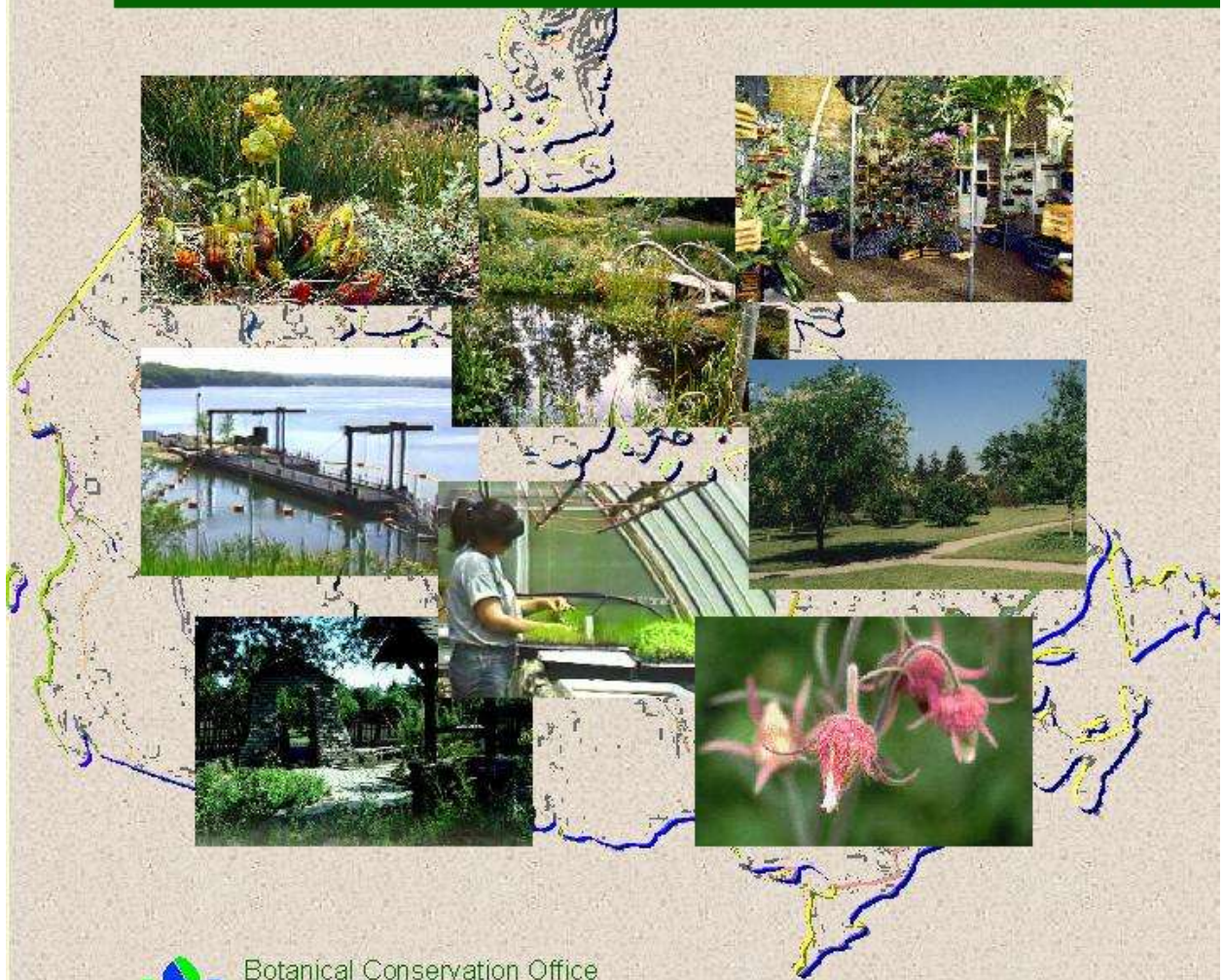


Biodiversity Action Plan for Botanical Gardens and Arboreta in Canada



Botanical Conservation Office
Royal Botanical Gardens
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Environment
Canada

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Executive Summary

- The Biodiversity Action Plan for Botanical Gardens and Arboreta in Canada is a comprehensive resource guide for botanical gardens and their partners and colleagues to expand their opportunities both national and internationally, in conservation, biodiversity, research, and education.
- A collaborative effort by individuals from horticultural, botanical, academic and scientific backgrounds, this Action Plan follows up the 1992 Convention of Biological Diversity (CBD), the 1995 Canadian Biodiversity Strategy (CBS) and the 2000 International Agenda for Botanic Gardens in Conservation (IABGC). The Action Plan clearly defines the concepts of biodiversity, summarizes the goals and objectives of the CBD, the CBS and the IABGC as they relate to botanical institutions, and recommendations practical means for this important sector of Canadian society to take the next steps.
- The objective of the Action Plan is to present a fresh perspective on an old truth: that botanical gardens are now, and have for many years been places of enjoyment, research, conservation, and scholarship in areas that are now collectively called biodiversity. Botanical gardens and arboreta across Canada provide biodiversity services to government, the private sector and the general public that cannot be found elsewhere.
- The Action Plan first summarizes the scientific, cultural and historical contribution of botanical gardens and arboreta in Canada to conserving and using biological diversity in sustainable ways. Second, the Plan reviews the many scientific and cultural aspects of biodiversity and threats to it, with examples of positive contributions by botanical gardens. Third, the Action plan organizes present and new activities to reinforce existing strengths and projects, and points the way to enhancing the understanding and conservation of Canada's natural biological diversity. Fourth, case studies prepared by many contributors provide context and concrete examples of progress being made. Finally, a series of appendices provide reference material, including a review of relevant goals and strategic directions of the Canadian Biodiversity Strategy and the Convention of Biological Diversity. Draft codes of conduct relative to conservation and access to genetic resources have been included as well.
- The Biodiversity Action Plan identifies five main themes for botanical gardens, and develops goals and actions to achieve them:
 - To contribute substantially to the conservation of Canada's natural plant diversity,
 - To enrich biodiversity training and education,
 - To support the foundations of research in ecology, systematics, sustainable use and other core biodiversity sciences,
 - To encourage best policies and practices, within and outside the garden walls, and
 - To secure the necessary resources to implement the aforementioned goals.
- This is both a "working plan" and a reference document that can be used directly by individual botanical gardens and arboreta, by botanical gardens networks, and by partners and other stakeholders.

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Chapter 1. Introduction

Biodiversity and Canada

Biological diversity, or biodiversity, is the rich variety among natural habitats, ecosystems, species and individual organisms. The living diversity we encounter today is the product of evolutionary change, ecological processes, and human activities, either planned or accidental. As such, biological diversity changes over time at the local, regional and global scales, because of natural processes and also because of the effects of humanity.

Since the mid 1980s, biodiversity has emerged as multi-faceted concepts with biological, social, economic and cultural dimensions. The natural biological diversity of our forests, prairies, wetlands and other wild habitats is at the heart of important natural resources and our heritage as Canadians. Biological diversity - and especially the natural and cultivated diversity of plants - is also at the heart of social and economic growth, and has been valued in the many billions of dollars per year to our national economy (Box 1). Cultural aspects of biological diversity, including expressions in the arts of horticulture, landscape design and gardening, are inseparable from our daily enjoyment of life. The arts of gardening and horticulture, in addition to their aesthetic value, are important sectors of the Canadian economy.

Box 1. Approximate annual values of plant products to the Canadian economy

Lumber and fibre	\$7,500,000,000
Grains	\$6,574,482,000
Animal Feed	\$5,718,400,000
Vegetables	\$517,104,000
Legumes	\$399,551,000
Fruits	\$319,504,000
Total:	\$21,029,041,000

(Data from Mosquin et al., 1995, Pages 108-109)

There are good reasons to be concerned about biological diversity, to understand how human society changes it, and to take steps to protect it for future generations. Our global human population continues to expand and is consuming more *per capita* than ever before as standards of living rise. In so doing, we have converted large areas of previously wild habitat to agricultural, urban and other uses, moved "weedy" invasive plants and animals into new environments where they have spread, and made significant changes in the physical and biological environments of nearly all other living species. In some cases these changes have

resulted in the decline or extinction of whole species, and in others communities of species has been radically changed.

Human society and economy is as dependant upon natural biological diversity as is the survival of other species. The net result of many human activities is a reduction of biological diversity, and the capacity of natural ecological systems to support themselves. More worrying, our economies depend on many natural resources and services that are taken from natural ecological systems that are increasingly under threat.

Although some may dismiss concern over biological diversity as an "environmental luxury," our quality of life and economy are already suffering because of the effects of invasive non-native species and our battles with them, and losses because of over-exploited fisheries and other extractive activities, to name a few. Many people are concerned with possible extinction of endangered species, and even our largest protected areas and national parks are losing native species because natural habitats are becoming fragmented.

It is common for people to think of animals when discussing biodiversity issues, and especially when considering endangered species. However, many of the biodiversity challenges we face arise because of the complex interactions between people and the world of plants. Not only do plants form the cornerstones of most habitats and food that all animals (including humans) need every day, but our society and quality of life are completely dependent on both human-shaped and natural plant diversity.

The protection of biological diversity for future generations depends on research and fostering public understanding. In turn, these are dependent on permanent collections of information and of biological specimens, living or preserved. Botanical gardens and arboreta have a long history as dynamic living museums where large numbers of people come to experience the diversity of plant life. Just as there is immense variety in the living world, botanical gardens are themselves diverse, with differing collections, missions and facilities.

Given the scale of the problem, how can individuals and organizations can make a difference and reverse the decline in biological diversity? Although it may seem an insurmountable problem, like all big challenges it is possible to stop the decline in biological diversity and ensure its enjoyment and use for future generations, by seeking a clear understanding of the issues involved, breaking the problem down into manageable parts, and taking on realistic projects with measurable results.

Declines in biological diversity have risen to international attention over the past two decades. The IUCN World Conservation Strategy of 1980 led directly to the 1985 Las Palmas declaration and the subsequent Botanic Gardens Conservation Strategy. In 1992 a new global treaty, the Convention on Biological Diversity, was opened for signature at the Earth Summit at Rio de Janeiro, Brazil, following several years of preparation. The Convention on Biological Diversity, or biodiversity convention, has three major objectives: conservation of biological diversity, sustainable use of biological diversity, and fair and equitable sharing of benefits arising from the sustainable use of genetic resources.

Canada has taken great satisfaction from its leadership in the biodiversity convention, and in late 1992 was the first major industrialized nation to ratify the treaty (the sixth overall). As of early 2001, the Convention on Biological Diversity had been ratified by 178 nations and the European Union. As part of Canada's response to the Convention on Biological Diversity, a wide cross-section of Canadian society was consulted in 1994 on ways in which Canada could respond to the many challenges posed by the convention. This consultation resulted in the publication in 1995 of the Canadian Biodiversity Strategy, Canada's Response to the Convention on Biological Diversity.

The Canadian Biodiversity Strategy listed five key goals for Canada as a whole nation:

- To conserve biodiversity and use biological resources in a sustainable manner,
- To improve our understanding of ecosystems and increase our resource management capability,
- To promote understanding of the need for conservation and sustainable use of biodiversity,
- To develop incentives and legislation that support the conservation and sustainable use. And
- To work with other countries to achieve the goals of the biodiversity convention

The Canadian Biodiversity Strategy expresses these five goals as 193 individual strategic directions, a comprehensive set of biodiversity objectives for all federal government departments.

From the outset, the government of Canada recognized that it cannot achieve the many goals of the national strategy and the biodiversity convention alone. The Canadian Biodiversity Strategy calls for all sectors of Canadian society to respond to the positive, forward-looking challenges of the Convention on Biological Diversity. The strategy notes:

"Successful implementation of the Strategy will be determined, in large measure, by the degree to which all parts of society adopt its vision and principles and contribute to achieving its goals. Ultimately, the conservation of biodiversity and the sustainable use of biological resources will require the support and participation of individual citizens, local and indigenous communities, urban and regional governments, conservation groups, business and industry, and educational and research institutions."

(Environment Canada. 1995. Canadian Biodiversity Strategy: Canada's Response to the Convention on Biological Diversity. Ottawa: Supply and Services Canada)

The objective of this biodiversity action plan is to present a fresh perspective on an old truth: botanical gardens are now, and have for many years been, places of enjoyment, research, conservation and scholarship in areas that are now collectively called biodiversity. Botanical gardens and arboreta across Canada provide biodiversity services to government, the private sector and the general public that cannot be found elsewhere.

About this Action Plan

This action plan is a resource for the botanical gardens and arboreta of Canada, for their partners in government and other sectors. It describes both existing programs and activities of the botanical garden community that are in support of the Canadian Biodiversity Strategy and the Convention on Biological Diversity, and also proposes voluntary actions that botanical gardens and arboreta that would strengthen our communities' contribution to biodiversity activities.

The specific objectives of this Action Plan are:

- To review and summarize the scientific, cultural and historical contributions of botanical gardens and arboreta in Canada to conserving and using biological diversity in sustainable ways,
- To set goals and strategic directions for Canada's living plant museum community in support of the Canadian Biodiversity Strategy and the Convention on Biological Diversity,
- To introduce new projects and proposals to enhance understanding and conservation of Canada's natural biological diversity by Canada's botanical gardens and arboreta,
- To propose and guide new actions by botanical gardens and arboreta, in the form of proposals and projects, taken to enhance the conservation of Canada's natural biological diversity,
- To enhance understanding among botanical gardens and arboreta of the need for and objectives of conservation of Canada's biodiversity,
- To raise the profile of arboreta and botanical gardens in Canada as a coherent and well coordinated sector or community contributing to Canada's biodiversity conservation goals, and
- To act as a basis for shared or community actions and to enhance coordination.

This plan was developed between 1998 and 2001 through consultations with a wide cross-section of botanical gardens and stakeholders. The consultation process included presentations at annual general conferences of the American Association of Botanical Gardens and Arboreta in 1999 and 2000 and at the 1999 International Botanical Congress. In early 2001, complete drafts of the Action Plan were circulated widely, and made available on the World Wide Web in HTML, Microsoft Word 7 and Adobe Acrobat Reader formats. An interactive Web forum for discussions and exchanging ideas on the plan attracted 75 subscribers between January and March, 2001. Many correspondents submitted suggestions and comments directly to the editor.

Chapter 2: Canadian Botanical Gardens and Arboreta: New Concepts, Rich History

The Growth of Canadian Botanical Gardens

Long before biodiversity was a word, botanical gardens were doing all of the things we now associate with it. They were describing new species, studying newly-discovered plants for uses in agriculture, industry, landscaping and medicine, conserving rare wild plants and vanishing agricultural and horticultural varieties, providing public education on the diversity and beauty of life, and acting as museums housing living specimens and preserved reference collections. Over many decades, the collections of botanical gardens have become indispensable databases for systematics and taxonomy. Botanical gardens have also been active in many areas of conservation of biological diversity in its native setting (*in situ* conservation), particularly in exploration, assessment and planning.

More than a century before American entomologist E. O. Wilson spread the term "biodiversity" in a 1986 book of the same name, botanical gardens were compiling some of the world's first true databases on biological diversity. Based initially on the index of Royal Botanic Gardens Kew (UK)'s herbarium, for example, Index Kewensis first published in 1890, was one of the first lists of all known vascular plants.

The first botanical garden in Canada was established in 1860 at Queen's University in Kingston, Ontario (then called the University of Queen's College). Built on the campus by the newly founded Botanical Society of Canada, the garden was built as a teaching garden in the Faculty of Medicine. Unfortunately, the botanical garden in Kingston proved vulnerable to changes in the academic program of the young university and persisted less than a decade.

Today, many different kinds of institutions in Canada can be labeled as "botanical gardens." The most current definition of "botanical garden" in use by Botanic Gardens Conservation International, the global environmental non-governmental organization linking botanical gardens and conservation, is:

institutions holding documented collections of living plants for the purposes of scientific research, conservation, display and education

Botanic Gardens Conservation International (1999)

Dozens of institutions in Canada currently fit this definition (Box 2). Many individual botanical gardens in Canada have had long and distinguished histories of scholarship and horticultural excellence, and are important public amenities that enhance the enjoyment and livability of our cities and towns (Box 3).

Roughly half of all botanical gardens and arboreta in Canada are based in universities, and most of the rest are municipal or city facilities. A few gardens are operated by provincial or federal

government agencies, and a few are operated privately. Classifying individual gardens is difficult, as many have multiple roles and could be associated with several of the functions listed in Box 3. Many of these institutions maintain community gardens or areas developed by volunteers.

Box 2: Botanical Gardens, Public Gardens and Arboreta in Canada

Province/Territory	Institutions
Alberta	11
British Columbia	15, plus 1 planned
Manitoba	7
New Brunswick	4
Newfoundland	1
Nova Scotia	1
Northwest Territories	0
Nunavut	0
Ontario	35, plus 2 planned
Prince Edward Island	0
Quebec	8
Saskatchewan	4
Yukon Territory	1
Total:	87, plus 3 planned

(source: Canadian Botanical Conservation Network)

Box 3: Common types of botanical gardens in Canada

‘Classic’ or Multipurpose Gardens

Usually large, with a range of activities including horticulture, training, public programs, research, and display gardens. Often with associated herbaria or research sections. Examples: Royal Botanical Gardens, Montreal Botanical Gardens

Ornamental Gardens

Beautifully designed and maintained gardens, often with diverse horticultural collections, but with relatively little capacity for research or formal educational programs; may not place emphasis on conservation or on labeling collections. Example: Buchart Display Gardens

University Gardens

Many universities develop botanical gardens as teaching and research facilities and also as campus beautification. Their sizes and capacities vary immensely from public gardens that could be in the "multipurpose" class to much smaller theme or research gardens. Examples: University of Alberta Devonian Botanic Gardens; The Arboretum, University of Guelph

Combined Botanical and Zoological Gardens

Some large institutions include both zoological collections and also significant functions normally associated with botanical gardens. In some cases, the financial value of the botanical collections exceeds that of the zoological collections. Some zoos place great emphasis on recreation of animal habitat, and some maintain natural ecological areas. Examples: Toronto Zoo, Calgary Zoo.

Agro-Botanical And Germplasm Collection Gardens

Institutions maintaining research collections of plant germplasm for agricultural or horticultural breeding purposes may be either open or closed to the public. Examples: Morden Arboretum

Native Plants Gardens and Natural Gardens

These gardens contain an area of natural or semi-natural vegetation, which is protected and managed. Most are established to play conservation and public education roles and include areas where native plants are grown. Example: Native Plant Garden of Royal British Columbia Museum

Horticultural Gardens

Public gardens that are operated in part as training facilities for amateur or professional horticulturists often have magnificent garden areas. Examples: Niagara Parks Botanical Gardens

Conservatories

The climate of Canada lends itself to the development of substantial in-door garden areas offering year-round public amenities, educational and research opportunities. Some conservatories in Canada feature garden areas that are designed as would be an outdoor garden, while others painstakingly recreated natural habitats and ecosystems. Examples: Muttart Conservatory; Biodôme de Montreal

Thematic Gardens

Some gardens are established around specialized collections or themes, which can include biological or social elements. The most rapidly growing class of thematic gardens in Canada may well be wildlife and butterfly gardens. Example: Dr. Sun Yat-Sen Classical Chinese Garden

The range of institutions that can be considered as botanical gardens is matched only by the breadth of activities they undertake. Many of the traditional activities of botanical gardens in Canada are directly in support of the concepts of conservation of biological diversity and the sustainable use of our natural resources (Box 4).

Box 4: Some current biodiversity-related activities of botanical gardens and arboreta in Canada

- Research on the conservation and management of wild plants, in both *ex situ* and *in situ* conditions
- Promotion of the sustainable use of natural plant resources
- Recovery planning of endangered species with possible propagation and reintroduction when called for
- Field botany research
- Wildlife biology research
- Plant taxonomy and systematics
- Habitat restoration and production of biologically-appropriate native plant stocks
- Applied research in horticulture and arboriculture
- Information and library services for specialists and the public
- Environmental education programs for children and adults
- Training programs for teachers and curriculum content development
- Ecological and gardening tourism
- Recreation and enhancement of urban public health
- Ornamental horticulture and floriculture
- Training of professional and amateur horticulturists
- Training of specialists in horticultural therapy
- Maintenance and cataloguing of ornamental plant cultivars
- Seed gene banks for rare and endangered native plants, and for genetic resources of plants that are not necessarily rare or endangered
- Living plant (field) gene banks
- Development and maintenance of herbaria and support for or cooperation with researchers
- Plant propagation research, including tissue culture and conventional plant cultivation
- Research into the history of horticulture and ethnobotany

Botanical Garden Networks in Canada

Botanical gardens around the world have realized that they can extend the effectiveness of their missions by working together in local, national or regional networks. National and regional networks of botanical gardens and arboreta are effective ways to share information and organize resources among disparate institutions. Several networks, each established for different purposes and furnishing different products, overlap to form the present grid of relationships among botanical gardens and arboreta in Canada.

Interest in the role of botanical gardens in conservation was fueled in the early 1980s by visionary work of the International Union for the Conservation of Nature, which organized two important meetings that resulted in the publication of The Botanic Gardens Conservation Strategy (BGCS 1989) and the formation of the Botanic Gardens Conservation Secretariat. The Strategy included important suggestions for botanical gardens to work together at all levels, and resulted in national and regional networks around the world.

Canada was ahead of the curve. In fact, in the early 1970s, Canada's botanical gardens began to consider means of organizing themselves to their mutual benefit and greater effect. The idea of a network of botanical gardens across the country emerged as a natural outgrowth of the diverse regions making up Canada. In 1971, conferences at University of Alberta and Royal Botanical Gardens proposed that such a network should include programs for conservation of horticultural and endangered native flora on a regional basis, and set the stage for increasing contact and cooperation among institutions.

Canadian Plant Conservation Program

Inspired by participation in international discussions on plant conservation, several botanical gardens worked together in the mid-1980s to launch the Canadian Plant Conservation Program. This program improved communications among the gardens through a regular newsletter and a series of meetings that tackled difficult issues such as guidelines for best practice in conservation projects. Discussions under CPCP included the conservation of rare horticultural varieties and native plants. The program complemented other national and international plant conservation efforts, and provided a specific means of communication among the staff of botanical gardens on all aspects of *ex situ* conservation, plant protection, cultivation and the protection of natural habitats. This program functioned for approximately 6 years. In the early 1990s a new effort to circulate information among botanical gardens in Canada was launched by the University of Alberta Devonian Botanic Garden with a new newsletter, Plant Collections Newsletter: Canada, which ran between 1993 and 1998.

Canadian Botanical Conservation Network

Efforts to further organize the connections among the arboreta and gardens of Canada reached a new level in 1994 with the creation of the Canadian Botanical Conservation Network (CBCN). A project of the Botanical Conservation Office of Royal Botanical Gardens, Hamilton/Burlington,

Ontario, with many partners including Environment Canada, and McMaster University, CBCN was organized as a successor in spirit to the Canadian Plant Conservation Program, and several of the key participants in CPCP have guided the development of CBCN. A coordinator was hired for CBCN in early 1995, and in the fall of 1996 Royal Botanical Gardens held a three day workshop to develop the network. The network was formally incorporated as a not-for-profit organization under the name "Canadian Botanical Conservation Network - Le réseau canadien pour la conservation de la flore" and registered as a Charitable Organization by Revenue Canada (Charitable Business Number 87277 5697) in 1998.

A primary purpose of CBCN is to assist the botanical gardens, arboreta and other organizations interested in enhancing their capacity to participate in *in situ* and *ex situ* plant conservation efforts and biodiversity programs. The network has been very effective in developing linkages among botanical gardens, and between the botanical garden community, other sectors and with other national and international conservation and botanical garden networks and agencies. By early 2001, about a dozen botanical gardens and related organizations have joined CBCN as members. As an inclusive organization, CBCN has looked to have many participants involved in plant conservation and biodiversity.

Membership in CBCN is open to both organizations and individuals. Full membership is limited to institutions maintaining collections of plants, but associate memberships for individuals and other organizations are both available. Membership fees for full members are based on annual institutional operating budgets.

Projects and products of the Canadian Botanical Conservation Network include:

- CBCN Newsletter, in production since early 1995. CBCN Newsletter is produced in both print and multiple electronic formats. Plant Collections Newsletter: Canada was incorporated into CBCN Newsletter in 1999. The newsletter goes out to about 200 addresses every 3 months,
- CBCN-L, an Internet list-server focussing on botanical conservation news in Canada, with about 130 subscribers,
- The CBCN Web Site (<http://www.rbg.ca/cbcn>), which presents more than a thousand documents and files on botanical gardens in Canada, plant conservation issues, coming events and notices. The Web site is currently visited by about 30 unique visitors per day, and
- Special reports and participation in conferences and other outreach activities.

The network is maintained as a project of the Botanical Conservation Office of Royal Botanical Gardens, Hamilton.

Canadian Botanical Gardens Consortium for Biodiversity

In 2000, the Directors of five of the major botanical gardens in Canada met to consider how they could further their mutual interests in promoting biodiversity and conservation programs. The meeting resulted in a new commitment to participate jointly in the identification, study, preservation and recovery of Canadian rare plants, and to promote the sustainable management of plant biodiversity in Canada. The cooperative effort was named the Canadian Botanical Gardens Consortium for Biodiversity.

Representatives from University of Alberta Devonian Botanic Garden (Edmonton, AB), University of British Columbia Botanical Garden (Vancouver, BC), Royal Botanical Gardens (Hamilton/Burlington, ON), Montreal Botanical Garden (Montreal, QU) and Memorial University of Newfoundland Botanical Garden (St. John's, NF) met in Edmonton on June 5-6, 2000. The meeting, hosted by Devonian Botanic Garden, and sponsored by the Alberta Science and Research Authority (ASRA), looked for new ways that the research-based botanical gardens of Canada could cooperate.

The five botanical gardens have agreed to each work as regional centres for plant diversity, under the name of the Consortium. The purpose of the Consortium is to promote and facilitate the sustainability of plant diversity and conservation in Canada by coordinated projects in research, education and information services, including a national seed bank program for native plants and training courses in plant identification. The Consortium is making make use of networking services provided by CBCN.

The intent of the Consortium is to help both larger and smaller institutions to achieve their missions related to biodiversity, and participation in Consortium projects is open to all botanical gardens and other stakeholders.

The Consortium is presently focussed on three major projects:

- A national seed bank program for rare and endangered terrestrial plants,
- Training programs in plant diversity, and
- A travelling museum exhibit entitled "Green Legacy," a joint project of Royal Botanical Gardens and the Canadian Museum of Nature that is scheduled to open in the summer of 2002.

American Association of Botanical Gardens and Arboreta

Many Canadian botanical gardens are active members of the American Association of Botanical Gardens and Arboreta, or AABGA. The association was founded through the work of several garden directors in 1940, and since 1972 has relied on professional staff for many of its functions. Since 1990, institutional membership in AABGA has grown dramatically from about 100 gardens to nearly 500 at present, with nearly 3,000 individual members. This growth is due

in part to the growing strengths of the association and also to increasing numbers of botanical gardens. The association is developing professional and institutional development resources involving botanical gardens across North America.

Approximately 17 botanical gardens, arboreta and other Canadian institutions are members of AABGA, which also includes active members from Mexico, the British Virgin Islands, Cayman Islands, Costa Rica, England, and the U.S. Virgin Islands. Among the many regular activities of AAGBA is a very active plant conservation committee, which holds regular meetings in conjunction with association-wide annual general conferences. The Canadian Botanical Conservation Network and AABGA maintain a close relationship, including reciprocal memberships with each other.

Botanic Gardens Conservation International

Botanic Gardens Conservation International was founded in 1987 as the IUCN Botanic Gardens Conservation Secretariat, and is based in the United Kingdom as a registered charity. Over 450 institutions are members of BGCI, located in over 100 countries world-wide. About seven botanical gardens, arboreta and related institutions in Canada are members of BGCI. The Canadian Botanical Conservation Network and Botanic Gardens Conservation International have worked together on joint projects since 1996, including CBCN participation in a workshop on the use of computers in botanical gardens of countries of the former Soviet Union in Kazakhstan in 1998 and conference planning and participation in the Fifth International Botanic Gardens Congress in South Africa in 1998 and the First World Botanic Gardens Congress in North Carolina in 2000.

Botanic Gardens Conservation International projects include:

- Providing support to botanical gardens world-wide in the form of technical guidance, data and other information. BGCI has organized an important series of international botanical gardens congresses, and has run professional development courses in countries as far-flung as Poland, China, Colombia, Mexico and Russia,
- Creating and strengthening regional and national botanical gardens networks around the world, with active national networks in Australia, Brazil, China, India and Indonesia.
- Maintaining a database on rare plants in over 300 institutions worldwide,
- Publication of Botanic Gardens Conservation News, and Roots, a newsletter for education in botanical gardens,
- Production of educational and awareness products such as packages of slides, videos, posters and newsletters in several languages, and
- Development and support of BG-Recorder, a computer database program for maintaining plant collections records that is distributed freely to BGCI members.

Twenty-five arboreta and botanical gardens in Canada currently maintain memberships among the four active networks described above. Fourteen institutions are members of the Canadian Botanical Conservation Network, and five are acting as regional nodes within the Canadian Botanical Gardens Consortium for Biodiversity. Twenty Canadian gardens are currently members of the American Association of Botanical Gardens and Arboreta (as is CBCN itself), and seven are members of Botanic Gardens Conservation International (Box 5). This network of networks, or grid, of botanical gardens and arboreta includes members in all major regions of Canada.

Box 5. Canadian institutional members of botanical garden networks.

