

National and International Conservation Efforts and Their Relevance to Plant Conservation in the Southwest

NANCY R. MORIN

The Arboretum at Flagstaff

Plant conservation in the United States benefits directly and indirectly from national and international conservation initiatives. The United Nations Convention on Biological Diversity, which began in December 1993, serves as a guiding force for conservation in the United States even though the U.S. is not a party to the convention. An international meeting in 1998 of leaders concerned with biological collections and the field of systematics addressed what was called the Taxonomic Impediment, consisting of gaps of knowledge in our taxonomic system, a shortage of trained taxonomists, and the negative impact these have had on our ability to manage and use our biological diversity. This meeting resulted in the Darwin Declaration (Anonymous 1998), which calls for initiatives to inventory and provide taxonomic information on the world's organisms and to support the scientific collections and expertise needed to do the work. The Gran Canaria Declaration (Anonymous 2000), stemming from an international meeting in April, 2000, of leaders in botanical conservation, issued a call for global plant conservation.

Within the United States, several networks provide both standards and a framework for plant conservation efforts. State and national agencies are responsible for enforcing laws relating to conservation, and various nongovernmental organizations are devoted to habitat protection through land acquisition or actively advocating for plant and animal conservation.

The Convention on Biological Diversity (CBD), fondly thought of as the mother of all conventions, has many components, all aimed at achieving three basic objectives:

- Conservation of the world's biological diversity
- Sustainable use of its components
- Fair and equitable sharing of benefits

The parts of the CBD most relevant to plant conservation in the Southwest are summarized here; the full text is available online at www.biodiv.org. This paper addresses issues within the Southwest or within the United States, but it is important to remember that Canada and Mexico are signatories to the CBD, and any cooperative work that crosses

these borders will be legally constrained by the articles of the CBD.

Develop National Strategies

Article 6 of the CBD calls for the development of national strategies for the conservation and sustainable use of biological diversity and specifies steps to achieve this:

Article 6: Convention on Biological Diversity

Develop or adapt national strategies, plans, or programs for the conservation and sustainable use of biological diversity.

Integrate, as far as possible and as appropriate, the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programs, and policies.

The Plant Conservation Alliance was established in 1984 (as the Native Plant Conservation Initiative) to develop a comprehensive plan for plant conservation in the United States. Plant conservation receives only about 3 percent of total federal conservation funding, even though more than half of the federally listed taxa are plants, and almost 30 percent of U.S. native plant species are considered threatened (Walter and Gillett 1998). Furthermore, the general public tends to be much less aware of the plight of plants than they are of charismatic animals. The importance of plants in maintaining healthy ecosystems, and as essential links in the web of life that sustains animals and virtually all other organisms, is poorly understood and not appreciated. Consequently, the agenda set out by the Plant Conservation Alliance includes a significant public education component.

Botanic gardens and arboreta in the United States are participating in the development of a plant conservation action plan to implement the International Agenda for Botanic Gardens in Conservation (Wyse Jackson and Sutherland 2000). The Center for Plant Conservation, with its central office at the Missouri Botanical Garden in St. Louis, and its network of botanical gardens and arboreta elsewhere in the United States, provides a national framework for conservation of genetic material of threatened and endangered plants.

Native plant societies or their equivalents, field offices of the Nature Conservancy, Natural Heritage Programs, and formal or informal groups of plant or conservation experts in state agencies, nongovernmental organizations, and academic institutions meet annually or more often to evaluate the status of individual species of concern and to develop plans for their protection. In the past several years regional rare plant task forces have begun meeting to assess status, set priorities, and develop conservation plans. The Southwest Rare Plant Task Force had its inaugural meeting in conjunction with the Third Southwest Rare Plant Conference held in Flagstaff, Arizona.

Although these activities are all encouraging, there is still a need for a nationally adopted comprehensive plan for plant conservation.

The first directive in Article 6 of the CBD also speaks to the sustainable use of biological diversity, perhaps one of the most divisive and difficult issues in the United States today. Attention in the conservation community is focused largely on the restoration of natural processes following resource use that proved unsustainable and on preventing further degradation.

