Chapter 10
Maintaining Biological **Diversity Internationally**

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Maintaining Biological Diversity Internationally

HIGHLIGHTS

Existing international laws and programs to maintain biological diversity are too disconnected to address the full range of concerns over the loss of biological diversity. As a result, redundancies and gaps exist.

- Concerns over free flow of genetic resources have led to heated political controversy in international fora. However, debates have been largely counterproductive and could benefit from a more informed and less impassioned analysis of the issues.
- Intergovernmental and nongovernmental organizations are making significant contributions to maintaining biological diversity worldwide. These organizations, however, have different strengths and weaknesses; those of nongovernmental groups are largely the converse of intergovernmental groups.

OVERVIEW

International laws and programs relevant to maintaining biological diversity have evolved on an ad hoc basis. Efforts tend to be focused on particular species or habitat types and undertaken in relative isolation from other conservation and development activities. Consequently, overall efforts fail to deal comprehensively with diversity maintenance concerns. Redundancy and gaps in coverage result, and benefits of interactions between different activities go unrealized.

As a relatively new platform, biological diversity maintenance has yet to achieve prominence on international agendas. Increasingly, however, international conservation and development organizations, both public and private, are redefining their activities around the concept of diversity maintenance. What remains to be accomplished is an overall accounting of the scope and effectiveness of this increased activity to determine gaps in the current system and methods to fill them.

Onsite laws and programs have their roots in early 19th century Europe and a narrow constituency concerned with the protection of certain bird species (10). Since World War II, however, the number of organizations, legal instruments, and scope of activities in the international arena has increased dramatically. There has also been a shift in focus from protecting particular species to recognizing the importance of habitat in species maintenance. Programs for maintaining genetic resources offsite are barely a decade old, and increased attention has led to efforts to define national obligations to maintain and provide access to genetic resources. Growing realization of the threats to diversity has also focused attention on the importance of cooperation between onsite and offsite programs. Efforts to control trade in endangered species on an international scale and

initiatives to link conservation activities of zoos and botanic gardens with onsite conservation programs highlight these potentials.

The diversity of international institutions and programs dealing with conservation defies complete enumeration or simple categorization. In general, however, their principal functions encompass one or more of the following: problem identification, monitoring and evaluation, data gathering, risk estimation and impact assessment, information exchange and dissemination, national and international program coordination, standard setting and rulemaking, standards and rules supervision, and operational activities (62).

This chapter outlines the major international laws and programs with particular bearing on maintaining biological diversity. International laws are described by the breadth of diversity they cover, ranging from global conventions on ecosystems to treaties concerned with particular species. International conservation programs and institutional networks are also highlighted. Onsite and offsite program activities are addressed separately because of the distinctness of their operations.

INTERNATIONAL LAW

Public international law governs relations between countries, compared with private international law, which governs relations between individuals, Public international law provides a variety of direct and indirect tools for maintaining onsite biological diversity. Most are part of broader conservation objectives, commonly focused on protection of single species, groups of species, or habitats.

The instruments of international law dealing with conservation have varying levels of binding obligation. The terms “hard” and “soft” law are used to distinguish levels of legal significance (52). “Hard” law refers to binding obligations reflected either in treaties or customary international law. “Soft” law refers to instruments that have little legally binding force but may carry persuasive influence and policy guidance for state conduct (e.g., international declarations and resolutions from international conferences or intergovernmental organizations).

The effectiveness of international law depends on the support, implementation, and enforcement at the national level. The uneven distribution of diversity creates major complexities in promulgating binding international law in this area. The difficulty is compounded because regions with the greatest diversity are often those with the most limited financial and technical capacities to devote to these efforts.

In international law, a state has authority over all natural resources within its territory. When a state ratifies a treaty, however, it voluntarily restricts some of its rights and assumes certain obligations. The early development of international conservation law was inspired by interests in protecting Iarge game mammals and birds. Less attention has been paid to onsite conservation of wild plants, unless they are indirectly protected by international traffic controls to protect commercial and agricultural plants from pests or pathogens, An exception is the convention to control trade in endangered wild species of fauna and flora (discussed later in this chapter).

The extensive array of international laws that deal with various aspects of biological diversity maintenance should not be interpreted as evidence that concerns for diversity loss have been adequately addressed. As noted previously, many laws deal with specific species or habitat types. Comprehensive coverage is lacking. Further, it is important to consider the degree of obligation (e.g., hard v. soft law) and effectiveness of legal instruments (e. g., existence or adequacy of a secretariat or other operational support).

The following discussion of international law examines onsite and offsite maintenance, the former being the focus of the majority of legal instruments. The onsite discussion examines

various hard-law treaties and several soft-law documents. Although international laws related to off site maintenance are scant, several soft-law agreements exist. Relevant hard-law agreements deal with tangential issues of international patenting and quarantine,

International Laws Relating to Onsite Maintenance

The existence of an internationally recognized and established obligation to conservation can be of substantial importance to maintaining biological diversity onsite at national and international levels, Increasingly, international obligations are providing national conservation authorities with the extra justification needed to strengthen their own conservation programs. Particularly because of this growing role, international conservation conventions and soft-law documents are important legal and policy tools to be used with other technical, administrative, and financial measures.

Global and regional treaties are also important tools for long-term conservation, although many are not effectively implemented. For some treaties, lack of institutional machinery, such as a secretariat and a budget, is a major drawback. Many are difficult to enforce because incentives are weak and early signs of success are hard to identify, making retaliation difficult if a party chooses to ignore the treaty or fails in its obligations. Some global conventions have too few non-European parties. Finally, in many developing countries in particular, technical and financial resources for implementation are scarce (47).

Global Conventions

Of the five conventions discussed here, the first four are commonly referred to as the "big four" wildlife conventions and are the most important for protection of flora, fauna, and their habitats (47). The Law of the Sea Convention is also included because of its global scope, (For texts of these international and regional treaties, see ref. 11; for summaries of major environmental treaties, see ref. 73,)

The *Convention on International Trade in Endangered Species of Wild Fauna and Flora [CITES),* established in 1973, controls international trade in wild species of plants and animals listed in the convention appendices as endangered or threatened. with 91 countries now party to it (48), CITES has been called the most successful international treaty concerned with wildlife conservation (52).

The convention has been reinforced by U.S. legislation. U.S. importation of wildlife taken or exported in violation of another country's laws was prohibited by amendments in 1981 (Public Law 97-79) to the Lacey Act of 1900. This legislation supports other nations' efforts to conserve their wildlife resources and the international controls under CITES. It provides a Powerful tool for wildlife conservation throughout the world because of the significant amount of wildlife imported by the United States.