- Appleby College (Oakville, ON): AABGA
- Belle Terre Botanic Garden and Arboretum (Otter Lake, QC): AABGA
- Brickman's Botanical Garden (Sebringville, ON): CBCN
- Calgary Zoo and Botanical Garden (Calgary, AB): CBCN, AABGA
- City of Mississauga (Mississauga, ON): CBCN, AABGA
- City of Toronto, Parks & Recreation Division (Toronto, ON): AABGA
- David Douglas Botanical Garden Society (Prince George, BC): CBCN

- Jardin Botanique de Montreal (Montreal, QC): CBGCB, AABGA, BGCI
- Kingsbrea Horticultural Garden, Inc. (St. Andrews, NB): AABGA
- Les Jardins de Metis, (Grant-Metis, QC): CBCN
- Memorial University of Newfoundland Botanical Garden (St John's, NF): CBCN, CBGCB, AABGA, BGCI
- Milner Gardens and Woodland (Nanaimo, BC): AABGA
- Morgan Arboretum Association (Ste. Anne de Bellevue, QC): CBCN, AABGA
- Niagara Parks Botanical Gardens (Niagara Falls, ON): CBCN, AABGA
- Royal Botanical Gardens (Hamilton/Burlington, ON): CBCN, CBGCB, AABGA, BGCI
- Sherwood Fox Arboretum (London, ON): CBCN, AABGA, BGCI
- Summerland Ornamental Gardens (Summerland, BC): AABGA
- The Arboretum, Royal Roads University (Victoria, BC): CBCN

- The Arboretum, University of Guelph (Guelph, ON): CBCN, AABGA, BGCI
- The Faro Arboretum (Faro, YT): AABGA
- Toronto Zoo (Toronto, ON) CBCN, AABGA, BGCI
- University of Alberta Devonian Botanical Garden (Edmonton, AB): CBCN, CBGCB, AABGA
- University of British Columbia Botanical Garden (Vancouver, BC): CBGCB, AABGA
- Van Dusen Botanical Display Garden (Vancouver, BC): CBCN, AABGA, BGCI

Abbreviations:

CBCN: Canadian Botanical Conservation Network (14 Canadian member institutions)

CBGCB: Regional Plant Diversity Centre of Canadian Botanical Gardens Consortium for Biodiversity (5 regional nodes)

AABGA: American Association of Botanical Gardens and Arboreta (20 Canadian member institutions)

BGCI: Botanic Gardens Conservation International (7 Canadian member institutions)

Chapter 3. Basic Concepts in Biodiversity

Biological diversity is often described at three levels: diversity among individuals within populations (genetic diversity), diversity among species, and diversity among ecological systems. In addition to the biological dimensions of biodiversity, four additional dimensions that are related to human activities are also important: diversity among organisms that has been generated by human activities, diversity reduced by human activities, diversity among human-shaped landscapes, and the social and economic dimensions of both natural and human-mediated biodiversity.

Botanical gardens have long been associated with the discovery, interpretation, documentation and public display of biological diversity at all of its levels. Variation within species brought into cultivation is the basis for the development of garden varieties, and variation among individuals in wild populations is the basis for their adaptation to a varied landscape and ultimately to their survival. Among species, botanical gardens have long been interpreters of the vast range of species diversity among vascular plants. Even ecological diversity is a significant theme for larger botanical gardens and arboreta, and individual institutions are increasingly paying attention to their ecological contexts and settings relative to natural areas.

In this section of the action plan, we briefly review the key concepts in biodiversity, with emphasis on their relevance to botanical gardens and arboreta. Various collections or projects from within the botanical garden community have been highlighted below as examples, and are not intended as forming a complete list. A list of significant collections within botanical gardens and arboreta in Canada is available from the Canadian Botanical Conservation Network (Galbraith, 2001).

Genetic Diversity

Genetic diversity encompasses all of the differences in inherited biological information among individuals within a species. Some genetic diversity is of obvious practical importance, as it forms the basis for differences among individuals that is the raw material of both natural and artificial selection. Recent advances in molecular genetics have also demonstrated that while much of the total genetic diversity within species is not of obvious biological importance to individual organisms, the large amount of DNA in higher organisms may be involved in generating new genetic material and in regulating gene expression. All of this diversity can be used to study the dynamics of wild populations, to understand the probability of survival of rare species, and document evolutionary history.

Botanical gardens have important roles in the conservation of genetic diversity that is both of practical use and may also be important for the survival of wild populations. Many botanical gardens operate seed gene banks or gene banks consisting of plants under cultivation, conserving both naturally occurring genetic variation and variation that has been created through artificial

breeding. Seed gene banks, or seed banks for short, are particularly effective tools for the short-term preservation of genetic diversity.

- The Arboretum, University of Guelph maintains a living tree gene bank for native trees of southern Ontario, and especially rarer species of the Carolinian forest, including:
 - Pawpaw
 - Kentucky Coffee Tree
 - Red Mulberry
 - American Chestnut
 - American Elm

Species Diversity

Species diversity is sometimes thought of as being synonymous with biological diversity. It is true that much effort in biodiversity studies has been directed at systematics (the science of discovering the natural relationships among organisms) and at documentation of the occurrence and distribution of organisms at the species level. Botanical gardens have traditionally displayed plants that are of practical use and also plants of interest to systematic biology.

In order to conserve biological diversity and use its components sustainably, it is necessary to have a good working understanding of the identification and distribution of individual species. As museums that highlight the relationship between people and the natural world, and people and the world of plants, botanical gardens have been involved in the scientific documentation of plant species diversity for many years. Many botanical gardens operate herbaria, museum collections of dried plant specimens that are the working biodiversity databases for plants. Herbaria are also found commonly in association with museums, universities and agricultural institutions, and are not restricted to botanical gardens in their scope.

As members of the larger community of museums, botanical gardens are actively developing their plant collections, including recent progress in using computer and information sciences (the field of informatics) to make their collections more useful to researchers around the world. The production of herbarium catalogues and related sources of information that can be accessed through the Internet is one example of the impact of modern information technology on plant species information associated with botanical gardens.

The living collections of botanical gardens are also important sources of information on the world of plant species diversity. Living plant collections provide contact with specimens that are still metabolically and reproductively functional, unlike specimens preserved in conventional museums and herbaria.

Botanical gardens are irreplaceable educational resources and centers for plant species diversity. At the levels of informal public education, formal school curricula and professional development, the living plant collections and interpretive areas of botanical gardens provided a key resource for education on plant systematics. As important as the collections, staff at botanical gardens are

among the most highly trained botanists. Some botanical gardens maintain research projects and highly trained scientific staff, including experienced field botanists and plant systematists.

Botanical gardens with collections of native plant species include:

- Memorial University of Newfoundland Botanical Garden
- Morgan Arboretum
- Royal Botanical Gardens
- University of Alberta Devonian Botanic Garden
- University of Guelph Arboretum

Ecological Diversity

Just as individuals vary within species, and species vary one to another in their taxonomic characters, ecological systems display diversity in their function and makeup. Ecological systems are not static collections of sharply-defined components. Instead, they change over time through processes such as ecological succession, the natural turn-over in the kinds of species found in a particular habitat through time. Because of their dynamic character, ecological systems are less easily categorized than are species, but the diversity of ecological systems is just as important.

Botanical gardens, and especially arboreta, often have substantial contact with undisturbed ecological systems or with ecological systems that have been shaped through human activities. Some botanical gardens are actively pursuing the documentation and monitoring of ecological systems, including the development of ecological land classification and the mapping of natural areas using geographic information systems. Botanical gardens that include nature sanctuaries and those involved in providing plants for habitat rehabilitation projects have been involved for many years in the developing field of ecological restoration, and have come to understand very well that ecological systems evolve over time through complex dynamics. Gardens involved in the restoration or recreation of wild habitat must plan long-term projects to achieve natural ecosystem function.

- Royal Botanical Gardens includes nearly 1,000 hectares of nature sanctuaries among its properties. These extensive holdings include wetlands, remnant oak savannah and mixed hardwood forests. The RBG herbarium and field botany program is mapping the ecological areas using an in-house geographic information system (GIS) facility.
- University of Alberta Devonian Botanic Garden, the northernmost major garden in Canada, includes 40 hectares of unique ecological associations such as Tamarack Fens and Sedge Fens as well as Pine and Balsam Poplar plant communities.
- Memorial University of Newfoundland Botanical Garden includes a large natural area that experienced a forest fire in 1961 and has regenerated to include many of the natural habitats of the Canadian boreal forest biome including spruce and fir, freshwater, and marginal aquatic plant habitat types.

Landscape Diversity

There is no wall separating nature and humanity. Our urban landscapes are (ideally) constructed with both functionality and aesthetics in mind, and can be seen as rich, interacting mosaics that include both natural elements and those under human control. Increasingly, municipal and other levels of government are turning attention to naturalization of urban green space and returning ecological function to parks, greenbelts, and other open areas. Botanical gardens have been involved in this process as active partners, providing expertise, plant material, and even interpretive signage and educational programming.

- Montreal Botanic Garden is very active in promoting the use of plants and trees in cities, and in working with local people to improve the urban and peri-urban environment
- Royal Botanical Gardens maintains a Woodland Garden, integrating natural landscape features and vegetation with purpose-built structures and cultivated plants.

People and Plant Diversity

As a class of museums, botanical gardens have long had the relationship between people and plants as their central focus. This relationship takes many forms, from the casual appreciation of floral beauty to the preparation of plant material for endangered species recovery. Botanical gardens emphasize that this relationship is dynamic and changing.

Plant diversity is the foundation of much of our historical and cultural diversity, and holds great promise for future practical development in the fields of pharmaceuticals, building materials, industrial processes, food, fiber, and even aesthetic enhancement. Examples of the richness and variation in the many scenes surrounding plant diversity include the major economic role plants played as the source of spices during the era of European exploration and expansion, the irreplaceable role of natural rubber in our present industrial society, the use of natural fibers such as cotton and in clothing and manufacturing, and of course the dozens of species of plants that form the basis for our entire agriculture and agrifood industry.

Our cultural diversity has also been greatly shaped by plants. Whether it's been the raw material provided by forests for the production of homes, or the bark from which fibers are taken for the production of clothes, indigenous peoples around the world continue to make use of plants as the source of material for many of their practical daily needs, the living roots of their cultural identities. Our local vegetation is a major part of our sense of local place and is used to create the landscapes we live in.

The direct use of native plant diversity for economic and social development in Canada must not be underestimated. For example, in the 1995 report by the Canadian Museum of Nature entitled Canada's Biodiversity: the variety of life, its status, economic benefits, conservation costs and unmet needs (Mosquin *et al*, 1995), the value of lumber and fibre woods being taken from natural forests in Canada was estimated to exceed \$7,000,000,000 per year. Several botanical gardens

and arboreta in Canada maintain collections of various tree species, and some participate in research on genetic diversity and sustainable use of forest resources.

The importance of plant species diversity to human societies includes more than obvious economic development. The use of native plants by aboriginal peoples in Canada for medicines and other purposes is one of the cornerstones of their unique cultures, and traditional medical practices continue to this day. Globally, the scale of medicinal plant use is staggering. Several thousand plant species are harvested from natural areas as the basis for traditional medicines in India, China and elsewhere, and are increasingly as medicines and therapies exported to other countries around the world. Many medicines in use in western medicine have their origins as plant material.

- University of Alberta Devonian Botanic Garden presents a Native Peoples Gardens, and Montreal Botanic Garden is developing a First Nations Garden
- A medicinal plant garden is a popular feature of Royal Botanical Gardens.
- The University of British Columbia Botanical Garden maintains a medicinal plants garden based on a 16th Century monastery, as well as a traditional Japanese garden.

Sustainable Use of Biological Resources

Individual human beings and the societies in which we live are dependent upon biological resources. From the food that we eat to the fiber making up clothing to building materials, medicines, industrial materials and even as raw material for the arts, every facet of human activity touches upon natural resources that are derived from plants.

In the 1980's, awareness of the concept of sustainable use gradually entered both the scientific and political arenas. Although there are many different formulations of the concept of sustainable use, the most widely used definition is that the present generation should be able to meet its needs without interfering with the ability of future generations to meet their own needs. This definition was used in the 1987 report of the Brundtland commission, Our Common Future, which emphasized that responsible human activity does not necessarily jeopardize the biological resources upon which we depend and upon which our descendants will depend.

As a guiding concept, sustainable use rests upon an understanding of the degree to which presents human activities affect functional natural systems. Botanical gardens around the world are in the forefront of developing truly sustainable approaches to human activities such as agriculture and local industry. Through expertise in economic botany and plant propagation, botanical gardens are indispensable resources for community development at many levels.

Botanical gardens have also had a long history facilitating the study of plants that might hold novel uses. Through the collections of plants that are maintained by botanical gardens, both the scientific study of the world of plants and the exploration of their utility in the development of new products and processes are supported.

Botanical gardens have always been a source of both plant material and horticultural expertise. As world's population is still growing, and demands on natural ecological systems for products such as plant based medicines grows, botanical gardens can play a pivotal role in the survival of medicinal plants in the wild through supporting the development of sustainable plant agriculture and appropriate harvest for these plants. The first botanical gardens were, after all, teaching resources for medical students. That role has evolved over the past 300 years, and as interest in the use of natural remedies and plant based medicines continues to grow in the developed world, the relationship between botanical gardens and the sustainable use of plant diversity, including in the critical area of medicinal plants, will grow deeper. Botanical gardens are also increasing their scope of participation in broader environmental conservation, in areas such as education for sustainability and in promoting sustainable lifestyles.

Economic Botany

Economic botany is the study of plants that are of direct importance to human needs or that are in use in a broad economic sense. Traditionally, botanical gardens have had a great deal of involvement in economic botany. In some cases that involvement has led to criticisms that plants grown in botanical gardens have replaced the original source when that plant could have been grown or harvested within its natural range.

Among the key historical effects of botanical gardens has been to set much of the pattern for world agricultural development over the past two hundred years. In the tropics, European colonial powers frequently established botanical gardens as both research and teaching centres. This influence has continued to more recent times, also. In countries of the Former Soviet Union, botanical gardens were probably the primary source of introduction of new plants destined for economic use this century.

Botanical gardens in Canada continue the tradition of exploring plant diversity for economic and social uses.

- Both Jardin Botanique du Nouveau Brunswick and Muttart Conservatory maintain economic botany displays
- Most or all university botanical gardens include teaching and research in their missions:
 - University of Alberta Devonian Botanic Garden
 - University of British Columbia Botanical Garden
 - University of Waterloo Botanical Garden, and many others

Genetic Resources

Genetic resources are those sources of inherited biological information that can be used to develop new plants or products or change existing plants or products, through either traditional breeding methods or through biotechnology.

It is important to differentiate between conventional natural resources (such as timber or fish) and genetic resources (such as the seeds or eggs these would produce). Genetic resources can often be exploited without large-scale consumption that is implied with the consumption of natural resources.

A great many industries are dependent upon using genetic resources. Traditionally, genetic resources have most important in agriculture. Plant breeding and the development of new crops have been active areas of research and development that have involved botanical gardens and related institutions and collections for many years. More recently, attention has been focused on the role of genetic resources as the necessary raw material in new industries such as biotechnology and the development of new pharmaceuticals. However, genetic resources are of great importance beyond the agricultural and pharmaceutical sectors. Industries that rely on biological fibers such as wool or cotton, industries that rely on bulk biological materials such as the pulp and paper industry, petrochemical industries, plastics and other polymers, the rubber industry: all of these and more make use of biological material that is derived, for the most part, from plants have been chosen for particular characteristics. The process of selection for those characteristics is dependent upon genetic resources.

People harvesting raw materials from natural ecological systems may consider the materials as either genetic resources or natural resources, depending upon the use to which the materials are put. For example, lumber and pulpwood are taken from either natural or planted forests and are used in a variety of manufacturing processes to create everything from building materials to paper. The use of the biomass of such natural materials to make a product would classify them as being used as a natural or renewable resource, but not a genetic resource. However, if seeds from the same trees were collected and used to breed hardier varieties, or if genetic material (DNA) was collected from the living tissues of the tree for subsequent study and use in biotechnology, these materials would be classified as genetic resources. When a biological resource is used to grow future generations of that resource, the resource is considered to be genetic. In the terminology used in the Convention on Biological Diversity, a genetic resource is any biological material that contains functional units of heredity, and that is of actual or potential value.

Recognition of the importance of genetic resources to the global economy as well as to the economies of individual countries has become a major theme in international negotiations about biodiversity. The biodiversity convention has encapsulated several important concepts about the fair use of genetic resources. Three key concepts are that legitimate access to genetic resources should be not be restricted but should in fact be facilitated, that benefits that arise from the use of these resources should be shared with the country of origin of the resources, and that all access should take place in a sustainable way. In order to accomplish that balance, access to genetic resources should take place under terms of mutual agreement between providers and users, and with the prior informed consent of the legitimate owners of those resources, as well as with the involvement of stakeholders such as local peoples.

The importance of the plant collections of botanical gardens as repositories of genetic resources varies from country to country and from collection to collection. Some critics of botanical gardens have contended that these collections have been used inappropriately as sources of genetic resources that can be obtained without reference to the country of origin of the resource. Relatively few botanical gardens in Canada have had their collections accessed in this fashion.

- Royal Botanical Gardens is one of 17 botanical gardens from around the world participating in a pilot project to harmonize the policies of individual institutions maintaining *ex situ* plant collections with provisions of the Convention on Biological Diversity on access to genetics resources and the fair and equitable sharing of benefits arising from the use of genetic resources.

Horticulture and Landscape Design

The purposeful cultivation of useful plants is synonymous with the rise of human civilization. Many different classes of horticultural activity are commonplace within Canada:

- Commercial horticulture (nurseries, market gardening, cut flower industry, ornamental retail trade)
- Amenity horticulture (ornamental display, public parks and gardens and open spaces, trees in urban environment)
- Home gardening (including allotments and home food production)
- Therapeutic horticulture (applying gardening as an activity to improve physical or mental health)

Agriculture and Agrifood Canada has estimated that the value of horticultural products in North America exceeds \$55,000,000,000 per year (Finklestein, 2000). These products may be conveniently divided into two categories:

- Floriculture (one-third of all grower cash receipts: potted flowering plants, cut flowers and cultivated greens, potted foliage, bedding and garden plants, predominantly used indoors)
- Environmental Horticulture (two-thirds of all grower cash receipts: fruit and nut plants, bulbs, sod, seedlings, cuttings and nursery trees and shrubs, predominantly used outdoors)

Botanical gardens are important partners in commercial horticulture, acting as locations for trials of new varieties and sometimes engaging in the development of new breeds. Of all of the forms of the relationship between people and plants that are embodied in botanical gardens, horticulture, and in particular, ornamental horticulture, and the use of plants in landscape has become the theme and the chief recognizable feature of botanical gardens in Canada. Some botanical gardens have made considerable strides in exploring and assessing native and exotic plant diversity as a source for new varieties to introduce into horticulture, and many more act as showcases for ornamental plants that enrich the environment and lives of Canadians.

There is no clear line of distinction dividing botanical gardens and ornamental or display gardens, except that botanical gardens rely on scientific principles and information in the design and curation of collections, and in the presentation of those collections and interpretive materials

to the public. Many botanical gardens include ornamental or show garden features for the public, and many city gardens and other display gardens include some degree of interpretive signage.

Few activities in modern society involve as many people as does horticulture. In recent public opinion surveys, more than 60% of Canadians have indicated that they participate in some kind of gardening or horticultural activity as part of their daily lives. Many of these people tend their own gardens or use public allotment gardens. Living plants are used to create our home habitat - our garden landscapes.

The majority of the foods that find their way to Canadian tables comes from fewer than 20 species of plants and animals. Horticulture for aesthetic and ornamental purposes is therefore by far the single largest source of exposure that the public has to biological diversity in their daily lives. Typical house gardens may trees, shrubs, and dozens of annual and perennial flowering plant species, all interacting with many more animal species (pollinating insects, birds, small mammals and others, for example) in a human-mediated ecological system. These landscapes provide shelter, serenity, activity areas, and individual expression.

As showcases of ornamental plant diversity, and as repositories of horticultural expertise and landscape ideas, botanical gardens are indispensable in the engagement of the public with the world of plants. Educational programs of botanical gardens often feature master gardener classes, wild plant identification, ornamental flower arranging, and even classes in still-life painting emphasizing the world of plants. There is no other institutional sector in Canadian society that more thoroughly exposes and educates the public about biological diversity than does botanical gardens and arboreta.

- Royal Botanical Gardens pioneered the development of horticultural therapy programs in Ontario
- Major displays of annual and perennial horticultural varieties can be found at most botanical gardens and arboreta. Some major collections include:
 - Montreal Botanical Gardens' Perennial Demonstration Garden
 - Royal Botanical Gardens' Hardy Herbaceous Perennials Garden

Threats To Biological Diversity

Biological diversity is not a static entity. Since life first appeared on earth billions of years ago, the number of species within any particular geographic area, variations in the communities of organisms from place to place, and variation among individual organisms within species, have changed over time in response to many different factors.

Today, one class of factors is exerting overwhelming pressure reducing diversity at the ecosystem, species and genetic diversity levels: accidental and intentional effects of human activities.

Human-caused changes to biological diversity are sometimes reduced to overly-simplistic, all-or-nothing terms. Some feel it is possible to deflect concern over extinction or the degradation of

habitats because all natural habitats and species are in a state of change. Because the effects of human activities are just another form of change, the extinction of a species or the destruction of habitat is therefore not held as a cause for concern by some.

Human beings have been a part of the natural landscape since the origins of our species, and even in highly-industrialized western societies, we remain as important and as active an element of nature as any other species. Uniquely, however, we have the technological capability to alter habitats and other species far beyond that of any other biological agent on earth. As uniquely, we also have the intellectual and ethical capacity to choose our actions and understand their consequences. It is therefore our collective responsibility to understand that our actions entail consequences, and to choose our actions wisely.

To date, empirical research has shown that biological diversity is most strongly affected by several specific classes of human activities. These include the alteration or destruction of habitat, the effects of invasive species, the spread of diseases, overexploitation, and pollution.

Habitat Destruction

Although some aspects of life are not "zero sum games," habitable space on planet earth is finite, as is the amount of space available to any particular species. It has been a characteristic of human society for millennia that in order to develop our towns and farms, we use space, displacing other species and causing a spectrum of changes in natural habitats. That our activities are damaging to natural habitats is of grave concern both to people interested in natural ecological systems and also to those whose concerns focus on the survival and future of human societies.

Habitat degradation and destruction are not new. What is unique in the early 21st century is that we now have a globalized human population accessing resources and technical capabilities far in excess of anything previous generations could have dreamed of, facilitated by truly global systems of finance, transportation and communications. Globalization means that the consumption of a product in one location is no longer clearly associated with the consequences of its production. Educating consumers about the costs of production that impact local environments is a major challenge.

Botanical gardens in Canada have been amongst the leading institutions calling for conservation of intact ecological systems and understanding of the effects of fragmentation on the survival of those systems. Because most ecological systems are dominated by plants, and many of the experts working within botanical gardens are particularly interested in plants in the wild, it's no surprise that studying the survival of plant populations in the wild and contributing to the recovery of endangered plant species and habitat restoration is an important role of today's botanical garden and arboreta sector.

Of all of the threats to the survival of ecological systems, species and diversity within species, nothing has as broad an impact as fragmentation of habitats. Some human activities are very broadly damaging to ecological systems, ranging from the outright destruction of ecological systems for other forms of land use, such as agriculture or urban development. Other activities, notably the construction of roads, have the effect of slicing intact ecological systems into smaller

and smaller fragments. Such fragmentation introduces many new factors into natural systems. For example, it has been recently estimated that in southern Ontario, only about 2% of the remaining stands of forested land are large enough to include areas which are not affected by nearby roads or other human disturbances. When natural ecological areas are subdivided, the human activities responsible for that subdivision introduce boundaries and transitions that were not present prior to fragmentation. Transitional zones of this kind are often called ecological edges. The ecological effects of edges extend many hundreds of metres into otherwise intact natural habitats.

Combating the effects of habitat fragmentation, degradation and destruction is a massive job. Concern over the survival of endangered species is the most visible form of that concern. Many endangered species in Canada are threatened precisely because their habitat has been damaged through human activity. However, concern over endangered species may be thought of as equivalent to the emergency trauma room in a hospital, where only the most urgent and life-threatening cases are dealt with. For many years biologists have been emphasizing the need to take an ecosystem approach to understanding and compensating for the effects of human activities on the natural environment.

Botanical gardens are involved in all of these aspects of conservation, ranging from plant rescue efforts when a critically threatened population may fall to development, to the restoration of damaged habitat and the protection of sensitive areas.

- Royal Botanical Gardens owns Cootes Paradise, a major Great Lakes coastal wetland that has been significantly degraded over the past century by pollution, changes in water levels and the effects of introduced carp. Project Paradise is a large and innovative habitat rehabilitation project led by RBG and including many partners.
- The Arboretum, University of Guelph is a leader in the development of habitat restoration projects, especially in woodlands. Horticulturists at the Arboretum teach regular courses in habitat restoration. A collection of plants important for restoration of gravel pits is maintained at the Arboretum.

Invasive Species

Human activities have had the effect of moving other species since the beginning of history. Whether for human use or as an accident, the introduction of a non-native species into a natural habitat can have devastating effects. Not all newly-released species become invasive. In Canada, there are approximately 800 plant species which have become naturalized in to our urban and rural landscapes. These plants have arrived in Canada mostly from Europe and Asia in historical times, either as purposeful introductions for ornamental, horticultural, industrial or even cultural uses, through accidental transportation because of the movement of soil or other species, or by other means.

Species which have the capacity to invade intact ecological systems are significant conservation concerns. Several invasive, non-native species have become real ecological problems. Plants like

purple loosestrife, dog strangling vine, Norway maple, and garlic mustard are now widely recognized as damaging to natural ecological systems in Canada.

Botanical gardens and arboreta have been responsible for some serious introductions of invasive plants to Canada, but many more have come from other routes. A few notorious examples that were related to botanical gardens include:

- European frog-bit (*Hydrocharis morsus-ranae* L.) was introduced from Europe at the Central Experimental Farm Arboretum in Ottawa in the 1930s, and by 1939 had spread to near-by waterways. It is also thought that some plants escaped from Montreal Botanic Garden.
- Purple loosestrife (*Lythrum salicaria* L.) which entered Canada through several routes, including as seeds for bedding plants and also in the ballast of ships and possibly as bedding and feed for livestock. Some ornamental varieties of Purple Loosestrife were bred at botanical gardens in Canada.
- Glossy buckthorn (*Frangula alnus* P. Mill. syn. *Rhamnus frangula* L.) was established in several locations in Canada in the late 19th and early 20th centuries as a landscape plant. It is probable that this species became naturalized in Prince Edward Island because it was planted at the Experimental Farm in Charlottetown in hedges.
- European water chestnut (*Trapa natans* L.) was reported in Canada for the first time in 1998, having spread north from the east coast of the USA. Although it is not known where the plant escaped from cultivation, it was in cultivation in a botanical garden in the area of Harvard University in Massachusetts in the late 1870s, within three years of its introduction to North America. Less than six years after it was first brought to North America, European Water Chestnut was documented to be living in the Charles River.

Many of these introduced species life history characteristics which makes them invasive. These species are able to enter new ecological systems and displace other species because they possess the characteristics of good colonizers: a wide latitude in habitat preference and the ability to reproduce and disseminate across large areas in a short time.

Because of their role in promoting plant introductions for human use, botanical gardens have been a source of concern over the potential for releasing new invasive species that may enter ecological systems. Increasingly, arboreta and botanical gardens are among the forefront of institutions in society calling for appropriate and effective action against the damaging effects of invasive species.

- The American Association of Botanical Gardens and Arboreta and the Canadian Botanical Conservation Network are promoting the use of professional codes of conduct regarding potentially invasive species (See Appendix IV for the draft codes)
- Researchers at McMaster University have been conducting detailed field experiments at Royal Botanical Gardens to understand the reasons species like Garlic Mustard (*Alliaria petiolata*) have become invasive. Dr Susan Dudley and her students have examined the role of carbon acquisition and overwintering strategies in this species.

Disease

Among the several forms of biological invaders that have entered Canada in historic times, few have been as damaging as diseases that have affected our native trees. Chestnut blight and Dutch elm disease are examples of plant pathogens that have been introduced to North America in recent generations. In both cases, these diseases have entered Canada and encountered trees that have no natural defenses against them. The results of these invasions has been the drastic decline of American Chestnut and White Elm. Even though there are numerous survivors of these two diseases, they no longer have a dominant position in their respective forest habitats nor provide the valuable forest resources we once utilized. In addition to the loss of their aesthetic enhancement of our landscapes, the loss of these tree species has been a significant blow to the economy of Canada, as these trees were significant sources of high-quality timber products.

Arboreta and botanical gardens are very active in the modern battle to combat in these diseases, primarily through programs to select and enhance plants that display natural resistance to the diseases.

- The Arboretum at University of Guelph is leading the fight against Dutch Elm Disease and Chestnut Blight by gathering seeds and cuttings from resistant trees and beginning the long process of breeding resistant individuals. Particularly important is the development of disease-resistant elms that are propagated by seed, as recent cloned varieties that were assumed to be resistant have been shown to be susceptible to fungal disease.

Over-Exploitation

Many of the endangered species that come to public attention do so because of the effects of direct human exploitation. Images of over-hunting of mammals and birds, for example, presents a startling and emotionally gripping spectacle that readily engages the imagination and action of the public. Overexploitation of endangered plant populations is far less photogenic but no less damaging.