Survey and Monitor

Article 7 of the CBD addresses our current state of knowledge about biological diversity, as well as the need to monitor the components, to discover what is likely to adversely affect biological diversity, and to manage the information.

Article 7: Convention on Biological Diversity

Identify components of biological diversity important for its conservation and sustainable use.

Monitor the components, paying particular attention to those requiring urgent conservation measures and those which offer the greatest potential for sustainable use.

Identify processes and activities likely to have significant adverse impacts on the conservation and sustainable use of biological diversity.

Maintain and organize data derived from identification and monitoring.

The U.S. Bureau of Land Management, National Park Service, and Fish and Wildlife Service have responsibility for surveying and monitoring terrestrial biological diversity. The National Biological Survey, part of the National Partnership for a Biological Survey (Committee on the Formation of the National Biological Survey 1993) brought together the scientific expertise of these various agencies to develop coordinated programs. The National Biological Survey was moved into the

U.S. Geological Survey as its Biological Resources Division, which has provided national leadership to many governmental and nongovernmental partners to address regional conservation needs and to develop a mechanism for sharing information through the National Biological Information Infrastructure.

Efforts such as the Gap Analysis (Scott et al. 1993), which maps keystone species and habitats on a regional level, and environmental monitoring and assessment by the Environmental Protection Agency, provide broad baseline data for identifying large-scale trends. The Nature Conservancy has published a survey of the rare plant communities of the United States (Grossman et al. 1994).

Our knowledge of plant taxa and their distribution in the United States varies considerably. All 50 states have natural resource agencies and natural heritage data centers, and 20 percent also have biological surveys. Excellent floras have been published for the Northeast, Great Plains, and Intermountain regions. Flora of North America is a multi-institutional project that brings together information on all of the plant taxa growing outside of cultivation in the United States and Canada. Many new taxa are still being discovered. For instance, between 1975 and 1995 about 1,000 plant taxa new to science were described from the contiguous 48 states (Hartman and Nelson 1998). Of these, 217 were from California, 183 from Utah, 63 from Nevada, 57 from Arizona, and 41 from New Mexico. Yet many areas of the country are still very poorly known floristically. For instance, despite 20 years of relatively intensive collecting, the Klamath Mountains of southwestern Oregon can still be considered underexplored (Morin 1995). In contrast, the number of herbarium specimens from the Intermountain Region has more than doubled since 1975, and systematic exploration of the Rocky Mountains is underway by botanists at the University of Wyoming. Arizona may be one of the floristically richest areas in the United States but is one of the most poorly known. In need of further collecting are the Arizona Strip region, Navajo Reservation, Glen Canyon, Grand Canyon, the Mogollon Rim, and the eastern Mojave. For bryophytes, the states of Nevada, Arizona, New Mexico, and part of Texas are in most need of work (Whittemore and Allen 1995).

Population level information on rare plants is monitored by responsible state and federal agencies, the Nature Conservancy, Center for Plant Conservation gardens and arboreta, and botanists studying specific taxa.

Table 1. Floristic statistics (Stein et al. 2000).

	Total species	Conservation concern	Endemic
North America north of Mexico	20,000	23%	–
Arizona	3510	604	164
California	6400	1735	1517
Nevada	2844	479	90
New Mexico	3290	409	81
Utah	2960	515	169

The basic requirements for survey and monitoring are expert knowledge and collections that both underpin and document that knowledge (Heywood 1995). Although the lack of botanical experts and collections is much more serious in biologically rich developing countries, we also face many challenges in the United States. The need for basic taxonomic facilities, collections, specialists, and mechanisms for managing and sharing information is being addressed by several initiatives. An agenda for action is set out most broadly in the Darwin Declaration:

Darwin Declaration:

Countries should invest in the development of appropriate infrastructure for their national collections.

Encourage partnerships between institutions in developed and developing countries to promote scientific collaboration and infrastructure rationalization. Should include training initiatives. Should develop national priorities in taxonomic training, infrastructure, and new technology.

Adopt internationally agreed levels of collection housing.

Provide training programs at different educational levels.

Use information systems to maximize effect in taxonomic institutions.