The *Convention on Wetlands of International Importance Especially as Waterfowl Habitat* (commonly known as Ramsar, after the town in Iran where the convention was signed), passed in 1971, established a wetlands network and promotes the wise use of all wetlands with special protection for those on the List of Wetlands of International Importance, As of mid-1985, there were 40 contracting parties to the convention and about 300 wetland sites, covering some 20 million hectares, on the List of Wetlands of International Importance (47). Once a site is on the list, the party concerned has a legal obligation to conserve the site (article 3(1)),

The *Convention Concerning the Protection of the World Cultural and Natural Heritage,* signed in 1972, established a network of protected areas and provides a permanent legal, administrative, and financial framework for identification and conservation of areas of outstanding cultural and natural importance. It organized a world Heritage Committee, a world Heritage List, a List of World Heritage in Danger, and a World Heritage Fund to help achieve convention goals. (The World Heritage program is discussed later in this chapter.)

The *Convention on the Conservation of Migratory Species of Wild Animals* (commonly cited as the Bonn Convention), passed in 1979, provides strict protection for migratory species in danger of extinction throughout all or a significant part of their range, and encourages range states to conclude agreements for management of species that would benefit from international cooperation. Fifteen states were party to the convention as of 1984, and the first meeting of the parties in October 1985 established machinery for implementing the convention,

Marine conservation also has received increased attention, particularly in the past two decades, The *Convention on the Law of the Sea,* adopted in 1982 at Montego Bay and yet to come into force, identifies a number of general obligations relevant to conservation. Article 192 imposes an obligation on states to protect and preserve the marine environment. Coastal states are obliged to ensure through proper conservation and management measures that living resources in their exclusive economic zones are not endangered by exploitation (article 61(2)). Activities outside national jurisdiction are to be undertaken "in accordance with sound principles of conservation" (article 15(b)).

Regional Conventions

Other regional treaties have emphasized conservation of habitat through creation of protected areas and other programs. The major conventions in force are the *Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere* from 1940; the *African Convention on the Conservation of Nature and Natural Resources* from 1968; the *Convention on the Conservation of European Wildlife and Natural Habitats* from 1979; and the *ASEAN Agreement on the Conservation of Nature and Natural Resources* from 1985. With habitat destruction being a principal threat to biological diversity, treaties that call for protection of flora and fauna through habitat protection are particularly important and need long-term support. The Western Hemisphere and African conventions, however, have had difficulties with implementation and enforcement at the national level, largely due to financial and technical limitations. The more recently developed Association of Southeast Asian Nations (ASEAN) Convention involved regional consultations to incorporate management and conservation techniques and therefore elicits greater hopes for success.

The regional seas programs developed by the United Nations Environment Programme (UNEP) in cooperation with other agencies, particularly the Food and Agriculture Organisation of the United Nations (FAO) and the International Meteorological Organization, involve 10 regions encompassing about 120 of the 130 or so coastal states in the world. (The 10 regions are the Caribbean, Mediterranean, Persian Gulf, West and Central Africa, East Africa, East Asia, Red Sea and Gulf of Aden, South Pacific, South-East Pacific, and South-West Atlantic.) The objective is to reduce pollution and conserve biological resources through cooperative management efforts. The legal mechanisms include action plans and regional conventions. The regional seas conventions include articles on pollution from ships, aircraft, and land-based sources; pollution monitoring; and scientific and technological cooperation. Protocols are authorized in each convention text and address specific approaches to certain problems. Technical annexes provide standards for regulatory or cooperative activity.

protocols are also being explored for protection of easily disrupted marine ecosystems and for habitats of depleted or endangered marine life through the creation of protected areas. The *Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region,* signed in Cartagena, Colombia in 1983, is generating government discussion on protected areas and wildlife in this region, Resolutions adopted call for preparation of draft protocols (19). U.S. technical support could be a key factor in the ratification and implementation of such protocols (2o).

The *Convention on the Conservation of Antarctic Marine Living Resources,* passed in 1980, contains important innovations on the conservation of biotic resources. It obliges parties to adopt an ecosystem approach to exploitation

of Antarctic resources, thus requiring consideration of impacts on interdependent species and the marine system as a whole when setting harvest limits. Article I(2) of the convention defines marine living resources to include all species of living organisms, including birds, found south of the Antarctic convergence (where the warm and cold waters of the Antarctic Ocean meet).

Species-Oriented Treaties

A group of species-oriented treaties focus on controlling exploitation of specific wildlife, such as polar bears, vicka, northern fur seals, whales, and Antarctic seals (52). Although these treaties are concerned primarily with controlling harvesting, attention to specific species commonly extends to concerns for their habitat, thus potentially serving biological diversity more broadly, The major species-oriented treaties are listed in table 10-1.

Declarations and Resolutions

The United Nations Conference on the Human Environment, held in Stockholm, Sweden in 1972, adopted a *Declaration on the Human Environment* that remains a key soft-law document on international environmental issues. The Stockholm Declaration contained 26 principles to guide the international effort to protect the environment, Principle 2 addresses conservation of the Earth's biological resources:

> The natural resources of the earth including the air, water, land, flora and fauna, and especially representative samples of natural ecosystems must be safeguarded for the benefit of present and future generations through careful planning or management as appropriate,

Another important soft-law is the *World Conservation Strategy (WCS),* a comprehensive document prepared by the International Union for Conservation of Nature and Natural Resources (IUCN). Advice, cooperation, and financial assistance for the preparation of WCS were provided by UNEP and the World Wildlife Fund, with collaboration from FAO and the United Nations Educational, Scientific, and Cultural Organization (UNESCO).

The strategy was launched worldwide in 1980 in some 30 countries. It provides broad policy guidelines for determining development priorities to secure sustainable use of renewable resources, and it links conservation and development, The world Conservation Strategy has three principal objectives: 1) maintenance of essential ecological processes and life-support systems, 2) preservation of genetic diversity, and 3) sustainable use of species and ecosystems.

Introductory sections of the WCS define conservation as:

> . . . the management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations (43).

Development is defined as:

> . . . the modification of the biosphere and the application of human, financial, living, and non-living resources to satisfy human needs and improve the quality of human life.

As defined and used in the WCS, conservation and sustainable development are mutually dependent processes.

A key WCS priority is the promotion of national conservation strategies. These conservation planning tools are now completed or in preparation in 29 countries (see table 10-2), Their long-term purpose is to integrate conservation and development planning and provide an important tool for all stages of development.

The *World Charter for Nature* offers a third example of soft law that is becoming increasingly influential in development. This document, the result of 7 years of effort by international organizations and the United Nations, proclaims 24 principles of conservation by which all human conduct affecting nature is to be guided and judged. In 1982, the United Nations General Assembly, by a vote of 111 to 1, adopted the charter sponsored by the Government of Zaire and 35 other nations,

The United States, the only dissenting vote, objected to the mandatory language contained in the supposedly nonbinding document (14).