Relatively few plant species are of conservation concern in Canada because they are subject to overexploitation. Botanical gardens can ease concern over overexploitation by helping to develop alternative and sustainable sources of plant material that may be of economic importance, and through public education on the damaging effects of unsustainable use of our natural resources.

Internationally, botanical gardens are important partners in CITES, the Convention on International Trade in Endangered Species, acting as resource for implementation, plant identification and housing confiscated plant specimens.

- Royal Botanical Gardens is a participant in the endangered species recovery team for American Ginseng, listed as Endangered in Canada. American Ginseng stands out as an important example, however, of a species that is thought to be experiencing unsustainable harvest from wild populations at present.

Pollution

Much of the original concern about the effects of human society on our environment and natural systems arose in the 1960s through public awareness about pollution. Whether through the deliberate release of industrial materials such as pesticides, or the unintentional release of pollutants as part of industrial processes, pollution forms an important theme in concern over the survival of intact natural ecological systems and biological diversity.

Sources of pollution can be described as either "point source" or "diffuse." Point sources are highly localized, such as a particular industrial site or power station. Such localized sources of pollution are not often associated with critical losses of biodiversity, such as the survival of an endangered species or the degradation of specific habitats.

Of more general concern are the more diffuse, widespread pollution types, especially the effects of acid rain. Acid rain can have significant effect on the ecological functioning of fungi, some species of which are critical for healthy growth of other plants. Symbiotic associations between fungi and the roots of many trees and other plants are termed mycorrhiza. About 75% of higher plants depend on these mycorrhizal relationships to supply moisture and nutrients, especially for coniferous trees.

- Montreal Botanical Garden is involved in research collaborations on phytoremediation (the use of plants to remove toxins from soils) at contaminated sites within the City of Montreal.
- University of Alberta Devonian Botanic Garden includes the University of Alberta Microfungus Collection & Herbarium (UAMH), a world-class collection of fungi that includes species that are endophytes and mycorrhizal symbionts of wood plants, orchids and others.

Climate Change

World concern over the effects of climate change on biological diversity is rapidly growing. In 2000, the blue ribbon expert panel on climate change submitted its report to the United Nations which concluded that over the next century, average global temperatures are almost certain to rise between 0.5° C and 6° C. The localized effects of climate change are more complicated than an average upwards shift in temperature. Across Canada, it is anticipated that some areas will experience an increase in average temperatures, while others will become cooler over the next century. Furthermore, changes in patterns of precipitation and evaporation are also anticipated. Taken together, these anticipated changes in climatic patterns mean a significant challenge to the survival of natural ecological systems and of biological diversity as measured in species richness.

Biologically, Canada is a young country. Almost all of the territory of Canada was covered by ice sheets as recently as 10,000 years ago. In the time since the retreat of the last glaciers, the rich natural ecological systems ranging from the Carolinian zone of southern Canada to the high Arctic have developed through repopulation from refuges to the south, and through the occasional arrival of new species from Europe and Asia. Although our natural ecological systems

are relatively new compared to other areas that have been free of catastrophes such as glaciation for many millions of years, the natural ecological systems of Canada and the biodiversity they support have developed rich interactions over many thousands of years. Recent studies have highlighted that the movement of species across the landscape is a process that takes place at a finite speed. Plants and animals are able to move varying distances in a year, depending upon their natural rates and modes of dispersal. It is therefore no surprise that concern is being expressed in Canada over the changes that might occur because of climate change, and the rate at which ecological systems may have to move to keep up such change.

In a study released in 2000, researchers at Faculty of Forestry at University of Toronto projected that many of the rare plants of Canada will not be able to disperse quickly enough to keep up with anticipated climate change. As temperatures and precipitation patterns shift, habitat characteristics might move across the landscape at rates in excess of 2 km per year in some cases. Many of the highly localized rare and endangered plants of Canada cannot move at that pace. Their survival is clearly threatened by the effects of anticipated climate change on the characteristics of their habitats.

The fact that many areas to the south of Canada that were refuges during the last glaciation are relatively rich in plant diversity compared to many areas of Canada indicates that plant species in general are slow to adapt to climate change.

- The Natural Heritage Gene Bank and associated projects by the Canadian Botanical Gardens Consortium for Biodiversity make it possible to envision conservation of samples of native genetic material from plant populations that may be lost to climate change.
- PlantWatch is a phenology program based at University of Alberta Devonian Botanic Garden. By recording the flowering dates of known plant varieties across Canada, PlantWatch participants help to track long-term changes in weather and climate patterns.

Chapter 4: Botanical Gardens in Action for Biodiversity

The preceding chapters have outlined the many ways that botanical gardens and arboreta contribute to or are touched by biodiversity issues. The Canadian Biodiversity Strategy and the International Agenda for Botanic Gardens in Conservation have recommended many of these kinds contributions, and many others, as objectives or goals. This chapter presents a synthesized outline for individual gardens and associations of institutions to respond to the diversity of these challenges. First, we distill the many goals, objectives, targets and recommendations of biodiversity conservation down to five major themes:

- Conserving the Elements of Biological Diversity,
- Promoting Awareness, Education and Training,
- Generating New Knowledge,
- Encouraging Professional Best Practices, and
- Seeking Resources, Partnerships and Linkages.

After outlining each of these themes, we present a checklist of options and ideas that anchor these broad themes in concrete goals and actions that can be embraced by the botanical gardens and arboreta of Canada. As independent institutions with their own missions, constituencies and programs, seeking participation in proposals such as the framework recommended in this action plan must be a process of seeking partnerships, understanding mutual goals and individual needs, and careful and realistic prioritization.

Key questions need to be answered: How realistic is a focus on these five themes? Is anything happening already? What could be gained by heightened cooperation among these institutions, and at what cost? First, let's examine each of the five main themes for their relevance to the botanical garden community. Second, we will develop specific actions proposed under each theme to enhance the role individual botanical institutions can play within them.

Theme 1: Conserving Canada's Natural Plant Diversity

Focusing on the conservation of native plant diversity, whether at the population, species or community/ecosystem/landscape levels, recognizes two important facts: that botanical gardens and arboreta are willing partners that have important capacities for botanical scholarship, plant propagation, *ex situ* conservation and partnership in *in situ* programs, monitoring invasive plants, networking and action, and that these widely-based activities involve a great many partners and stakeholders beyond the "garden gate."

Many government and non-governmental organizations are involved in achieving the important goal: that each known threatened plant and ecosystem in Canada is included in a recovery program, with the ultimate aim of safeguarding them and their genetic diversity in the wild.

Projects and proposals under **Theme 1: Conserving Canada's Natural Plant Diversity**, are in support of the following Strategic Directions of the Canadian Biodiversity Strategy:

- CBS Goal 1: Conservation and Sustainable Use

Strategic Directions:

- 1.1 Integrated planning and ecological management with CBD objectives.
- 1.8 Prevent *in situ* populations from becoming jeopardized by specimen collecting.
- 1.9 Promote role of NGO *ex situ* institutions in *in situ* conservation.
- 1.21 Enhance *ex situ* role in recovery of species-at-risk & ecosystem management.
- 1.27 Improve ecosystem restoration and rehabilitation approaches.
- 1.78 Prevent introduction of harmful alien organisms and:
 - a. develop and implementing effective means to identify and monitor alien organisms;
 - b. prioritize allocation of resources for control of harmful alien organisms;
 - c. identify and eliminate common sources of unintentional introductions;
 - d. develop database to anticipate the introduction of harmful alien organisms;
 - e. ensure enforcement to control introductions or escapes of harmful alien organisms;
 - f. enhance public awareness of impacts of harmful alien organisms.
- 1.87 Promote acceptance of CBD within development sectors through:
 - a. the establishment of codes of ethics; and
 - b. the provision of relevant information and awareness material.

- Goal 2: Ecological Management

Strategic Directions Under Goal 1:

- 2.2 Focus research on understanding of ecosystems and management by:
 - d. improving *in situ* and *ex situ* conservation methods
- 2.9 Inventory genetic diversity for conservation and economic use of genetic resources.
- 2.29 Implement measures to monitor *ex situ* collections of biological resources.

Theme 2: Enriching Biodiversity Training, Education and Awareness

One of the major strengths of the botanical garden community is the scope of contact with the general public, with interested gardeners and naturalists, and with professional botanists, recovery specialists and others interested in plant diversity. An oft-quoted statistic is that more people visit botanical gardens in North America every year than attend all professional sporting events combined (and even more people visit parks and protected areas). This vast audience, in many ways pre-selected for their interest in biodiversity, can help achieve our national conservation aspirations by learning more about sustainable development, responsible gardening and stewardship, species at risk, invasive species, economic botany, and even systematics, at our institutions.

Botanical gardens are also major places of professional training and scholarship. Fully half of the significant botanical gardens and arboreta in Canada are based in, or strongly affiliated with, universities. These factors offer the opportunity for major enhancement of public education and outreach programs on conservation, sustainability and the environment for garden visitors,

members, stakeholders and the general public, through the botanical gardens and arboreta of Canada.

Projects and proposals under **Theme 2: Enriching Biodiversity Training, Education and Awareness**, are in support of the following Strategic Directions of the Canadian Biodiversity Strategy:

- CBS Goal 1: Conservation and Sustainable Use

Strategic Directions:

- 1.78 Prevent introduction of harmful alien organisms and:
 - f. enhance public awareness of impacts of harmful alien organisms.
- 1.87 Promote acceptance of CBD within development sectors through:
 - a. the establishment of codes of ethics; and
 - b. the provision of relevant information and awareness material.

- CBS Goal 3: Education and Awareness

Strategic Directions Under Goal 3:

- 3.1 Deliver biodiversity education and awareness programs by:
 - c. Build on existing interpretive programs in (...) botanical gardens; and
 - d. strengthen co-ordination among (...) botanical gardens (...) and other organizations.

Theme 3: Supporting the Foundations of Research

The missions of most botanical gardens and arboreta rest on the creation, dissemination and use of new knowledge about the world of plants. Although most widely recognized for their displays of ornamental varieties, a great deal of serious research takes place behind the scenes at many botanical gardens, whether or not they are directly associated with institutions of higher learning.

As strong partners for the future of biodiversity research in Canada, in areas as diverse as population ecology, genetics, sustainable development and ecological landscaping to systematics and horticulture, botanical institutions are at once the holders of vital collections of living plants, herbarium specimens, seed collections and the associated data that makes these collections relevant, and also the curators of institutional knowledge and skills in all areas of plant science.

These resources are not built out of stone, however: they need careful tending, and to have their relevance brought forward into the age of bioinformatics. As places of research and higher learning, the botanical garden community of Canada can be enhanced through networking and information support systems, in addition to enhancement of the roles and curation of collections.

Projects and proposals under **Theme 3: Supporting the Foundations of Research**, are in support of the following Strategic Directions of the Canadian Biodiversity Strategy:

- CBS Goal 1: Conservation and Sustainable Use

Strategic Directions Under Goal 1:

- 1.1 Integrated planning and ecological management with CBD objectives.
- 1.8 Prevent *in situ* populations from becoming jeopardized by specimen collecting.
- 1.9 Promote role of NGO *ex situ* institutions in *in situ* conservation.
- 1.21 Enhance *ex situ* role in recovery of species-at-risk & ecosystem management.
- 1.27 Improve ecosystem restoration and rehabilitation approaches.

- 1.78 Prevent introduction of harmful alien organisms and:
 - a. develop and implementing effective means to identify and monitor alien organisms;
 - b. prioritize allocation of resources for control of harmful alien organisms;
 - c. identify and eliminate common sources of unintentional introductions;
 - d. develop database to anticipate the introduction of harmful alien organisms;
 - e. ensure enforcement to control introductions or escapes of harmful alien organisms;

- Goal 2: Ecological Management

Strategic Directions Under Goal 2:

- 2.2 Focus research on understanding of ecosystems and management by:
 - d. improving *in situ* and *ex situ* conservation methods
- 2.9 Inventory genetic diversity for conservation and economic use of genetic resources.
- 2.29 Implement measures to monitor *ex situ* collections of biological resources.

Theme 4: Encouraging Best Policies and Practice

As an active sector of Canadian society that encompasses many different professions and disciplines, arboreta and botanical gardens have developed many resources for sharing information with colleagues in Canada and abroad. With increasing participation in associations such as the American Association of Botanical Gardens and Arboreta and Botanic Gardens Conservation International (Chapter 2), management, staff and volunteers at our botanical institutions have become very conscious of the many issues surrounding the responsible operation of a public garden.

Biodiversity issues have emerged as serious challenges to conventional activities in many areas of Canadian life. Such cross-cutting issues as preventing the release of invasive species and coming to terms with those already naturalized in Canada, and understanding responsibilities toward emerging national and international priorities such as the role of botanical gardens collections as sources of genetic resources relative to the Convention on Biological Diversity, now occupy much of the substance of meetings of botanical gardens associations.

Draft recommendations on institutional policies and practices that support, and are supported by, their relevance to the goals and objectives of the Convention on Biological Diversity and the Canadian Biodiversity Strategy, in areas like invasive species and genetic resources, are now available and under discussion within this sector. In addition, as botanical gardens are influential partners with the landscape and horticulture trades that are already leading in the development of sensitive park and municipal land management practices, their consideration and adoption of policies, guidelines and codes of conduct or best practice will lead the way for others.

Projects and proposals under **Theme 4: Encouraging Best Policies and Practice**, are in support of the following Strategic Directions of the Canadian Biodiversity Strategy:

- Goal 1: Conservation and Sustainable Use

Strategic Directions Under Goal 1:

- 1.1 Integrated planning and ecological management with CBD objectives.
- 1.8 Prevent *in situ* populations from becoming jeopardized by specimen collecting.
- 1.9 Promote role of NGO *ex situ* institutions in *in situ* conservation.
- 1.21 Enhance *ex situ* role in recovery of species-at-risk & ecosystem management.
- 1.27 Improve ecosystem restoration and rehabilitation approaches.

- 1.78 Prevent introduction of harmful alien organisms and:
 - a. develop and implementing effective means to identify and monitor alien organisms;
 - b. prioritize allocation of resources for control of harmful alien organisms;
 - c. identify and eliminate common sources of unintentional introductions;
 - d. develop database to anticipate the introduction of harmful alien organisms;
 - e. ensure enforcement to control introductions or escapes of harmful alien organisms;
 - f. enhance public awareness of impacts of harmful alien organisms.
- 1.87 Promote acceptance of CBD within development sectors through:
 - a. the establishment of codes of ethics; and
 - b. the provision of relevant information and awareness material.

- Goal 2: Ecological Management

Strategic Directions Under Goal 1:

- 2.2 Focus research on understanding of ecosystems and management by:
 - d. improving *in situ* and *ex situ* conservation methods
- 2.9 Inventory genetic diversity for conservation and economic use of genetic resources.
- 2.29 Implement measures to monitor *ex situ* collections of biological resources.

- Goal 3: Education and Awareness

Strategic Directions Under Goal 3:

- 3.1 Deliver biodiversity education and awareness programs by:
 - c. Build on existing interpretive programs in (...) botanical gardens; and
 - d. strengthen co-ordination among (...) botanical gardens (...) and other organizations.

- Goal 5: International Cooperation

Strategic Directions Under Goal 5:

- 5.0 Join international activities for conservation and sustainable use of biological resources by:
 - a. encouraging the implementation and integration of the objectives of the Convention;
 - b. Joining international bodies drafting agreements to complement the CBD;
 - c. considering the objectives of the CBD relative to other international agreements.
- 5.2 Facilitate transfer of technologies for conservation & sustainable use of biodiversity, including:
 - b. facilitate access to samples of Canada's genetic resources on mutually agreed terms;
- 5.3 Encourage all sectors to share benefits of using genetic resources of other countries.
- 5.4 Encourage the participation of stakeholders in international efforts to implement the CBD.

Theme 5: Cultivating Partnerships, Resources and Capacity

The themes above are already represented among the activities of botanical gardens in Canada, and many of our institutions would be involved in biodiversity programs if modest degrees of further support, encouragement and information were available:

- Recognizing that the botanical gardens and arboreta in Canada are already making significant contributions, and are important participants in national and global responses to the challenges of conserving biological diversity and ensuring that it is used sustainably would provide the encouragement and professionalism to go further.
- Making new partnerships and encouraging further use of regional, national and international networks and associations would open up new opportunities for collaboration, joint projects and effectiveness.

- Emphasizing that our institutions are built on the dedication, talent and hard work of our local communities, volunteers, staff, and stakeholders focuses our attention on further development of training, awareness, and professional development in the technical, scientific and even ethical underpinnings of biodiversity issues and programs.
- Celebrating the many successes of our institutions in responding to these challenges, we can promote our ability to act as effective and highly visible partners to other non-governmental organizations, government agencies, and sponsors.

In order to achieve our objectives of conservation and sustainable use of the components of biological diversity, and the sharing of benefits arising from the use of genetic resources (the three objectives of the Convention on Biological Diversity), both new attitudes and new resources need to be found. Activities listed below under Theme 5 are intended to cultivate the development of all of these necessary underpinnings of our community response.

Theme 1: Conserving Canada's Natural Plant Diversity

The intent of Goal 1 is to ensure, through partnerships with government and non-governmental organizations engaged in the identification and recovery of species and ecosystems at risk, and through appropriate action by our own institutions, that threats to biological diversity are mitigated and that each known threatened plant and ecosystem in Canada is included in a recovery or management program for conservation, with the ultimate aim of safeguarding them and their genetic diversity in the wild.

Objective 1.1: Develop a national program for the identification, preservation and study of native plant diversity, including:

- Establishment of five regional plant diversity resource centres at existing major botanical gardens, through the Canadian Botanical Conservation Network and the Canadian Botanical Gardens Consortium for Biodiversity, including:
 - Participation in and cooperation with recovery planning for rare and endangered plants and habitats
 - Determination of priorities for *ex situ* and integrated conservation programs at botanical gardens and elsewhere
 - If needed, collection and storage of seeds of rare and endangered species in specialized cold storage conditions for use in recovery projects and research
 - Partnership agreements with universities and other institutes for species research (recovery planning, population biology, genetics, ecology, plant propagation and conservation methods, etc.)
 - Unified, identifiable signage for rare and endangered plants
- Preparation of guidelines and protocols for the collection and conservation of seed stock, plant stock DNA tissue samples, and data collection
- Production of guide/reference materials for use in the laboratory or field.
- Preparation and linkage of databases in support of research and recovery projects

Objective: 1.2: Support habitat conservation and species-at-risk recovery projects with dissemination of appropriate plant information and, if needed, plant material, including:

- Guidelines for the use of rare plant material in conservation and restoration
- Databases and sourcebooks to support local habitat restoration initiatives, designed for practical use by land managers

- Propagation of endangered plants and supply of seed stock to recovery teams
- Development of professional development opportunities for related professionals
- Link ecological information on plant communities and recovery and rehabilitation efforts by collaborators, recovery teams, community seed gene banks, etc.

Theme 2: Enriching Biodiversity Education

The intent of Theme 2 is to foster within the botanical gardens and arboreta of Canada a public education and outreach program on conservation, sustainability and the environment for garden visitors, members, stakeholders and the general public.

Objective 2.1 Establish rare plants gardens, rare ecosystem recreations or other related exhibits at major botanical gardens, with interpretative information, emphasizing the important role of ecological context, through networking with the Canadian Botanical Conservation network and the Canadian Botanical Gardens Consortium for Biodiversity.

Objective 2.2 Develop and present training and educational programs and materials available onsite and by website, and share information on education and training, especially for field biologists and others directly involved in inventory and monitoring of plant diversity.

Objective 2.3 Create school resource material for educators about rare plants, their habitats and ecology, which will be adaptable to each province's curriculum, including:

- Provision of public education to increase appreciation of our native plant heritage.
- Creation of databases with plant facts on rare and endangered native plants
- Development of informative Web pages on ecologically responsible plant propagation and how to create or restore native plant communities (i.e. not introducing invasive plants, what types of fertilizers to use, etc.)
- Information on local restoration and conservation activities

Objective 2.4 Compile and link resources on current research on plant species, in partnership with botanical associations, and disseminate this information through botanical gardens networks and associations.

Theme 3: Supporting the Foundations of Research

The intent of Theme 3 is to support plant diversity research by or in partnership with, botanical gardens in Canada. Promoting existing plant collections, plant ecology and population-level diversity research, restoration ecology and environmental landscape design, systematics, and the field identification of plants for ecological monitoring and inventory contributes to individual institutions as well as the progress of our community.

Objective 3.1. Encouraging Science in Botanical Gardens

- Individual botanical gardens in Canada should be encouraged to participate in collaborative research projects with universities, and to engage in collaborative projects among gardens.
- The results of publication of research projects conducted botanical gardens should be shared among institutions, including a list of publication titles produced each year, compiled and distributed by CBCN and the Canadian Botanical Gardens Consortium for Biodiversity.

Objective 3.2. Annual State of the Collections Report

- The Canadian Botanical Gardens Consortium for Biodiversity and the Canadian Botanical Conservation Network should produce an annual report detailing the state of living and preserved plant collections in Canada. Immediate valid concerns regarding the future of individual collections should be expressed in an appropriate and constructive forum to allow the community to be of most appropriate assistance to the long-term maintenance and development of plant collections.

Theme 4. Encouraging Best Policies and Practices

The intent of Theme 4 is to develop within botanical gardens and arboreta in Canada institutional policies and practices that support, and are supported by, their relevance to the goals and objectives of national and international agreements, programs, agendas and policies for the conservation and sustainable use of biological diversity. The following actions are in support of that intent:

Objective 4.1. Promote Voluntary Codes of Conduct

- The botanical gardens of Canada should be encouraged to participate in the on-going process of developing codes of conduct and guidelines on conservation issues, such as are already taking place in forums such as AABGA and BGCI. Appendix IV presents draft codes of conduct on conservation activities currently being discussed within AABGA, and Appendix VIII is a report on the issue access to genetic resources and sharing benefits).

Objective 4.2. A Biodiversity Action Progress Registration System

- The Canadian Botanical Conservation Network has developed a national registration system for botanical gardens and arboreta that have agreed to participate in realizing the goals of this Action Plan. This registration system consists of a database that can record the responses of individual institutions to this plan, and Web pages to communicate and share our successes. The registration system will facilitate evaluation of progress toward the goals identified in this action plan as well as serve to update and guide future actions. Through linkages with the new registration system being developed for the International Agenda for Botanic Gardens in Conservation, being developed by BGCI, CBCN will eliminate duplication of effort in reporting, and provide a sectoral system of reporting on progress to partners and stakeholders such as Canada's Biodiversity Convention Office.

Objective 4.3. Create a Consultative Panel of Canadian Expertise

- The Canadian Botanical Conservation Network should organize and maintain a roster of experts in botanical gardens, arboreta, universities, museums and related organizations, and as individuals where appropriate, to aid and guide future technical development in biodiversity issues and botanical gardens.

Objective 4.4. Annual Botanical Gardens Meeting

- The Canadian Botanical Conservation Network and the Canadian Botanical Gardens Consortium for Biodiversity should work toward an annual meeting of botanical gardens representatives to address plant diversity and conservation issues. Initially this objective can be achieved effectively through existing means such as collateral events at larger annual meetings (such as the annual conferences of the American Association of Botanical Gardens and Arboreta) and through the use of electronic communications.

Eventually, a "stand-alone" meeting may be organized if resources permit. The annual meeting should be the vehicle for annual business meetings of the Canadian Botanical Conservation Network and the Canadian Botanical Gardens Consortium for Biodiversity, as well as the venue for annual updates and revisions of this action plan.

Theme 5. Cultivating Partnerships, Resources and Capacity

The intent of Theme 5 is to facilitate the development of collaborative arrangements, new partnerships and resources necessary to implement the objectives of this Action Plan, including highlighting expertise and distributing advice, through cooperative interactions with non-governmental organizations, government agencies and other stakeholders.

Objective 5.1. A Regional Approach to Plant Diversity in Canada

- The first step in developing the resources and partnerships necessary to achieve the proposals in this action plan have been taken, in the form of the creation of the Canadian Botanical Gardens Consortium for Biodiversity. The creation of the Consortium highlights the fact that botanical gardens are already doing a great deal that should be recognized and celebrated, and that these efforts could be enhanced and expanded through sharing of information, highlighting each other's programs and opportunities, and building a track record over time under a recognizable banner. Since the proposal for the creation of the National Botanical Gardens System for Canada in 1971, there have been repeated efforts to develop such an umbrella. The creation of the Consortium in the summer of 2000 represents a very practical approach to this process. By bringing existing projects under the umbrella of the Consortium, including the forthcoming travelling museum exhibit on rare and endangered plants of Canada entitled Green Legacy, the development of the national seed gene bank program, and educational programs among our respected institutions, the institutions within the Consortium are able to at once participate in broader programs and rightly claim a national relevance for their individual approaches to conservation and diversity issues, and also strengthen the local and regional approaches to biodiversity conservation and education which are at the heart of their programs.

Objective 5.2. Building National Networking and Connections

- The second important element to developing expanded linkages and contacts within this community is the ongoing work of the Canadian Botanical Conservation Network. By acting as a networking resource provider for the Canadian Botanical Gardens Consortium for Biodiversity, and a convenient point of contact for organizations outside of Canada, CBCN has emerged as an effective networking partner with organizations such as the American Association of Botanical Gardens and Arboreta and Botanic Gardens Conservation International, in addition to interacting regularly with the federal government of Canada.

There is a limit to how much can be achieved by enhancing networking and communications among existing institutions. Although these steps are necessary to ensure efficiency and minimize redundancy of activities, new resources are necessary to achieve some of the conservation objectives listed above. In particular, the development of a national program for conservation of rare and endangered plants in Canada requires funding partners, such as corporate donors, foundation sponsors, and federal government departments whose interests are advanced by the program under discussion. The emergence of a pan-Canadian program for endangered native plants, such as the Natural Heritage Gene Bank program, is a strong

partnership opportunity with the proposed Global Strategy for Plant Conservation which is currently under development. It should be noted that at the Fifth meeting of the Conference of the Parties to the Convention on Biological Diversity, the Parties recognized that there is a need for further consideration of the development a global strategy, and recognized that the efforts to launch such a strategy were valid. The Canadian Botanical Gardens Consortium for Biodiversity and the Canadian Botanical Conservation Network should be fully involved in the development of both national and global strategies for plant conservation.

Chapter 5: Case Studies and Contributed Information

- **The International Environment for Botanical Gardens**

The Global Role of Botanic Gardens in the Convention on Biological Diversity (CBD)

Author: Peter Wyse Jackson, Botanic Gardens Conservation International

The Role of Botanic Gardens in Implementing the Convention on Biological Diversity

Author: Barbara diGiovanni, RBG Kew, UK

Botanic Gardens Conservation International (BGCI)

Author: Peter Wyse Jackson, Botanic Gardens Conservation International

- **Conservation of Plant Diversity**

The role of seed banks in botanical gardens and arboreta

Author: Brigitte Laliberte, IPGRI, Rome, Italy

The creation of an *ex situ* conservancy for rare and endangered plants at Les Jardins de Metis

Author: Alexander Reford, Director, Les Jardins de Metis

Royal Botanical Gardens' Seed Bank Preserves the Genetic Identity of Rare Native Plants

Author: Sarah Stewart, Royal Botanical Gardens

Hoary Mountain Mint

Author: Paul O'Hara Royal Botanical Gardens

- **Sustainable Use of Plant Diversity**

Conservation and Enhancement of Genetic Resources in Canada

Author: Ken W. Richards, PGRC Canada

Medicinal Plant Specialist Group: IUCN - The World Conservation Union

Author: Danna Leaman, Chair-elect, IUCN MPSG

- **Ecosystem Monitoring and Rehabilitation**

Using an International Protocol to Monitor Forest Biodiversity on the Niagara Escarpment

Author: Sarah Stewart, Royal Botanical Gardens

Prairie and Northern Plant Diversity Centre and other Devonian Botanic Garden Plant Diversity Initiatives

Author: Alina Fischer, PNPDC Coordinator, Devonian Botanic Garden

Botanical and Ecosystem Conservation and Education at Calgary Zoo

Author: Brian Keating and Colleen Hyslop, Calgary Zoo and Botanical Garden

Restoring Marsh Ecosystems at Royal Botanical Gardens

Author: Sarah Stewart, Royal Botanical Gardens

Geographic Information Systems and Habitat Conservation at Royal Botanical Gardens

Author: Sarah Stewart, Royal Botanical Gardens

Royal Botanical Gardens' Aquatic Plant Nursery Provides Native Plants for Habitat Restoration

Author: Sarah Stewart, Royal Botanical Gardens

- **Research and Botanical Gardens**

Royal Ontario Museum and Plant Biodiversity Initiatives

Author: Deborah Metsger and Erling Holm, ROM

The Role of Herbaria in Biodiversity Research and Conservation
Author: Tyler Smith, Royal Botanical Gardens
University of British Columbia Botanical Garden
Author: Iain Taylor, UBCBG

The Role of Botanic Gardens in the Convention on Biological Diversity (CBD)

Peter Wyse Jackson, Botanic Gardens Conservation International

The world community has recognised, through the United Nations Convention on Biological Diversity (CBD), the negative effects of the loss of biodiversity on quality of life and on the survival of humankind and life in general on this planet. This Convention entered into force in December 1993, 18 months after it opened for signature at the United Nations Convention on Education and Development (UNCED) in Rio de Janeiro, Brazil in 1992.

The Convention aims to:

- Conserve the world's biological diversity.
- Promote the sustainable use of the components of biological diversity.
- Provide for the equitable sharing of benefits from the use of biodiversity, including providing access to genetic resources and the transfer of relevant technologies.