The Global Taxonomy Initiative (www.biodiv.org) provides some specific recommendations. It has been adopted by the Conference of Parties (representatives of the countries signatory to the Convention on Biological Diversity) and provides a vehicle by which countries can develop their expert capacity as well as a vehicle for funding. The Global Taxonomy Initiative calls for development of a national taxonomic needs assessment and creation of employment opportunities for taxonomists. It includes building capacity for bioprospecting, habitat conservation, sustainable use of biological diversity, and adequate, long-term housing of collections and records. Countries are to designate national reference centers to make

information housed in collections available to countries of origin.

We need to conduct a national assessment of taxonomic capacity. For instance, it is well known that many groups of invertebrates have no specialist, and there are many major plant groups for which there is no specialist. A recent survey of herbaria in the southeastern United States (Funk and Morin 2000) showed that although most of the larger herbaria were active and secure, many smaller regional herbaria were at risk. Surprisingly, even the fate of one of the largest of the herbaria was in doubt. Similar surveys should be done for each region in the United States.

Processes Affecting Biodiversity and Sustainable Use

The greatest threat to biological diversity in the United States, as in the rest of the world, is population growth. The U.S. population is increasing by 2.8 million each year. Eighty percent of the population lives in metropolitan areas, making a great impact on natural areas adjacent to them. Agriculture affects grasslands in particular, grazing impacts grasslands and arid regions, and forests are harvested for timber.

Many of our major habitats have been severely impacted. Freshwater wetlands in the United States occupied 200 million acres (81 million hectares) in presettlement times. Only 95 million acres (38 million hectares) remain and some states have lost 90 percent of their wetlands. It is thought that 240,000 to 360,000 acres are impacted each year (Raven et al. 1993).

Grasslands once covered 40 percent of the U.S. landmass. Originally these grasslands were dominated by perennial grasses; now they are mostly annuals. Only 1 percent of virgin grassland remains. For instance, in the California Floristic Province, needlegrass originally covered 5 million hectares and is now reduced to 400 hectares, whereas annual grasses once covered only 400 hectares and now cover 3.5 million hectares (Bryant 1998).

Only 10 percent of old-growth temperate rain forests survive, and that is in scattered patches. More than half of the forest land in the United States is privately owned. The U.S. Forest Service governs 300,000 square miles of forest, of which 136,000 square miles are classified for commercial logging.

Deserts occupy 5 percent of the North American landmass. In 1981, 350,000 square miles in the

United States were undergoing severe or very severe desertification. Changes in succession due to fire suppression, grazing, and other disturbances are leading to tree and shrub dominance in deserts. Erosion is severe in some areas.

Organization of data

The number of initiatives to compile information on the world's organisms is large. Although they may seem to overlap, in fact each one serves a specific purpose (Table 2).

Many museums and herbaria are computerizing data from their collections to make those data more generally available and usable. These databases, many available as Internet resources (and prefixed by <http://>), are compiled mostly on a state or regional basis. Examples include the SMASCH database of the University of California at Berkeley and Jepson Herbaria (ucjeps.berkeley.edu), the Vascular Plant Catalog of the

Intermountain Region of the Western United States (www.nybg.org/bsci/hcol/intf), the Atlas of the Vascular Plants of Utah (www.nr.usu.edu), the Atlas of the Vascular Plants of Wyoming, the Flora of Texas Consortium (csdl.tamu.edu/flora; www.esb.utexas.edu), the Atlas of the Flora of New England (www.herbaria.harvard.edu), the Atlas of Tennessee Vascular Plants (www.bio.utk.edu/botany/herbarium), the Pennsylvania Flora Database (www.upenn.edu/paflora/dbsearch.html), the South Carolina Plant Atlas (cricket.biol.sc.edu/herb), and the Atlas of Florida Vascular Plants (www.plantatlas.usf.edu).

Databases that synthesize information from many different sources for the entire country include the Plants Database (plants.usda.gov), the Association for Biodiversity Information (www.natureserve.org), and the American Bryophyte Catalog (www.nybg.org/bsci/hcol/bryo/). An example of a special-topic database is the Southwest Exotic Mapping Program (www.usgs.nau.edu/swemp).

Table 2. Hierarchy of taxonomic initiatives.