Table 10-1 .—International Treaties and Conventions for Onsite Maintenance

Title	Established	U.S. signed
Global conventions		
Convention on Wetlands of International Importance Especially as Waterfowl Habitat	1971	pending
Convention Concerning the Protection of the World Cultural and Natural Heritage	1972	1973
Convention on International Trade in Endangered Species of Wild Fauna and Flora	1973	1975
Convention on the Conservation of Migratory Species of Wild Animals	1979	
Convention on the Law of the Sea	1982	not signed
Regional conventions		
Convention on Nature Protection and Wildlife Presentation in the Western Hemisphere	1940	1942
African Convention on the Conservation of Nature and Natural Resources	1968	NA
Convention on the Conservation of European Wildlife and Natural Habitats	1979	NA
Convention on the Conservation of Antarctic Marine Living Resources	1980	1982
ASEAN Agreement on the Conservation of Nature and Natural Resources	1985	NA
Convention for the Protection of Mediterranean Seas Against Pollution	1976	NA
Kuwait Regional Convention for Cooperation on Protection of Marine Environment and Pollution	1978	NA
Convention for Cooperation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Regions	1981	NA
Convention for the Protection of Marine Environment and Coastal Areas of Southeast Pacific	1981	NA
Convention for the Conservation of Red Sea and Gulf of Aden Environment	1982	
Convention for Protection and Development of Marine Resources of the Wider Caribbean Region	1983	1983
Convention for Protection and Development of the Natural Resources and Environment of the South Pacific Region	1985	pending
Species-oriented treaties		
Birds:		
Convention for the Protection of Birds Useful to Agriculture (Europe)	1905	NA
Convention for the Protection of Migratory Birds (Canada/U. S. A.)	1916	1916
Convention for the Protection of Migratory Birds and Game Animals (Mexico/U. S. A.)	1936	1936
International Convention for the Protection of Birds (Europe)	1950	NA
Benelux Convention on the Hunting and Protection of Birds (Europe)	1972	NA
Convention for the Protection of Migratory Birds and Birds in Danger of Extinction and Their Environment (Japan/U. S. A.)	1972	1972
Convention for the Protection of Migratory Birds and Birds Under Threat of Extinction and on the Means of Protecting Them (U.S.S.R./Japan)	1973	NA
Agreement for the Protection of Migratory Birds and Birds in Danger of Extinction and Their Environment (Japan/Australia)	1974	NA
Convention Concerning the Conservation of Migratory Birds and Their Environment (U. S. S. R./U. S. A.)	1976	1976
Directive of the Council of the European Economic Community on the Conservation of Wild Birds (EEC)	1979	NA
Polar bears		
Agreement on the **Conservation** of Polar Bears	1973	1976
Seals		
Interim Convention on the Conservation of North Pacific Fur Seals	1957	1957
Agreement on Measures To Regulate Sealing and To Protect Seal Stocks in the Northeastern Part of the Atlantic Ocean	1957	
Agreement on Sealing and the Conservation of Seal Stock in the Northwest Atlantic	1971	
Convention for the Conservation of Antarctic Seals	1972	1978
Vicuna:		
Convention for the Conservation of Vicufia	1969	NA
Convention on the Conservation and Management of Vicuria	1979	NA
Agreement Between the Bolivian and Argentinean Governments for the Protection and Conservation of Vicufia	1981	NA
Whale:		
Convention for the Regulation of Whaling	1931	1935
International Convention for the Regulation of Whalina	1946	1948

SOURCES Simon Lyster, *International Wildlife Law* (Cambridge, England" Grotius Publications Ltd , 1985); Barbara Lausche, "International Laws and Associated Programs for *In-Situ* Conservation of Wild Species, " OTA commissioned paper, 1985, Federal Interagency Global Issues Work Group, U S *Government Participation* in *International Treaties,* Agreements, Organizations and Programs, *In the Fields of Environment, Natural* Resources and Popu/af/err, 1984, United Nations Environment Programme, *Regional Seas Achievement and Planned Development of UNEP's Regional* Seas *Programmes and Comparable Programmes Sponsored by Other Bed/es,* UNEP Regional Seas Reports and Studies No 1, 1982, and M Wecker, Council on Ocean Law, personal communication 1986

Table 10-2.—Countries Where National Conservation Strategies Are Being Developed

Australia	Madagascar	Sierra Leone
Bangladesh	Malawi	Spain
Belize	Malaysia	Sri Lanka
Botswana	Mauritania	St. Lucia
Great Britain	Nepal	Switzerland
Canada	Netherlands	Togo
Costa Rica	New Zealand	Uganda
Fiji	Norway	Vanuatu
Guinea Bissau	Oman	Venezuela
Honduras	Pakistan	Zambia
Indonesia	Panama	Zimbabwe
Italy	Philippines	
Jordon	Senegal	

SOURCE Mark Halle, deputy director, Conservation for Development Center, International Union for Conservation of Nature and Natural Resources Gland, Switzerland, personal communication Oct 17, 1986

That is, the document used "shall" rather than "should," despite a general recognition that "by its very nature, the charter could not have any binding force, nor have a regime of sanctions attached to it" (83).

The charter includes several principles relevant to biological diversity:

- The genetic viability on the Earth shall not be compromised; the population levels of all life forms, wild and domesticated, must beat least sufficient for their survival, and to this end, necessary habitats shall be safeguarded.
- The allocation of areas of the Earth to various uses shall be planned, and account shall be taken of the physical constraints, the biological productivity and diversity, and the natural beauty of the areas concerned.
- The principles set forth in the present charter shall be reflected in the law and practice of each State, as well as at the international level.
- All planning shall include among its essential elements the formulation of strategies for the conservation of nature, the establishment of inventories of ecosystems, and assessments of the effects on nature of proposed policies and activities; all of these elements shall be disclosed to the public by appropriate means in time to permit effective consultation and participation.

Other documents include action plans and recommendations from international organizations, such as the UNESCO Action Plan for Biosphere Reserves (discussed later in this chapter), the IUCN Bali Action Plan and Recommendations (resulting from the 1982 World National Parks Congress), and IUCN General Assembly Resolutions. A recently developed tropical forests action plan (84) has also been receiving increased recognition by various countries and intergovernmental and international nongovernmental agencies.

International Laws Relating to Offsite Maintenance

The scope of international law addressing offsite maintenance of diversity is far more limited than that for onsite maintenance. Growing international concern over loss of genetic resources and recognition of the increased importance of offsite maintenance in supporting national and international conservation initiatives have focused attention on this gap in international law (21,47).