Botanic gardens are playing an important role in achieving these aims. Botanic gardens' collections and the application of their skills in areas such as taxonomy, botanical research, conservation, propagation and cultivation contribute significantly to the implementation of the CBD. They also provide a major link between *in situ* and *ex situ* conservation and are frequently involved in national planning processes such as biodiversity strategies. Their work in other sectors, from the development of new crops for agriculture and the discovery of new plant-based medicines, to education, illustrates the important role they can play in implementing the Convention.

Botanic gardens implement the CBD in several ways.

General Measures for Conservation and Sustainable Use

Contributing to national biodiversity strategies and sustainable development (Article 6).

Identification and Monitoring

Undertaking work in plant taxonomy systematics, floristics, inventories, monitoring, and surveys (Article 7).

In situ Conservation

Contributing through the development, designation, care and management of protected areas, habitat restoration or re-creation and wild plant population research, recovery or management (Article 8).

Ex situ Conservation

Developing and maintaining germplasm collections including seed banks, field genebanks, tissue collections in culture, individual species recovery programmes, and databanks (Article 9).

Sustainable Use of the Components of Biological Diversity

Identifying and developing economically important species in commercial horticulture, forestry and agriculture, and in bioprospecting (Article 10).

Research and Training

Undertaking research in many relevant fields, such as taxonomy, ecology, biochemistry, ethnobotany, education, horticulture, plant anatomy, biogeography and providing training opportunities and courses in conservation and related disciplines, often available to national and international trainees (Article 12).

Public Education and Awareness

Providing public education and developing environmental awareness, including programmes to promote public understanding of biodiversity, its importance and loss. Many botanic gardens play important roles in school and university teaching (Article 13).

Access to Genetic Resources (and benefit sharing)

Developing the capacity of partner institutions for biodiversity conservation through collecting fees, research support, equipment, information, training, shared specimens. As well as providing access to their vast conservation resource of stored and managed biodiversity (Article 15).

Exchange of Information

Making information on their collections and the results of their research widely available through published and unpublished literature and accessible databases. Many botanic gardens share data on their collections (Article 17).

Technical and Scientific Co-operation

Cooperating in technical and scientific areas, including joint research and staff exchanges (Article 18).

The CBD is a binding international regulation for the countries that are parties to it. Their obligations are constantly evolving as parties negotiate further decisions and legislation and policies are adopted and implemented at national level. The CBD has a major impact on the way botanic gardens operate in all parts of the world. The International Agenda for Botanic Gardens in Conservation recommends that botanic gardens should:

- Develop an institutional policy on the CBD and a strategy for its implementation in the garden. This will ensure that the best possible use is made of the present and future resources and all the actions of the botanic garden are in line with the spirit and letter of the Convention.
- Seek to publicise the CBD and its objectives to their constituency to increase its understanding of the value of biodiversity and the importance of plant conservation.
- Work to implement the CBD at a national and international level through practical action and by working with other bodies, governments and the Secretariat of the CBD.

The Role of Botanic Gardens in Implementing the Convention on Biological Diversity

Barbara diGiovanni, Royal Botanic Gardens Kew, UK

The Convention on Biological Diversity (CBD) provides a new mandate for botanic gardens. New policy and practical challenges, as well as opportunities, for botanic gardens have arisen since the Convention entered into force.

The CBD entered into force on 29 December 1993 and has been subsequently ratified by 178 parties. It is an international treaty and an institutional framework for the continual development of legal, policy and scientific initiatives on biological diversity. Its scope is global, covering all components of biological diversity, from ecosystems and habitats, species and communities to genomes and genes, and it deals not only with the conservation of biological diversity *in situ* and *ex situ*, but also with its sustainable use and benefit sharing.

The CBD and national laws on access to genetic resources have introduced certain legal obligations with which botanic gardens must comply. For the *ex situ* collections held in botanic gardens to be of value to science and conservation, they must be maintained and improved. To achieve this, continued access to plant, fungal, microbial and animal genetic resources is essential. The exchange of genetic resources between botanic gardens is also necessary to facilitate taxonomic and other scientific research and to ensure that the levels of diversity held in *ex situ* collections are adequate for conservation. Additionally, botanic gardens act as an important 'clearing house' as the genetic resources they collect may be supplied to a wide range of organisations including other botanic gardens, universities, research institutions and industry.

The CBD presents important opportunities for botanic gardens with reference to *in situ* (Art. 8) and *ex situ* (Art. 9) conservation, the sustainable use of biodiversity (Art. 10) and the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources (Art. 1). Botanic gardens can also contribute to other aspects of the CBD, such as the formulation and implementation of national biodiversity strategies (Art. 6), identification and monitoring (Art. 7), public education and awareness (Art. 13), access to genetic resources (Art. 15), exchange of information (Art. 17), and technical and scientific cooperation (Art. 18) through research and training. Furthermore, since 1993, parties have developed thematic areas and programmes of work that are also relevant to botanic gardens, such as biological diversity of dryland, Mediterranean, arid, semi-arid, grassland and savannah ecosystems, forest biodiversity, agricultural biodiversity, alien species, the Global Taxonomy Initiative, and the Clearing-House Mechanism.

The implementation of the CBD increasingly depends on the extent to which scientific and technical expertise is involved in the process. By taking a voluntary, proactive approach, botanic gardens need to explore ways by which can contribute more effectively to international discussions. This will help devise solutions which meet the CBD requirements and relevant national law, and which are appropriate to their activities.

Botanic Gardens Conservation International (BGCI)

Peter Wyse Jackson, Botanic Gardens Conservation International

BGCI was founded in 1987 to link botanic gardens as a co-operating global network for plant conservation. It now includes over 500 member institutions in 110 countries, working together to implement a worldwide policy on conservation, *The International Agenda for Botanic Gardens in Conservation*, published in 2000.

BGCI provides technical guidance, data and support for botanic gardens worldwide. It has a wide range of activities and has organised major meetings and workshops, such as a series of International Botanic Gardens Congresses and training courses in many countries.

In 2000 BGCI has been at the forefront of efforts to develop a new broadly based Global Plant Conservation Strategy through the Convention on Biological Diversity (CBD). It published *The Gran Canaria Declaration*, prepared by a high level international group of botanists, which was presented to the CBD's 5th Conference of the Parties, calling for a Global Program for Plant Conservation. A priority task for BGCI will be to ensure that such a Strategy is adopted and that botanic gardens become central to its implementation.

BGCI has helped to create or strengthen national and regional networks of botanic gardens in many parts of the world, such as Australia, Brazil, China, India and Indonesia, to focus their efforts on plant conservation in new co-operative partnerships.

A BGCI priority has been to support and encourage the development of effective and efficient information management systems for botanic gardens. This has included the preparation of two editions of the International Transfer Format for Botanic Gardens Plant Records (ITF and ITF2) and computer software programs (BG-Recorder) for use by botanic gardens in the management of plant records. BGCI also maintains a global list of botanic gardens and their facilities and primary activities that is used to compile the International Directory of Botanical Gardens. BGCI has also developed a computer database on rare plants in over 400 institutions to bring worldwide, helping to bring co-ordination to the individual efforts of each garden. It is currently preparing the first ever global checklist of plants in cultivation in botanic gardens worldwide. It has also helped to create plans for new botanic gardens and projects in many countries.

BGCI publications, such as the regular *Botanic Gardens Conservation News* and the education magazine *Roots* provide a means for those working in botanic gardens to share experience and information. Technical publications have been prepared, to guide conservationists on such subjects as conservation techniques; illegal rare-plant trade; recording plant data on computers; re-introductions to the wild and other subjects.

BGCI education work has become an important means of enhancing the role of gardens in many countries in environmental education and awareness and it has produced and distributed a wide range of new educational materials, such as videos, a slide pack, posters and newsletters, in several languages.

BGCI is funded by members' subscriptions, donations and special projects. Its headquarters is in the U.K. but it maintains regional and project offices in several countries, including BGCI Foundations in Russia and the USA.

The Role of Seed Banks in Botanical Gardens and Arboreta

Brigitte Laliberté, International Plant Genetic Resources Institute (IPGRI), Rome, Italy

The conservation of plant diversity can be achieved through an integrated approach balancing *in situ* (in its natural habitat) and *ex situ* (outside of its natural habitat) conservation strategies. Habitat destruction is inevitable and to ensure the survival of several thousands of plant species threatened, a backup strategy, acting as a kind of "insurance policy" is needed to make the recovery and reintroduction of plant species possible. This is best achieved through *ex situ* conservation such as seed banking.

Seed banking is the long-term storage of seeds, initially dried to 5-8% RH, under cold conditions such as -20°C. Several species can be preserved for several hundreds of years if the conditions are optimal. Seed banking is undeniably the most cost-effective method of providing plant genetic resources for long-term conservation. It allows large populations to be preserved and genetic erosion to be minimised.

Today as a result of the continuous efforts of botanic gardens for the last 2 hundred years in collecting plant material, and the great efforts of crop germplasm collection during the 1970s and the 1980s, there is a large number of genebanks and germplasm collections around the world. According to FAO, approximately 6,000,000 plant accessions (samples) are conserved in over 1,300 genebanks around the world. The number of seed stores has dramatically increased over the last 20 years from only 54 in the 1970s. However, there are gaps in the collections of important groups of species such as wild relatives of crops, minor crops and under-utilised species as well as medicinal plants, culinary herbs and spices, ornamental and landscape plants, and habitat restoration and forestry species. Botanic gardens have a comparative advantage in filling these gaps. The important role that botanic gardens and arboreta can play in programmes of plant genetic resources conservation was emphasised at the international Technical Conference on Plant Genetic Resources that was held in Leipzig, Germany, in June 1996. This led to the development of the Global Plan of Action for the Conservation and Utilisation of Plant Genetic Resource for Food and Agriculture.

There are more than 1,700 botanic gardens and institutions world-wide holding plant collection that serve both the purpose of conservation and education. Most botanic gardens have seed collections mainly for distribution and exchange. These are generally stored at room temperature in paper envelopes. However, an estimated 30% botanic gardens surveyed in 1994 have some form of cool to low temperature seed storage, and 70% with the intention of long-term conservation. Most of the seed bank collections are of particular taxonomic groups, flora of specific geographical area and of wild species of socio-economic value, often endangered.

Most of the botanic gardens store seeds under more than one storage condition. Often a part of the collection is used and distributed and a part is maintained for long-term conservation to safeguard the valuable germplasm. However, the representation of the population in genetic terms is not always ensured and often very small samples are collected from few individuals not fully representing the natural population. For genetic resources conservation, this is one of the

most important considerations to ensure not only that the species are protected but that the genes distributed among the populations are conserved. Therefore collections of well-documented wild sources are necessary following rigorous sampling strategies and garden origin of accessions should be gradually replaced. There is also a need to improve the quality of long-term conservation standards in seed banks in botanic gardens, to increase the conservation value of the accession stored. Well established standards have been developed by organisations like the International Plant Genetic Resources Institute (IPGRI see www.ipgri.cgiar.org) and FAO and are recommended by recommended BGI.

The Creation of an *Ex Situ* Conservancy for Rare and Endangered Plants at Les Jardins De Metis

Alexander Reford, Director, Les Jardins de Metis

Les Jardins de Métis (Reford Gardens) are developing one of the first *ex situ* gardens in North America dedicated to the preservation, exhibition and propagation of rare and endangered species. The project is in the planning stages and is being developed in collaboration with Quebec's ministry of the Environment and other partners, both public and private. The focus of the garden is the plants of the St. Lawrence estuary that are endangered or considered to be at risk.

Les Jardins de Métis are an historic garden located on the south shore of St. Lawrence River at Grand-Metis, mid-way between Rimouski and Matane. Formerly the private estate of Lord Mount Stephen, the founder of the Canadian Pacific Railway, a vast private garden was developed on the property by his niece, Elsie Reford, between 1926 and 1959. Boasting a collection of native and exotic plants of more than 3,000 species and varieties, the gardens are the northernmost in eastern North America. Among the rarities are large collections of azaleas, rhododendrons, lilies, gentians, and the Tibetan Blue Poppy (*Meconopsis betonicifolia*). Plants are displayed in a naturalistic setting in beds, in niches along a natural stream under the cover of a mature forest of conifers.

Since the 1960's, one-third of the gardens has been dedicated to the display of native plants. This area was conceived and designed by Dr. Henry Teuscher, then conservator of the Montreal Botanical Gardens. It is here that a conservancy will be created to preserve and exhibit rare and endangered plants in a variety of specifically designed habitats: peat bog, pond, marsh, alpine outcrops and the boreal forest. With the aid of leaflets and other interpretative tools, the visiting public (on average 100,000 every summer) will have the opportunity to explore the plants indigenous to the St. Lawrence eco-system. Visitors will be educated about rare and endangered species and the special measures taken by governments and conservation agencies to protect them.

The second part of the conservancy will be adjacent to the Metis River where it flows into the St. Lawrence. One of the few undeveloped and uninhabited coastal areas in the lower St Lawrence region, the bay is a natural haven for birds and coastal plant life. Here a selection of plants will be protected, planted and displayed. Interpretative tools will be provided for visitors.

The project is now in its planning stages. Julie Isabel, a graduate in environmental studies from the Université de Sherbrooke, is co-ordinating the project. A complete bibliographical analysis has been undertaken to examine the policies and practices employed at other *ex situ* conservancies and at botanical gardens around the world. Draft guidelines and principles have been submitted to various groups dedicated to the preservation of rare and indigenous species in Quebec. Technical assistance has been solicited from Quebec's ministère de l'Environnement, whose Direction de patrimoine écologique et du développement durable is responsible for the protection of endangered plants. Design concepts are currently being prepared as part of the

Garden's overall development plan. The creation of the first of the endangered plant habitats will be undertaken during the summer of 2001.

Some educational initiatives have already been undertaken. In May 2000, the Gardens launched a French language web site, "Plantes en danger" (Plants at risk). This site (which can be seen at www.refordgardens.com see "jeu" section) is essentially an interpretative tool, geared towards children ages 6 to 12. To win, they have to look for the nineteen rare and endangered plants hidden in various habitats located in three different regions of Quebec. A team from the Jardins de Métis created the web site with the assistance of Versalys, a multi-media firm in Rimouski. In addition to its popularity, the site has also been a critical success. It was recently awarded the gold medal in the interactive web site category at the Multimedia International Market held in Montreal in October 2000.

Over time, and in collaboration with other ongoing development projects at the gardens (the International Garden Festival and an accompanying international symposium on gardens and the landscape), the conservancy will become an important part of the Garden's mission. With the increased interest in eco-tourism, the conservancy will also be an important addition to the environmental opportunities presented to tourists during their visit to the region.

Royal Botanical Gardens' Seed Bank Preserves the Genetic Identity of Rare Native Plants

Sarah Stewart, Royal Botanical Gardens

Royal Botanical Gardens (RBG) is home to 900 hectares (2,200 acres) of both terrestrial and aquatic natural lands. Some of RBG's upland communities like the talus slopes of the Niagara Escarpment and the Oak Woodlands in the Cootes Paradise and Hendrie valleys are considered unique in southern Ontario. As human induced pressures from urbanization increase, these natural habitats become increasingly more rare. And as the availability of natural areas declines, so too does the diversity of native plant and animal species that live there. Several of RBG's rare and endangered native plant species grow in these threatened habitats. Royal Botanical Gardens and the Canadian Botanical Conservation Network have developed a program to help preserve the genetic identity of rare and threatened native plant species trying to survive human-induced habitat disturbances.

The Seed Bank Pilot Project was developed in 1999 as one part of a plan to create a Natural Heritage Gene Bank at Royal Botanical Gardens. While the main focus of the Seed Bank Pilot Project is to conserve rare and endangered native plant species on RBG property, in a larger sense it is the beginning of a national program to preserve plant biodiversity across Canada. Field botanists are responsible for collecting, storing and distributing seeds for various habitat restoration projects as well as for maintaining the viability of individual populations. The national program will consist of several gene banks including a living plant gene bank, a seed bank, and a DNA tissue bank and will also provide educational and training opportunities.

Through the Seed Bank Pilot, RBG Field Botanists have identified ten rare and endangered plant species that would benefit from this program including Red Mulberry, Canada's most endangered tree. Seed collection of these target species began in 2000 and will play a role in the future protection of not only the individual plant species but also the communities in which they live. It is through initiatives like the Seed Bank Pilot Project that the future of threatened and rare native plant species will be able to persist, helping to maintain genetic biodiversity and protect them from extinction.

Profile of a Species at Risk: Hoary Mountain Mint

Paul O'Hara Royal Botanical Gardens

Hoary Mountain Mint (*Pycnanthemum incanum* var. *incanum*) is an attractive, herbaceous perennial that grows about 1 m in height, has white flower clusters and fragrant foliage. It is found in dry, open woods and clearings in Eastern North America. Though relatively common throughout its U.S. range, Hoary Mountain Mint has been found in only one location in Canada, in the Aldershot area of Burlington, Ontario. For this reason, it is listed as Endangered by the Committee on the Status of Endangered Wildlife in Canada, and is in regulation under Ontario's Endangered Species Act.

First documented in Canada in around 1900, Hoary Mountain Mint was not seen again until 1981 when it was rediscovered near Royal Botanical Gardens by Dr. William J. Crins. Recent exploration by the field botany staff of Royal Botanical Gardens has confirmed its presence at several sites along the north shore of Burlington Bay, in remnant prairie and oak savanna habitats. In pre-settlement days, prairie and oak savanna were found in many parts of Southern Ontario, including the Burlington and Hamilton area. Today, it is estimated that less 0.08% of the historical prairie and savanna remains in Hamilton-Wentworth Region (Goodban et al. 1998), and what little is left is usually in a degraded state.

The habitat for Hoary Mountain Mint has certainly been degraded. Threats to the extant populations include encroachment from invasive species, trampling (one population has a footpath beside it), and shoreline erosion. In order to protect these populations, Royal Botanical Gardens has been working jointly with the Ministry of Natural Resources to formulate a recovery strategy. As part of this strategy, seed and leaf tissue samples have been collected that will permit study of the populations' genetic diversity, and highly-successful propagation methods have already been developed. Hoary Mountain Mint may have as yet unrealized biological and economic significance. Because of the potential for unique adaptations to Canada's climate, it is important that this population at the northern edge of its range receives proper protection.

According to Crins 1985, "[Hoary Mountain Mint] has been shown to contain a high natural rubber content, and may have some potential as a rubber-hydrocarbon crop." One conservation plant grower has said that Hoary Mountain Mint attracts bees by the thousands and would be useful in honey production. Furthermore, other species of Mountain Mint have shown odor-blocking and anti-fungal properties, and have been used to flavor soups and meats.

The goal of the current conservation work surrounding Hoary Mountain Mint is to ensure that this attractive and potentially useful plant will remain a proud part of our Canadian natural heritage.

Conservation and Enhancement of Genetic Resources in Canada

Ken W. Richards, PGRC Canada

Globally 300,000 to 500,000 species of higher plants are believed to exist, yet only about 250,000 are described taxonomically. About 100,000 plant species are considered important as genetic resources for food and agriculture and historically about 7,000 species have been cultivated at one time or another. Currently about 300 crop species are widely used for food and only about 30 species "feed the world", providing about 95% of the dietary energy (calories) or protein to an increasing human population.

Canadian agriculture has, compared to other parts of the world, a relatively short history. Very few plant species of economic importance to agriculture (ie. strawberry, saskatoon berry, current) have their centre of diversity or domestication in Canada. Therefore, the introduction of new species or varieties for cultivation by settlers immigrating from other countries has been essential for successfully establishing agriculture. Many of these early introductions originated from botanic gardens, mainly from Europe but also other continents. Germplasm for Canada is still acquired from botanic gardens as these collections frequently occur near the primary centres of *in situ* diversity for a crop species and as continued geneflow occurs between the crops and their wild relatives in these areas that can contribute to new variability. Within Canada some centres of genetic diversity exist for crop species such as sunflower, cranberry, strawberry, saskatoon (Small 1993, 1995). Similarly a number of native plant species of importance within Canada's biodiversity which have either some economic value, are important in the ecosystem or deserve special conservation attention (eg. rare, threatened, or endangered species). All these species should have priority for conservation either in botanic gardens or seed gene banks such as Plant Gene Resources of Canada. Special attention for exploitation must be paid to the five ecological regions within Canada identified as areas at greatest risk to loss in biodiversity (Environment Canada 1996).

Increasing the Canadian content with botanic gardens or national seed collections will help ensure the long-term conservation of these species and help fulfill Canada's commitment to the Canadian Biodiversity Strategy and the Convention on Biodiversity. Attention should also be paid to obtain plants with known medicinal or nutraceutical value as they are frequently underutilized or overlooked (eg. Monarda, Echinacea, Arctostaphylos (Small and Catling 1999). Easy access as through a botanic garden or seed gene bank to them should come from within Canada. Very few of the native plant species have been exploited in Canada. North American aboriginal people used more than 1,000 species for nutrition (Morton 1963). And within Canada a list of more than 100 relatively promising native plant species were used by the first nations people (Turner 1981). Thus there is considerable potential to acquire and potentially exploit native Canadian plant species. However, first these plant species need to be conserved in Canadian botanic gardens or national seed gene banks. Seed gene banks (PGRC) and botanic gardens can play a significant role in acquiring, distributing, studying and conserving these Canadian genetic resources.

Medicinal Plant Specialist Group: IUCN - The World Conservation Union

Danna Leaman, Chair-elect, IUCN Medicinal Plant Specialist Group

The Medicinal Plant Specialist Group (MPSG) is a global voluntary network of experts contributing within their own institutions and in their own regions to the conservation and sustainable use of medicinal plants. The MPSG was founded in 1994, under the auspices of the Species Survival Commission of the IUCN - the World Conservation Union, to increase global awareness of conservation threats to medicinal plants, and to promote conservation action. Our group is currently made up of approximately 70 individual scientists, field researchers, government officials, and conservation leaders world-wide.

The MPSG has recently established a programme office in Canada (Aymer, PQ), hosted by the Canadian Museum of Nature. Establishment of this office is facilitating programme and website development, institutional collaboration, and fundraising for the MPSG's global and regional activities related to identification and conservation of threatened medicinal plants.

Many members of the MPSG are botanic gardens staff or work with botanic gardens. Botanic gardens are particularly well placed to contribute to medicinal plant conservation, both *in situ* and *ex situ*. Botanic gardens and herbaria have a long history of work on ethnobotany, systematics, and ecology of medicinal plants. Many maintain living collections of medicinal plant species, and have the expertise in horticulture and maintenance of germplasm required to understand and protect the enormous range of genetic diversity found in medicinal plants. Botanic gardens are, moreover, providing institutional leadership in articulating and applying ethical practices for access to and the sharing of benefits from the genetic resources derived from medicinal plants and traditional knowledge of their use in medicine.

Our overall aim is to support and promote efforts leading to medicinal plant conservation and rational, sustainable use. Our approach is to provide information, tools, and strategy coordination that builds on the efforts of local, national, regional, and global partners to conserve and use medicinal plants sustainably, focusing particularly on actions that reduce threats to endangered species and habitats.

Our programme consists of three major integrating activities:

- Centres of Medicinal Plant Diversity - We are contributing to regional projects that support national and regional conservation strategies, action, and capacity building within existing centers of medicinal plant diversity (defined by their biological diversity, traditional knowledge and use, trade, and research activity relevant to medicinal plants). Botanic gardens are important research institutions within these Centres.
- TOP 50 Threatened Medicinal Plants - Through Red Lists and other priority-setting activities, we are increasing the awareness of highly threatened species of medicinal plants worldwide among the stakeholders: the medicinal plant industry, consumers, governments, and health and conservation policy makers. Public education activities in partnership with botanic gardens are key elements of this activity.

- Policy and guidelines for sustainable use of medicinal plants - We are working toward the application of international treaties (CITES, CBD), health policy (WHO), and trade policy (WTO) to the sustainable use and conservation of medicinal plants. For example, our members contribute information and analyses to CITES, are involved in medicinal plant conservation projects supported by the Global Environment Facility (under the CBD), contribute to WHO monographs on medicinal plants, and contribute to discussions with industry concerning a certification system for sustainable harvest and production of medicinal plants.

Using an International Protocol to Monitor Forest Biodiversity on the Niagara Escarpment

Sarah Stewart, Royal Botanical Gardens

The United Nations Educational, Scientific and Cultural Organization (UNESCO) named Ontario's Niagara Escarpment a World Biosphere Reserve in 1990. This largely forested, geologic corridor extends 725 kilometres from Niagara Falls to Tobermory, passing through one of Canada's most densely populated and highly developed regions. The UNESCO World Biosphere designation recognizes the importance of the Escarpment's natural environment and helps support management initiatives like the Niagara Escarpment Plan. As part of the World Biosphere agreement, a new reserve must establish an environmental monitoring program within five years.

The Niagara Escarpment Commission, the Association for Canadian Educational Resources (ACER) and the Council of Outdoor Educators of Ontario (COEO) followed through with the World Biosphere agreement by leading a partnership to develop an environmental monitoring program on the Niagara Escarpment. In the mid 1990s, through the Niagara Escarpment Biosphere Reserve Studies network (NEBRS), Royal Botanical Gardens joined with several other organizations and school boards to establish forest biodiversity monitoring plots along the length of the Niagara Escarpment. The objective of the program is to develop a community-based forest biodiversity monitoring program, following international guidelines to provide a standardized information database for scientists, teachers and the general public both locally and abroad.

Three primary sites were established along the south, central and northern portions of the Niagara Escarpment. Royal Botanical Gardens hosts the southern site. Each site has two, one-hectare plots, one for teaching and demonstration purposes and one for scientific research. RBG's demonstration plot is used as a teaching tool for public education and environmental monitoring. Volunteers and students from the local community learn research and monitoring skills and use them to survey the demonstration plot. This hands-on experience teaches the general public about forest biodiversity and helps foster stewardship practices. The scientific plot is used for research purposes only and receives minimal human impact.

Each one-hectare forest plot is subdivided into 25 quadrants. Each quadrant is surveyed following international guidelines developed by the Smithsonian Institution/Man and Biosphere Program (SI/MAB) for monitoring biodiversity in World Biosphere Reserves. The diameter and height of all trees over four centimetres DBH are measured and the trees are identified, mapped and tagged with an inventory number. Other parameters like soil temperature and snow cover are also measured. Each site is to be re-surveyed every five years. The SI/MAB protocol is followed at other Environmental Monitoring and Assessment Network (EMAN) sites throughout Canada. The host of each primary site was encouraged to establish at least one twin site. In 1997, Royal Botanical Gardens met this obligation by creating a twin site on Hamilton Naturalists' Club property at Short Hills Sanctuary, adjacent to Short Hills Park Reserve. Through the twin site partnership, biodiversity surveying and monitoring skills are taught and resources are shared.

Using universal biodiversity monitoring standards and measurements enables both the local and international community to conduct and share their research and provides a standardized platform to develop a forest biodiversity strategy for the future.

Prairie and Northern Plant Diversity Centre and Other Devonian Botanic Garden Plant Diversity Initiatives

Alina Fischer, PNPDC Coordinator, Devonian Botanic Garden

In April 2000, the Devonian Botanic Garden established the Prairie and Northern Plant Diversity Centre, which proposes to function as a regional node coordinating and enabling plant conservation activities in the three prairie provinces, the Northwest Territories, and Nunavut.

Key activities of the PNPDC since its inception have included the following:

1. Conferences and Workshops

In early May, PNPDC has hosted a workshop to:

- establish partnerships with the Millenium Seed Bank at the Royal Botanic Gardens - Kew, the Plant Gene Resources of Canada Seed Bank of Agriculture and Agri-Food Canada in Saskatoon, and the Association for Biodiversity Information - Canada
- create linkages with the Canadian Botanical Conservation Network
- to create the Canadian Botanical Gardens Consortium for Biodiversity (CBGCB). CBGCB is a new cooperative effort for the identification, study, preservation and recovery of Canadian rare plants, and for the sustainable management of plant biodiversity in Canada. CBGCB members are Devonian Botanic Garden (Edmonton, AB), University of British Columbia Botanical Garden (Vancouver, BC), Royal Botanical Gardens (Hamilton/Burlington, ON), Montréal Botanical Garden (Montréal, QU) and Memorial University of Newfoundland Botanical Garden (St. John's, NF).

2. State of the Science Report

Peter Achuff and Alina Fischer have written a report on Plant Diversity Conservation in Canada, synthesizing information on the current state of plant conservation in Canada.

3. Certificate Program

PNPDC has initiated a certificate program that provides consultants and professional the opportunity to upgrade and update their knowledge of plant identification and conservation. The courses offered as presented by experts and included 1 to 4-day intensive workshops.

Three courses, Introduction to the Mosses of North Central Saskatchewan, Identification of Rare Ferns, and What Makes a Plant Rare? were held between May and September 2000. These received rave reviews. Student feedback will be used to further tailor course development for the upcoming summer. All three courses will be re-offered again next year, as well as identification workshops for other plant groups, including Identification of Rare Willows and Identification of Algae and Aquatic Plants. As of the summer of 2001, the PNPDC plans to offer the certificate program in its entirety, including all courses listed on our web site at: <http://www.devonian.ualberta.ca/devonian/pnpcourses.html>

4. Database for Seed Bank

The seedbank database is the first phase in developing an integrated, plant database system, which will include also databases of the Devonian Botanic Garden (DBG) living collections, as well as the dried plant collections. This project is currently in an advanced planning stage. The seed bank database will store all information related to seed collections made by the DBG and by interested members of Canadian Botanical Gardens Consortium for Biodiversity. The information will be made available on the Internet to both the research community and to the general public, who will be able to view data and order seeds through a web browser. In addition, data entry will be through a web browser interface to make it possible for our CBGCB partners to contribute and retrieve data. We have consulted with the Royal Botanical Gardens - Kew and the Plant Gene Resources of Canada Seed Bank at Saskatoon about database structure compatibility to enable easy data exchange with those institutions. The seed database will be online in the first quarter of 2001.