Clearing House Mechanism	As specified by the CBD, every country must designate a national center through which information on its own biological diversity, and information it holds on the biodiversity of other countries, must be made available.
Global Biodiversity Information Facility	A mechanism for coordinating and making interoperable diversity databases; ultimately a digital library of biodiversity knowledge (Edwards et al. 2000).
Species 2000	A database of basic taxonomic information about all organisms worldwide. Species 2000 acquires data for major taxonomic groups, e.g. birds (Bisby 2000).
International Organization for Plant Information	IOPI is compiling taxonomic and distributional data on plants of the world. Their World Checklist brings together data from various floras, which are then checked by taxonomic specialists (Morin 1998). It provides the plant component of Species 2000. The Species Plantarum Project of IOPI provides expanded treatments of plant families.
Flora of North America	An example of a continental flora that provides basic taxonomic information for IOPI and Species 2000. It contains new scientific work as well as information from other floristic works (Morin et al. 1989).
Intermountain Flora	An example of a regional flora based on field work, examination of specimens, and evaluation of the literature. Local floras and checklists.

Protecting Plants in Place

Almost 60 percent of the land in the United States is privately owned. About 30%, or 655 million acres, is under federal management, distributed as follows: BLM 265 million acres, USFS 191 million acres, NPS 83 million acres, FWS 91 million acres, and DOD 25 million acres. Three percent is owned by Native American tribes, and the remainder is state or municipal (M. Olwell, personal communication, February 2000). Federal agencies are legally mandated to manage much of their land for multiple uses, and even lands not subjected to extractive economic use may be severely impacted by those simply wishing to enjoy them; nearly 60 million people visit the 50 U.S. National Parks each year. The Nature Conservancy owns and provides stewardship for more than 12 million acres. In the past decade various agencies and the Nature Conservancy have begun to manage land on a very large scale in recognition of the impact that adjacent land use has on preserved areas and the necessity of maintaining the integrity of natural processes, such as water drainages and catchments. Within states, decisions about which areas need to be protected are often made as a collaborative effort among federal, state, and non-governmental biologists and resource managers. Educating the public, and especially private landowners, is a key element to in situ conservation.

Article 8: In Situ Conservation

Establish a system of protected areas.

Develop guidelines for their selection, establishment, and management.

Promote the protection of ecosystems, natural habitats, and the maintenance of viable populations of species in natural surroundings.

Establish buffer areas.

Rehabilitate and restore degraded ecosystems and promote the recovery of threatened species through the development and implementation of plans or other management strategies.

Control risks associated with use of living organisms.

Prevent the introduction of, control, or eradicate the alien species which threaten ecosystems, habitats, or species.

Respect, preserve and maintain knowledge, innovations, and practices of indigenous and local communities.

Perhaps the greatest challenge to in situ conservation, after direct use for development, is the extent to which land management practices have altered natural processes. Fire suppression and grazing practices have resulted in unhealthy forests in many areas of the United States, but most conspicuously in the West. Grasslands have been irreversibly altered; wetlands completed converted. Catastrophic fires now occur on an enormous scale, and we have little knowledge of how to seed or replant millions of acres in a way that facilitates normal succession of native plants rather than extreme erosion or invasion by non-native plants.

Invasive plants pose the second greatest threat to endangered plants after habitat destruction; nonnative species threaten two-thirds of all endangered native species. Some 8–47 percent of the total flora of most states is composed of introduced invasive plants (Randall and Marinelli 1996). Invasive weeds cost the U.S. economy more than \$20 billion each year, according to a 1994 figure (Westbrooks 1998). According to Pimentel et al. (2000), yellow star thistle (*Centaurea solstitialis*) now dominates more than 4 million hectares of northern California grassland. European cheatgrass (*Bromus tectorum*) now forms monocultures on 5 million hectares in Idaho and Utah, where it has fundamentally altered cyclical fire patterns. A U.S. Department of the Interior survey reported that noxious weeds are invading western wildlands at a rate conservatively estimated to be

nearly 5,000 acres per day (Environmental News Network, Inc. Web site, 6 October 1998). On BLM land alone, approximately 35 million acres are infested with invasive species.