To date, attention has been largely focused on defining national responsibilities with regard to crop germplasm maintenance and exchange between countries. Tangentially related international legal instruments deal with international patent protection of biological material and processes, as well as international quarantine as it relates to the flow of plants, animals, and microbes between countries.

Germplasm Maintenance and Exchange

Issues of offsite germplasm maintenance, control, and exchange have assumed a prominent, if controversial, position in international debates in recent years. Declarations of the importance of genetic diversity can be traced to the 1972 Stockholm Conference on the Human Environment. In addition to the Stockholm Declaration mentioned earlier, the conference produced 106 recommendations as tasks and guidelines that should be adopted by governments and international organizations (76). Rec-

ommendation 39 called on governments to agree to an international program to preserve genetic resources. This recommendation has been implemented most actively with offsite conservation of cultivated and domesticated materials, particularly crop germplasm. In fact, the creation of the international plant germplasm system that now exists has been credited, in large part, to the Stockholm conference (63).

The only other international agreement dealing specifically with offsite maintenance of germplasm is the *FAO International Undertaking on Plant Genetic Resources*. This initiative to establish, among other things, an international convention dealing with the maintenance and free flow of plant germplasm has been controversial since its inception in 1981. Although initiated as a binding convention, for political expediency it emerged **as a** nonbinding agreement in 1983, although efforts to make it binding continue (3). As outlined in article 1 of the resolution (26):

> The objective of this undertaking is to ensure that plant genetic resources of economic and/or social interest, particularly for agriculture, will be explored, preserved, evaluated, and made available for plant breeding and scientific purposes. This undertaking is based on the universally accepted principle that plant genetic resources are a heritage of mankind and consequently should be available without restriction.

Subscription to the FAO undertaking has been polarized along industrial and developing-country lines, with some exceptions on both sides (68,82). Developing-country charges that industrialized countries have been capitalizing on Third World genetic resources without remuneration is central to the debate (53). The most hotly contested aspect, however, is free access to private breeders' germlines. Industrial countries with plant breeders' rights legislation (discussed later in this chapter), which include the United States, are unable, if not unwilling, to subscribe to the undertaking without major reservations.

The issues of control and free flow of genetic resources are likely to be debated further in international fora. A closer examination of the U.S. position and options is needed. (Further consideration of this issue is provided in the following discussion of international offsite programs.)

International Patent Law

International patent law is tangentially relevant to genetic resource maintenance because the proprietary status that patenting living organisms provides is central to the debate on international access to germplasm. Current debate focuses on plant patenting, although it could well extend to microbial patenting, for example, in the future. Advances in biotechnology have brought increased attention to patenting living organisms because of the lucrative possibilities the technology offers and because of the likelihood that these advances will accelerate trends toward patenting (e.g., through the ability to establish genetic "signatures" on human-altered organisms). The ability of legislation to keep pace with rapidly evolving biotechnologies is uncertain and raises serious questions for policymakers (67). Effects of patenting on genetic diversity in agricultural crops raise further concerns (see box 1O-A).

The expansion of plant patenting into international law occurred with the establishment in 1961 of the *International Union for the Protection of Nevv Varieties of Plants* (I UPOV), consisting of countries party to the international convention on this issue. The convention itself does not provide global patent protection. However, the parties to the convention—almost exclusively industrial countries—agreed to enact plant breeders' rights (PBR) legislation and to guarantee citizens the right to obtain protection under their respective national patent systems (6).

The system does not affect the free flow of germplasm as such. It typically permits protected material to be used for research and breeding by nations that have obtained the rights. Further, there is currently no legal obstacle in using the same material in other countries (6).

Critics charge that since the inception of IUPOV, there has been a concerted effort to

Box 10-A.—Patent Law And Biological Diversity

Patent law essentially entitles inventors to profit from their inventions for a specified period in return for disclosing the secrets of the invention in the public domain, presumably to allow others to build on it. Although the patent system has engendered much controversy since it was formalized, legislation enabling the patenting of living organisms has become one of its most controversial aspects (8,81).

The U.S. Congress passed the Plant Patent Act of 1930 covering asexually propagated plant species. Coverage was extended to sexually propagated species with the 1970 Plant Variety Protection Act (PVPA). With the Supreme Court decision in *Diamond v. Chakrabarty in 1980,* microbes became patentable products under the basic patent act (Section 101}. A recent decision by the Board of Patent Appeals of the U.S. Patent and Trademark Office has now extended patentability under Section ***101*** of the Patent Act to included plant material, a reversal of an earlier decision [4).

European countries have a similar system of plant varietal protection, commonly referred to as plant breeders' rights (PBR). In addition to providing patent protection, however, the European system establishes a system of seed control using common catalog requirements to establish legitimate cultivars that can be grown **legally (5,61).** The European control system is cited as having greater detrimental implications for biological diversity, by increasing uniformity and reducing crop genetic variability, than the basic legislative protection that exists in the United States (9).

Since the emergence of PBR, concerns have been expressed that the proprietary controls it provides may create undesirable trends in the agricultural economy, including several of consequence to biological diversity. Specifically, concerns exist that such legislation is contributing to a consolidation in the seed industry, a reduction of sharing of germplasm and information among researchers, and the loss of genetic diversity.

A review of studies on these linkages **(12,49,50,56)** reveals different interpretations of their magnitudes, with most analysts agreeing that a strong link is not apparent or at least is difficult to determine. Most pronounced is the degree of consolidation in the seed industry, but separating the specific impact of PBR from other factors is difficult. Studies do, however, reveal that plant patents tend to be concentrated among larger companies and for certain types of crops. Some of these companies have petrochemical interests, which has raised concerns that their research will be directed by efforts to promote agrochemical sales (e.g., emphasizing development of pesticide-tolerant or fertilizer-dependent plant varieties). With regard to the other concerns (reduced exchange of germplasm and research information, or loss of genetic diversity), evaluation is hampered by a lack of objective measures. The conclusion is that careful monitoring in each of these areas seems warranted **(8,9).**

Perhaps more important is the finding that plant breeding by public agencies plays a critical role in countering the potential negative consequences of the patent system by contributing to competition in the seed industry, to the flow of information and germplasm, and to crop diversity (12). This finding suggests that continued support of national and international (e.g., International Agricultural Research Centers) plant breeding programs is important for maintaining and enhancing genetic diversity. Their contributions should be considered in the context of concerns that interest in biotechnology has detracted from emphasis on traditional breeding and cultivar development (9).

encourage developing countries to adopt plant breeders' rights laws and become members of the union (56). The trade-offs for a developing country enacting a plant patent system, however, are different from those for industrial countries (5). The arguments for adoption are that it would encourage private breeders to develop varieties suited to conditions in each country and that private firms would be less reluctant to export seeds to countries having such legislation (2,5). Without adopting PBR, however, a country would still be able to take advantage of publicly developed varieties, which constitute the most important source of im-

proved seeds for most crops (81). In addition, developing countries are not restricted from using seeds protected under IUPOV.