5. Pilot Program for Interactive Searches for Rare Plant Information

Developing an interactive website for searching the Alberta rare plant database is being done in cooperation with the Alberta Natural Heritage Information Centre, Alberta Environment. The target users are mainly the resource industry and environmental consultants who need easily available, base-line information on rare plants. The system allows web users to locate the sites of rare plants, as well as obtain summaries of plant diversity by townships, ecoregions, and specific sites within the province. The system is GIS-based and uses innovative, cutting-edge software technology to display rare plant information on dynamic maps. The user can fully explore the database using freely available web browsers. In the next stage of development, this project will be scaled up to provided interactive web mapping for all the rare plants in western Canada. The website will be online by the end of December 2000.

Botanical and Ecosystem Conservation and Education at Calgary Zoo

Brian Keating and Colleen Hyslop, Calgary Zoo and Botanical Garden

Calgary Zoo, like Toronto Zoo and many other zoological gardens, includes significant plant-related programs, ranging from horticulture and conservation to gardening. Recent botanical and ecosystem programs at Calgary Zoo include:

Schoolyard Naturalization Programme

Kevin Strange and Sue Arlidge of the Calgary Zoo's Education Department are working to promote the Schoolyard Naturalization Programme. This innovative programme assists local schools in the planning and construction of gardens that will attract wildlife to school property. Zoo staff train teachers to incorporate these gardens into their regular teaching programmes and emphasize the use of native plants. Fifteen schools from three different school boards are involved, and applications are being accepted for additional new sites. Partial funding for this project, now in its second year, has been received from the Alberta Ecotrust.

Master Gardeners

Master Gardener volunteers at the Zoo are participating in a programme to rescue native plants in areas destined for building development. The plants are relocated to school and community sites where habitat gardens have been created. The gardeners also prepared a comprehensive series of curriculum-based teaching kits for schools and are conducting follow-up workshops with teachers interested in habitat gardens. Volunteers in this programme complete one hundred hours of training, both theoretical and hands-on, in ecological gardening, growing native plants, and habitat restoration.

Nature Conservancy of Canada

The Calgary Zoo is partnering with the Nature Conservancy of Canada in a series of educational programmes to promote the work of the Conservancy. Programme participants visit a number of sites where private landowners have created "conservation easements" on their land to guarantee the protection of its natural character in perpetuity. This exciting partnership for habitat conservation has recruited new supporters for both organizations and will become an ongoing project.

Ecotourism: Contributing to Sustainable Development

The Conservation Outreach programme supports responsible and sustainable Ecotourism. We believe that exposure to nature is one of the most powerful educational tools available. Conservation Outreach has a long term relationship in running Zoofari, the Zoo's ecotour travel programme, with Civilized Adventures, a Calgary-based travel company. Proceeds from ecotours go to the Conservation Fund. Zoofari helps to establish long term relationships between tour participants and the Zoo. Ongoing tourism also creates a mutually beneficial relationship between the Zoo and local communities that encourages them to protect wildlands and wildlife.

Restoring Marsh Ecosystems at Royal Botanical Gardens

Sarah Stewart, Royal Botanical Gardens

Royal Botanical Gardens (RBG) manages over 900 hectares (2,200 acres) of natural habitat, one third of which are wetlands. Cootes Paradise marsh and Grindstone estuary, located in the western pocket of Hamilton Harbour at the extreme west end of Lake Ontario, support many rare and threatened plants and animals. Cootes Paradise, recognized by the Ontario Government as a Class 1 Wetland, is considered an important staging ground for fall migratory waterfowl and is the largest nursery habitat for fish in the region. Both Cootes Paradise and Grindstone estuary are listed as Environmentally Sensitive Areas (ESA) and Areas of Natural and Scientific Interest (ANSI).

Over time, human induced stresses like high nutrient levels, sediment accumulation, overgrazing by Carp (a non-native introduced species) and the control of Lake Ontario water levels contributed to a decline in the health of the once biologically diverse, productive wetlands of Hamilton Harbour. Concerns over environmental degradation of the Great Lakes led the International Joint Commission (IJC) to designate Hamilton Harbour as one of 42 Areas of Concern (AOC). In 1986, the Hamilton Harbour Remedial Action Plan (HH-RAP) was established to address environmental concerns in and around the Harbour. The Fish and Wildlife Habitat Restoration Project (F&WHRP) is the fish and wildlife habitat component of the HH-RAP. It is through this program that RBG's "Project Paradise" was established in 1993.

Project Paradise, the collective restoration of Cootes Paradise marsh and the marshes of the lower Grindstone Creek floodplain, is the largest habitat restoration initiative ever undertaken by RBG. It is largely driven by the Cootes Paradise Fishway, the only Carp exclusion barrier and two-way fishway structure on the Great Lakes. The primary habitat restoration goal of Project Paradise is to create self-sustaining, mixed, emergent and submergent aquatic plant habitats with diverse, predator-dominated fish communities in degraded areas. To reach this goal, RBG and RAP partners conduct many small and large-scale habitat restoration projects and several watershed research and monitoring programs to address the human induced stresses on these wetlands. Some of the remedial actions include improvements to local Combined Sewer Overflow (CSO) systems and sewage treatment, watershed sediment controls, creating and restoring lost habitat for native fish and amphibians, excluding destructive non-native species like Carp and implementing public education and planting programs.

Since Project Paradise began, 95% of the Hamilton Harbour Carp population has been excluded from Cootes Paradise. The active feeding and spawning behaviour of Carp destroys aquatic plants, re-suspending shallow bottom sediments contributing to poor water clarity. Carp exclusion improves light penetration in the water column allowing aquatic plant seeds buried in the sediment to germinate and establish strong root systems. Mature aquatic plants provide food, shelter and breeding /spawning sites for fish, amphibians and birds, stabilize marsh bottom sediments, help remove excessive nutrients and unwanted pollutants and slow water flow preventing downstream flooding. In addition to Carp exclusion, local Conservation Authorities, Environment Canada, and the regional municipality continue implementation of a variety of initiatives designed to improve inflowing water quality as identified by the RAP process. Most

recently, agencies have begun to examine the affects of Lake Ontario water level management on coastal wetlands like Cootes Paradise and Grindstone Creek.

As RBG's wetlands improve it is hoped that they begin to be re-colonized by the native species that once lived here. Evidence of this has already been seen with an increase in the number of historically present native aquatic plant species including species that haven't been recorded in 50 years like Wild Rice and Mud Plantain. Native fish like Northern Pike and Bowfin are returning to the area, as are native amphibians like the Grey Tree Frog. As human induced stresses are gradually removed or their impact lessened the overall quality of water and fish and wildlife habitat are expected to continue improving.

Geographic Information Systems and Habitat Conservation at Royal Botanical Gardens

Sarah Stewart, Royal Botanical Gardens

A Geographic Information System (GIS) is a computer-based system used to collect, store, assemble and display geographically referenced information. Numbers and words are taken from the rows and columns in spreadsheets and databases and mapped, allowing users to view, understand, question and interpret data in ways simply not possible in rows and columns. A GIS stores information about the world in a series of layers. For example, lines used to represent trails are stored in one layer while polygons representing forest patches are displayed in a different layer. Any number of layers can be combined in any order to produce detailed customized maps. When combined with other tools a GIS can perform statistical analyses and searches, and create graphical reports of the results.

Following a successful pilot project in 1998, Royal Botanical Gardens implemented a full GIS in 1999 that has since become a valuable tool in the management and conservation of their 900 hectares (2,200 acres) of natural lands. Data representing changes in water quality, plant and wildlife populations, the extent of exotic invasive vegetation and the location of rare or sensitive plant species can be collected, digitized and displayed using a GIS. In addition, existing collections like Herbarium records can be mapped, analyzed and searched geographically. The GIS-generated information can then be used to compliment other research and be incorporated into the adaptive management of RBG's natural areas.

Geographic Information System technology is especially useful when conducting biological monitoring programs because it allows RBG scientists to track and evaluate any changes in a habitat over time. A Global Positioning System (GPS), a device connected to satellites, can very accurately determine the location of objects like a rare plant species which, when used in conjunction with a GIS can be used to create detailed maps of emergent aquatic or terrestrial vegetation. For example, during the 2000 field season RBG botanists discovered several Red Mulberry Trees (Canada's most endangered tree) on their property. With both a GPS and a GIS the location of each tree can be accurately recorded, mapped and used to make important land management decisions to help ensure the preservation of this endangered species. Together these tools provide valuable and precise information used to interpret the progress of previous habitat restoration initiatives and can help scientists and planners determine the direction of future conservation actions.

Royal Botanical Gardens' Aquatic Plant Nursery Provides Native Plants for Habitat Restoration

Sarah Stewart, Royal Botanical Gardens

In 1993 Royal Botanical Gardens (RBG) established its own aquatic nursery to meet the heavy demands of Project Paradise (RBG's largest habitat restoration initiative) planting activities, public education programs and to assist other habitat restoration projects throughout Ontario. Sustaining native plant species populations is important in any natural habitat because native plants provide food and shelter for a variety of native wildlife and are the foundation of many vital wetland-based ecological processes. RBG's aquatic nursery now grows over 50 native aquatic plants. After years of experimentation the nursery staff have developed several techniques to successfully germinate and grow these indigenous plant species.

Every fall, the aquatic nursery staff explore RBG grounds within a 20-kilometre radius of Cootes Paradise marsh collecting thousands of seeds and rootstocks from native aquatic plants. The collected plant material is cleaned and kept in cold storage over the winter. This step simulates the natural winter dormancy period that many seeds depend on for successful spring germination. In early spring the refrigerated seeds and rootstocks are planted in moist, shallow trays and kept warm under the controlled lighting and temperature of RBG greenhouses. In late spring, the tender seedling plants are moved outdoors and continue to grow throughout the summer. These propagated plants are then available for public education, area planting programs and off-site restoration projects to help re-vegetate other degraded Ontario marshes like Cootes Paradise.

Since 1994, RBG and the Bay Area Restoration Council (BARC) have conducted on-going wetland habitat educational programs where students and teachers plant seeds, and grow their own miniature marsh in the classroom. Through this program students and teachers learn about wetland ecology by growing and caring for their own aquatic habitat. This hands-on approach helps students learn about the development and function of aquatic plants and enables them to understand how important wetlands are to the environment.

Although the aquatic nursery focuses mainly on the propagation of native emergent aquatic plants from local sources, native underwater plants, floating-leaf and wet meadow species are also grown. The nursery provides a catalogue and price list with information on all available native plant species and offer habitat restoration project planning, consultation and biological inventory services.

Royal Ontario Museum and Plant Biodiversity Initiatives

Deborah Metsger and Erling Holm, ROM

The Ontario Species at Risk website www.rom.on.ca/ontario/risk.html has been designed to make authoritative information on Ontario's species accessible to the general public at a regional scale. Lists of species at risk are available for each of Ontario's five bioregions. Within each bioregion the information is organized according to five risk categories [extinct, extirpated, endangered, threatened, vulnerable], and according to the type of organism (birds, fish, insects, mammals, plants, and reptiles.) Fact sheets for individual species include maps of Ontario and North American distribution, colour images where available, and a description of the species biology and conservation status.

The Ontario Species at Risk website has been produced as a partnership between the Royal Ontario Museum and the Ontario Ministry of Natural Resources.

Hands On Biodiversity Gallery

The Royal Ontario Museum's Hands on Biodiversity Gallery takes a dynamic and interactive approach to introducing Museum visitors to the biodiversity of the natural world. Developed by the ROM Center for Biodiversity and Conservation Biology, the Gallery features specimens and current research from each of the ROM's seven life science disciplines: Botany (including Mycology), Entomology, Herpetology, Ichthyology, Invertebrate Zoology, Mammalogy, and Ornithology. Thematic alcoves place the organisms in context within representative habitats. Field tents and specimen drawers introduce the hows and whys of Museum collections as important tools for discovering, understanding, and preserving biodiversity. Gallery facilitators engage visitors in the fun, yet intellectually challenging activities and displays, discovery boxes, touch tables, costumes, and even living displays such as a Great Lakes Stream and an active Beehive. Plants and Fungi are featured prominently throughout the gallery. A native plant wall promotes the concept of native plant gardening and ecological restoration.

The Hands-on Biodiversity Gallery supports the Ministry of Education and Training Science Curriculum. Direct links can be made to the approved curricula for grades 1,2,3,4,6,7. The gallery also supports environmental advocacy by a rotating feature on different advocacy groups and by advertising ways that visitors can "get involved" in responding to the Biodiversity Crisis.

For more information on the Hands-on Biodiversity Gallery please call 586-5730, or visit our webpage at www.rom.on.ca/biodiversity.

The Herbaria of the Royal Ontario Museum on the World Wide Web

The Center for Biodiversity & Conservation Biology (CBCB) of the ROM includes two herbaria. Since "herbaria" may be unfamiliar to many visitors both to the Museum and to the Museum website (www.rom.on.ca) a set of illustrated web pages was created to introduce these two collections (www.rom.on.ca/biodiversity/herbaria/). These pages answer the following questions: (1) What are herbaria? (2) How do herbaria document biodiversity? and (3) Who uses the CBCB

Herbaria? Links are also available to take visitors to the site directly to the home pages of the Vascular Plant Herbarium and the Cryptogamic Herbarium, where the location, collections, and staff are described. Other links take visitors to the homepages of other sites maintained by Herbaria staff in collaboration with others or on their own, including the orchids of Muskoka District, a plant families course at the University of Toronto, an online identification tool, and a description of a recent book on herbarium management edited by one of the Herbaria staff. The homepages of the CBCB Herbaria will be of great value in publicizing their new location and names now that both have moved into the main building of the ROM. By moving the Bryophyte collections in with the vascular plants the two CBCB Herbaria will soon be known as the ROM Green Plant Herbarium and the ROM Fungal Herbarium.

The "Aquatic Ecosystems of Walpole Island" is a joint project of the Royal Ontario Museum and the Walpole Island First Nation (WIFN), Nin-Da-Waab-Jig to study the biodiversity of the delta marshes of Walpole Island, one of the largest and most significant of the Great Lakes wetland complexes. The marshes are an integral part of the economic base and cultural heritage of the WIFN. Through the joint project they sought:

- knowledge of the community structure of the Walpole Island wetlands that would provide essential and authoritative information needed to properly manage and protect them
- training for Walpole Island First Nations employees at the ROM, and in the field, that would give them the skills to study, identify, and disseminate information about fish, reptiles, plants and invertebrates among their people so that they might be better informed about the resources that they hold
- to bring the state of their knowledge about their wetlands in line with that of their terrestrial communities for which they have won international conservation awards for their efforts at environmental protection and habitat preservation

Documentation and preservation of Ontario biodiversity is a mandate of the ROM's Centre for Biodiversity and Conservation Biology (CBCB). The CBCB used this project as an opportunity to work hand-in-hand with a native group and be a concerned partner in the protection and conservation of an important wetland complex for several disciplines (Ichthyology, Botany, Invertebrate Zoology) from the Centre for Biodiversity and Conservation Biology (ROM) to be involved in a holistic study of an important ecosystem complex and to compare natural and diked wetland communities to gain significant information about the status and distribution of several rare and threatened species and several invasive exotic species.

A total of 157 sites were sampled during the 1999 season. The sites were selected to cover all habitats within the marsh and to traverse the geographic range of the wetland complex. Fish were sampled by seining, trawling and electro-fishing. Invertebrate samples were collected from sediment samples. Emergent and submerged aquatic plants were collected working from a boat or canoe, or from roadsides dikes and shorelines.

For information on the results of, and future plans for this study please contact Deborah Metsger debm@rom.on.ca or Erling Holm erlingh@rom.on.ca at the Royal Ontario Museum or Mike Williams heritage@web.net at the Walpole Island Heritage Center.

In addition to gathering scientific information the ROM and the WIFN worked together to raise the profile of the marsh and its natural resources with in the community and to the broader public in Ontario and the neighboring states. During the course of the 1999 field season the stories generated by this project - of rare fishes and plants, North American native efforts at sustainable development and conservation, threats by invasive species and manipulation of natural systems - were told via media coverage, public programs, live demonstrations, conference posters and fliers.

The "Aquatic Communities of Walpole Island" project is an excellent example of collaboration with North American aboriginal peoples toward the sustainable development of their lands and the protection of biodiversity within the confines of modern-day situations. The Nin-Da-Waab-Jig try to balance knowledge from western science with their native culture. There is much that we as scientists and interpreters can learn from their culture of consensus and make accessible to the public at large.

The Aquatic Communities of Walpole Island Project has received financial support from the Royal Ontario Museum Foundation, The Great Lakes Renewal Foundation, The ROM Centre for Biodiversity and Conservation Biology and the Walpole Island First Nation.

The Role of Herbaria in Biodiversity Research and Conservation

Tyler Smith, Royal Botanical Gardens

The herbarium is an essential tool for the study of biodiversity. At the most fundamental level, taxonomic work conducted in herbaria defines the limits of the individual units that constitute the term biodiversity: species and subspecies with their varieties; genus, family and higher taxa. The type specimens housed in major research herbaria are the inalterable expression of what constitutes a given taxon. Without these records to draw upon, biodiversity would remain an abstract term ungrounded in the natural world. Organisms may not always fit neatly into the categories of the taxonomist, but a systematic classification of living creatures provides a foundation from which we can make inquiries into the nature of life.

On a more immediately practical level, herbaria large and small provide data for those interested in the geography and history of plants. As a pertinent example for wetland restorationists, Stuckey and Salamon (1987) used herbarium records to show that the historical distribution of *Typha angustifolia* suggest that the species is in fact a recent introduction in North America. The assumption that *Typha angustifolia* is a native species has now been largely rejected, and many land managers view it as an invasive exotic. At a more local level, Goodban et al. (1996) used a combination of herbarium records, historical observations and surveyors' notes to document the pre-settlement extent of tallgrass prairie and savanna communities in the vicinity of Hamilton, Ontario. This habitat is critically imperiled in southern Ontario, and a variety of endangered species require intact tallgrass communities to persist.

For field workers, herbarium records are critical for ongoing monitoring programs. Royal Botanical Gardens field botanists have been actively involved in documenting the occurrence of the endangered *Scirpus verecundus* as part of our Natural Heritage Gene Bank project. Using specimens collected from the 1950's we have been able to relocate, identify, and monitor populations of this species. Not only do the records provide insight into the particular locations and habitat conditions that the plant is found in, they provide a physical reference against which new specimens can be compared. This is especially important with *Scirpus verecundus* as it is visually a rather unremarkable plant and proper identification can be problematic.

As concern over exotic plant species grows, there is a special role that arboreta and botanical gardens can play in developing herbarium collections. Large horticultural collections often contain the first specimens of an exotic species to occur in a region. That species may later become a naturalized member of the flora. If its history and physical characteristics have been documented with a herbarium specimen the task of tracking its spread and assessing the risk it poses to natural communities will be considerably easier.

University Of British Columbia Botanical Garden

Iain Taylor, University of British Columbia Botanical Garden

The Asian Collection is increasing as is the Alpine, but the Native Garden remains in disarray because we do not have money in place to assign a full time curator.

Our immediate initiatives are:

The appointment of a faculty member (ornamental plant breeder) who is settling in well and hopes to have his lab and programmes running as research funding becomes available. His immediate applied goal is the development of materials with potential to be introduced to horticulture through the Plant Introduction Scheme.

We are committed to a National Seedbank programme and will be seeking further funding for this. The native flora is our priority. The paper side of the Flora of BC project is based in Victoria (BC Ministry of Environment, BC Ministry of Forests, and the Royal British Columbia Museum). We hope to take a place in the live collections. We also hope to move into a programme on BC rare plants. There is also interest (but no support yet) in Asian medicinal plants. We do not plan a new garden, but do hope that we can have a virtual collection accessible through our accession database system. We can then make material available to interested researchers.

We have established teaching gardens for plant taxonomy. These are 'order' beds and are a resource for others who need live materials for teaching on campus.

Chapter 6: A Call To Action

"We need to be careful about just dreaming and come up with something that will lead to real action!--in the field, not just lists to collect dust on shelves."

- Dr. John Ambrose (Pers. Comm.)

The range of biodiversity-related activities that botanical gardens and arboreta in Canada undertake extend from endangered species recovery and support of systematics and taxonomy, to public education and the conservation of genetic resources under *ex situ* conditions. The diversity among these institutions is also great: many are functions of universities or cities, and others are charitable organizations in their own right or are expressions of private enterprise. All of them are bound together by the theme of serving as living museums for the many relationships between people and plants.

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For Further Information

For more information on the projects proposed in this action plan, or on biodiversity and conservation projects and priorities in botanical gardens in Canada, please contact:

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<http://www.rbg.ca/cbcn>

Appendix I: Reports on the Implementation of the Biodiversity Convention in Canada

Several important reports have been prepared on Canada's involvement with the Convention on Biological Diversity. Two national overviews have been produced to date. The Canadian Biodiversity Strategy sets out goals and strategic directions by which the Convention on Biological Diversity might be implemented in Canada. Caring for Canada's Biodiversity is the first national report on implementation of the CBD in Canada, and was produced as part of Canada's responsibilities under Article 6 of the Convention.

Key Reports To Date

- Canadian Biodiversity Strategy: Canada's Response to the Convention on Biological Diversity
- Caring for Canada's Biodiversity: Canada's First National Report to the Conference of the Parties to the Convention on Biological Diversity
- Caring for Canada's Biodiversity: Annex to Canada's First National Report to the Conference of the Parties to the Convention on Biological Diversity: Inventory of Initiatives

Federal Reports on Implementation of the Canadian Biodiversity Strategy

- Environment Canada has produced Conserving Wildlife Diversity: Implementing the Canadian Biodiversity Strategy as its action plan for issues surrounding wildlife.
- Environment Canada has also produced Learning About Biodiversity: A First Look at the Theory and Practice of Biodiversity Education, Awareness and Training in Canada
- Agriculture and Agri-Food Canada has produced a departmental action plan entitled Biodiversity In Agriculture and the Canadian Forest Service, a section of Natural Resources Canada, has produced an action plan entitled Biodiversity In the Forest

Other Reports on Biodiversity

- The Lincoln Papers: Presentations on behalf of Canada by the Honourable Clifford Lincoln, MP to the first three meetings of Parties to the Convention on Biological Diversity
- Public Opinion and the Environment 1999: Biodiversity Issues

- Guide to Developing a Biodiversity Strategy from a Sustainable Development Perspective

Provincial/Territorial Reports on Implementation of the CBS

Three provincial biodiversity reports have been prepared to date:

- Alberta Biodiversity Report
- Quebec (French only)
- Saskatchewan Biodiversity Report

The Clearing House Mechanism

The Clearing House Mechanism of the Convention on Biological Diversity is an emerging international mechanism for sharing biodiversity projects, priorities and data, based on the World Wide Web. Canada has taken a leading role in the development of the CHM, outlined in: [Canada's approach to developing a national node of the clearing-house mechanism](#)

Traditional knowledge, and the cultures and heritage of indigenous peoples, are important issues in biodiversity matters. Several reports are now available that review aspects of traditional and indigenous knowledge in the light of the CBD:

- Lambrou, Y. Control and access to indigenous knowledge and biological resources
- Mann, H. Indigenous peoples and the use of intellectual property rights in Canada: Case studies relating to intellectual property rights and the protection of biodiversity
- Intellectual Property Rights, Biodiversity and Indigenous knowledge: A Critical Analysis in the Canadian Context
- Traditional Aboriginal Knowledge and Science Versus Occidental Science
- Brockman, A. When All Peoples Have the Same Story, Humans will Cease to Exist: Protecting and Conserving Traditional Knowledge

The Biodiversity Convention Office of Environment Canada has facilitated the production of several reports by "Biodiversity Associates" working at or in cooperation with the office:

- Ferns
- Fresh Water Mussels
- Ocean Forests: The Diversity and Value of Kelp Forest Ecosystems

- Strategies for a Living Earth: Examples from Canadian Aboriginal Communities

Appendix II: Glossary of Biodiversity Acronyms

AABGA - American Association of Botanical Gardens and Arboreta
ABI - Association for Biodiversity Information
ANPC - Australian Network for Plant Conservation
AZA - American Zoo Association
AZH - Association of Zoo Horticulturists
BCIN - Biota of Canada Information Network
BCO-EC - Biodiversity Convention Office, Environment Canada
BCO-RBG - Botanical Conservation Office, Royal Botanical Gardens
BGCI - Botanic Gardens Conservation International
BSWG - Open-ended Ad Hoc Working Group on Biosafety
CBCN - Canadian Botanical Conservation Network
CBGCB - Canadian Botanical Gardens Consortium for Biodiversity
CBIN - Canadian Biodiversity Information Network
CBD - Convention on Biological Diversity
CBS - Canadian Biodiversity Strategy
CBSG - Conservation Breeding Specialist Group
CCIW - Canadian Centre for Inland Waters
CDC - Conservation Data Centre (or Center)
CFS - Canadian Forest Service
CGIAR - Consultative Group on International Agricultural Research
CGRFA - Commission on Genetic Resources for Food and Agriculture
CIELP - Canadian Institute for Environmental Law and Policy
CHM - Clearing House Mechanism
CITES - Convention on Trade in Endangered Species
CMN - Canadian Museum of Nature
CMS - Convention on the Conservation of Migratory Species of Wild Animals (The Bonn Convention)
CPC - Center for Plant Conservation
CPCP - Canadian Plant Conservation Program
CPG - Common Policy Guidelines
COP - Conference of the Parties
COSEWIC - Committee on the Status of Endangered Wildlife in Canada
DFID - Department For International Development (UK)
EMAN - Ecological Monitoring and Assessment Network (Environment Canada)
EMCO - Ecological Monitoring Coordinating Office (Environment Canada)
ENB - Earth Negotiations Bulletin
ENGO - Environmental Non-governmental Organization
BGA - Global Biodiversity Assessment
GBF - Global Biodiversity Forum
GBIF - Global Biodiversity Information Facility
GBS - Global Biodiversity Strategy
GEF - Global Environmental Facility
GMO - Genetically Modified Organisms

GRULAC - Group of Latin American and Caribbean Nations
 IABGC - International Agenda for Botanic Gardens in Conservation
 IBIN - Indigenous Peoples Biodiversity Information Network
 IBPGR - International Board for Plant Genetic Resources
 IDRC - International Development Research Centre
 IISD - International Institute for Sustainable Development
 IPR - Intellectual Property Rights
 IPGRI - International Plant Genetic Resources Institute
 IU - International Undertaking on Plant Genetic Resources
 IUCN - International Union for the Conservation of Nature
 ISOC - Intersessional Meeting on the Operation of the Convention
 ISIS - International Species Information System
 ITIS - Integrated Taxonomic Information System
 ITIS*CA- Canadian node of ITIS
 MAA - Material Acquisition Agreement
 MAB - Man and Biosphere Program (UNESCO)
 MSA - Material Supply Agreement
 MSB - Millennium Seed Bank
 NCC - Nature Conservancy of Canada
 NGO - Non-governmental Organization
 NHGB - Natural Heritage Gene Bank
 NHIC - Natural Heritage Information Centre (or Center)
 PGR - Plant Genetic Resources
 PGRFA - Plant Genetic Resources for Food and Agriculture
 PMTA - Plant Material Transfer Agreement
 PNPDC - Prairie and Northern Plant Diversity Centre
 RAMSAR - The Convention on Wetlands of International Importance (especially as Waterfowl Habitat)
 SARA - Species At Risk Act
 SBSTTA - Subsidiary Body on Scientific, Technical and Technological Advice
 SCBD - Secretariat of the Convention on Biological Diversity
 SGB - Seed Gene Bank
 SSC - Species Survival Commission
 SSP - Species Survival Program
 TNC - The Nature Conservancy
 UNCED - United Nations Conference on Environment and Development
 UNEP - United Nations Environmental Programme
 UNESCO - United Nations Educational, Scientific and Cultural Organization
 UNO - United Nations Organization
 VGBF - Virtual Global Biodiversity Forum
 WCMC - World Conservation Monitoring Centre
 WHC - Convention Concerning the Protection of World Cultural and Natural Heritage
 WRI - World Resources Institute

Appendix III: Canadian Botanical Gardens and Arboreta

† - indicates a botanical garden or arboretum planned or under construction but not open to the public at the time of this report.

A. Atlantic Canada

Annapolis Royal Historic Gardens

441 St. George Street
Box 278
Annapolis Royal, NS B0S 1A0
<http://www.historicgardens.com/index.html>

Fredericton Botanic Garden

Box 57
Station A
Fredericton, NB E3B 4Y2
<http://www.cybersmith.net/nbtour/database/attract/category/htm/4390.htm>

Kingsbrae Horticultural Garden Inc.