To halt intentional introduction of nonnatives, a 1994 Executive Memo and a 1999 Executive Order (EO 13112) by President Clinton directs that native plants be used in plantings and seeding on federal lands whenever feasible. “Feasibility” is a serious issue, however. A workshop called in February 2000 by W. Brown, Science Advisor to Secretary of the Interior Babbitt, tried to identify and address the barriers to using native plants. The greatest problem is lack of appropriate material in large enough quantities. In 1999, 2.5 million acres of BLM land burned in the Great Basin alone. To reduce erosion due to rain after the fire, it is necessary to seed the burned area quickly, and there is not enough time to propagate and bulk up seeds from appropriate genetic material. Most nurseries cannot afford to maintain large stores of seeds with no assurance of a buyer. Because it is very labor intensive to gather seeds of native plants, the seeds are much more expensive, even in small quantities, and this is another factor in what is considered feasible. The workshop recommended that internal federal purchasing procedures be changed to make it economically possible for nurseries to gather, grow, and store the seeds that will be needed. Large areas with mostly native plant communities, such as reserves, military installations, and botanical gardens, could serve as sources of native seeds.

Botanical gardens and arboreta can help to educate the public about weeds and the problems they cause, as well as helping prevent introduction of new invasives through the horticultural trade. Regional nonnative plant pest councils play an important role in identifying local problems and developing management plans, including public education and public weed eradication activities. President Clinton created an Interagency Invasive Species Council and a Federal Interagency Weed Committee, and Secretary Babbitt established an Invasive Weed Awareness Coalition.

In the West, Native SeedSearch may be one of the best-known organizations devoted to preservation of indigenous knowledge and heritage seed material. Local botanists and herbalists work individually with Native American elders to learn and preserve their knowledge of plants, plant remedies, and foods. There are other organizations

that research, acquire, and maintain heritage cultivars, but we are probably on the brink of losing a tremendous amount of knowledge held by people born in the early part of the 1900s for whom native plants and home-grown foods were an essential part of life. Many of these people transferred knowledge and experiences that they had gained in their birth countries to the plants they found in the United States. Their knowledge is likely to die with them.

Protecting Plants Outside Their Habitats

Direct conservation of genetic material of plants of conservation concern is the goal of the Center for Plant Conservation (CPC). Established in 1984, CPC is a network of 29 botanical gardens and arboreta that have agreed to maintain genetically viable material of threatened or endangered plant species. In June 2000, the U.S. Fish and Wildlife Service designated CPC as an official partner and clearinghouse in plant conservation. Currently, the network holds material of 570 critically imperiled taxa out of 735 threatened or endangered species listed by USFWS.

Article 9: Ex Situ Conservation

Adopt measures for ex situ conservation of components of biological diversity, preferably in the country of origin.

Establish and maintain facilities for ex situ conservation of and research on organisms, preferably in the country of origin.

Adopt measures for the recovery and rehabilitation of threatened species and for their reintroduction into their natural habitats under appropriate conditions.

Regulate and manage collection of biological resources.

Cooperate in providing financial and other support for ex situ conservation.

In addition to selecting, acquiring, and maintaining genetic material for permanent protection, the Center for Plant Conservation has provided leadership in developing standards and protocols for seed storage, handling of recalcitrant seeds, tissue culture of difficult plants, and documentation (e.g., Falk and Holsinger 1991). CPC and its member gardens now are extending their work to full recovery plans, in which ex situ conservation plays an essential role (Falk et al. 1996). The Gran Canaria meeting also recommended integrating ex situ and in situ conservation strategies:

Gran Canaria Declaration

- Set agreed levels and standards in plant diversity conservation and services worldwide to be achieved within a defined time frame.
- Give special attention to the conservation of the world's most important centers of plant diversity, including the ecosystems and the species they contain.
- Support the maintenance of genetically diverse and accessible samples of the world's plant species in botanical collections throughout the world.
- Pay special attention to the conservation of plant species of direct economic importance to human societies.
- Control invasive alien plants and animals, which pose one of the greatest threats to natural habitats.
- Develop and implement best practices in plant conservation which will ensure the fullest community and institutional participation at all levels.