The extent to which private investment would be encouraged by instituting PBR, given that markets and infrastructures in many developing countries are weak and thus unattractive to many private seed companies, is not clear (5), Concerns also are expressed over the impact that PBR would have on research activities at international agricultural research centers. In the final analysis, whether a country decides to adopt PBR will depend on how governments perceive their own best interests given these and other considerations,

Microbes are patentable (at least for specific process applications) in most industrial nations. The *Treaty on the International Recognition of Deposit of Micro-organisms for the Purposes of Patent Protection* (known as the Budapest Treaty), however, supports a degree of internationalization of the microbial patenting system. This treaty, established in 1977, was instituted in part as a means to provide "enabling disclosure" (as required under patent law) that permits third parties to understand an invention and presumably build on it. It establishes an agreement among participants to recognize deposit of a micro-organism in another country as adequate for patenting purposes. The Budapest Treaty also sets standards and procedures for such depositories (6). This system has engendered much less controversy than the IUPOV system, which may reflect the current limited concern among developing countries over microbe patenting, although this may change in the future (5).

International Quarantine Restrictions

Plant and animal quarantine rules, actions, or procedures are established by governments to prevent entry of pests or pathogens in or on articles imported along pathways created by humans. Regulated articles include plants, animals, propagative material (e.g., seeds, cuttings, cultures, sperm, and embryos), commodities, soil, packing materials, nonagricultural cargo, and used vehicles and farm equipment, as well as their containers and means of conveyance.

The legal umbrella under which international plant quarantine activities are covered is the *International Plant Protection Convention* (IPPC) of 1951 (known as the Rome Convention). The IPPC provided the international model for the phytosanitary certificate that accompanies certain articles in transit (45) and proposed creation of inspection services (6), However, the program seems to have suffered from lack of funds and attention (13,35). Since the mid-1970's, FAO has explored the possibility of establishing a special phytosanitary certificate for the international transfer of germplasm *(6).*

Though no equivalent to IPPC exists for animals, many countries have signed bilateral agreements on import health requirements of animals, including the establishment of protocols. In general, these international treaties or commissions between governments deal with the movement of live animals or specific animal products such as meat or semen. Restrictive requirements for commerce are generally under the jurisdiction of the respective veterinary services because of hazards related to disease prevention and control (57).

Policies on international commerce in live animals have generally been established and accepted. Research has been considerable and will likely continue, and relaxation of current health-related constraints is anticipated. Policies on international shipment of animal semen are still largely based on the health status of the donors. The technology of embryo transfer is now at the point where research could facilitate international transfer of animal germplasm (57).

INTERNATIONAL PROGRAMS AND NETWORKS

There are so many different organizations involved in international programs to maintain biological diversity, it is difficult to generalize about their effectiveness. Nonetheless, the strengths and weaknesses of two basic categories of organizations—intergovernmental and

nongovernmental—are evident. Three intergovernmental organizations, all part of the United Nations, are most prominent:

1. FAO, by virtue of its interest in crops, livestock, forestry, and wildlife (the latter primarily in terms of exploitable resources);
2. UNESCO, whose involvement in biological diversity emphasizes a more scientific and cultural approach (reflected in the Man in the Biosphere concept, outlined below); and
3. UNEP, which extends intergovernmental involvement into more traditional conservation activities (10).

Perhaps the greatest asset of intergovernmental organizations is their ability to elevate issues to international prominence, based largely on the organizations' access to top-level authorities. They may also be able to influence national agendas in various ways. Funding to support activities is central to the influence of these organizations. In recent years, however, the functions and effectiveness of certain offices have been questioned, particularly in the case of UNESCO. Of concern have been the costs of programs in relation to their accomplishments and the politicization of activities and rhetoric, reflecting the dominance of a number of developing countries with an anti-Western bias (62). In general, however, there has been less political volatility and controversy where scientific activity and personnel are central elements of particular intergovernmental initiatives. In fact, UNESCO's most important program dealing with onsite maintenance of biological diversity, Man in the Biosphere, has been singled out for its integrity,

Nongovernmental organizations (NGOS) are most effective as catalysts of international conservation activities, The early work of institutions such as the International Council for Bird Preservation (ICBP) and the International Council of Scientific Unions influenced the evolution of international environmental organizations (10). Considerable activity on maintaining diversity has also resulted from extending national programs to the global arena, a trend that continues and that supports the maxim "environmentalism breeds globalism" (10).

The strengths and weaknesses of NGOs are largely the obverse of those of intergovernmental organizations ***(62).*** Their major advantage is the ability to adopt a problem-oriented approach outside a governmental framework, thus minimizing problems associated with political interests and conflicts. This is not to imply that such activities should ignore the political nature of conservation activities. As one analyst has noted:

> For the conservationist to argue that nature is apolitical can be a useful strategy. For him actually to believe this is a recipe for ineffectiveness (10).

Lack of financial resources is the major limiting factor of international NGOs. Yet, limited funds are likely to be applied in a more flexible and responsive way than in intergovernmental institutions, and NGOs often benefit from the voluntarism and enthusiasm characteristic of such groups. However, what is lacking is the ability to influence national governments directly. International NGOs must be cautious to avoid the impression that they are meddling in the affairs of state or impinging on national sovereignty.

The emergence of the International Union for the Conservation of Nature and Natural Resources marked a departure from the traditional dichotomy. IUCN is unique not only because of its emphasis on biological diversity but because of a membership arrangement that combines a number of state and government agencies with an array of national and international conservation groups and scientific organizations. In a sense, it reflects a hybrid institution. The linkages IUCN has cultivated with FAO, UNESCO, and UNEP reinforce its dual nature. Certain advantages are evident in such an arrangement:

> The combination of the two types of organizations provides two approaches to the resolution of problems: the individual scientists working in the non-governmental organization are able to provide a problem-oriented approach with an analysis of the studies being undertaken that is independent and has a minimum of political bias, while the intergovernmental organization can provide political and finan-

cial support for programmed and can make available the time of scientists working in the national research councils and national institutes ***(23)***.

Cooperation between intergovernmental organizations and NGOs has not been without conflict, however, especially over how to treat conservation concerns within the context of development, The rapid increase in U.N. membership that occurred in the 1960s, as many developing countries became independent, led to an increasing emphasis on development issues. The landmark 1972 U. N.-sponsored Conference on the Human Environment emphasized the need to incorporate economic development concerns in conservation activities. IUCN responded gradually at first but today the integration of conservation and development has emerged as a central theme of IUCN activity as reflected in its development of such documents as the World Conservation Strategy and the emergence of its Conservation for Development Center.

