire a love of nature, particularly at a time when people have less contact with natural environments. In total Chinese botanic gardens attract up to 18 million visitors every year (Zhang Zuoshuang, 2007). Botanic gardens can also enrich and enhance people's cultural lives, for example by displaying historical civilizations, various art forms and popularising science. SCBG is the largest Southern subtropical botanical garden in China, located in an area rich in natural resources for tourism and therefore a desirable holiday location. SCBG is called 'the forest of the city' and 'the lung of Guangzhou'. The garden includes a modern greenhouse of 10,000 sq m., the first Guangzhou village (where people from Guangzhou first originated), as well as a multi-functional Popular Science Information Centre, all of which provide good platforms for the development and dissemination of cultural and scientific

Above: Kunming Botanic Garden (BGCI)

Left: *Artemisia annua* in the Kunming Botanic Garden (BGCI)



Right:
Bamboo in the
Kunming
Botanic Garden
(BGCI)



Above:
The seed bank
and laboratories
at Kunming
Botanic Garden
(BGCI)

knowledge to a wide city audience. Botanic gardens usually educate people through plant-based exhibitions. For example, during 2008, the Fairy Lake Botanical Garden (FLBG) is organizing an exhibition on bryophytes with the theme 'Dwarves of the plant kingdom - Introduction to bryophytes', which vividly demonstrates basic information on bryophytes through a large number of live plant materials and pictures. The exhibition explains what bryophytes are and displays their characteristics, habitats and diversity. The exhibition also explains the economic, academic and aesthetic values of bryophytes, and the important roles they play in maintaining the water balance, carbon metabolism, pollution monitoring, and other ecological aspects. At a time of a rapidly changing global environment, this exhibition provides a powerful new perspective for people in

Right:
Reading
interpretation
panels in Wuhan
Botanic Garden
(BGCI)

understanding the relationship between man and nature. The exhibition also leads people into the micro-world of the colourful and beautiful mosses. FLBG is seen as a "shining pearl on the green crown". It is known as one of the world's most beautiful gardens, and is seen as an ecological business card in the process of building the ecological city of Shenzhen.

Conclusions

Botanic gardens contribute significantly to Chinese cities by conserving plant diversity to ensure the health of people and the planet. They provide public education for enhancing environmental awareness, undertake scientific research to promote social development, provide attractive, green and clean areas for leisure and for enhancing citizenship. Through putting



education into recreation, botanic gardens become models for the harmonious development of the community, human and nature. China needs not only world class botanic gardens, but gardens of all scales, types and functions to support its increasingly urbanized population.

References

- ➔ He Shan'an, 2007. *Responses of the botanical garden to the development of Chinese cities*. *Blue-sky Landscape*. **5**: 7-8.
- ➔ Lu Dongmei, 2005. *Significance and means of conserving city biodiversity*. *Fujian Science and Technology of Tropical Crops*. 2005. **30** (3): 35-41.
- ➔ Xu Zaifu, 1996. *The status and strategy for ex situ conservation of plant diversity in Chinese botanic gardens — Discussion of principles and methodologies of ex situ conservation for plant diversity*. in: *Conserving China's Biodiversity*. MacKinnon, J., Wang, S. *et al* (eds.). China Environmental Science Press. Beijing. 79-95p.
- ➔ Zhang Zuoshuang, 2007. *The mission and responsibility of China's botanical gardens*. *Blue-sky landscape*. **5**: 5-6.

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Nature walks for conservation and awareness in Mauritius

The Forestry Service of the Ministry of Agro-Industry and Fisheries is the oldest institution on the island of Mauritius. Established in 1777 by the Dutch, the aim of the Forestry Service was the logging of timber species such as ebony (*Diospyros* spp.) and other native species like tatamaka (*Calophyllum inophyllum*), and bois de natte (*Labourdonnaisia glauca*). Forests were also cleared to make room for the early settlers and their infrastructural as well as agricultural developments. During this process of colonization, the introduction of exotic species of fauna and flora caused a misbalance in the natural ecosystem of the island. As a result, the very survival of native species was called into question and many are now threatened with extinction. Conservation and sensitisation campaigning for conservation awareness have always been a major part of the work of the Forestry Service. Being a small island, land space is a limiting factor for development and the conservation of forest areas is a challenge. Efforts for conservation have been multi-pronged,



including *in situ* and *ex situ* conservation activities, awareness programmes and re-afforestation programmes. The article below showcases two concrete examples of conservation activities undertaken in urban areas that contribute to our efforts to preserve our biodiversity.

