http://www.actionbioscience.org/biodiversity/rinker2.html
**February 2002**

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# The Weight of a Petal: The Value of Botanical Gardens

## H. Bruce Rinker

### articlehighlights

*Plants play a key environmental role and botanical gardens are committed to their preservation. Plants*

- *contribute to the health of ecosystems*
- *sustain us by giving us food, medicines, and other commodities*
- *provide opportunities for recreation and exploration*
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***Plants influenced the evolution of life on land.***

Botanical gardens are global treasures in an age of ecological crisis. This gazebo is part of the public gardens at historical Spanish Point, Florida. Photograph: Oksana Hlodan.

***Plants predate human origins.***

Gardens, as landscapes with scattered trees and copses interspersed with open spaces or bodies of water, widely appeal to our aesthetic sense and our need to perceive an organized natural world. Such settings may even appeal to a genetic memory of humanity's remote origins on the African savanna. Undoubtedly, flowers and the near-infinite diversity of their fruits influenced the survival of early hominids and the skill of modern humans to inhabit every corner of the planet.[7] Flowering plants originated during the Cretaceous Period, nearly 100 million years ago when Africa and South America were still connected to each other. The dramatic co-evolution of flowering plants and their insect pollinators colored the face of the planet and set the stage for the emergence of our vision-dominated ancestors millions of years later. Loren Eiseley, late anthropologist from the University of Pennsylvania, exclaimed, "the weight of a petal changed the face of the world and made it ours."[4]

### What are botanical gardens?

Some people have the mistaken impression that botanical gardens are parks devoid of play, something like 19th century museums where plants bear labels with unpronounceable names. Modern botanical gardens, however, are global treasures in an age of ecological crisis. Today numbering more than 2000 gardens worldwide, they are places devoted to the culture, study, and exhibition of documented collections of living plants.[12,13] Further, they:

***Gardens are more than places to visit; they are centers of research and conservation.***

- are committed to developing, documenting, verifying, maintaining, sharing, propagating, and disseminating their plant collections — a description offered by the American Association of Botanical Gardens and Arboreta (AABGA)[11]
- serve as reference centers for plant identification, cultivar registration, nomenclature, and plant exploration
- and, for some threatened species, have become the last hope for their precarious survival

Simply put, modern botanical gardens are scholarly places for the research and conservation of plants.

### The western tradition of botanical gardens

Botanical gardens can be traced to human beginnings and are found in all cultures, past and present. In the western world, gardens went through a metamorphosis:

***The first gardens in Europe were medicinal.***

*Medicinal Gardens:* 16th and 17th centuries The early European institutions were medicinal gardens, also called physics gardens or gardens of simples (such as Florence's Giardino dei Semplici), whose principle role was to provide material for medical faculties in Italy, France, and other western countries. The earliest medicinal gardens in Europe were all established in the 16th and 17th centuries: Pisa (1543), Zurich (1560), Paris (1597), Oxford (1621), Berlin (1679), and others.[9,11]

*Colonial Gardens:* 17th and 18th centuries

Later on, governments created tropical botanical gardens as instruments of colonial expansion and commercial development.[2] The celebrated 18th century Calcutta Botanical Garden and Royal Botanic Gardens Pamplemousses in Mauritius come to mind.

***The scientist Linnaeus inspired gardens to conduct plant research.***

*Linnaean Gardens:* 18th and 19th centuries Gradually, a strict utilitarian display gave way to a comprehensive study of plants. Based on the work of Carolus Linnaeus (1707-1778),[15] the father of modern taxonomy, gardens were laid out to

show plant relationships. Live and preserved material poured into the botanical gardens of Europe, especially from the New World, to be exhibited, studied, and identified. As taxonomy gained in prominence, botanical gardens emphasized their herbaria, laboratories, and libraries over their living collections, on which little research was then undertaken.
*Civic Gardens:* 19th and 20th centuries Municipal gardens were founded in the 19th and 20th centuries (e.g., Missouri Botanical Garden in 1859) that advanced the horticultural aspects of their living collections.
*Specialist Gardens:* 20th and 21st centuries Specialist gardens, such as experimental stations and orchid gardens, emerged in the 20th century that highlighted research on particular plant groups. Floristic explorations and taxonomic studies, especially in remote tropical locations, allowed botanical gardens to expand their living and preserved collections. It also allowed them to advance as leading research centers for plant conservation.