220 King Street
St. Andrews, NB E0G 2X0
Tel: 1 (506) 529-3335
Fax: 1 (506) 529-4875
email: kinghort@nbnet.nb.ca
<http://www.townsearch.com/kingsbraegarden/index.htm>

Memorial University of Newfoundland Botanical Garden

Memorial University of Newfoundland
St. Johns, NF A1C 5S7
<http://www.mun.ca/botgarden/>

New Brunswick Botanical Garden

P.O. Box 1629
Saint-Jacques, NB E7B 1A3
<http://www.cybersmith.net/nbtour/database/attract/location/htm/1662.htm>

Odell Park and Odell Arboretum

City Public Works Dept.
P.O. Box 130
Fredericton, NB E3B 4Y7
506 460-2038
<http://www.cybersmith.net/nbtour/database/attract/category/htm/2170.htm>

B. Quebec

Jardin Botanique de Montreal

4101, rue Sherbrooke Est
Montreal, QC H1X 2B2
Information : (514) 872-1400
<http://www.ville.montreal.qc.ca/jardin/jardin.htm>

Jardin pedagogique

Fac. des scie de l'Agr. & de l'alim.
Universite Laval, Cite Universitaire
Quebec, QC G1K 7P4

Le Jardin van den Hende

Universite Laval
2450 boul. Hochelaga
Saint-Foy, QC G1K 7P4
<http://www.fsa.ulaval.ca/fsaawww/vdhende.html>

Les Jardins de Metis

C. P. 242
Mont-Joli, QC G5H 3C1
http://www.versicolores.ca/jardins-du-quebec/en/html/metis_gardens.html

Morgan Arboretum

Box 500
Macdonald College
McGill University
Ste.-Anne-de-Bellevue, QC H8X 3Z9
<http://www.total.net/~arbo/>

Parc Marie-Victorin

385, Marie-Victorin, C.P. 356
Kingsey Falls, QC J0A 1B0
<http://www.ivic.qc.ca/mv/padresse.html>

Belle Terre Botanic Garden & Arboretum

Otter Lake, QC J0X 2P0

Les Quatre Vents

Quebec City, Quebec
Information: Frank H. Cabot Box 222
Cold Spring, NY (before May 1)
345 rue Fraser, La Malbaie, QC
G5A 1A2 (after May 1)
<http://www.virtuel.collegebdeb.qc.ca/bio/laurentd/j4vents/apercu.html>

C. Ontario

Niagara Parks Botanical Gardens and School of Horticulture

P.O. Box 150
2565 North Niagara Parkway
Niagara Falls, ON L2E 6T2
<http://www.niagaraparks.com/hort/botanical-idx.html>

Arboretum and Greenhouse

Department of Horticulture
Niagara College of Applied Science and Technology
360 Niagara Street
St. Catharines, ON L2M 4W1

Walker Botanic Garden

Rodman Hall Arts Centre
109 St. Paul Crescent
St. Catharines, ON L2S 1M3

Mississauga Public Garden

2038 Lorelei Road
Mississauga, ON L5A 1C2

Erindale College Arboretum

Erindale College
Mississauga Road North
Mississauga, ON L5L 1C6

Appleby College

540 Lakeshore Road West
Oakville, Ontario, L6P 3P1

J. A. Carol Arboretum

74 McCaule Street
Brampton, ON L6V 1J3

Royal Botanical Gardens

P.O. Box 399
Hamilton, ON L8N 3H8
<http://www.rbg.ca>

Toronto Zoo

P.O. Box 280
West Hill, ON M1E 4R5
<http://www.torontozoo.com>

Botany Greenhouse

Department of Botany
University of Toronto

St. George Campus
Toronto, ON M5S 1A1
<http://www.botany.utoronto.ca/facilities/greenhouse.stm>

Allan Gardens

Department of Parks & Recreation
21st Floor, East Tower
City Hall
Toronto ON

Centennial Conservatory

Parks and Recreation Department
Etobicoke Civic Centre
Etobicoke, ON M9C 2Y2

Humber Arboretum

Humber College
Box 900
Rexdale, ON M9W 5L7
<http://www.metrotor.on.ca/services/parks/parks/humar.html>

Larkwistle Garden

R.R. #1
Miller Lake, ON N0H 1Z0

Centennial Arboretum of the Barrie Horticultural Society

Barrie, ON

Brickman's Botanical Garden

R.R. #1
Sebringville, ON N0K 1X0

Lemoine Point Gardens

Kingston, ON

J. J. Neilson Arboretum

Ridgetown College of Agricultural Technology
Ridgetown, ON N0P 2C0
<http://www.ridgetownc.on.ca/jjna/welcome.htm>

Civic Gardens Complex

London, ON
Garden Club of London

Cedar Valley Botanical Gardens

Brighton, ON K0K 1H0
(613) 475-0535
<http://www.interlog.com/~cvbg/>

The Arboretum

University of Guelph
Guelph, ON N1G 2W1
<http://www.uoguelph.ca/~arboretu/>

Lord and Burnham Conservatory

Ontario Agricultural College
University of Guelph
Guelph, ON N1G 2W1

The Greenhouse

Department of Biology
University of Waterloo
Waterloo, ON N2L 3G1

University of Waterloo Botanical Garden

University of Waterloo
Waterloo, ON N2L 3G1
<http://www.dcs.uwaterloo.ca/~marj/Courses/Web/botanical.html>

Sherwood Fox Arboretum

University of Western Ontario
London, ON N6A 5B7
<http://www.uwo.ca/aboutuwo/arboretum/index.html>

Fogolar Furlan Botanic Garden

1800 E. C. Row (North Service Road)
Windsor, ON N8W 1Y3

Parks and Recreation Department

City of Windsor
2461 McDougall Street
Windsor, ON N8X 3N5
<http://www.city.windsor.on.ca/parkrec/>

Becky Hughes Arboretum

New Liskeard College of Agriculture
New Liskeard, ON P0J 1P0

Plum Grove Arboretum

R.R. #1
Kakabeka Falls, ON P0T 1W0

Laurentian University Arboretum

Department of Biology
Laurentian University
Sudbury, ON P3E 2C6
<http://www.laurentian.ca/www/biology/arboretum.html>

Canadian Forestry Service Arboretum

Botanical Society of Sault Ste. Marie
P. O. Box 490
Sault Ste. Marie, ON P6A 5M7

Lakehead University Arboretum

School of Forestry
Lakehead University
Thunder Bay, ON P7B 5E1

Centennial Conservatory

Division of Parks and Recreation
Thunder Bay, ON P7E 5V3
<http://www.tourism.thunder-bay.on.ca/conservatory.htm>

The International Friendship Garden

Parks Division
City of Thunder Bay
111 South Syndicate Avenue
Thunder Bay, ON P7E 6S4

Edna and Frank C. Miller English Garden

University of Guelph
Guelph, ON N1G 2W1

D. The Prairies and Northern Region**George Pegg Botanic Garden**

Box 82
Glenevis, AB T0E 0X0

Boreal Botanic Garden

Box 1106
High Level, AB T0H 1Z0

Golden Prairie Arboretum

Crop Diversification Centre South
Bag Service 200
Brooks, AB T0J 0J0

Olds College Arboretum

Olds College
Olds, AB T0M 1P0
<http://www.agt.net/public/townolds/coll.htm>

The Arboretum at Trochu

Trochu and District Arboretum Society
P.O. Box 340

Trochu, AB T0M 2A0
<http://www.albertasouth.com/town/ltrochu.html>

Nikka Yuko Centennial Garden

Box 751
Lethbridge, AB T1J 3Z6
<http://www.albertasouth.com/town/lleth.html>

Calgary Zoo, Botanical Garden & Prehistoric Park

P.O. Box 3036
Station B
Calgary, AB T2M 4R8
<http://www.calgaryzoo.ab.ca/>

Crop Diversification Centre North

McCalla Orchard & Arboretum
R.R. #6
Edmonton, AB T5B 4K3

Muttart Conservatory

10th Floor
C.N. Tower
Edmonton, AB T5J 0K1
<http://www.gov.edmonton.ab.ca/parkrec/muttart/>

Devonian Botanic Garden

University of Alberta
Edmonton, AB T6G 2E1
<http://www.discoveredmonton.com/devonian/dbg.html>

Indian Head Tree Nursery

P.F.R.A.
Agriculture Canada
Indian Head, Saskatchewan, S0G 2K0

Wascana Centre Authority

3475 Albert Street
Regina, SK S4S 6X6
<http://www.wascana.sk.ca/home.html>

Mendel Gallery and Conservatory Corporation

Box 569
Saskatoon, SK S7K 3L6
<http://www.mendel.saskatoon.sk.ca/>

Patterson Garden

Department of Plant Science
University of Saskatchewan
Saskatoon, SK S7N 0W0

The International Peace Garden, Inc.

P.O. Box 419
Boisevain, MB R0K 0E0
<http://www.peacegarden.com/>

Skinner's Nursery, Ltd.

P.O. Box 220
Roblin, MB R0L 1P0

Island Park Arboretum

Parks Division
97 Saskatchewan Avenue East
Portage la Prairie, MB R1N 0L8

Assiniboine Park

2355 Corydon Avenue
Winnipeg, MB R3P 0R5
<http://www.zoosociety.com/zoomain.htm>

Woody Plant Test Arboretum

Department of Plant Science
University of Manitoba
Winnipeg, MB R3T 2N2

Research Station Arboretum

Agriculture Canada Research Station
Unit 100-101
Route 100
Morden, MB R6M 1Y5

Living Prairie Museum

Winnipeg, MB
30 acre preserve of true/tallgrass prairie
<http://www.mbnet.mb.ca/city/parks/envserv/interp/living.html>

E. British Columbia

Hatley Park Public Gardens

Royal Roads University
2005 Sookie Road
Victoria, BC V9B 5Y2
Tel: 250-391-2511
Fax: 250-391-2500
<http://www.royalroads.ca/fg/garden/>

David Douglas Botanical Garden Society†

P.O. Box 1305
Prince George, BC V2M 2S3

Minter Gardens

Box 40
Chilliwack, BC V2P 6H7
<http://www.minter.org/index.htm>

S.F.U. Arboretum

Department of Biological Sciences
Simon Fraser University
Burnaby, BC V5A 1S6

Queen Elizabeth & Bloedel Conservatory

2099 Beach Avenue
Vancouver, BC V6G 1Z4
Tel: 604-872-5513

VanDusen Botanical Garden

5251 Oak Street
Vancouver, BC, V6M 4H1
<http://www.hedgerows.com/VanDusen/>

University of British Columbia Botanical Garden

6501 NW Marine Drive
Vancouver, BC, V6T 1W5
<http://www.hedgerows.com/UBCBotGdn/>

Dr. Sun Yat-Sen Classical Chinese Garden

578 Carrall Street
Vancouver, BC
Tel: 604-652-4422

Fantasy Garden World

10800 No. 5 Road
Richmond, BC V7A 4E5

The Park & Tilford Garden

Park & Tilford Centre
440 - 333 Brookbank Avenue
North Vancouver, BC V7J 3S8
http://www.northshore-online.com/park_tilford/index.htm

Native Plant Garden

Royal British Columbia Museum
675 Belleville Street
Victoria, BC V8V 1X4

Douglas Fir Arboretum

c/o Research Division
B.C. Forest Service
Victoria, BC V8V 1X5

Horticulture Centre of the Pacific

505 Quayle Road
Victoria, BC V8X 3X1
<http://www.islandnet.com/~hcp/>

Butchart Gardens

P.O. Box 4010
Station A
Victoria, BC V8X 3X4
<http://vfv.com/butchart/>

Riverview (collection of large undisturbed native tree species)

c/o Riverview Horticultural Centre Society
PO Box 31105
Port Moody, BC V3H 4T4
Tel: 290-9910

Appendix IV. Draft Codes of Conduct to Guide Ethical Conservation Activities for Botanical Gardens and Arboreta

These draft codes of conduct have been compiled in 2000 by Dr Sarah Reichard, Ecosystem Science Division and Center for Urban Horticulture, University of Washington, and are included here by permission of the author. These guidelines are still under development by various bodies around the world. Initial organization for the development of these guidelines included work by Dr Reichard, Peter White, Dr Peter Raven, Director, Missouri Botanic Garden and Dr Peter Crane, Director of Royal Botanic Gardens, Kew, in the UK.

Although not all seed gene banks are operated by botanical gardens or arboreta, these codes of conduct apply equally well to conservation projects of any kind.

Overarching/Guiding Principles

“Do no harm to plant diversity and safeguard diversity in wildlands”

1. Gardens should adopt governing values that reflect this philosophy and translate these values into both written policies and wisely chosen activities. These policies and activities should be interpreted to the public within the context of appropriate conservation practices and local/regional conservation needs and priorities. This interpretation should include illuminating coverage of both activities undertaken and activities avoided. The risk of any activities that may impact the environment should be considered.
2. Gardens should work to implement the letter and spirit of the Convention for Biological Diversity (CBD), implementing its objectives with regard to the conservation of biological diversity. This includes integrating conservation efforts with those undertaken by other qualified entities, allowing appropriate access to collections, providing expertise for conservation purposes, sharing benefits derived from the use of biological diversity and respecting intellectual property rights.
3. Gardens should perform an environmental and conservation self-assessment as a part of their annual report. They should compare their performance with the principles laid out in these guidelines.

Draft Ethics Statements for Horticultural Use With Respect To Native Species

1. Whenever possible, assist in education efforts about the value of native plants and environmentally sensitive gardening. This includes the general public, the commercial plant trade, hobbyist collectors, and government agencies.

2. Collect responsibly:

Take minimal seed or cuttings and coordinate efforts with other institutions so double collections are not made. Document every source collection well, using herbarium specimens when possible. Always obtain appropriate permissions and permits for plant collecting from the wild.

3. Develop a clear institutional policy on when and under what circumstances to undertake activities designed to receive or collect plants taken or rescued from the wild.

Do not dig plants except where construction is truly imminent, not just planned. There should be guidelines about when to do it at the request of the developer to “clear the way,” or even as mitigation. There should be coordination with governmental agencies. Do not purchase material dug from the wild. Make “rescued plants” available to the public only if they are abundant species. Rescued plants should be available mostly to responsible agencies involved with the protection and preservation of native plant communities.

4. Do not draw or alert the public to sensitive sites where damage can occur from undertrained volunteers, ecotourism and gardener collection, unless harm to the site is imminent and public involvement would increase protection. Draw attention to sites only when the security of that population can be reasonably ensured.
5. For rarer species, begin propagation for cultivation only when genetic materials for conservation/restoration are already secure in conservation collections such as seed banks.
6. Make appropriate propagated material available through botanical garden programs and to nursery growers to help reduce pressure for wild collection. When possible, research propagation methods for desirable species while at the same time following and respecting any legal or other regulations or agreements governing the use of plant material.
7. Understand and interpret to the public why moving a plant from the wild to the flower bed is NOT necessarily saving plant diversity. Treat every restoration and reintroduction as an experiment.
8. Follow the best available standards or nationally/internationally agreed guidelines for restoration. Understand and interpret to the public why moving a plant from cultivation to “naturalized areas” or the wild is NOT necessarily restoration.

9. Provide research, technical and outreach support to determine if concerns raised about the impacts of gardening on nearby natural communities are justifiable.

Draft Ethics Statements for *Ex Situ* Cultivation

1. Try to work within established networks or create new networks to ensure that *ex situ* activities are generally accepted and of high priority in the local, regional, or national conservation community. *Ex situ* should be a collaborative process.
 - A. Identify appropriate local, national, or regional networks with which to work in *ex situ* conservation.
 - B. Be inclusive – work with the widest possible range of networks and bodies involved with complementary issues and disciplines relevant to support *ex situ* conservation.
 - C. Make links with academic and other conservation communities via adjunct appointments, conferences, etc.
2. Use sound current scientific principles and practices in management and experimentation for design and implementation of *ex situ* plant conservation programs.
 - A. Develop or use established guidelines for specific issues required for the implementation of effective *ex situ* conservation programs such as genetic sampling procedures and recovery planning.
 - B. Consider how to deal with aging collections – evaluate their conservation value (e.g., is it still genetically representative or genetically unique?). Can they be used for other purposes such as research or education? Should they be de-accessioned? The conservation value of the collection should be documented.
 - C. Botanic gardens should document their conservation collections according to the highest possible available standards and following relevant national and international guidelines. They should be open to peer review and scrutiny.
3. Engage in activities that further, through research, information or germplasm conservation, the conservation of species in their wild habitats or provide significant options for future conservation activities. The first priority should be the conservation of the species
4. Ensure that all collection activities of an institution (e.g. for conservation, horticulture, education, and so on) are done according to current local, national, and international legislation and permitting systems and conforms to CBD and other binding international conventions.
5. *Ex situ* should not lead to the loss of species or habitats, their diversity, or result in numerical diminution of the species or reduction in habitat.

Draft Ethics Statements for Harmful Invasive Non-Native and Native Invasive Species

1. Perform risk assessment for all introductions, to help ensure that new harmful species do not escape cultivation. This may be done prior to introduction, using established risk assessment methods, or may be done through extensive monitoring on the garden site. Do not distribute plants, seeds, or cuttings until the invasive ability of the particular taxon is understood.
2. Remove invasive species from plant collections when they are determined to present a risk of becoming invasive.
3. Seek to control invasive species in natural areas managed by the garden and assist others in controlling them on their property, when possible.
4. Do not grow known harmful invaders in the garden. When they are removed, try to include interpretation about the reason for their removal.
5. Develop non-invasive alternative plant material through plant selection and breeding.
6. Do not distribute plants and seeds if you suspect they are or could potentially become invasive elsewhere.
7. Do not include seeds of known invasive species in your *Index Seminum* listings and note potentially invasive species on the list
8. Educate the public about the prevention of the introduction and spread of invasive species. Work with the local nursery and seed industries to assist the public in environmentally safe gardening and sales. Horticulture education programs, such as those at universities, should also be included in education and outreach efforts.
9. Participate in developing, implementing, or support national, regional, or local early warning systems so that harmful invasive species are reported and controlled immediately.
10. Become partners with other conservation organizations in the management of harmful invasive species.
11. Assess what popular non-native horticultural plants commonly in use may present a threat to wild congeners. Assess the possibility of hybridization in threatening wild stocks and the diversity of such species.
12. Follow all laws on importation and quarantine of plant materials across political boundaries.

Appendix V: Biodiversity Processes: Conventions, Plans and Policies

Conventions, Strategies and Action Plans

The ranges of action necessary to conserve biological diversity on a global scale is reflected by the complexity and scope of international conventions, strategies and plans that have emerged in the past decade. The cornerstone of biodiversity planning is the Convention on Biological Diversity, a treaty sponsored by the United Nations that was opened for signature (i.e., ready to be adopted by individual nations) in 1992. The Convention on Biological Diversity (detailed below) came into effect in late 1993, and since then has touched off many biodiversity planning efforts around the world.

Although much has happened since 1992, it would be a mistake to consider this date as the beginning of serious international attention to biodiversity loss and our capacities to conserve and use biological diversity sustainably. Particularly significant were the 1980 IUCN World Conservation Strategy, which set in motion several subsequent initiatives, such as the first of a series of International Botanic Gardens Conservation Congresses held in 1985, and the publication of the Botanic Gardens Conservation Strategy four years later.

As a framework convention, the Convention on Biological Diversity seeks to address the daunting scale of the global extinction crisis, and also to recognize that human development and welfare is dependent on biological diversity. It aims to achieve this by setting in motion a series of logical steps that integrate biodiversity planning at the global level with activities in single countries, and emphasizes the need for policies, laws and activities at the national level. At the international level, the Convention provides a legal framework that requires Parties to the Convention to review their own laws and policies on the conservation and sustainable use of biological diversity, and to ensure that these laws and policies prevent the loss of biological diversity. The means by which individual countries achieve the goals of the biodiversity convention are almost wholly up to the countries themselves. Article Six of the Convention, entitled "General measures for conservation and sustainable use," requires Parties to the Convention to conduct that review and to create strategic plans that indicate how the Party will achieve the Convention's goals.

In turn, strategic plans provide broad national targets related to conservation and sustainable use. To be practicable, the aspirations of strategic plans must be further broken down into discrete actions that can be achieved at the working level. In Canada, these action plans have been developed by individual departments within the federal government. Thus, in order to make good the commitments of governments in ratifying the Convention on Biological Diversity, it ultimately falls to individual departments to carry out actions.

Biodiversity planning and actions are not solely the responsibility of government. In order to achieve the the goals of the Convention, all sectors of society must understand the necessity of conserving biological diversity and using its components in a sustainable manner, and undertake

actions in support of those goals. Actions by sectors of society different from government cannot be expected to be the same as those actions taken by individual government departments, but in many cases are in direct support of government initiatives.

The objective of this section of the Biodiversity Action Plan is to review the Convention on Biological Diversity and Canada's strategic response to the Convention, entitled the Canadian Biodiversity Strategy, and examine how botanical gardens support the aspirations of these two important documents.

The Convention on Biological Diversity

The 1992 Convention on Biological Diversity is a complex international treaty, both because of the number of issues it addresses and the manner in which it addresses those issues. Four key points should be kept in mind about the CBD.

First, unlike many international agreements, the CBD presents several interlocking objectives. In addition to the widely-recognized objective of conservation of biological diversity, the CBD also has as objectives the sustainable use of biological diversity and the equitable sharing of benefits from the use of genetic resources, within a framework intended to facilitate access to those resources. Each of these objectives encompasses the activities of human societies and economies and our scientific, aesthetic, utilitarian and even spiritual interactions with other species. These objectives are as much instruments of social change as they are of wildlife conservation.

Secondly, the CBD is a detailed list of goals and objectives, including mechanisms to move towards those goals, but it is not a prescription or mechanism for immediate regulatory action. It is therefore quite different from other, more familiar international treaties such as CITES, the Convention on International Trade in Endangered Species.

Thirdly, it seeks to achieve multilateral agreements on complex issues of biological conservation, human rights, sustainable and economic development. The CBD is complex in part because it is an agreement among the parties to it, and these are nations or groups of nations. As the Convention recognizes national sovereignty over issues such as natural resources, it must be remarkably flexible in the approach it takes to achieving its objectives.

Fourthly, the Convention on Biological Diversity is dependent both on government action and widespread participation by non-governmental parties to achieve its objectives. Government action alone cannot solve the fundamental social and economic challenges that arise because of humanity's simultaneous dependence upon and degradation of natural biological diversity.

The Convention on Biological Diversity was several years in the writing, and was opened for signature at the 1992 Earth Summit in Rio de Janeiro, Brazil. It formally came into force in December, 1993. Despite the formidable challenges listed above, the CBD has now been ratified by over 177 parties.

Structure and Function of the Convention

Since 1993, the function of the CBD has been developed through regular meetings of the Conference of the Parties (COP) and the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA), which meets between COPs to develop expert advice for the Parties to the Convention.

The complete text of the Convention includes 42 articles, plus a lengthy preamble and appendices. About ten or eleven articles are of direct relevance to botanic gardens and arboreta, either because the activities of botanic gardens (such as conservation of endangered species, plant taxonomy, education, supporting research, activities in economic botany, etc.) are relevant to the goals of the CBD, or because the national and international consequences of the Convention may entail changes to botanic gardens' legal, scientific and educational environments and roles.

The numerous contributions of botanic gardens to the process of implementing the Convention on Biological Diversity were summarized for the third Convention of the Parties, which met in 1996 in Buenos Aires (Royal Botanic Gardens, Kew and Botanic Gardens Conservation International, 1996)

Article 1. Objectives

The Preamble and Article 1 of the Convention set the tone and define its objectives. The CBD has three primary objectives:

1. the conservation of biological diversity, defined as natural diversity at the genetic, species and ecological levels,
2. the sustainable use of the components of biological diversity, and
3. the fair and equitable sharing of the benefits arising from the use of genetic resources

These three are frequently described as being the complete list of objectives of the Convention on Biological Diversity. It should also be noted that "Article 1. Objectives" of the Convention recognizes that appropriate access to genetic resources, appropriate transfer of relevant technologies, and appropriate funding, are important elements toward achieving the goals.

Article 6. General Measures for Conservation and Sustainable Use

Parties to the Convention are required to make sure that they develop national strategic plans to deal with the challenges of the Convention. Article 6 sets out this requirement, but also recognizes that many national strategies and policies already deal with elements of the Convention. Article 6 also indicates that the objectives of the conservation and sustainable use of biological diversity should be integrated into policies and programs across sectors.

Botanic gardens are involved in these activities in many countries through integration into national programs of conservation and the conservation of natural resources.

Article 7. Identification and Monitoring

Botanic gardens have traditionally been centres of research on the identification of components of biological diversity, particularly through plant taxonomy research. Article 7 specifies that

participating nations should identify and monitor the "components of biological diversity" and identify factors that might have significant negative effects.

Botanic gardens contribute to many elements of both identification and monitoring, and have made the results of these activities available through monographs, flora, checklists and other products. More recently, botanic gardens have been involved in the production of geographic information systems and electronic biodiversity inventories.

Article 7 also makes reference to Annex I, the "indicative list" of categories of significant elements of biological diversity which should be identified and monitored. While it is broadly taken that the Convention recognizes three levels of biological diversity (ecological, species and genetic levels) as being important, Annex I to the Convention provides a little more detail. Annex I specifies that the following are important for identification and monitoring:

A1. Ecosystems and habitats: containing high diversity, large numbers of endemic or threatened species, or wilderness; required by migratory species; of social, economic, cultural or scientific importance; or, which are representative, unique or associated with key evolutionary or other biological processes;

A2. Species and communities which are: threatened; wild relatives of domesticated or cultivated species; of medicinal, agricultural or other economic value; or social, scientific or cultural importance; or importance for research into the conservation and sustainable use of biological diversity, such as indicator species; and

A3. Described genomes and genes of social, scientific or economic importance." (Glowka et al., 1994)

Thus, the CBD places restrictions on which elements of the natural world are considered to be of importance to its process, placing emphasis on those things which are either unique or are of utilitarian value.

Article 8. *In-situ* Conservation

In situ conservation is the conservation of the elements of biological diversity - species, genetic diversity or ecosystems - in their natural habitats. Many botanic gardens are involved in the conservation of protected areas, either on their own sites or in collaboration with government and non-governmental agencies involved in protecting sensitive ecological areas. Article 8 also calls for the recovery of endangered species and degraded ecosystems, of which many botanic institutions and networks, such as the Center for Plant Conservation in the United States, have been taking an important part for many years.

Many botanic gardens are also involved directly in the protection and maintenance of nature sanctuaries and other protected areas. In some cases, botanic gardens supply native plants for rehabilitation of *in situ* habitats.

Article 8 also addresses the issue of invasive alien species, through prevention of new introductions and control or eradication of those species which threaten ecosystems, habitats or

other species. Controlling the process of new introductions, and especially assessing the risk of a new introduction to become invasive, should be a priority for all botanical gardens.

Article 9. *Ex-situ* Conservation

Institutions maintaining *ex-situ* collections of the components of biological diversity, including botanical gardens, are recognized by Article 9 of the Convention on Biological Diversity on genetic resources as being of value in the conservation of biological diversity, especially in roles they can play in integrated conservation efforts. The Convention encourages the establishment and maintenance of *ex-situ* collections, but also places emphasis on developing collections within the country-of-origin of the resources.

Botanic gardens have long been active in *ex-situ* conservation, through seed gene banks and living plant gene banks, the conservation of threatened species, and in species recovery programs.

Article 9 also requires that the collection of biological resources "from natural habitats for *ex-situ* conservation purposes" does not threaten ecosystems or the survival of in-situ populations. (Glowka et al., 1994).

Although botanic gardens are not mentioned explicitly in Article 9, I have encountered individuals who maintain that this is the only article relevant to botanic gardens. It should be obvious that botanic gardens participate in many more activities related to the Convention than the maintenance of *ex-situ* collections alone.

Article 10. Sustainable Use of the Components of Biological Diversity

Article 10 seeks to integrate the principles of sustainable into decision making at all levels, and to ensure that customary uses of biological resources are protected and encouraged. Botanic gardens have traditionally been strong proponents of economic botany and ethnobotany in all their forms, and have supported the identification and development of economically-important species. Some institutions are involved in sustainable biological prospecting, and the development of horticulture and horticultural training.

Article 12. Research and Training

Central to the objective of conservation and sustainable use of biological diversity is both research and training, especially important in the developing nations which hold the bulk of the world's biological diversity. Article 12 emphasizes the need to enhance research and training capacities. Botanic gardens have traditionally been deeply involved in both biodiversity research and in training taxonomists and other biodiversity specialists, both in developed countries and in developing countries. Other relevant activities of botanic gardens in research and training relative to biological diversity include evolutionary studies, population and conservation genetics, ecology, biogeography, conservation techniques, plant anatomy and the social and economic aspects of plant use.

Article 13. Public Education and Awareness

One of the strongest roles of botanic gardens relevant to the CBD is in raising public awareness and in delivering programs about plants, natural landscapes and their ecological functions. Through interpretive signs and displays, educational literature, school programs and even traveling exhibits, botanic gardens have educational contact annually with millions of people around the world.

Article 14. Impact Assessment and Minimizing Adverse Impacts

Article 14 enjoins parties to the CBD to apply impact assessment to development projects. Botanic gardens have been important participants in assessing the impacts of development projects, especially through floristic inventories of natural areas.

Article 15. Access to Genetic Resources

Article 15 consists of 7 paragraphs which outline the rights and obligations of Parties to the Convention regarding access to genetic resources and related issues. This article is of great importance to institutions maintaining collections of plants, because it sets out the basic conditions under which genetic resources (defined by the CBD as biological materials containing functional units of heredity which are of actual or potential value) are to be made available for sustainable use. It also requires that Parties to the Convention arrange for "fair and appropriate sharing of benefits arising from the use of genetic resources."