The Monvert Nature Walk

Monvert Nature Walk, located about 3 km from the city centre of Curepipe, was a highly degraded native forest, heavily infested by invasive alien species like *Psidium cattleianum*, *Ardisia crenata*, *Ravenala madagascariensis* and *Rubus alceifolius* with two industrial installations and a cattle farm in its neighbourhood. Without intervention, Monvert forest would have ended up as either an industrial site or a grazing area. However with a view to provide a recreational facility for the city dwellers and extend conservation efforts, the Monvert Nature Walk was conceived by the Forestry Service.

Efforts to rehabilitate the forest were initiated in 2003, with the removal of the invasive alien species in small parcels of the forest area. On-site training was provided to the labourers to help them properly identify native plant species and with the supervision of Forest Officers, care was taken to ensure no damage was caused to native species. In parallel, the Forestry Service started a propagation programme for plants that would be



used for enrichment planting. Over a period of three years, the invasive species were removed and appropriate native species were re-introduced into the open spaces. The species that were used for enrichment planting in the nature walk were from a predetermined list of plants that used to occur naturally within that area, including trees, shrubs and ground cover. Some tree species that were introduced are listed in Table 1. The rehabilitation of the forest was followed by the creation of trails leading to various points of interest, such as ponds, rare plants and view points of the forest and marshes. The tracing out of the trails was one of the most challenging tasks, since new trails had to be created through the forest while causing minimal disturbances to the key areas of interest. Some additional infrastructures were also installed for the convenience of the visitors and trekkers. There include two kiosks, one elevated platform to have a bird's eye view of the area and a boardwalk.

Above:
The Visitor
Centre from
the outside

Left:
Kiosk connected
by a boardwalk

Coupled with this Nature Walk, the Forestry Service also created a Visitor Centre with audiovisual facilities, and this compound has been converted into an arboretum, with a fernery and an open-air lecture theatre. The Visitor Centre has a photographic collection of native flora and fauna with information in a simple language emphasizing why conservation is important. The audiovisual centre runs two tailor-made films, regarding conservation activities, the importance of mountains and their role as water-catchment areas and how to conserve nature. Two Forest Officers are attached to the Visitor Centre to assist visitors and to act as guides. The audio-visual room is also a meeting place where small workshops and training courses in conservation, eco-tourism and awareness raising can be held.

The compound of the Visitor Centre has been landscaped exclusively with endemic/indigenous plants and all the plants have been properly labelled with their names and description. The plant species that were introduced into the arboretum were selected from a list of plants that have been classified as

Critically Endangered and in need of *ex situ* conservation action. A list of critically endangered plants cultivated in the arboretum is provided in Table 2. The fernery has a collection of native species of ferns and orchids. It is the only fernery on the island and here one can view a collection of some 250 species of ferns together with 86 species of orchids, all in one place. Since its creation, the Monvert Nature Walk has welcomed many types of visitors, including students, families,

tourists and nature lovers. On an average the Monvert Nature Walk receives around 40,000 visitors annually. The recreation of the native vegetation at Monvert Forest can be said to have been successful up to now. However the rehabilitation work continues as the recurrence of invasive alien species is constant. A team of 18 labourers is attached to the Nature Walk to continue with weeding exercises as an ongoing process.

Table 1. List of plant species used in enrichment planting at the Monvert Nature Walk