Much of the tension in our communities these days comes from differences of opinion and perception about the value of preserving native biological diversity and natural processes versus economic or social benefits of actions that destroy biological diversity and upset natural processes. Housing developments, grazing, logging, dams, and recreation, are all traditional uses of natural resources. The livelihood of individuals, families, or entire communities may depend on these uses. At the same time, some citizens consider their desire for conservation of species, for pristine habitats, and for a return to natural processes to be as legitimate as any economic need.

Article 10: Sustainable Use of Components of Biological Diversity

Promote incentives for the conservation and sustainable use of components of biological diversity.

Ensure adequate incorporation of market and non-market values of biodiversity into plans, policies, and programs, including national accounting systems and investment strategies.

Develop training and capacity building programs and promote private sector initiatives.

Incorporate biodiversity considerations into impact assessments.

Research supports the concept that biological diversity, as individual components or as communities or habitats, provides essential services to people and the environment, including cleaning water and removing pollutants from the air (Pimentel et al. 2000). The Nature Conservancy's ecoregion programs address conservation issues on a large scale and engage the interest and par-

ticipation of human communities in addressing sustainable use of the area. The Gran Canaria workshop summarized the issues as they relate to plants specifically.

Gran Canaria Declaration

- Identify and assess the socio-economic value and the cultural value both of particular species of plants and of plant diversity itself.
- Identify and assess the existing and potential products and services provided by plant diversity.
- Ensure that benefits derived from the use of plants are fairly and equitably shared.
- Identify the underlying causes of plant diversity loss and assess the potential risks and constraints on conservation, particularly in countries that are rich in plant diversity.

Build Capacity

The CBD and the Gran Canaria Declaration both emphasize the need for research on the biology of organisms, on their ecology, and on their relevance to social, cultural, and economic factors. A full inventory of the plant diversity of the world and information systems to manage the data is urgently needed. As discussed above, much floristic work is needed in the United States as well.

Article 12: Convention on Biological Diversity

Establish and maintain programs for scientific and technical education and training for the education, conservation, and sustainable use of biological diversity.

Promote and encourage research which contributes to the conservation and sustainable use of biological diversity.

Promote and cooperate in the use of scientific advances in biological diversity research in developing methods for conservation and sustainable use of biological resources.

The establishment of programs in conservation biology in a number of universities is encouraging; the loss of traditional expertise and training in descriptive botany is discouraging. There are 628 herbaria in the United States and 110 in Canada. As mentioned above, a recent survey of herbaria in the southeastern United States showed a pattern of smaller, regional herbaria being abandoned or absorbed by larger herbaria (Funk and Morin 2000).

Gran Canaria Declaration

- Undertake international programs of research on plant biology and interactions with social, cultural, and economic factors that impact biodiversity.
- Document the plant diversity of the world, including up-to-date information on its distribution in the wild, its conservation status and trends, and its use and preservation in protected areas and ex situ collections.
- Develop an integrated, distributed, interactive information system to manage and make accessible information on plant diversity.
- Monitor the status and trends in global plant diversity and its conservation and produce regular reports.

Educate!

It seems fitting to close this paper with statements from the Convention on Biological Diversity and the Gran Canaria Declaration. If we are to achieve conservation goals, we must engage the interests and emotions of people whose decisions will, in the end, decide the fate of plant and animal species. We must do this for every age group, economic group, and ethnic group. We must reach taxpayers and legislators, individuals, groups, communities, and countries. Plants are essential to our lives and to the lives of generations yet to come, and it is only by understanding this that we can save them and ourselves.

Article 13: Convention on Biological Diversity

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 programs.

Gran Canaria Declaration

- Articulate and consistently emphasize the benefits of conserving plant diversity, to raise awareness of the importance of plants and the threats they face, thereby encouraging active participation in their conservation.
- Inform citizens and policy makers in every country about conservation priorities and policy options for plant species and their ecosystems.
- Use relevant botanical institutions as shop windows for plant conservation by demonstrating the interdependence of human beings and plants within all ecosystems.
- Incorporate the importance of plants and plant conservation into formal and informal education. Cooperate, as appropriate, with other States and international organizations in developing educational and public awareness programs with respect to conservation and sustainable use of biological diversity.

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