Although IUCN and the affiliated World Wildlife Fund represent the central international NGOS, a large number of actors are present in the international conservation arena. These organizations vary greatly in size, function, constituency, approach, and focus. Although the contributions of these many groups is acknowledged, the following discussion is necessarily restricted to the largest and most prominent international organizations.

Onsite Programs

Ecosystem and Species Maintenance

Among the array of international programs dealing with onsite diversity maintenance, several stand out for their breadth of coverage. Under the umbrella of UNESCO are two independent programs involved in protection of specific sites, partially chosen for and indirectly concerned with protection of biological diversity. The Man in the Biosphere Program (MAB) supports conservation of sites representing the Earth's different ecosystems, based on the Udvardy system described in chapter 5. The World Heritage Convention mentioned earlier promotes preservation of sites that have outstanding examples of nature.

The *Man and the Biosphere Program* is an international scientific cooperative program supporting research, training, and field investigation. Research focuses on understanding the structure and function of ecosystems and the environmental impacts of different types of human intervention. The program involves disciplines from the social, biological, and physical sciences; it is supervised by an International Coordination Council and is tied to the field through national-level scientific MAB committees.

Launched in 1971, MAB took as one of its themes the "conservation of natural areas and the genetic material they contain. " The concept of biosphere reserve was introduced as a series of protected areas linked through a global network that could demonstrate the relationship between conservation and development. Building this network has formed a focus for implementing the program through national-Ievel scientific committees. The first biosphere reserves were designated in 1976. At present, the network consists of 252 reserves in 66 countries (see figure 10-1) (30).

In view 'of their joint interests, UNESCO, FAO, UNEP, and IUCN convened the First International Biosphere Reserve Congress in 1983 to review experiences and lessons and to develop general guidance for future action. One result of the congress was the preparation of an Action Plan for Biosphere Reserves, which has three main thrusts:

1. improving and expanding the biosphere reserves network;
2. developing basic knowledge for conserving ecosystems and biological diversity; and
3. making biosphere reserves more effective in linking conservation and development, as envisioned by the World Conservation Strategy (71).

The biosphere reserve concept is being applied in a number of cases, but evaluation of

Figure 10-1.—Distribution of Biosphere Reserves Worldwide

SOURCE: International Union for the Conservation of Nature and Natural Resources. *1985 United Nations List of National Parks and Protected Areas* (Gland, Switzerland and Cambridge, United Kingdom: IUCN, 1985).

success is premature. Full application of the concept, essentially as a conservation and development tool, presents complex problems both legally and administratively. The program has not required special legislation, which leaves each country to adapt existing laws, which are often too weak and too segmented for the kind of integrated multiple-use planning and conservation required (ranging from core areas receiving strict protection to buffer zones in agricultural or other compatible uses).

Moreover, because large areas are involved, generally with some human settlement, application of such a concept necessarily involves many levels of government as well as several technical agencies. Most government administrations tend to be sector-oriented and inexperienced in coordinating jurisdiction and program reponsibilities in such areas as public health, agriculture, forestry, wildlife conservation, and public works—all of which may be required for an effective long-term biosphere reserve program. Special councils or committees of governmental and nongovernmental representatives may need to be formed to play this coordinating role.

Notwithstanding the program's practical problems, the planning and management principles in the biosphere reserves concept reflect what an international conservation program needs to endorse—''conservation as an open system, " where areas of undisturbed natural ecosystems can be surrounded by areas of "synthetic and compatible use, " and where people are considered part of the system (71).

A number of more recent developments suggest that the MAB program will become an increasingly important investment opportunity for biological diversity maintenance. First, the concept and purpose of biosphere reserves has been sharpened and clarified to reflect pragmatic lessons learned over the 10 years since the first biosphere reserve was established (7). The establishment of the Scientific Advisory Panel for Biosphere Reserves in 1985 promises a more informed, consistent, and structured approach to the MAB system. Current directions also suggest that MAB will continue to stress the important work in research on human needs and impacts within its conservation approach as reflected in its four recently approved research areas (72):

1. ecosystem functioning under different intensities of human impact,
2. management and restoration of resources affected by humans,
3. human investment and resource use, and
4. human response to environmental stress.

Critical review of the existing system has prompted greater attention to ensuring that all three basic elements of biosphere reserves are incorporated into existing and future reserves. These basic elements are the following:

1. Conservation Role: conservation of genetic material and ecosystems.
2. Development Role: association of environment with development.
3. Logistic Role: international network for research and monitoring (7).

Placing greater emphasis on the last two roles, as opposed to the first role which has been predominant to date, will likely contribute increased opportunities and benefits to the biosphere reserve system. Finally, the MAB program may be able to provide important contributions and cooperation within the most recently launched international environmental program, the International Geosphere/Biosphere Program, being formulated by the International Council of Scientific Unions (54).

The United States withdrawal from UNESCO has had a number of implications for U.S. participation in MAB (59). An evaluation of the impacts of this withdrawal suggests that, because MAB activities are largely undertaken as national projects or bilateral arrangements, the short-term impacts on MAB are not very significant. Long-term impacts, however, could seriously compromise the effectiveness and potential of international MAB unless alternatives can be found to provide U.S. scientific and financial participation (59).

The *Convention Concerning the Protection of the world Cultural and Natural Heritage* began in 1975 and at present has 85 member states

and 52 natural sites—8 in the United States. Sites are selected by domestic committees, technically reviewed by IUCN, and then evaluated and described by the Bureau of the World Heritage Committee. Approved sites are placed on the World Heritage List.

Site-selection criteria do not specifically mention biological diversity but include areas of ongoing biological evolution, areas of superlative natural phenomena, and habitats of endangered species important to science and conservation. Only exceptional sites are chosen, and the focus is on well-known animals, especially mammals. Sites must have domestic protection in place before being listed. Most nations select already protected sites, such as national parks, rather than new ones. Managers of such sites may have different priorities than those of the convention. The impact of becoming a World Heritage Site on management practices is not fully known.

In signing the convention, members agree to protect their properties and those of other nations, Although the language in agreement is strong, its legal strength has not been established and member governments often ignore provisions, Members are assigned a fee or voluntarily contribute to a World Heritage Fund. Resources are used for training, equipment purchases for members with few resources, and assistance in identifying candidate sites. This support, though small, can be crucial to identifying and protecting sites especially in less well-off nations.

The convention's annual budget averages $1 million, The United States, one of the forces behind the convention's founding, normally contributes at least one-fourth of the budget. In fiscal years 1977 and from 1979 through 1982, U.S. voluntary contributions averaged $300,000. No contributions were made the following two years. The United States contribution in fiscal year 1985 was $238,903. In fiscal year 1986, $250,000 was appropriated (cut to $239,000 under budget-reduction legislation), but no money has yet been contributed. Unless Congress agrees to an Office of Management and Budget request for recision of the entire amount, the contribution will be made, which means the United States, having contributed for two consecutive years, can run for a seat on the World Heritage Committee.