Scientific Name	Family
<i>Barleria observatrix</i>	Acanthaceae
<i>Ochrosia borbonica</i>	Apocynaceae
<i>Helichrysum yuccifolium</i>	Asteraceae
<i>Helichrysum proteoides</i>	Asteraceae
<i>Syzygium guehoi</i>	Myrtaceae
<i>Sideroxylon grandiflorum</i>	Sapotaceae
<i>Pandanus iceryi</i>	Pandanaceae
<i>Pandanus macrostigma</i>	Pandanaceae
<i>Trochetia parviflora</i>	Malvaceae
<i>Trochetia boutoniana</i>	Malvaceae
<i>Trochetia triflora</i>	Malvaceae
<i>Dombeya mauritiana</i>	Malvaceae
<i>Dombeya populnea</i>	Malvaceae
<i>Zanthoxylum heterophyllum</i>	Rutaceae
<i>Gastonia mauritiana</i>	Araliaceae
<i>Begonia salaziensis</i>	Begoniaceae
<i>Senecio lamarckianus</i>	Asteraceae
<i>Diospyros egrettarum</i>	Ebenaceae
<i>Diospyros pterocalyx</i>	Ebenaceae
<i>Diospyros revaughanii</i>	Ebenaceae
<i>Coffea macrocarpa</i>	Rubiaceae
<i>Labourdonnaisia glauca</i>	Sapotaceae

Table 2. List of critically endangered plants cultivated in the Visitor Centre arboretum

Species	Family
<i>Acalypha integrifolia</i>	Euphorbiaceae
<i>Psiadia arguta</i>	Asteraceae
<i>Aphloia theiformis</i>	Aphloiaceae
<i>Gaertnera</i> spp.	Rubiaceae
<i>Dombeya acutangula</i>	Malvaceae
<i>Trochetia blackburniana</i>	Malvaceae
<i>Pandanus</i> spp.	Pandanaceae
<i>Coffea myrtifolia</i>	Rubiaceae
<i>Distephanus populifolius</i>	Asteraceae
<i>Diospyros nodosa</i>	Ebenaceae
<i>Pittosporum senacioa</i>	Pittosporaceae
<i>Olea lancea</i>	Oleaceae
<i>Sideroxylon cineeum</i>	Sapotaceae

Right: Board walk within the Nature walk



Right: *Dombeya acutangula* var. *rosea* in the arboretum at the Visitor Centre





Nature Corner in Schools

In an attempt to promote *ex situ* conservation in urban areas, the Forestry Service has also launched a very challenging project to create nature corners in schools and colleges. Small areas, normally 20m x 20m are identified within the school compound, the area is fenced and endemic plants are introduced into these areas by the students themselves.

The Forestry Service provides planting materials and fencing free of charge, including labour, to set up the nature corners. Lectures and talks are also delivered in the schools by Forest Officers. The topic of the lectures is always focused on the conservation of endemic plants.

This project has helped in the creation of new areas for:

- *Ex situ* conservation of endemic species
- Increased tree cover
- Popularization of endemic species as landscaping components

Up to now about 80 schools have benefited from this programme. The Forestry Service believes that conservation awareness and education should start from the Primary level,

where these values are instilled in young children for the development of a more conservation-conscious generation. Normally the school curriculum does promote conservation education. However having these specimens in the school backyard is an added advantage for teachers. Thus a win-win situation arises for the both the Forestry Service, with more sites for *ex situ* conservation and increased tree cover and for school teachers who are able to conduct more lively classes without leaving the school compound. The role of the Forestry Service is a continuous one as it provides advice on aftercare management of these nature corners.

The Forestry Service believes that environmental education and conservation awareness programmes are vitally important and should start at a very tender age. The Forestry Service believes in involving citizens in the conservation of their biodiversity and natural resources. Encouraging children to take an interest in nature is an important part of this process. Like the Monvert Nature Walk, two more nature walks have already been created in other distinct areas and a fourth nature walk with a strong component of fauna is presently being established.



Far left:
Dombeya acutangular
var. *rosea*

Left: The fernery
with a vast
collection of
ferns and
orchids

Key references:

- ➔ Font, X. and Tribe, J. (Eds) 2000. *Forest tourism and recreation. Case studies in environmental management.* CAB International UK.
- ➔ Government of Mauritius, 2006. *National Biodiversity Strategic Action Plan 2006-2015.* Available at: <http://www.gov.mu/portal/site/moa>.
- ➔ National Forest Policy. 2006. Available at: <http://www.gov.mu/portal/site/forestry>
- ➔ Rouillard, G. and Guého, J., 1985. *Histoire des Plantes d'intéret Horticole, Medicinal et Economique a L'île Maurice.* Henry & Cie Ltée, Ile Maurice.