Beyond a general definition, the Convention does not provide detailed definitions of genetic resources. In general, Article 15 is aimed at research for commercial development of plant products or products derived from plant genes. The wording of the Convention and emerging national assess policies place freedom of exchange of plant specimens for non-commercial research in jeopardy if not addressed. Many nations have imposed or are planning to impose restrictions on the movement of biological specimens if there is the potential for their use as a source of genetic material. Under some circumstances, for example, it is possible that herbarium specimens and related scientific materials can be considered genetic resources if DNA can be retrieved from them.

The CBD requires that nations owning genetic resources make those resources available to others for research and commercial use, under conditions which include mutually agreeable terms (MAT) and prior informed consent (PIC).

Globally, about 50% of all known species of vascular plants are in botanical garden collections and were collected prior to the CBD. These plant specimens and their descendants are therefore outside of CBD provisions linking economic use of genetic resources with their country-of-origin. This has lead to some exploration of gardens' collections by pharmaceutical companies, and vocal concern by critics that gardens are seeking to side-step the CBD for financial gain.

Prior to the 1992 Rio Earth Summit, the drafters of the CBD passed a resolution in Nairobi calling upon the FAO's Global System for the Conservation and Utilization of Plant Genetic Resources to seek solutions to questions of access to pre-existing ex-situ collections of genetic resources. As of the date writing (late 1998) the FAO has yet to release its answers to this

question. It should be noted, however, that the FAO process is intended to address the problems posed by collections made prior to the CBD coming into force of those plants which are of agricultural and food significance.

Of all the aspects of the CBD, perhaps the concept of sharing benefits from the use of genetic resources with the country-of-origin of those resources presents the most difficulties. Article 15 enjoins Parties to the Convention to adopt policies and practices aimed at:

"sharing in a fair and equitable way the results of research and development and the benefits arising from the commercial and other utilization of genetic resources with the Contracting Party providing such resources. Such sharing shall be upon mutually agreed terms."

The activities of botanic gardens are among the strongest traditional activities that constitute benefits from the use of genetic resources. Many gardens have strong traditions of cooperating with similar institutions in developing countries, carrying out joint research and sharing plant material itself.

Article 17. Exchange of Information

The Convention directs its Contracting Parties to facilitate the exchange of information on the conservation and sustainable use of biological diversity through Article 17. The need to support this exchange has resulted in the development of the Clearing House Mechanism of the CBD. Botanic gardens have long contributed to information exchange, as sharing of research results, providing access to libraries and data bases, helping to standardize information exchange through the International Transfer Format for Botanic Gardens Records, and in services such as taxonomy.

Article 18. Technical and Scientific Cooperation

International cooperation in science and technology related to the conservation and sustainable use of biological diversity is promoted through Article 18. As is the case for information exchange, botanic gardens maintain programs of staff exchange between gardens, herbaria and laboratories, and often develop joint research programs that directly support cooperative research and the transfer of technical and scientific information.

CBD Mechanisms and Working Bodies

As a framework convention, the CBD calls for the creation of several agencies by which its various functions will be achieved. The basic working group on the Convention on Biological Diversity is the Conference of the Parties or COP. The Conference of the Parties is a meeting of all of the bodies that are Parties to the Convention and takes place approximately every two years. At each of the COP meetings, a carefully orchestrated program of work is opened for her development and discussion. Individual parties to the convention participate in these meetings as voting members.

The conference of the parties years a political decision-making body, and cannot hope to deal with all of the technical issues raised by the convention on biological diversity. In order to provide scientific and technical advice to the conference of the parties, the convention on biological diversity also created the subsidiary body on scientific technological and technical advice or SBSTTA. This subsidiary body also holds regular meetings and develops information about issues that are then passed along to COP meetings.

The convention on biological diversity also recognizes explicitly that funding is needed for her a variety of programs in order to achieve the goals of the convention. Funding is especially important in developing countries, many of which are rich in biological diversity but have relatively poor economic and physical infrastructure. In order to aid the developing countries in achieving the goals of the convention the global environmental facility or GEF was created as a funding source. Developed-nation Parties to the Convention provide funding for the GEF, through a funding schedule established by the convention itself.

As important as providing funding is exchanging information on biodiversity freely and efficiently. The convention on biological diversity called for the development of a clearing house mechanism, or CHM, in order to facilitate the exchange of information developments related directly to the convention, its subsidiary body is, working groups, and even regional and national priorities and projects. When the convention on biological diversity was opened for signature in 1992, the World Wide Web was only three years old. Since 1992, the worldwide web has exploded in information content and connectivity around the world, and the Clearing House Mechanism has built on this development. At present the CHM is largely based on the worldwide web, and consists of extensive documentation on the convention itself, as well as national and thematic bodies of information.

The Canadian Biodiversity Strategy

Introduction

Many nations have now prepared their initial responses to the Convention on Biological Diversity, and have acted on Article 6, which requires Contracting Parties to produce "strategies, plans or programmes" to reflect the measures set out by the convention, or modify existing policies or plans to the same effect. Canada has enjoyed a prominent position among nations in the development and implementation of the Convention, and has produced its own response to the CBD.

The initial response of the Canadian government to the Convention on Biological Diversity was a multi-sector stakeholder consultation process, through a series of Focus Groups that met in 1994. Each focus group considered the implications of the Convention for a different sector of society, and drafted extensive recommendations as to what should be done in Canada to achieve the objectives of the Convention. These recommendations were then reviewed and edited by an office within the Ministry of the Environment, specifically created to administer Canada's CBD commitments. The recommendations were among the material that was compiled as the Canadian Biodiversity Strategy: Canada's Response to the Convention on Biological Diversity.

Canadian botanic gardens played a role in the development of the Canadian Biodiversity Strategy through participation by individuals in the *Ex-Situ* Focus Group. The recommendations of the *Ex-Situ* Focus Group included important items through which botanical gardens could increase their participation in fulfilling the commitments of the CBD. One practical consequence of these recommendations was the creation of the Canadian Botanical Conservation Network, in part to aid the botanical gardens and arboreta of Canada with their participation in the CBD process.

The Canadian Biodiversity Strategy (CBS) was released in 1995. It incorporated several of the suggestions of the Ex-situ Focus Group, but many more were not used in the final draft. The final form of the Canadian Biodiversity Strategy begins with "A vision for Canada" of -

"A society that lives and develops as a part of nature, values the diversity of life, takes no more than can be replenished and leaves to future generations a nurturing and dynamic world, rich in its biodiversity."

The CBS presents all sectors of Canadian society with five goals by which to achieve the objectives of the Convention:

1. to conserve biodiversity and use resources in sustainable manner
2. to improve understanding of ecosystems and increase resource management capability
3. to promote conservation and sustainable use
4. to apply incentives and legislation to achieve conservation
5. to cooperate with global partners in conservation and the sharing of benefits from genetic resources

Each of these goals was then iterated in detail through numerous "Strategic Directions." In total the Strategy includes more than 190 Strategic Directions. Many Strategic Directions of the CBS are of direct relevance to the botanic gardens and arboreta community in Canada.

Although it takes its objectives from Article 6 of the CBD, The Canadian Biodiversity Strategy has a somewhat different balance in its approach to the three principal goals of the Convention. The Strategic Directions of the CBS place a much stronger focus on sustainable use of biological resources than does the Convention on Biological Diversity, and relatively little weight on the issues of access to genetic resources and the sharing of benefits from their use, the so-called "Article 15" issues.

Canada is still evolving its response to the Convention. In 1996, all ten Provincial and two Territorial governments signed a general statement with the Federal Government acknowledging that they are committed to the principles of biodiversity conservation and sustainable use of biological resources, and that they will be guided by the Canadian Biodiversity Strategy in those efforts.

The History and Scope of the CBS

The Canadian biodiversity strategy was produced as Canada's response to Article 6 of the convention on biological diversity. Article 6 calls for parties to the convention to produce national strategies and policies regarding biological diversity.

Following Canada's ratification of the convention on biological diversity in 1993, and the convention coming into force the federal government of Canada undertook a period of consultation with a wide cross section of stakeholders interested in biodiversity and sustainable development. The consultations took place in the form of focus groups that met in 1994 to assemble suggestions to the federal government ways in which Canadian society could respond to the convention on biological diversity and its challenging objectives. Following the focus group consultations, environment Canada worked with the recommendations of the group's to prepare the Canadian biodiversity strategy itself. The strategy was published in 1995, and calls for all sectors of society to respond to its five broad goals and over 190 specific strategic directions.

Strategic Goals of Relevance to Botanical Gardens

Each of the five strategic goals of the Canadian Biodiversity Strategy have relevance to the botanical gardens of Canada. Goal One is to conserve and use biological diversity in a sustainable manner. In order to conserve biological diversity, it is first necessary to document and understand the distribution of biological diversity. Canada's botanical gardens have been involved since their inception in the documentation of the natural and horticultural plant worlds. Many strategic directions classified under Goal One of the Canadian Biodiversity Strategy have strong resonance for individual botanical gardens.

Goal One: Conservation and Sustainable Use

Many of the strategic directions under Goals One are aimed at the preservation of biological diversity *in situ*. While botanical gardens are usually recognized for their *ex situ* conservation activities, they are frequently direct participants in *in situ* efforts aimed at both individual species and the conservation of ecological systems. Botanical gardens are involved in projects to recover individual endangered species, and restore habitats. Institutions such as the University of British Columbia Botanical Garden, University of Alberta Devonian Botanic Garden, Royal Botanical Gardens, and Memorial University of Newfoundland Botanical Garden have nature sanctuaries or wild areas which are conserved through the stewardship attitudes of the institutions. These institutions are also often involved in the conservation of biological diversity off-site. The Prairie and Northern Plant Diversity Centre of University of Alberta's Devonian Botanic Garden conducts courses on plant diversity involving sustainable forest network of the Natural Research Council of Canada.

Some of the strategic directions under Goal One address the activities of botanical gardens directly. Strategic Goal 1.11 for example, to "foster the participation of non-government *ex situ*

conservation experts and institutions in *in situ* conservation efforts, and improve the participation of government agencies in non-government *ex situ* conservation efforts," speaks directly to the need for a greater role in the support of botanical gardens and related institutions, and their key role as partners in *in situ* conservation. Unfortunately, botanical gardens and arboreta are not strongly supported by government at present.

Strategic Goal 1.50, is to "maintain or develop *in situ* and *ex situ* conservation mechanisms to support the conservation and sustainable use of biological resources essential to agriculture by: a) determining and acting upon regional, provincial, territorial, national and international priorities for the conservation of biological resources, research and training, and the establishment of facilities; and b) continuing to support federal existing federal, provincial, territorial, regional and international *ex situ* institutions." Botanical gardens in Canada have a relatively light involvement in agriculture. Although botanical gardens in some countries are principal research centers for agriculture and development of new crops, in Canada, botanical gardens have largely been associated with the developmental of ornamental plants and horticulture. Nevertheless, some botanical gardens are involved in species of agricultural importance, and have collaborations with facilities more directly involved in agriculture and agrifood.

Addressing the impacts of harmful exotic species on natural biological diversity and the human landscape is an important role for botanical gardens. Frequently associated with the introduction of the new plant species for ornamental horticulture, botanical gardens have been responsible for several introductions that have become significant pest problems, or emerged as invasive exotic species damaging to natural landscapes. The most notorious example of invasive plants that have had a botanical garden association in Canada is the introduction of purple loosestrife (*Lythrum salicaria*). This terrestrial plant, dispersed by water, is thought to have entered North America initially as seed in ballast stones in the holds of ships. By the 1860s, purple loosestrife was established in some port areas along the east coast of North America. Possessing attractive purple flowers, purple loosestrife has been bred as ornamental varieties and promoted as ornamental plants. Because purple loosestrife does not spread around terrestrial plantings, it was long assumed that it did not pose any kind of invasive threat. However, because the seeds of purple loosestrife are minute and can be distributed long distances in rivers and streams, natural areas downstream of urban areas are frequently cloaked in purple.

Botanical gardens continue to be actively involved in the process of exploring novel plants for introduction into ornamental horticulture. Awareness and research on the issue of the potential for invasive this of new plant species is emerging as a key theme for botanical gardens in the 21st century.

It is very difficult, or impossible, to control an invasive alien species once it has entered a new habitat. The rate of success of so-called biological control is relatively low, and in some notorious cases, biological control efforts have end up causing as more damage as the species they were directed at controlling. It is by far more effective to prevent the introduction of potentially invasive alien species than to attempts to correct the situation after the fact. Trials for the introduction of new species into horticulture now routinely include assessment of the potential of the species for invasiveness.

Goal Two: Understanding and Managing Ecosystems and Resources

The second strategic goal of the Canadian Biodiversity Strategy is to "improve our understanding of ecosystems and increase our resource management capability." Many botanical gardens, especially the larger institutions involved and ecological and management, are active participants in their local and regional ecological planning processes. For example, Royal Botanical Gardens in Hamilton, Ontario, is a key player in the Remedial Action Program for Hamilton Harbour, and is owner of Cootes Paradise, a Great Lakes class 1 wetland. Botanical gardens support several strategic directions under Goal Two. This includes Strategic Direction 2.2, "focus research to increase our understanding of ecosystems and our ability to manage human use of ecosystems and resources by... b) developing cost-effective biodiversity inventory and monitoring methods and programs, including rapid assessment procedures and biodiversity indicators, to detect and monitor changes to ecosystems, species, and genetic diversity... d) improving *in situ* and *ex situ* conservation methods, especially to enhance the recovery of populations, species or ecosystems that are at risk."

Goal Three: Education and Awareness

Botanical gardens and arboreta have a critical role to play in achieving Goal Three: education and awareness. Goal Three, "to promote an understanding of the need to conserve biodiversity and use biological resources in a sustainable manner," requires that people come into direct contact with the world of plant diversity. Botanical gardens are centres centers for research and education in to natural plant and ecosystem diversity, a role that is not widely appreciated. In fact, Strategic Direction 3.1 c) expressly recognizes the role of botanical gardens and arboreta in "increasing biodiversity conservation and the sustainable use of biological resources messages by building on existing interpretive programs in national and provincial parks and other protected areas, and at libraries, museums, zoos, aquariums, botanical gardens, businesses, conservation groups and other organizations," and d) "strengthening coordination among educational institutions, government departments, museums, zoos, aquariums, botanical gardens, businesses, conservation groups and other organizations. "

Goal Four: Legislation and Incentives

Goal Four, "to maintain or develop incentives and legislation that support the conservation of biodiversity and the sustainable uses of biological resources" is largely a function of government in developing both legislation and incentives in the form of funding, tax breaks, and other measures that support the conservation of biological diversity. Individual sectors of society can be effective communicators and partners with federal and provincial governments in achieving this goal. This role should not be underestimated however, because government cannot achieve its goals in the area of biological conservation and biodiversity without the engagement and mutual support of a wide range of partners. Botanical gardens have demonstrated over and over that they are cost effective partners in the delivery of biodiversity education and services.

Goal Five: International Cooperation

Goal Five, to aid international cooperation, "to work with other countries to conserve biodiversity, use biological resources in a sustainable manner and share equitably the benefits that arise from utilization of genetic resources" is a reiteration of the primary objectives of the Convention on Biological Diversity itself. The thrust of Goal Five is to reinforce the importance of cooperating with other countries in the delivery of the three main objectives of the convention. Strategic Direction 5.5 for example, to "encourage the participation of stakeholders, including non-government organizations, the private sector, and indigenous communities, and international efforts to implement the Convention" is strongly supported by the participation of institutions like Royal Botanical Gardens in efforts to implement the Convention and its goals within the international botanical garden sector. Because the botanical garden sector is recognized globally as a key player in the conservation of plant diversity, and as plant diversity is fundamental to biological diversity, the role of botanical gardens in the delivery of this strategic goal must not be underestimated.

Action Plans of Canadian Government Bodies

Canadian government bodies have had two primary forms of response to the Convention on Biological Diversity and the Canadian Biodiversity Strategy. The federal government department charged with the implementation of the Canadian Biodiversity Strategy in Environment Canada, specifically through the Biodiversity Convention Office. The Biodiversity Convention Office is a unit within the Canadian Wildlife Service, and has been actively encouraging the development of programs that fulfill the goals of the Convention and the Strategy. The key role of the Biodiversity Convention Office is the facilitation of biodiversity action plans by individual federal government departments. Because of the scale biodiversity as an issue, and the complexity of documents like the Canadian Biodiversity Strategy, which presents nearly 200 different strategic directions, it is impossible to simply adopt these documents as working plans. In fact, the Convention on Biological Diversity itself is a framework convention, and most of it cannot be directly implemented by individual Parties. Only specific sections of the Convention, such as Articles Six on the development of national strategies and policies, can be achieved by individual countries operating on their own. Most of the Convention on Biological Diversity is being developed over time through Protocols and other actions of the Conference of the Parties. In the case of the Canadian Biodiversity Strategy, individual government departments cannot successfully adopted it as a working plan. Instead, it is necessary for a detailed review of the activities of individual departments relative to the Strategic Directions and Goals of the biodiversity strategy, and development of points of correspondence in the programs of those departments with of the strategy. The resulting action plans are vehicles by which to develop responses of individual departments to the strategy. Several government departments have produced action plans in response to the strategy. These include Environment Canada, Health Canada and Natural Resources Canada. To be effective, such action plans must include detailed timetables for implementation, and discrete goals and targets that can be objectively measured in their delivery.

The International Agenda For Botanic Gardens In Conservation

During the past decade, the efforts of Botanic Gardens Conservation International have led the world in the effort to develop and support botanical gardens acting on behalf of conservation. Originating as the Botanic Gardens Conservation Secretariat of IUCN, the International Union for the Conservation of Nature, Botanic Gardens Conservation International is an independent charitable organization based in the United Kingdom.

The Botanic Gardens Conservation Secretariat compiled and published the Botanic Gardens Conservation Strategy in 1989. The Strategy presented a systematic blueprint for the participation of botanical gardens and arboreta in all aspects of the conservation of plant diversity, in research and in education. Since its publication, the Strategy has been an indispensable aid to gardens and garden networks.

During the last ten years, global awareness and organization toward the conservation of biological diversity has reached new heights, first with the organization leading to the 1992 Rio Earth Summit and its key documents, Agenda 21: the sustainable development agenda, and the Convention on Biological Diversity. Since 1992, the extensive international program of work of the Convention on Biological Diversity has brought the urgency of both the biological and social impacts of the present extinction crisis into the halls of power and onto the agendas of politicians and policy makers.

By 1998, the many changes to the environment for global plant conservation convinced BGCI Secretary General Peter Wyse Jackson that a new document, akin to the 1989 Botanic Gardens Conservation Strategy was needed. Rather than being a revision or update of the strategy, however, a fresh approach had to be taken, involving extensive collaboration and consultation.

At the September, 1998 Fifth International Botanic Gardens Congress at Kirstenbosch National Botanical Garden in Cape Town, South Africa, Dr. Wyse Jackson announced that a new International Agenda was needed to bring all of the many different objectives and priorities for botanical gardens in conservation together. Following extensive workshops at the Kirstenbosch meeting, BGCI undertook nearly two years of circulating surveys, holding consultations and revising drafts of the emerging International Agenda for Botanic Gardens in Conservation. The completed International Agenda was published in May, 2000, by BGCI, as an attractive 56 page book.

The International Agenda consists of three sections. In the Introduction, the many roles of botanical gardens in conservation are summarized, as are gardens' part in achieving the objectives of policies and treaties like the Convention on Biological Diversity, CITES, the United Nations Convention to Combat Desertification, and others. The Introduction concludes with suggestions to help gardens define their own missions relative to conservation.

Section 2, "The Practice of Conservation," reviews dozens of ways that botanical gardens contribute to conservation. It has long been a common assumption that botanical gardens are chiefly - or even exclusively - involved only in *ex situ* conservation. While *ex situ* efforts such as seed banks and living plant gene banks are being increasingly recognized as important, the

International Agenda lays to rest the tired myth that *ex situ* conservation is all that botanical gardens can do. Botanical gardens are increasingly at the forefront of conservation of ecological areas, *in situ* conservation of endangered species, and in training and implementation of monitoring biodiversity.

The third section of the International Agenda outlines its implementation, including suggestions to botanical gardens on its implementation, and mechanisms for monitoring the impact that the agenda is actually having. Among the mechanisms for implementation is an international registry of botanical gardens adopting the International Agenda, to be created by Botanic Gardens Conservation International.

In essence, the International Agenda for Botanic Gardens in Conservation is a set of goals and project proposals that, if completed, would maximize the contribution of botanical gardens and arboreta to the conservation of plant diversity. In total, the International Agenda presents 186 specific recommendations for botanical gardens.

In addition to suggestions and recommendations, the International Agenda for Botanic Gardens in Conservation contains significant reference material, such as check-lists for individual gardens to compare their activities to policies and treaties such as the CBD, CITES and Agenda 21.

Relationship Of IABGC To The Convention On Biological Diversity

The International Agenda has a strong relationship to some of the mechanisms of biodiversity planning called for in the Convention on Biological Diversity. The CBD is known as a "framework treaty" because it establishes overarching principles and goals, but does not itself specify the "on the ground" steps necessary to achieve its objectives. The CBD covers a lot of ground in its 42 Articles, and could not possibly identify all of the answers to threats to biological diversity, means to ensure biodiversity is used sustainably, and ways to ensure that the benefits that arise from using genetic resources are shared fairly and equitably. Instead, the CBD includes mechanisms to achieve its three main goals through long-term programs of work that are still on-going.

Article 6 of the CBD calls on the Parties to the Convention (almost all of which are individual states) to produce national strategies for implementing the treaty itself. Such strategies often then require the creation of Action Plans at the level of government departments or ministries. It is at the level of Action Plans that concrete government responses to the Convention itself are developed in detail, with specific goals, objectives, target dates and measurable products. While not all national biodiversity planning follows this three-step process, it represents a common approach, and is the model in use in Canada.

There can be considerable confusion over the use of terms like "goals," "objectives," "targets," and "deliverables," because one person's goal might seem like an objective to someone else. Here I use the term "goal" as the highest-level aspiration under consideration, "objective" as a necessary step toward a specific goal, and "action" as an individual and manageable activity or product that is necessary to reach a goal. We can liken the CBD to a set of goals, a National

Biodiversity Strategy to a set of national or governmental objectives, and action plans at the departmental level as actions in support of national objectives.

Within individual Parties to the Convention, then, we can think of biodiversity and conservation programs as the result of three nested levels of prioritization.

The Convention on Biological Diversity and Canada's own Canadian Biodiversity Strategy each call upon all sectors of society to participate in achieving the vital goals of ending the present global extinction crisis and ensuring the moral imperative of social justice in the use of natural resources. Unlike national governments that have explicit direction from the CBD on steps to take as Parties, other sectors in society do not have a road-map for participation.

The International Agenda for Botanic Gardens in Conservation can be thought of as a voluntary sectoral biodiversity and conservation strategy, akin to the national biodiversity strategies required of Parties in Article 6 of the CBD. It carefully sets out the many ways in which members of the international community of botanical gardens and arboreta contribute to the higher goals of plant biodiversity conservation and sustainable use. Like national biodiversity strategies, the IABGC cannot provide the level of detail of an Action Plan that might be created by an individual botanical garden or national network of gardens. Such detail requires considerable information on the national environment of individual organizations, conservation priorities, histories and capacities.

It is possible for individual botanical gardens to make use of the International Agenda in planning their biodiversity and conservation programs, and this was certainly the hope of the authors. It is unlikely, however, that most individual botanical gardens will find the IABGC to be a complete blue-print for their own activities and projects. Instead, individual plans of action need to be created in response to the IABGC that indicate which of the over 200 recommendations a particular institution is able to take on, and how it will happen. Thus, like the Action Plans developed at the level of government ministries in response to national biodiversity strategies, Action Plans, Work Plans, or Implementation Plans will likely be created by individual botanical gardens or networks of gardens in response to the IABGC.

More than the Biodiversity Convention

The International Agenda for Botanic Gardens in Conservation is not only a powerful sectoral response to the Convention on Biological Diversity. The International Agenda makes explicit the relationship of botanical gardens to other important international policies and legislation, such as the Convention on International Trade in Endangered Species of Fauna and Flora (CITES), the United Nations Framework Convention on Climate Change (UNFCCC), The Convention on Wetlands (RAMSAR) and others. Most importantly, the IABGC directly expresses the need for botanical gardens to be actively involved in global efforts to combat extinction, a true "goal" that does not need any international treaty as its justification.

Of course, individual botanical gardens and arboreta do not need a document such as the International Agenda to justify their missions in conservation, research and education. However, having a single, coherent and well-organized global agenda for a specific institutional sector is a

powerful advantage when expressing those missions to government agencies, funding bodies and the general public. By drawing together the many threads of conservation and biodiversity together, the International Agenda provides guidance to individual botanical gardens, botanical garden networks, and related institutions.

Appendix VI. Text of Articles of the Convention on Biological Diversity Relevant to Botanical Gardens and Arboreta

The following articles are quoted from the 1992 Convention on Biological Diversity:

Article 1. Objectives

The objectives of this Convention, to be pursued in accordance with its relevant provisions, are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding.

Article 6. General Measures for Conservation And Sustainable Use

Each Contracting Party shall, in accordance with its particular conditions and capabilities:

- a) Develop national strategies, plans or programmes for the conservation and sustainable use of biological diversity or adapt for this purpose existing strategies, plans or programmes which shall reflect, *inter alia*, the measures set out in this Convention relevant to the Contracting Party concerned; and
- b) Integrate, as far as possible and as appropriate, the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programmes and policies.

Article 7. Identification and Monitoring

Each Contracting Party shall, as far as possible and as appropriate, in particular for the purposes of Articles 8 to 10:

- (a) Identify components of biological diversity important for its conservation and sustainable use having regard to the indicative list of categories set down in Annex I;
- (b) Monitor, through sampling and other techniques, the components of biological diversity identified pursuant to subparagraph (a) above, paying particular attention to those requiring urgent conservation measures and those which offer the greatest potential for sustainable use;
- (c) Identify processes and categories of activities which have or are likely to have significant adverse impacts on the conservation and sustainable use of biological diversity, and monitor their effects through sampling and other techniques; and
- (d) Maintain and organize, by any mechanism data, derived from identification and monitoring activities pursuant to subparagraphs (a), (b) and (c) above.

Note: Annex I lists the definitions of the three levels of biological diversity of most interest:

Annex I: Identification and Monitoring

1. Ecosystems and habitats: containing high diversity, large numbers of endemic or threatened species, or wilderness; required by migratory species; of social, economic, cultural or scientific importance; or, which are representative, unique or associated with key evolutionary or other biological processes;
2. Species and communities which are: threatened; wild relatives of domesticated or cultivated species; of medicinal, agricultural or other economic value; or social, scientific or cultural importance; or importance for research into the conservation and sustainable use of biological diversity, such as indicator species; and
3. Described genomes and genes of social, scientific or economic importance.

Article 8. In-situ Conservation

Each Contracting Party shall, as far as possible and as appropriate:

- (a) Establish a system of protected areas or areas where special measures need to be taken to conserve biological diversity;
- (b) Develop, where necessary, guidelines for the selection, establishment and management of protected areas or areas where special measures need to be taken to conserve biological diversity;
- (c) Regulate or manage biological resources important for the conservation of biological diversity whether within or outside protected areas, with a view to ensuring their conservation and sustainable use;
- (d) Promote the protection of ecosystems, natural habitats and the maintenance of viable populations of species in natural surroundings;
- (e) Promote environmentally sound and sustainable development in areas adjacent to protected areas with a view to furthering protection of these areas;
- (f) Rehabilitate and restore degraded ecosystems and promote the recovery of threatened species, *inter alia*, through the development and implementation of plans or other management strategies;
- (g) Establish or maintain means to regulate, manage or control the risks associated with the use and release of living modified organisms resulting from biotechnology which are likely to have adverse environmental impacts that could affect the conservation and sustainable use of biological diversity, taking also into account the risks to human health;
- (h) Prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species;
- (i) Endeavour to provide the conditions needed for compatibility between present uses and the conservation of biological diversity and the sustainable use of its components;
- (j) Subject to its national legislation, respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge, innovations and practices;

- (k) Develop or maintain necessary legislation and/or other regulatory provisions for the protection of threatened species and populations;
- (l) Where a significant adverse effect on biological diversity has been determined pursuant to Article 7, regulate or manage the relevant processes and categories of activities; and
- (m) Cooperate in providing financial and other support for *in-situ* conservation outlined in subparagraphs (a) to (l) above, particularly to developing countries.

Article 9. Ex-situ Conservation

Each Contracting Party shall, as far as possible and as appropriate, and predominantly for the purpose of complementing *in-situ* measures:

- (a) Adopt measures for the *ex-situ* conservation of components of biological diversity, preferably in the country of origin of such components;
- (b) Establish and maintain facilities for *ex-situ* conservation of and research on plants, animals and micro-organisms, preferably in the country of origin of genetic resources;
- (c) Adopt measures for the recovery and rehabilitation of threatened species and for their reintroduction into their natural habitats under appropriate conditions;
- (d) Regulate and manage collection of biological resources from natural habitats for *ex-situ* conservation purposes so as not to threaten ecosystems and *in-situ* populations of species, except where special temporary *ex-situ* measures are required under subparagraph (c) above; and
- (e) Cooperate in providing financial and other support for *ex-situ* conservation outlined in subparagraphs (a) to (d) above and in the establishment and maintenance of *ex-situ* conservation facilities in developing countries.

Article 10. Sustainable Use of Components of Biological Diversity

Each Contracting Party shall, as far as possible and as appropriate:

- (a) Integrate consideration of the conservation and sustainable use of biological resources into national decision-making;
- (b) Adopt measures relating to the use of biological resources to avoid or minimize adverse impacts on biological diversity;
- (c) Protect and encourage customary use of biological resources in accordance with traditional cultural practices that are compatible with conservation or sustainable use requirements;
- (d) Support local populations to develop and implement remedial action in degraded areas where biological diversity has been reduced; and
- (e) Encourage cooperation between its governmental authorities and its private sector in developing methods for sustainable use of biological resources.