IUCN, is the central nongovernmental organization dealing with onsite diversity maintenance on a global scale, As noted earlier, IUCN is actually a network of governments, nongovernmental organizations, scientists, and other conservationists, organized to promote the protection and sustainable use of living resources. Founded in 1948, IUCN'S membership now includes 57 governments, 123 government agencies, 292 national NGOS, 23 international NGOS, and 6 affiliates in at least 100 countries. Developing-country representation has become a more visible component of the network in recent years, although limited active participation by African, Asian, and Latin American countries remains a problem.

Establishment of IUCN resulted from a desire to open up channels of communication between different countries and to serve as an umbrella for various organizations and individuals active in international conservation. Early initiatives focused on research and education activities, in part reflecting the initial funding provided through UNESCO. With the establishment of the World Wildlife Fund (WWF) in 1961 (largely to serve as a fund-raising initiative for IUCN and ICBP) and of UNEP in 1972 (which provided contract work for IUCN), the emphasis shifted back to species and habitat conservation. Today, IUCN and WWF have emerged as central actors in international environmental policy, with influence in both intergovernmental and national conservation work (10). IUCN support for national programs includes the following:

- provision of aid and technical assistance to countries and organizations;
- development of a series of policy aids, particularly in relation to the creation and management of national parks and other protected areas, the framing of legislative instruments, and the making of development policy; and
- preparation, on request from governments,

of specific policy recommendations pertaining to conservation and development plans (10).

Several components of IUCN are particularly relevant to international conservation efforts. These include the three centers that form part of the IUCN network—the Conservation for Development Center (Gland, Switzerland), the Conservation Monitoring Center (Cambridge, England), and the Environmental Law Center (Bonn, West Germany). Central to IUCN prominence and legitimacy in international conservation are its six commissions of experts on threatened species, protected areas, ecology, environmental planning, environmental policy, law and administration, and environmental education.

The Conservation for Development Center has emerged as one of IUCN'S most successful components. In particular, its role in assisting countries in the development of national conservation strategies has received growing support. The growth in the program reflects not only the importance of integrating conservation and development interests but IUCN'S growing commitment to following this approach.

The Environmental Law Center has been indexing national and international environmental legislation since the early 1960s, Some 20,000 titles are now part of the center's Environmental Law Information System. The center has recently developed a species law index that codes protected species of wild fauna to the corresponding national legislation. This index is computerized, allowing manipulation by species, region, or country, and it is becoming a valuable databank for program and policy planning by governments and NGOS when used in conjunction with scientific information about endangered species, ranges, and protection needs.

Ecosystem and Species Monitoring

Information on the status and trends in loss of the world's fauna and flora is a critical element in defining strategies and priorities, For this reason, a number of international organizations are involved in the inventory and monitoring of biological diversity. Most prominent are the efforts of UNEP, FAO, UNESCO, IUCN, WWF, and ICBP.

UNEP has an assessment arm, Earthwatch, whose function has been to acquire, monitor, and assess global environmental data. At the heart of Earthwatch is the Global Environment Monitoring System (GEMS), an international effort to collect data needed for environmental management. GEMS current activities are divided into monitoring renewable natural resources, climates, health, oceans, and long-range transport of pollutants, These activities are coordinated from the GEMS Programme Activity Center in Nairobi which, like UNEP, works mainly through the intermediary of the specialized agencies of the United Nations—notably FAO, the International Labour Organization, UNESCO, the World Health Organization, and the World Meteorological Organization—together with appropriate intergovernmental organizations such as IUCN (15).

To provide access to the databanks, UNEP-GEMS has begun a 2-year pilot project to set up a computerized Global Resource Information Database (GRID) (74), If successful, GRID may prove to be a powerful tool for international inventory and monitoring, not only of biological diversity but of other areas too (15), GRID will provide a centralized data-management service within the U.N. system, designed to convert environmental data into information usable by decisionmakers. The main data-processing facility will be in Geneva, Switzerland, but it will be controlled from UNEP headquarters in Nairobi.

The pilot phase of GRID is to result in an operational system with preliminary results and the training of some personnel. An initial evaluation could be expected by the end of UNEP'S 1986/87 biennium, A full assessment of the system is unlikely before several more years of operations (74).

Inventory and monitoring activities at the species level are also undertaken by the Conservation Monitoring Center (CMC), one of several centers operating under the auspices of the

IUCN. Its mandate is to analyze and disseminate information on conservation worldwide and provide services to governments and the conservation and development communities. CMC supplies information in the form of books, specialist publications, and reports. Major output includes Red Data Books on endangered species, protected-area directories, conservation site directories and reports, threatened plant and animal lists, U.N. Lists of National Parks and Equivalent Reserves, preliminary environmental profiles of individual areas (by request), comparative tabulations of transactions under CITES, and analyses of wildlife trade data for individual countries and taxonomic groups (15).

The International Council for Bird Preservation (ICBP) takes responsibility for ornithological aspects of IUCN'S activities and shares the IUCN database at CMC, ICBP is also in the process of establishing an oceanic-islands database to identify areas where action is required for numerous threatened endemic bird species. The initial target is to collect details about some 160 islands that support endemic species of birds, especially islands smaller than 20,000 square kilometers (15).

An important supplement to these initiatives is the growing number of national organizations taking an international perspective in their data collection efforts. Of particular importance is The Nature Conservancy International (TNCI), based in the United States. TNCI has developed a regional database on distribution of fauna and flora in the neotropics that is the most comprehensive of its kind and is promoting establishment of country-level conservation data centers (see ch. 11).

International Network

The emergence of IUCN as a recognized network of conservation specialists has both galvanized international conservation activities and established conservation programs as scientific initiatives. It also established two major functions of the organization:

1. promoting contacts among institutes and individuals, primarily by acting as a device for the exchange of information; and
2. setting up some kind of procedure whereby common platforms and goals could be articulated and, ultimately, a measure of influence exerted on public policy (10).

The Ecosystem Conservation Group (ECG), consisting of FAO, UNEP, UNESCO, and IUCN, was established in 1975 to advise on planning and execution of international conservation activities by the four organizations (75). ECG has recently begun to take a more active role in conservation, ECG agreed at its 1 lth General Meeting, held in Rome in February 1984, to institute an ad hoc Working Group on Onsite Conservation of Plant Genetic Resources (40). The working group consists of FAO (lead agency), UNESCO, UNEP, IUCN, and the International Board for Plant Genetic Resources (IBPGR). The first meeting of the working group was held at IUCN headquarters in April 1985, during the 12th General Meeting of ECG. The charge to the working group was twofold:

1. review ongoing and planned activities in onsite conservation in light of recommendations of the First Session of the FAO Commission of Plant Genetic Resources, UNESCO's Action Plan for Biosphere Reserves (see earlier discussion), and the IUCN Bali Action Plan; and
2. identify ways to strengthen action and cooperation in response to these recommendations, with particular attention to improving information flow and promoting pilot demonstration activities (40).