***Gardens today are havens for species that are extinct in the wild.***

*Sanctuary Gardens:* 20th and 21st centuries Today, much of the responsibility for the genetic protection of threatened species, along with *ex situ* protection of plants with economic and ecological importance, rests with botanical gardens. For instance, the Marie Selby Botanical Gardens in Sarasota, Florida propagates a handful of species that are listed as no longer existing in the wild: *Anthurium leuconeurum* (Araceae) from Chiapas, Mexico; *Epidendrum ilense* (Orchidaceae) from the Pinchincha Province in Ecuador; *Platycerium grande* (Polypodiaceae) from Mt. Banahau in the Philippines; and others. These species may depend upon the horticultural and scientific support of trained staff members at the Gardens for their survival. Botanical gardens have become flagships of our international botanical efforts in the service of science and humanity during an age of unparalleled ecological crisis.[2]

## Stewardship in an age of crisis

Botanists have identified more than 400,000 species of plants worldwide.[5] However,

***We may lose 2/3 of plant species by the end of the century.***

- approximately 34,000 are threatened at present[6]
- two-thirds of the world's plant species are in danger of extinction during the course of the 21st century[3]
- of the 20,000 known plant species in the United States, more than 200 had already vanished by the end of the 20th century; and another 600 to 700 are in imminent jeopardy[10]

***Humans are the main cause of plant extinctions.***

These plant species are in jeopardy because of a burgeoning human population that then affects proximate causes such as deforestation, habitat loss, the spread of invasive species, and agricultural expansion.[3,6] Given the deplorable rates of deforestation throughout the tropics, where most of the planet's biodiversity is located, we stand to lose thousands of plant species worldwide in the next few decades unless we make a concerted and collaborative effort to conserve them.

***Conservation is accomplished by wise management.***

Conservation is not always synonymous with preservation. Conservation implies wise management. Preservation means to put aside. Preservation can be a conservation strategy, however, for a natural resource that is rare, nonrenewable, or irreplaceable. For example, authorities for a national forest may decide to protect an old-growth stand from hunting, logging, and other extractive uses because of its overall value for posterity. Conservation, then, is an umbrella term that widely encompasses use and nonuse of natural resources, depending upon our management strategy. Ideally, that strategy should be based on four considerations:[1]

- What **ecosystem service** is provided by the resource?
- What is the **economic benefit** of the resource?
- What is the **aesthetic value** of the resource?
- What is the **ethical value** of the resource?

*Ecosystem service*

Easily overlooked are free services provided by nature, such as:

- clean air and water
- nitrogen cycling
- decomposition
- erosion control
- climate stability

***Services provided by nature are superior to human invention.***

It is near-to-impossible to place a dollar value on these benefits, and attempts to replace them with human technologies have fallen short. Mangroves are superior to seawalls, protecting our shorelines from wave erosion and acting as a resilient living barrier during hurricanes. Bacteria return nitrogen gas from our atmosphere to all other living things, where it is essential for the construction of proteins. No invention has been able to imitate that ancient global function. These services have immeasurable value for all living things on the planet.

***Many of our resources come from plants.***

*Economic benefit*

Many plants provide us with food, shelter, fuel, clothing, and medicines. Indigenous peoples face this reality on a daily basis. People in the United States and other affluent countries may think they live removed from local ecosystems, but no one escapes from nature entirely. As a global species, we gain our sustenance from our surroundings. For example:

- fully 50% of our medicines are derived from plants
- 25% of all prescription drugs have their origins in tropical forests

***Medicine, paper, and fuel are products derived from plants.***

The Rosy Periwinkle (Catharanthus roseus) is a native of Madagascar and is considered to be highly medicinal. Photo: Creative Commons.

The cinchona tree of the eastern Andean tropical forest yields the anti-malarial drug, quinine. The rosy periwinkle from Madagascar produces scores of different alkaloids, two of which led to major breakthroughs in cancer treatment. In addition to their medicinal value, plants provide us with numerous other economic benefits: food products, building materials, paper, ornamentation, fuelwood, green gas, even pest control (e.g., the use of the carnivorous plant, *Utricularia*, to trap aquatic insect pests in ponds). Life on the planet, much of it unexplored, represents a cornucopia of natural resources for humanity.