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Below: Nature
lovers in the
arboretum



Short communication

Propagation and cultivation of Sakura (*Prunus sargentii*) in the Main Botanic Gardens, Russian Academy of Sciences



Right:
Sakura in the
nursery of Main
Botanic Garden
RAS

Introduction

For the Japanese, Sakura is a sacred plant and when it blossoms, it is a delight to behold. In the spring over 100,000 tourists come from every corner of the world to admire the famous cherry blossom. As Japan is made up of a series of islands with different climatic conditions, the flowering period for Sakura can last for two full months. The first flower buds begin to open in the middle of March on the Southern part of Kyushu and the last buds are finished by the middle of May on Hokkaido Island. Sakura is not a defined plant, nor even a particular species. It is an image. In Japan several species of endemic cherries, such as *Prunus jamasakura*, *P. sargentii*, *P. incisa*, *P. vericunda*, *P. lannesiana* var. *speciosa*, *P. maximowiczii*, *P. nipponica*, *P. pendula* f. *ascendens*, *P. apetalata*, *P. buergeriana*, and *P. grayana*, are all known as 'Sakura'.

Trees without flowers cannot be called 'Sakura'; and the 11 species mentioned above are only called Sakura during the days when they are blossoming. The most important purpose of Sakura in ancient times was its honored function in relation to the moon calendar. Sakura in bloom means it is time for planting rice. Sakura was also a symbol of purity because its petals fell not wilted, but fresh and tender.

Propagating and growing Sakura

In the nursery of the Main Botanic Garden of the Russia Academy of Sciences (RAS), experience has been gained in propagating and growing *Prunus sargentii*.

In 1996, the Japanese Sakura Society presented the Main Botanic Garden with 100 two-year old sprigs of *Prunus sargentii* from Hokkaido Island. Some of those plants were planted in the Japanese Garden in the Main Botanic Garden RAS and others in the nursery of the Department of Plant Propagation with the purpose of studying the propagation and cultivation of this remarkable species under Russian climatic conditions.

At the end of May, 2001, green cuttings of *Prunus sargentii* were treated with a stimulator of root formation (0.05% Cirkon) and planted into hotbeds for rooting. From 60 cuttings, 30 rooted; 50% is a good rate for this species.

In the middle of July, 2004, 400 green cuttings were treated with a 0.005% solution of indolebutyric acid (IBA) for 16 hours and then planted. The resulting root formation was 13%. In 2005, 270 green cuttings were taken in the middle of June and treated with 0.01% IBA for 6 hours. Good rooting was shown in 15% of the cuttings. These experiments showed that it is possible to obtain reasonable results if selection, concentration and the period of treatment of cuttings with root formation stimulators is done carefully.

Seed propagation is however a more reliable method of propagation for Sakura. Many years of observation show that although *Prunus sargentii* in the nursery of Main Botanic Garden blooms yearly, it blooms either sporadically or massively. In 2005, *P. sargentii* was exceptionally abundant in flowering and fruiting. Many fruits were set and ripened. Within the one species, *P. sargentii*, a diversity of color of fruits was noted: one tree produced reddish-brown fruits; the others produced fruits that were yellow and yellow-orange with red sides.

Seed were collected in two batches. The first was collected in the middle of June, 2005. The drupes were cleaned of fruit pulp and soaked in water for twenty-four hours. On the next day the seeds were planted in the beds. Many seedlings appeared in the spring of 2006, between 20-25 April. Among the 285 drupes planted, 188 sprouted: a germination rate of 66%.

The second batch of fruits was collected 10 days later (24 June 2005), cleaned and immediately planted in beds. Seedlings appeared on 4-6 May, 2006. Among 136 seeds planted, 98 sprouted. The germination rate was 72%. *Prunus sargentii* therefore showed a high percentage of germination when freshly collected seeds were planted without additional treatments.

During the period of vegetative growth in 2006, seedlings reached a height of 20-25 cm and a root collar thickness of 0.7 cm. Young plants demanded light and even in light shadow, grew out towards the light. Young plants passed through the winter successfully. No damaged sprouts and/or buds on living plants were noted.

In May 2007, some one-year old seedlings were planted in plastic containers for further observations of growth and development. The other seedlings remained in the beds in open ground.