Article 12. Research And Training

The Contracting Parties, taking into account the special needs of developing countries, shall:

- (a) Establish and maintain programmes for scientific and technical education and training in measures for the identification, conservation and sustainable use of biological diversity and

its components and provide support for such education and training for the specific needs of developing countries;

(b) Promote and encourage research which contributes to the conservation and sustainable use of biological diversity, particularly in developing countries, *inter alia*, in accordance with decisions of the Conference of the Parties taken in consequence of recommendations of the Subsidiary Body on Scientific, Technical and Technological Advice; and

(c) In keeping with the provisions of Articles 16, 18 and 20, promote and cooperate in the use of scientific advances in biological diversity research in developing methods for conservation and sustainable use of biological resources.

Article 13. Public Education and Awareness

The Contracting Parties shall:

(a) Promote and encourage understanding of the importance of, and the measures required for, the conservation of biological diversity, as well as its propagation through media, and the inclusion of these topics in educational programmes; and

(b) Cooperate, as appropriate, with other States and international organizations in developing educational and public awareness programmes, with respect to conservation and sustainable use of biological diversity.

Article 14. Impact Assessment and Minimizing Adverse Impacts

1. Each Contracting Party, as far as possible and as appropriate, shall:

(a) Introduce appropriate procedures requiring environmental impact assessment of its proposed projects that are likely to have significant adverse effects on biological diversity with a view to avoiding or minimizing such effects and, where appropriate, allow for public participation in such procedures;

(b) Introduce appropriate arrangements to ensure that the environmental consequences of its programmes and policies that are likely to have significant adverse impacts on biological diversity are duly taken into account;

(c) Promote, on the basis of reciprocity, notification, exchange of information and consultation on activities under their jurisdiction or control which are likely to significantly affect adversely the biological diversity of other States or areas beyond the limits of national jurisdiction, by encouraging the conclusion of bilateral, regional or multilateral arrangements, as appropriate;

(d) In the case of imminent or grave danger or damage, originating under its jurisdiction or control, to biological diversity within the area under jurisdiction of other States or in areas beyond the limits of national jurisdiction, notify immediately the potentially affected States of such danger or damage, as well as initiate action to prevent or minimize such danger or damage; and

(e) Promote national arrangements for emergency responses to activities or events, whether caused naturally or otherwise, which present a grave and imminent danger to biological diversity and encourage international cooperation to supplement such national efforts and, where appropriate and agreed by the States or regional economic integration organizations concerned, to establish joint contingency plans.

2. The Conference of the Parties shall examine, on the basis of studies to be carried out, the issue of liability and redress, including restoration and compensation, for damage to biological diversity, except where such liability is a purely internal matter.

Article 15. Access to Genetic Resources

1. Recognizing the sovereign rights of States over their natural resources, the authority to determine access to genetic resources rests with the national governments and is subject to national legislation.
2. Each Contracting Party shall endeavour to create conditions to facilitate access to genetic resources for environmentally sound uses by other Contracting Parties and not to impose restrictions that run counter to the objectives of this Convention.
3. For the purpose of this Convention, the genetic resources being provided by a Contracting Party, as referred to in this Article and Articles 16 and 19, are only those that are provided by Contracting Parties that are countries of origin of such resources or by the Parties that have acquired the genetic resources in accordance with this Convention.
4. Access, where granted, shall be on mutually agreed terms and subject to the provisions of this Article.
5. Access to genetic resources shall be subject to prior informed consent of the Contracting Party providing such resources, unless otherwise determined by that Party.
6. Each Contracting Party shall endeavour to develop and carry out scientific research based on genetic resources provided by other Contracting Parties with the full participation of, and where possible in, such Contracting Parties.
7. Each Contracting Party shall take legislative, administrative or policy measures, as appropriate, and in accordance with Articles 16 and 19 and, where necessary, through the financial mechanism established by Articles 20 and 21 with the aim of sharing in a fair and equitable way the results of research and development and the benefits arising from the commercial and other utilization of genetic resources with the Contracting Party providing such resources. Such sharing shall be upon mutually agreed terms.

Article 17. Exchange of Information

1. The Contracting Parties shall facilitate the exchange of information, from all publicly available sources, relevant to the conservation and sustainable use of biological diversity, taking into account the special needs of developing countries.
2. Such exchange of information shall include exchange of results of technical, scientific and socio-economic research, as well as information on training and surveying programmes, specialized knowledge, indigenous and traditional knowledge as such and in combination with the technologies referred to in Article 16, paragraph 1. It shall also, where feasible, include repatriation of information.

Article 18. Technical and Scientific Cooperation

1. The Contracting Parties shall promote international technical and scientific cooperation in the field of conservation and sustainable use of biological diversity, where necessary, through the appropriate international and national institutions.
2. Each Contracting Party shall promote technical and scientific cooperation with other Contracting Parties, in particular developing countries, in implementing this Convention, *inter alia*, through the development and implementation of national policies. In promoting such cooperation, special attention should be given to the development and strengthening of national capabilities, by means of human resources development and institution building.
3. The Conference of the Parties, at its first meeting, shall determine how to establish a clearing-house mechanism to promote and facilitate technical and scientific cooperation.
4. The Contracting Parties shall, in accordance with national legislation and policies, encourage and develop methods of cooperation for the development and use of technologies, including indigenous and traditional technologies, in pursuance of the objectives of this Convention. For this purpose, the Contracting Parties shall also promote cooperation in the training of personnel and exchange of experts.
4. The Contracting Parties shall, subject to mutual agreement, promote the establishment of joint research programmes and joint ventures for the development of technologies relevant to the objectives of this Convention.

Appendix VII. Goals and Strategic Directions of the Canadian Biodiversity Strategy Relevant to Botanical Gardens and Arboreta

The following are strategic directions from the Canadian Biodiversity Strategy that are directly supported by the projects described in this biodiversity action plan. The index numbers preceding each item are those used in the Canadian Biodiversity Strategy. The text descriptions of the various strategic directions have been abbreviated, but care has been taken to retain the sense of each strategic direction. For the full text and sense of each strategic direction, please refer to the Canadian Biodiversity Strategy.

Goal 1: Conservation and Sustainable Use

Strategic Directions Under Goal 1:

- 1.1 Integrated planning and ecological management with CBD objectives.
- 1.8 Prevent *in situ* populations from becoming jeopardized by specimen collecting.
- 1.9 Promote role of NGO *ex situ* institutions in *in situ* conservation.
- 1.21 Enhance *ex situ* role in recovery of species-at-risk & ecosystem management.
- 1.27 Improve ecosystem restoration and rehabilitation approaches.
- 1.78 Prevent introduction of harmful alien organisms and:
 - a. develop and implementing effective means to identify and monitor alien organisms;
 - b. prioritize allocation of resources for control of harmful alien organisms;
 - c. identify and eliminate common sources of unintentional introductions;
 - d. develop database to anticipate the introduction of harmful alien organisms;
 - e. ensure enforcement to control introductions or escapes of harmful alien organisms;
 - f. enhance public awareness of impacts of harmful alien organisms.
- 1.87 Promote acceptance of CBD within development sectors through:
 - a. the establishment of codes of ethics; and
 - b. the provision of relevant information and awareness material.

Goal 2: Ecological Management

Strategic Directions Under Goal 1:

- 2.2 Focus research on understanding of ecosystems and management by:
 - d. improving *in situ* and *ex situ* conservation methods
- 2.9 Inventory genetic diversity for conservation and economic use of genetic resources.
- 2.29 Implement measures to monitor *ex situ* collections of biological resources.

Goal 3: Education and Awareness

Strategic Directions Under Goal 3:

3.1 Deliver biodiversity education and awareness programs by:

- c. Build on existing interpretive programs in (...) botanical gardens; and
 - d. strengthen co-ordination among (...) botanical gardens (...) and other organizations.
- (Goal 4: Incentives and Legislation, is not applicable to this Action Plan)

Goal 5: International Cooperation

Strategic Directions Under Goal 5:

5.0 Join international activities for conservation and sustainable use of biological resources by:

- a. encouraging the implementation and integration of the objectives of the Convention;
 - b. Joining international bodies drafting agreements to complement the CBD;
 - c. considering the objectives of the CBD relative to other international agreements.
- 5.2 Facilitate transfer of technologies for conservation & sustainable use of biodiversity, including:
- b. facilitate access to samples of Canada's genetic resources on mutually agreed terms;
- 5.3 Encourage all sectors to share benefits of using genetic resources of other countries.
- 5.4 Encourage the participation of stakeholders in international efforts to implement the CBD.

Appendix VIII. Botanical Gardens Policies on Access to Genetic Resources

The 1992 Convention on Biological Diversity (CBD) has three objectives: the conservation of biological diversity, the sustainable use of biological diversity, and the fair and equitable sharing of benefits arising from the use of genetic resources. This Appendix is a review of the issues surrounding access to genetic resources from the perspective of Canadian botanical gardens and arboreta, with notes on the experiences of one institution in Canada in this area.

Article 15 of the CBD and related articles present important challenges to botanical gardens about the genetic resources represented by their plant collections. These challenges include facilitating access to collections of genetic resources while respecting the spirit of the CBD, ensuring that the collections are managed in a sustainable way and with a view to conserving the genetic diversity represented.

There is a spectrum of opinion on this issue, ranging from serious concern that botanical gardens are being used by unscrupulous individuals to side-step the provisions of the Convention on Biological Diversity to equally urgent concerns that the positive important work of botanical gardens might be hamstrung by unrealistic concerns over potential values that can be attached to their collections.

The Convention on Biological Diversity is most often portrayed as a treaty about the conservation and sustainable use of the earth's living natural resources. It should be recognized that the CBD is also an agreement which seeks social and economic benefits for the countries of origin of those resources. As noted above, the third objective of the Convention, following the conservation and sustainable use of biological diversity, is "the fair and equitable sharing of the benefits arising out of the utilization of genetic resources."

It is the third objective of the CBD that has focussed attention on the ways in which genetic resources are found, conserved, and used. In some senses, the third objective is also the "teeth" of the CBD, because it is hoped that the economic and social incentive of receiving a share of benefits from the use of genetic resources will prompt biodiversity-rich countries to protect those resources in their natural form. The third objective also establishes the CBD as an important element in global social justice by setting the goal of ensuring that economic benefits generated in a user country are shared with the source country.

As it is a framework convention, the CBD does not set out the details a global system for recognizing just when genetic resources are accessed and when and how benefits should be shared. Instead, the convention has set in motion an extended set of international negotiations regarding genetic resources and also the creation of national regimes that regulate the exploration and use of genetic resources. While such regulatory regimes are an understandable response to the realization that genetic resources may be valuable there is concern that the potential value of individual specimens is being overestimated, and that heightened regulation may in fact work against the principle of facilitating appropriate access to genetic resources, a principle enshrined in the CBD itself.

Botanical gardens have been placed in an interesting position by this treaty and the processes it has generated. Historically, botanical gardens have acted as places of conservation and research on plant specimens gathered from around the world. While legitimately seeking to promote the importance of their collections as resources held as a public trust, botanical gardens have been open to criticism that their collections could be used to side-step the intent of the CBD by providing genetic resources to third parties without the countries of origin being offered a share of any benefits from their use.

Genetic Resources and The Convention on Biological Diversity

To say the least, the international response to the provisions regarding access to genetic resources and related issues in the CBD have been varied. Increasingly, individual nations are turning to regulation of access to genetic resources as a means to ensure that any actual benefits that arise from their use in other countries are indeed shared.

Another developing issue pertains to just what constitutes a "benefit." The Convention on Biological Diversity itself indicates in Article 1 that benefits will be shared through "appropriate access to genetic resources; appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and appropriate funding." Benefits were therefore initially recognized to include financial support, the sharing of technological developments related to genetic resources, and access to genetic resources themselves.

The involvement of other sectors has of necessity broadened the scope of benefits that can be considered as arising from the use of genetic resources, and also raises complex questions about how these should be shared equitably. Because the CBD is an agreement among Parties to the Convention, almost all of which are nations, the provisions of the framework treaty are not intended to apply to non-governmental organizations and other third parties in the same sense that they would to the Parties. Some Parties, including Canada, view sharing benefits as essentially a form of government to government foreign aid, ensuring that free and open access to genetic resources is maintained. Other Parties are instituting systems that require complex contracts to enable access to genetic resources. Such contractual agreements allow some of the provisions of the CBD to take concrete and immediate form for every transaction, including mutually-agreed terms for access ("MAT") and prior informed consent regarding the terms for access ("PIC").

Neither system is perfect, of course. Free-access systems assume that the responsibility for ensuring PIC and MAT, and for directing the return of shared benefits, are managed by national authorities that are able to track the conditions necessary to facilitate access, and that benefits are indeed shared in an equitable manner at the government to government level. Contract-based systems provide for tighter links between access to genetic resources and the return of benefits, and make PIC and MAT explicit, but have the tendency to place an exaggerated potential financial value on individual specimens and to take benefits out of the public sphere and place them in the context of conditions of the contract only.

Non-governmental organizations seeking to participate in the CBD process have a difficult time finding their way through the complexities of these international negotiations and emerging regulatory environments.

Genetic Resources and The Canadian Biodiversity Strategy

As noted above, the Canadian Biodiversity Strategy: Canada's Response to the Convention on Biological Diversity is an extensive listing of goals and objectives that places the CBD into the context of Canadian natural resources policy. The creation of the Canadian Biodiversity Strategy was part of the overall process by which the Government of Canada implemented Article 6 of the CBD, "General Measures for Conservation and Sustainable Use."

On the surface, relatively few of the large number of strategic directions listed in the CBS make direct reference to genetic resources issues or the third objective of the CBD. In part, this may be due to the emphasis placed within the CBD's Article 6 (a), which requires Parties to the Convention to "develop national strategies, plans or programmes for the conservation and sustainable use of biological diversity" and does not specifically ask Parties to address access to genetic resources.

Nevertheless, the CBS does address genetic resources questions. The CBS calls for the overall implementation of the Convention on Biological Diversity itself by all sectors of Canadian society. By so doing, the CBS draws attention to the CBD as an important set of goals and objectives for Canadian society, which includes the fair and equitable sharing of benefits arising out of the use of genetic resources.

Experiences of a Canadian Botanical Garden

Royal Botanical Gardens, in Hamilton, Ontario, is one of Canada's largest botanical gardens, with a long history of plant display, educational programs and research, in addition to major, on-going projects in ecological restoration and endangered species recovery. Today, five major cultivated garden areas now comprise the formal sections of Royal Botanical Gardens: The Arboretum (trees, lilacs), The Laking Garden (perennials), The Rock Garden, Hendrie Park (roses and other theme gardens) and the Mediterranean Garden conservatory.

In 1997, RBG was invited to participate in a series of workshops entitled "The Pilot Project to Harmonize the Policies of Participating Botanic Gardens with Access to Genetic Resources and Sharing of Benefits under the Convention on Biological Diversity." This pilot project was organized by the Conventions and Policies section of Royal Botanic Gardens, Kew, in the UK, and participation was facilitated by grants from the UK Department for International Development.

In the context of facilitated workshops, representatives of 17 botanical gardens from around the world (including gardens in Australia, Brazil, Cameroon, Canada, China, Colombia, Malaysia, Germany, Ghana, Mexico, Morocco, the Russian Federation, South Africa, the UK and the USA)

have gathered in the pilot project. Four workshops have been held to date, the most recent in Colombia the fall of 2000. The primary product of the Pilot Project is a document entitled Common Policy Guidelines for Participating Botanic Gardens on Access to Genetic Resources and Benefit Sharing. The Common Policy Guidelines, or CPG, are available on the Internet at: <http://www.rbg.ca/cbcn/en/biodiversity/cpg/index.html>

By the beginning of 2000, seven prominent botanical gardens had formally adopted the Common Policy Guidelines as their working policies on access to genetic resources and the sharing of benefits from the use of those resources. Institutions in Brazil, Colombia, the Peoples' Republic of China, Ghana, Germany, the Russian Federation and the United Kingdom have all formally signed the CPG as of 15 December, 1999.

In the fall of 2000, participants meeting in Colombia for the fourth workshop shared experiences and further refine the products of the project. The participants condensed many long discussions into a brief Statement of Principles (Box 6). Globally, more than two dozen botanical gardens have adopted this statement of principles in the first six months after its publication.

The degree of participation by Royal Botanical Gardens in the pilot project to harmonize botanic gardens' policies with the aspects of the 1992 Convention on Biological Diversity on access and benefit sharing, like all participants, is heavily dependent upon the environment of the institution, its history and present management practices. It is worth reviewing the present situation of this institution so that its participation in the CPG project can be seen in proper context.

Royal Botanical Gardens has a minimal involvement in issues that would conventionally be considered as involving genetic resources. It has not historically been involved in economic botany to any great extent and does not conduct collecting expeditions. The only direct aspect of commercialization of any genetic resource at Royal Botanical Gardens is participation in plant hardiness trials in cooperation with the ornamental plant industry in Canada. Most plants brought into the gardens are purchased from commercial plant suppliers, and the rest are received through plant and seed exchanges with similar institutions.

Participation in the Pilot Project that has developed the Common Policy Guidelines has been a very positive experience for Royal Botanical Gardens. The most important aspect of the participation to date has been to raise awareness of the need to consider access to genetic resources and the sharing of benefits within the institution, and also among other stakeholders in Canada. A second benefit to Royal Botanical Gardens has been to bring the issue of the Convention on Biological Diversity to the awareness of the Board of Directors.

Specific steps taken at Royal Botanical Gardens toward harmonizing the activities and policies of this institution with the provisions of the Convention on Biological Diversity, and in that context the possible adoption of the Common Policy Guidelines, include:

1. Circulation of the draft Common Policy Guidelines and accompanying to staff of Royal Botanical Gardens and with other stake-holders.

2. Senior management and staff met with the Board of Directors, and the joint staff-Board "Science and Conservation Committee" has kept up-to-date on the progress on the Pilot Project and the release of the Common Policy Guidelines.
3. A presentation was made in February, 2000 to the RBG Board of Directors on projects at RBG related to the biodiversity convention, including RBG's participation in the Pilot Project.
4. Royal Botanical Gardens is hosting a Web site on the CPG, prepared by RBG staff member David Galbraith, including several translations and an explanatory note by Kerry ten Kate. The Web site is part of the Web site of the Canadian Botanical Conservation Network, itself hosted by Royal Botanical Gardens.
5. Royal Botanical Gardens continues to extend support for and participation in the development of the biodiversity action plan for Botanical Gardens and Arboreta in Canada, which includes a review of harmonization, the Pilot Project, and the CPG.

Several important challenges remain regarding the adoption of the Common Policy Guidelines by Royal Botanical Gardens, which challenges will likely be shared by other institutions in Canada. Royal Botanical Gardens does not at present deal to any appreciable extent with those plants conventionally considered to be genetic resources. It does not maintain seed gene banks or field gene banks related to economic botany, and does not have extensive collections of plants of economic value. However, RBG is at present exploring the use of seed banks as an aid to *in situ* conservation of rare and endangered plants, including the economically important American Ginseng. The planned collections of seeds are for use in the recovery of wild populations within Canada. Furthermore, Royal Botanical Gardens does not engage in research that involves genetic resources, at least at present. This institution does not participate in field expeditions or in research related to the development of pharmaceutical or other commercial products. There are, therefore, real questions regarding the need for a policy that covers activities that are not, at present, a major priority for the institution.

Continued contact with the staff members responsible for collections management on this issue is the only way Royal Botanical Gardens will be able to move closer to developing an active participation in the harmonization process. Key to that contact will be the ability to express three important elements of the process that reinforce the relevance. First, the need for the harmonized environment must be expressed clearly and with direct relevance to the particulars of the institution. Secondly, the way in which harmonization will work and will affect the operations of the institution must be clearly understood. Thirdly, the form of an agreement on harmonization is important and also must convey why the process is important to the individual institution.

Royal Botanical Gardens is much more likely to be able to participate successfully and comfortably in a harmonized system of access to genetic resources and benefits sharing if that participation is seen as simple, transparent and not costly. That participation would be facilitated by a flexibility on the part of the products of the Pilot Project, including the preparation of a simple and free-standing Statement of Principles that might be adopted by any botanical garden regardless of that gardens' capacity to deal with the detailed Article 15 issues (Box 6). While such a statement would not, in and of itself, achieve the objective of bringing the practices of

participating botanical gardens in harmony with the CBD, it would be a very positive contribution toward that end, by emphasizing the need for such harmonized practices, regardless of the class of institution involved.

Other important elements in clearing this obstacle will be alternative model material transfer agreements that fulfil the requirements of the CPG without presenting an extensive contract, and elaboration and availability of interpretive materials that will help the participation of an institution like RBG be perceived as positive, constructive and not an excessive administrative burden.

The Common Policy Guidelines list several kinds of benefits that could be considered as appropriate for sharing in the context of the use of genetic resources. Of these, relatively few are applicable to Royal Botanical Gardens in any meaningful sense. At present, the only international program at Royal Botanical Gardens involving genetic resources in any sense is the work of Dr Jim Pringle, a plant taxonomist interested in the Gentian family. If we are to take the concept of the generation of benefits to be shared literally, then benefits arising from Dr Pringle's work would include taxonomic information and data, publications and educational materials, and possibly benefits in kind such as augmentation of national collections in the country of origin.

It is positive to note that the Biodiversity Convention Office of Environment Canada, which is responsible for Canada's implementation of the Convention on Biological Diversity, is paying attention to this and related issues, especially because of the focus on Article 15 issues at the level of COP and SBSSTA. In general, however, the sharing of benefits arising from the use of genetic resources is not an issue of national interest at present, and there are few examples that can be cited of benefit sharing agreements in the context of Canada.

Further exploration of the issue of benefits and their fair and equitable sharing is needed, and not only in the context of the CPG or botanical gardens. Having clear examples or models of real sharing of benefits in the context of a non-profit organization that does not sell commercial products would be helpful to Royal Botanical Gardens.

Royal Botanical Gardens has been very interested in participating in the development of the CPG and the effort to harmonize institutional policies. It has been recognized from the beginning that this effort is a "pathfinder" exercise, and therefore all participants are more or less feeling their way through the issues. Nevertheless, not having some examples of experiences of other institutions in the ways that the CPG has been implemented and has changed their procedures is a barrier to institutions that are cautious about resources and the actual relevance of the harmonization process to their activities.

This obstacle cannot be cleared until a group of botanical gardens frankly dealing in genetic resources issues is able to capture and convey its experience with the CPG. It is therefore very important that botanical gardens that have adopted the CPG as their policies on access to genetic resources and sharing of benefits capture and express their experiences, positive and negative, with this process. Without some idea of how this is actually working, and not just how the participants envision it to work, smaller institutions like RBG are going to remain reluctant to adopt the CPG. It must be shown that this process is an important, positive addition to institutional activities, and not just a "feel-good exercise."

As noted above, most of the plant material in use at Royal Botanical Gardens is purchased from the ornamental horticulture industry, and a small portion is obtained through the *Index Seminum* route. Royal Botanical Gardens cannot adopt a policy that would put it out of touch with the standards of practice within the ornamental horticulture trade in Canada and the USA.

At the intellectual level there is no question that trade in ornamental plants constitutes a form of trade in genetic resources. However, there is little or no awareness of the implications of the Convention on Biological Diversity, national access regimes on genetic resources, and related issues in commercial ornamental horticulture, and no process comparable to the Pilot Project to develop such awareness.

If Royal Botanical Gardens were to adopt the CPG as it presently stands, it is unclear as to how this would affect the institution's interaction with the ornamental horticulture trade. Canada has IP legislation concerning plants in the form of Plant Breeder's Rights legislation, but this legislation covers the propagation of registered ornamental varieties only. RBG is already bound to abide by the provisions of PBR, but PBR does not extend to non-registered varieties, and is difficult to enforce.

Over time, the issues of access to genetic resources and sharing of benefits in the context of ornamental horticulture will almost certainly be addressed. At the present time, an effort to explain the need for harmonization, the Pilot Project and its results to the ornamental horticulture trades in North America and Europe would be very welcome.

Royal Botanical Gardens remains very interested in the Pilot Project and the development of the CPG and related products. At the larger level, Royal Botanical Gardens believes that all botanical gardens have important roles to play in the implementation of the Convention on Biological Diversity and the achievement of its goals. One of the strengths of the botanical garden community is its diversity of institutions and activities related to biodiversity. It is felt that the participation of an institution like RBG brings an important voice to the Pilot Project, because RBG represents the most common class of botanical gardens: those not directly involved in activities that are conventionally considered as involving genetic resources, but that may be in the future.

At this time, Royal Botanical Gardens feels no pressing need to adopt the Common Policy Guidelines or any other specific measure as working guidelines or policy on access to genetic resources or on sharing of benefits arising from the use of genetic resources. In the short term, the adoption of a more general policy on the Convention on Biological Diversity is more likely, and is viewed as a necessary first step toward a harmonization of practice and policy.

Adoption of a specific set of guidelines or policy on access to genetic resources and sharing of benefits by Royal Botanical Gardens may take place if there is a clear need for such a policy relative to RBG's actual activities (especially relative to ornamental horticulture), a form of the relevant documents that is accessible and clear, and institutions that can relate actual experience in the operation of the harmonized system.

The further development of the Common Policy Guidelines project is being undertaken by Kerry ten Kate of the Policy and Conventions Section of RBG Kew. Ms ten Kate can be contacted at:

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Box 6. Principles On Access To Genetic Resources And Benefit- Sharing For Participating Institutions

Participating Institutions endorse the following Principles on access to genetic resources and benefit-sharing:

Convention on Biological Diversity (CBD) and laws related to access to genetic resources and associated traditional knowledge and benefit-sharing:

- Honour the letter and spirit of the CBD, The Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) and laws relating to access and benefit-sharing, including those relating to traditional knowledge.

Acquisition of genetic resources:

- In order to obtain prior informed consent, provide a full explanation of how the genetic resources will be acquired and used.
- When acquiring genetic resources from *in situ* conditions, obtain prior informed consent from the government of the country of origin and any other relevant Stakeholders, according to applicable law and best practice.
- When acquiring genetic resources from *ex situ* collections (such as botanic gardens), obtain prior informed consent from the body governing the *ex situ* collection and any additional consents required by that body.
- When acquiring genetic resources from *ex situ* sources, whether from *ex situ* collections, commercial sources or individuals, evaluate available documentation and, where necessary, take appropriate steps to ensure that the genetic resources were acquired in accordance with applicable law and best practice.

Use and supply of genetic resources

- Use and supply genetic resources and their derivatives on terms and conditions consistent with those under which they were acquired.
- Prepare a transparent policy on the commercialisation (including plant sales) of genetic resources acquired before and since the CBD entered into force and their derivatives, whether by the Participating Institution or a recipient third party.

Use of written agreements

- Acquire genetic resources and supply genetic resources and derivatives using written agreements, where required by applicable law and best practice, setting out the terms and conditions under which the genetic resources may be acquired, used and supplied and resulting benefits shared.

Benefit-sharing

- Share fairly and equitably with the country of origin and other Stakeholders, the benefits arising from the use of genetic resources and their derivatives including non-monetary, and, in the case of commercialisation, also monetary benefits.
- Share benefits arising from the use of genetic resources acquired prior to the entry into force of the CBD, as far as possible, in the same manner as for those acquired thereafter.

Curation

- In order to comply with these Principles, maintain records and mechanisms to:
 - record the terms and conditions under which genetic resources are acquired;
 - track the use in the Participating Institution and benefits arising from that use; and
 - record supply to third parties, including the terms and conditions of supply.

Prepare a policy

- Prepare, adopt and communicate an institutional policy setting out how the Participating Institution will implement these Principles.

Appendix IX. Internet Sites of Interest

- AAFC Agriculture and Agri-Food Canada: <http://www.agr.ca>
- Action 21: <http://www.ns.doe.ca/action21/menu.html>
- Biodiversity Convention Office, Environment Canada: <http://www.bco.gc.ca>
- Canadian Council of Ministers of the Environment: <http://www.mbnet.mb.ca/ccme>
- Canadian Forest Service/Service canadien des forêts: <http://nrcan.gc.ca/cfs/index.html>
- Clearing House Mechanism, Convention on Biological Diversity:
<http://www.biodiv.org/chm.html>
- Commissioner of the Environment and Sustainable Development: <http://www.oag-bvg.gc.ca>
- Committee on the Status of Endangered Wildlife in Canada: <http://www.cosewic.gc.ca>
- Canadian Wildlife Service: http://www.ec.gc.ca/cws-scf/cwshom_e.html
- EARTH SUMMIT (Agenda 21): <http://www.un.org/dpcsd/earthsummit>
- EC Greenlane - Issues and Topics: http://www.ec.gc.ca/issues_e.html
- EMAN The Ecological Monitoring and Assessment Network: <http://www.cciw.ca/eman-temp/intro.html>
- EnviroLink Network, The: <http://www.envirolink.org>
- Environment Canada's Green Lane/La Voie verte d'Environnement Canada:
<http://www.doe.ca/>
- MAB Canada/MAB (Man and the Biosphere): <http://www.cciw.ca/mab/mab.htm>
- MFP Model Forest Program/Programme de forêts modèles: <http://mf.ncr.forestry.ca/>
- SOER State of Canada's Environment Infobase (Eng/French): <http://www1.ec.gc.ca/~soer/>