*Aesthetic value*
In addition to deriving our livelihood directly and indirectly from the planet's rich biodiversity, we also value species richness for

- recreation
- scientific research
- wonder
- and primal companionship

***Plants add to our enjoyment of nature.***
Early exploration of the tropical rainforest canopy yielded new kinds of organisms and new ecological processes unknown to us. Fishermen, hunters, skiers, golfers, pet owners, and boatmen all value the outdoors for their sports and livelihoods. And who can say how the faithful of major world religions have been affected by the natural world in which their credos emerged?
***It is our moral obligation to protect all living things.***
*Ethical value*
What is the moral basis for conserving our natural resources, especially the more diminutive, not-so-glamorous species such as bacteria, mosses, and worms? Some scientists argue that morality is the most valid reason for our management strategies, obligating us to do everything possible to prevent human-caused extinction everywhere on the planet. For many scientists, *in situ* preservation of species is the first commandment of conservation. As Aldo Leopold wrote in his *A Sand County Almanac*, "To keep every cog and wheel is the first precaution of intelligent tinkering."[8]

## Education and environmental ethics

***The degree of extinction is greater than first imagined.***
Education and ethics are components of a vital formula for our survival on an ancient, but latterly threatened, planet. Already botanists have documented relentless threats facing the tropics and their plant stocks. Recent data from the latest *IUCN Red List of Threatened Species*, released in September 2000 by the International Union for the Conservation of Nature, indicate that the global extinction crisis is worse than previously believed:[14]

- Not only has the magnitude of risk increased with forest areas shrinking around the world, but the capacity of remaining forests to maintain biodiversity also appears to be diminishing significantly.
- Plant species are declining most rapidly in Central and South America, historically important areas for many botanical gardens, as well as in Central and West Africa, and Southeast Asia.
- Some plants are no longer found in the wild. Botanists have catalogued and preserved many species of orchids and bromeliads that, because of tropical habitat destruction, may now exist only in greenhouses.

In short, the plants forming the basis of botanical gardens' core mission and ethics are under serious threat around the globe. A solid commitment to education and ethics could stem this appalling trend, launching botanical gardens as leaders in ecological stewardship.

## Conclusion: the weight of a petal

***Botanical gardens are crucial in this age of biodiversity crisis.***
Many modern botanical gardens started in far different times. Twenty-five years ago the threats to tropical systems were not as widely documented as they are now. Then we had barely begun our explorations in the world's treetops. Today we sense the imminent collapse of entire ecosystems, including many vital habitats for threatened plant species. The early mission of botanical gardens prioritized the exploration and cataloguing of the wealth of tropical rainforest flora that formed the basis of their plant collections. Today exploration and collection of species are increasingly limited by international regulations and botanical gardens are expanding the scope of their mission to be relevant in the next 25 years.
***Conclusion: Without plant conservation, the balance in nature may be irreparably damaged.***
Botanists now recognize unequivocally the temporal/spatial ecological connections operating within plant communities. We no longer simply focus on collections of rare and unusual species but also include *in situ* and *ex situ* conservation of their ecological associates. Thanks to pioneering efforts during the last 25 years in many remote regions, especially the canopies of tropical rainforests, we now realize how little is known about the diversity and ecological richness of the world's plants — and how much effort is needed to conserve them. Botanical gardens can change the world as flagship institutions for research and education about the plant kingdom. Plants represent the basis of most life on the planet. Like the weight of a petal, a handful of botanical gardens across the globe can help us steward earth's green mantle and, thereby, insure our own survival in an age of ecological crisis.



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http://www.switzernetwork.org/dirdetails.taf?id=334

# The Weight of a Petal: The Value of Botanical Gardens

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***BioScience* Article**

"Horticulture as a Pathway of Invasive Plant Introductions in the United States." Although botanical gardens are important for preservation of rare plants, they can also be a gateway for invasive species. In the February 2001, *BioScience* article, Sarah Reichard and Peter White assert, "Most invasive plants have been introduced for horticultural use by nurseries, botanical gardens, and individuals." Read the abstract or log in to purchase the full article.
http://caliber.ucpress.net/doi/abs/10.1641/0006-3568%282001%29051%5B0103%3AHAAPOI%5D2.0.CO%3B2

**Threatened plants of the world**

The UNEP World Conservation Monitoring Centre provides a database of threatened plants, searchable by four categories, including scientific name or country.
http://www.unep-wcmc.org/species/plants/overview.htm

**Management guidelines for botanical gardens**

Generally accepted criteria for defining the term botanical gardens, as stated in *The Botanic Gardens Conservation Strategy 1989* and the *International Agenda for Botanic Gardens in Conservation 2000*.
http://www.anbg.gov.au/anbg/what-is-a-botanic-gardens.html

**Read a book**

Mary Soderstrom's *Recreating Eden: A Natural History of Botanical Gardens* takes garden lovers on a tour of nine of the most beautiful and exotic gardens in the world (Vehicule PR, 2001).