The height increase of second year seedlings during one month was on average 15-25 cm. The secondary branches were formed and the main shoot was clearly defined. By the spring of 2008, the average height of plants was 75-100 cm. and some of the plants were sold because the interest and demand for this crop is very high.

Conclusion

It is clear that *Prunus sargentii* grows, flowers and fruits well at the Main Botanic Garden RAS, and that this species can be proposed for mass propagation. This species is therefore suitable for enriching the assortment of ornamental woody plants in the central part of Russia.

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Resources

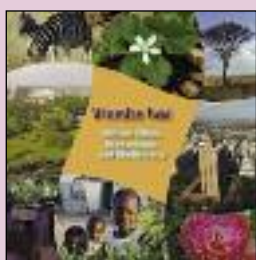
Books and journals

Vimbe hai: African Cities, Ecosystems and Biodiversity

The various case studies presented in this publication illustrate the importance and benefits of ecosystems and biodiversity to the overall well-being of city inhabitants. The value of biodiversity and ecosystems is another irreplaceable service provided to humankind and especially to urban dwellers. The case studies highlight the importance of cities in the context of regional and global efforts to protect and manage vulnerable urban ecosystems and biodiversity. Appropriately managed and conserved ecosystems provide cities with a variety of benefits, contribute towards city and national economies, provide an opportunity to improve human well-being and can play a key role in the reduction of urban poverty. In contrast, poorly managed and degraded urban ecosystems can lead to air, water and soil pollution which increases input prices and operating costs for industry as well as for the provision of basic urban services by local governments. Depleted natural resources in and around a city deter new investments, deteriorate the health of city residents and lead to income losses due to sick leave.

With growing urbanization in Africa, cities need to mainstream biodiversity management into city planning. African cities are leading by example: Cape Town,

Accra, Nairobi, eThekweni, Dar es Salaam, and Walvis Bay are showing us how cities can reap social, economic and environmental benefits from functioning and integrated urban ecosystems and biodiversity.



Available for download from:
<http://www.unhabitat.org/pmss/getPage.asp?page=bookView&book=2485>

Ecology, Planning and Management of Urban Forests

Urban forests play a fundamentally important role in building ecological cities. They improve the environmental quality of the urban environment and the aesthetics of urban landscapes, and in many developed and developing countries, the evolution of urban forestry has been

recognized as an essential means of maintaining urban ecosystem health, improving human living conditions, fostering a harmonious human-nature relationship, and ultimately achieving urban sustainability.



Ecology, Planning and Management of Urban Forests contains studies and perspectives on urban forests from a broad array of basic and applied scientific disciplines including ecosystem ecology, biogeochemistry, landscape ecology, plant community ecology, geography, and social science. The book contains contributions from experts in Asia, Europe, and North America, allowing the reader to evaluate methods and management that are appropriate for particular geographic, environmental, and socio-political contexts. Urban forests are also approached on regional and landscape scales to encompass more natural environments in and around cities, rather than within arbitrary municipal boundaries. The studies provided are intended to motivate scientists, planners, and managers to work together and to adopt a broader landscape ecology approach to urban forestry, and in so doing, better address the pressing needs for improving the quality of life in urban environments.

Edited by: Margaret M. Carreiro, Yong-Chang Song and Jianguo Wu
Published by Springer: Series on Environmental Management. 2007.
ISBN: 978-0-387-71424-0

Making Contracts Work for Wildlife: how to encourage biodiversity in urban parks

Today, more than ever before, we understand that promoting biodiversity in our parks is not something that we can just leave to chance. Rather than letting nature take its course, parks need careful day-to-day management to deliver environments where nature can flourish. *Making Contracts Work for Wildlife* advises green space professionals on



how to make the most of the potential for biodiversity in our urban parks. And it shows how the commitment of individuals and employers can make the difference between failure and inspiring success.

Published by the Commission for Architecture and the Built Environment (CABE)

White Oak Press, 2006, 63 pp.
ISBN: 1-84633-007-6

Guide to city greening

Recuperando o verde para as cidades: a experiência dos jardins botânicos brasileiros / organizadores.

This publication provides a series of case studies and guidelines for city greening programmes, based on the experiences of Brazilian botanic gardens. The publication includes sections on: creating and



managing a seed nursery; the restoration of degraded areas; the rescue of threatened species; education for conservation; using native species in amenity planting; and urban parks for conservation.