**Garden Mosaics - English and Spanish**

Learn more about the science behind gardening. Includes educator resources for class activities and information for the general public about topics such as composting, pest control and soil testing.
http://www.gardenmosaics.cornell.edu/pgs/science/mainscience.htm

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**The Garden Web**

A useful resource for anyone who loves plants, with a database of images, useful tips, forums, glossary of terms, and more. The second link takes you to their searchable calendar of events.
http://www.gardenweb.com/
http://www.gardencalendar.com/

**Equal Protection for Plants Campaign (U.S.A.)**

The California Native Plant Society is asking Americans to help them change environmental legislation to include protection of plants. Click on "letter writing" or "action alerts" to find out how you can help.
http://www.plantsocieties.org/eq_protection_2.htm

**Botanical Gardens World Map**

Click on the searchable map to find a garden you might want to visit. You can also click on country names or key words to find a garden's web site.
http://www.gardenvisit.com/m/ekey.htm

**Organizing a garden in your community**

Botanic Gardens Conservation International suggests ways that citizens, business, educators, scientists, and others can help to promote a botanical garden in their area.
http://www.bgci.org/botanic_gardens/promote_a_garden/

**Botanical Gardens Conservation International (BGCI)**

Would you like to visit a botanical garden? Search for a garden anywhere in the world on BGCI's site, the central organisation for plant conservation in botanic gardens around the world.
http://www.bgci.org.uk/botanic_gardens/index.html

**Pollinators in the backyard**

The Backyard Wildlife Habitat program offers tips on how to attract pollinators and other types of wildlife to your own habitat.
http://www.nwf.org/backyardwildlifehabitat/pollinators.cfm

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1. Blair, R.B. and H.L. Ballard. 1996. *Conservation Biology: A Hands-On Introduction to Biodiversity*. Stanford, California: Stanford University.
2. Bramwell, D., O. Hamann, V.H. Heywood, and H. Synge (eds.). 1987. *Botanic Gardens and the World Conservation Strategy*. London: Academic Press.
3. Cheney, Judith, Joaquín Navarrete Navarro, and Peter Wyse Jackson. 2000. *Action Plan for Botanic Gardens in the European Union* ("The Gran Canaria Declaration Calling for a Global Program for Plant Conservation"). BGCI/IABG European Botanic Gardens Consortium.
4. Eiseley, Loren. 1957. *The Immense Journey*. New York: Random House, p. 77.
5. Govaerts, Rafael. November 2001. "How many species of seed plants are there?" *Taxon* 50(4): 1085-1090.
6. Jenkins, D.W. and George Bañez. 2001. *Plant Species Threatened by Extinction Grown in the Marie Selby Botanical Gardens*. Sarasota, Florida: Marie Selby Botanical Gardens.

7. Kellert, Stephen R. and Edward O. Wilson (eds.). 1993. *The Biophilia Hypothesis*. Washington, DC: Island Press.
8. Leopold, Aldo. *A Sand County Almanac*. 1966. New York: Oxford University Press.
9. Steere, W.C. 1958. *Fifty Years of Botany*. New York: McGraw-Hill.
10. Wilson, E.O. 1992. *The Diversity of Life*. Cambridge, Massachusetts: Harvard University Press.
11. American Association of Botanical Gardens and Arboreta website. http://www.aabga.org. Accessed 2/02.
12. "What is a botanic gardens?" Australian National Botanic Gardens. http://www.anbg.gov.au/anbg/what-is-a-botanic-gardens.html. Accessed 2/02.
13. "GardenWeb glossary of botanical terms." http://glossary.gardenweb.com/glossary/. Accessed 2/02.
14. 2002 IUCN Red List of Threatened Species website. http://www.redlist.org. Accessed 2/02.
15. "Carl Linnaeus" biography. University of California at Berkeley. http://www.ucmp.berkeley.edu/history/linnaeus.html. Accessed 2/02.

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### ActionBioscience.org original lesson

This lesson has been written by a science educator to specifically accompany the above article. It includes article content and extension questions, as well as activity handouts for different grade levels.

**Lesson Title:** ***The Value of a Garden***

**Levels:** high school - undergraduate

**Summary:** This lesson engages students in critical thinking about the value of botanical, community, and other gardens in preserving biodiversity and in contributing to sustainable communities. It introduces several concepts drawn from system dynamics, including feedback loops, behavior-over-time graphs…and more!

**Download/view lesson.**

(To open the lesson's PDF file, you need Adobe Acrobat Reader free software.)

**PowerPoint Presentation:** ***Feedback Loops in Flower Gardening*** The PowerPoint presentation, which accompanies certain activities in the lesson "The Value of a Garden," contains 29 slides that will guide teachers and students through activities that generate feedback loops. Includes instructional information. Requires PowerPoint software.

Download/view PowerPoint Presentation

### Lessons for middle school

The following links will take you to middle school lessons available on other web sites:

- » The Junior Master Gardener Program A 4-H gardening project featuring curricula for grades 3 through 8.
http://www.jmgkids.us/
- » Kidsgardening.com This site offers a range of information and curricular materials for anyone involved in youth gardening. The website is particularly suited for teachers and those involved in school gardens.
http://www.kidsgardening.com/
- » Geometric Gardens (middle school)
http://www.education-world.com/a_lesson/01-1/lp229_02.shtml
- » Building a Mini-Park and Bird Sanctuary (middle-high school)
http://www.learningtogive.org/lessons/unit11/lesson4.html
- » Drawing a Landscape Map (middle-high school)
http://www.garden.org/articles/scripts/articles.taf?id=1296&kwd=lesson%20plans&Articlesstart=

### Useful links for educators

- » Case Study Lesson "Marketing Mostly Intangible Goods: The Case of Botanical Gardens and Arboreta" is a complete case study lesson suitable for high school and undergraduate students.
http://www.sciencecases.org/garden/garden_notes.asp
- » Garden Mosaics A Cornell University site that offers teacher's materials, student activities, databases, and links to an investigation of the mosaics of plants, people, and cultures in gardens. Middle to high school grades. Information is also provided for the general public.
http://www.gardenmosaics.cornell.edu/
- » Discovering the Food System A guided experiential learning program designed primarily for youth ages 12 to 18, meant for anyone who is curious about food and how it gets from farm to table
http://www.hort.cornell.edu/foodsys/
- » American Association of Botanical Gardens and Arboreta An association that supports the work, value, and achievements of public gardens in horticultural display, education, research, and plant conservation.
http://www.aabga.org/
- » System Dynamics For more information about system dynamics applications in education:
http://www.clexchange.org/
http://www.watersfoundation.org/
http://www.csdnet.aem.cornell.edu/
http://www.systemdynamics.org/
- » Solar Greenhouses (high school-undergraduate)
http://www.yale.edu/ynhti/curriculum/units/1983/1/83.01.13.x.html#top

### Useful links for student research

In addition to the links in the "learn more" section above:

- » Plant lists and botanical terms Botany from Vermont provides a list of plants, photo "portraits" of plants, a dictionary is provided for botanical and horticultural terms.
http://www.botanyvt.com/
- » Urban Agriculture Notes Features information and links to urban agriculture and community gardening projects around the world.
http://www.cityfarmer.org/
- » The American Community Gardening Association A clearinghouse for information and resource exchange for anyone affiliated with community gardeners and gardening. The link takes you to a variety of resource, e.g., community gardens by state, province, and country.
http://www.communitygarden.org/

- » The Rodale Institute This group works with people worldwide to achieve a regenerative food system that renews environmental and human health.
  http://www.rodaleinstitute.org/
- » National Gardening Articles, how-to projects, help, gardening terms, and more.
  http://www.garden.org/home
- » Resources about ecosystems
  http://www.esa.org/education/
  http://www.lternet.edu/education/
- » Casual Loop Diagrams Explanation and illustration of a variety of diagrams, including behavior-over-time graphs.
  http://www.thesystemsthinker.com/tstgdlines.html
- » Glossaries Garden Web Glossary of Botanical Terms (by keyword)
  http://glossary.gardenweb.com/glossary/
  Botanical Glossary
  http://www.b-and-t-world-seeds.com/botgloss.htm
  Gardening Glossary
  http://www.boldweb.com/greenweb/glossary.htm