Edited by: Tânia Sampaio Pereira, Maria Lúcia Nova de Costa and Peter Wyse Jackson, Rio de Janeiro: Rede Brasileira de Jardins Botânicos; Instituto de Pesquisas Jardim Botânico do Rio de Janeiro, BGCI 2007. 208p.
ISBN 978-85-98262-07-9.
Copies of the publication are available from Tânia Sampaio Pereira, Jardim Botânico do Rio de Janeiro. In Portuguese.

Urban Forests and Trees: A Reference Book

This book covers all aspects of planning, designing, establishing and managing forests and trees and forests in and near urban areas. The disciplinary background of the authors is varied, ranging from forestry and horticulture to landscape ecology, landscape architecture and even plant pathology.

The first part of the book deals with the concept, history, form, function and benefits of urban forests and urban trees. These are followed by the chapters in the second part that focus on the more strategic aspects of accommodating the

demands of the urban population, including policies, design, public participation and partnerships. In the third part the main emphasis is on the establishment and selection of trees for urban uses, as well as information on growing conditions specific for urban areas. Part four deals with the management of urban forests and trees, including the use of information in management and includes a chapter giving an overview of arboricultural practices. Finally the book concludes with three chapters that provide an overview of research and education in the field as well as shedding some light on the future perspectives for planning and managing urban forests and trees.

Edited by: C.C. Konijnendijk,
K. Nilsson, Th.B. Randrup and
J. Schipperijn.
Published by Springer. 2005. 516 p.
ISBN: 978-3-540-25126-2

The Ecological City: Preserving and Restoring Urban Biodiversity

This book is based largely around papers presented at the symposium "Sustainable Cities – Preserving and Restoring Urban Biodiversity" which was held in Chicago in 1990. The symposium focused on three key areas: the functions of biodiversity within urban areas; the impact of urbanization upon biodiversity; and ways to design cities compatible with their ecological contexts. The book is interdisciplinary in content, and the collection of essays it includes look at the ecology of urban communities, exploring issues of geography, ecology, landscape architecture, urban forestry, law and environmental education. Broad overviews of common problems are accompanied by specific case studies. Part 1 of the book comprises a trio of overview papers by a geographer, a landscape architect and a wetlands ecologist. The next two parts address biodiversity issues – relating respectively to urban aquatic ecosystems and terrestrial ecosystems, including urban forests, meadows and arid biomes.

Edited by: Rutherford H. Platt, Rowan A. Rowntree, and Pamela C. Muick.
Published by: University of Massachusetts Press. 1994. 336p.
ISBN: 978-0870238840

Landscape and Urban Planning

An international journal of landscape ecology, planning and design

Landscape and Urban Planning is concerned with conceptual, scientific, and design approaches to land use. It emphasizes ecological understanding and a multi-disciplinary approach to analysis,

planning and design. The journal attempts to draw attention to the interrelated nature of problems posed by nature and human use of land. Papers deal with ecological processes interacting within urban areas, and between these areas and the surrounding natural systems which support them.

Published by Elsevier
ISSN: 0169-2046

Web resources

Liveable Cities: The Benefits of Urban Environmental Planning

From the use of horse-drawn carriages to solve public transport shortage in Bayamo, Cuba to an emissions trading scheme in Taiyuan, China, cities around the world are providing inspiring examples in the global quest for sustainability and the fight against climate change. The report "Liveable Cities: The Benefits of Urban Environmental Planning", published by UNEP, Cities Alliance and ICLEI, showcases 12 examples of cities around the world. It explores various options for sustainable urban development ranging from practical tools and comprehensive policies to innovative market mechanisms, and makes a strong case for the environment as the key asset for cities.

The Cities Alliance, 2007
<http://www.citiesalliance.org/index.html>

UN-Habitat

The United Nations Human Settlements Programme, UN-HABITAT, is the United Nations agency for human settlements. It is mandated by the UN General Assembly to promote socially and environmentally sustainable towns and cities with the goal of providing adequate shelter for all. The main documents outlining the mandate of the organization are the Vancouver Declaration on Human Settlements, Habitat Agenda, Istanbul Declaration on Human Settlements, the Declaration on Cities and Other Human Settlements in the New Millennium, and Resolution 56/206.

UN-Habitat's Urban Environment Section helps cities get the most out of their vital role in social and economic development by promoting better environmental policies and programmes and improving urban environmental management.
www.unhabitat.org

Nature in the city

The mission of Nature in the City is to conserve and restore the nature and biodiversity of San Francisco and connect people with nature where they live.

Ecological restoration and long-term ecological sustainability depend upon people and institutions changing how they interact with their local natural environment. In San Francisco, a new culture of local community ecological stewardship is emerging.

While Nature in the City focuses on inspiring wonder, knowledge, celebration and respect for the San Franciscan bioregion and restoring urban people's sense of place and interconnectedness with their local biodiversity, the website also provides a wide selection of urban nature and biodiversity links.
www.natureinthecity.org

Biocity – Centre for Urban habitats

Adelaide, established in Australia 1836, led the world in environmental planning innovation. Since then the community has maintained an active interest in the protection, enhancement and enrichment of the urban environment. BioCity: The Centre for Urban Habitats has been established to further promote urban environmental awareness through environmental research, communication and education programmes.

BioCity is a partnership between the leading ecological and environmental institutions in the State including local and state governments, industry and the community. The Centre is hosted by the Discipline of Environmental Biology, School of Earth and Environmental Sciences at the University of Adelaide.
<http://biocity.edu.au/>

The Centre for Urban Ecology

The Center for Urban Ecology (CUE) identifies and responds to the natural resource needs of the National Capital Region (NCR), located in the Washington, D.C. metropolitan area.
<http://www.nps.gov/cue/index.htm>

Conferences

International Conference on Urban Biodiversity - 2008

Biodiversity in the city: reality or utopia? On September 26, 2008 the Observatoire Départemental de la Biodiversité Urbaine de Seine-Saint-Denis (the Seine-Saint-Denis Departmental Observatory on Urban Biodiversity), in association with the National Natural History Museum, is hosting a conference on the theme: "Dealing with biodiversity in the city: a new challenge?".

Further information: www.biodiv93.org/

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www.ebg2009.org.za



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

Name of responsible person			
Position			
Address			

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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	
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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

The mission of BGCI is to mobilise botanic gardens and engage partners in securing plant diversity for the well-being of people and the planet. It was founded in 1987 and now includes over 525 member institutions in 115 countries.

Institutions can join BGCI for the following benefits:

- Membership of the worldwide plant conservation network
- Botanic Garden Management Resource Pack (upon joining)*
- Regular publications:
 - the regular newsletter, *Cuttings*
 - *BGjournal* – an international journal for botanic gardens (2 per year)
 - *Roots* - environmental education review (2 per year)
 - A wide range of new publications
- Invitations to BGCI congresses and discounts on registration fees
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*Generally applies to institutions in less developed countries

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 - the regular newsletter, *Cuttings*
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 - *Roots* - Environmental Education Review (2 per year)
- Invitations to BGCI congress and discounts on registration fees

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L	Associate member (<i>Cuttings</i> and <i>Roots</i>)	40	80	60
M	Friend (<i>Cuttings</i>) available through online subscription only (www.bgci.org)	10	20	15

*Contents of the Botanic Garden Management Resource Pack: *The Darwin Technical Manual for Botanic Gardens*, *A CITES 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*, *BG-Recorder* (a computer software package for plant records).

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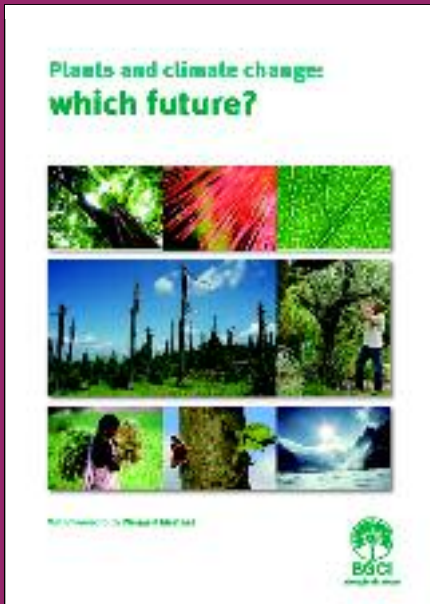
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