Six major goals for coordination and action were recognized at the first meeting of the ECG working group and activities were identified within the framework of these goals. This development signifies an important step among involved organizations to focus their programs on plant genetic resources within a common framework, and, as reflected by the addition of IBPGR, begin to build a mechanism to integrate onsite and offsite efforts.

Offsite Programs

International institutions dealing with offsite maintenance are most easily considered under the separate headings of plant, animal, and microbial genetic resources. The level of exist-

ing international activity between and within these categories of organisms varies considerably. Major factors determining the level of attention devoted to offsite maintenance include economic importance, threat of loss, and ability to maintain viable collections offsite,

Plant Diversity

International programs and networks are differentiated by the types of plants they deal with. By far, the most developed institutions are those concerned with major agricultural plants. For the most part, these offsite collections are maintained in association with agricultural research institutions. Concern over loss of wild species of nonagricultural plants in their natural habitats has prompted the establishment of an international network of botanic institutions for preserving rare and endangered species in living collections,

The focus, extent, and effectiveness of international genebank efforts in recent years have been largely shaped by International Agricultural Research Centers (IARCS) supported by the Consultative Group on International Agricultural Research (CGIAR). This organization was founded in 1971 and consists of donors that fund a network of centers doing research on increasing agricultural productivity, primarily in developing countries (see table 1o-3). Impetus to form the group stemmed from early successes of two institutes (later to become the first members of the CGIAR system), the International Maize and Wheat Improvement Center (better known by its Spanish acronym CIMMYT), and the International Rice Research Institute (IRRI). Both programs were the outgrowth of research centers supported by the Rockefeller and Ford Foundations.

Financial obligations soon became too great for the two U.S. foundations as budget costs grew with the establishment of two more centers. The desire on the part of several international development institutions, including FAO, UNEP, and the World Bank, to expand the system into a network of international centers led to the formation of the CGIAR, supported by a group of government and international donor agencies.

Table 10-3.—International Agricultural Research Centers Supported by the Consultative Group on International Agricultural Research

CIAT	—Centro International de Agricultural Tropical Cali, Columbia
CIMMYT	—Centro International de Mejoramiento de Maiz y Trigo Mexico City, Mexico
CIP	—Centro International de la Papa Lima, Peru
IBPGR	—International Board for Plant Genetic Resources Rome, Italy
ICARDA	—International Center for Agricultural Research in the Dry Areas Aleppo, Syria
ICRISAT	—International Crops Research Institute for the Semi-Arid Tropics Hyderabad, India
IFPRI	—International Food Policy Research Institute Washington, DC, U.S.A.
IITA	—International Institute of Tropical Agriculture Ibadan, Nigeria
ILCA	—International Livestock Centre for Africa Addis Ababa, Ethiopia
ILRAD	—International Laboratory for Research on Animal Diseases Nairobi, Kenya
IRRI	—International Rice Research Institute Manila, Philippines
ISNAR	—International Service for National Agricultural Research The Hague, Netherlands
WARDA	—West Africa Rice Development Association Monrovia. Liberia

SOURCE" Consultative Group on International Agricultural Research, *Summary of Internat~ortal Agricultural Research Centers" A Study of Achievemerrts and Potential* (Washington, DC 1985).

Today, most CGIAR centers have specific responsibilities in crop varietal development and germplasm conservation, and in certain cases serve as international base and active collections for specific crops (see table 1o-4). A number of IARCs also operate outside the CGIAR system, including several with responsibilities for germplasm maintenance. This group includes the International Soybean Program in Urbana, Illinois and the Asian Vegetable Research and Development Center in Shanhua, Taiwan (18),

The most prominent international institution dealing with offsite conservation of plant genetic diversity is IBPGR. Established in 1974 by CGIAR, it serves as a focal point for governments, foundations, international organizations, and individual researchers with interests in maintaining genetic diversity of crop spe-

Table 10-4.— International Agricultural Research Centers Designated as Base Seed Conservation Centers for Particular Crops

Center	Crop	Nature of collection
AVRDC	mung bean *(Vfgna radlata)*	global
	sweet potato (seed)	Asia
CIAT	beans *(Phaseo/us):* cultivated species . .	global
	cassava (seed)	global
CIP	potato (seed)	global
ICARDA	barley	global
	chickpea . .	global
	faba bean *(Vicia faba)* . .	global
ICRISAT	sorghum . .	global
	pearl mi!let	global
	minor millets *(E/eusine, Se(aria, Panicurn)*	global
	pigeon pea ..., ..., ...	global
	groundnut	global
	chickpea . . .	global
IITA	rice	Africa
	cowpea *(Vigna unguicu/ata)* .	global
	cassava *(Manihot escu/enta;* seed).	Africa
IRRI	tropical rtce (wild species and cultivated varieties)	global

SOURCE Consultative Group on international Agricultural Research, Summary of *International Agricultural* Research *Centers A Study of Achievements and Potential* (Washington DC 1985)

cies. IBPGR is a small group; part of the secretariat is provided by FAO Its mission has been a coordinating one, of setting priorities and creating a network of national programs and regional centers for the conservation of plant germplasm. It has provided training facilities, supported research in techniques of plant germplasm conservation, sponsored numerous collection missions, and provided limited financial assistance for conservation facilities (see ch. 11). It does not operate any germplasm storage facilities itself, however.

As envisioned by IBPGR, collection efforts were to focus on crop plants, based on priorities set by the board and reflecting the economic importance of the crop, the quality of existing collections, and the threat that diversity would disappear. The collected materials were to be kept in national programs and duplicated outside the nation in which they were collected. A global base collection was to be established for major crops, and there were hopes of creating regional programs,

The achievements of IBPGR are impressive, measured in its own terms and against the list of objectives. Ten years after IBPGR was established, the network for base collection storage included 35 institutions in 28 countries. Regional maize collections exist in Japan, Portugal, Thailand, and the United States, for example, and one in the Soviet Union is under negotiation. For rice, a global collection has been established in Japan and the Philippines, and regional collections are found in Nigeria and the United States (27). National programs were created during IBPGR's first 10 years in about 50 countries, and by 1986 some 50 base collection centers had been designated for about 40 crops of major importance (38,79). The program has limited itself to a particular group of plants and has been successful in coordination, in encouragement of national programs, and in scientific and educational assistance (33). In all, IBPGR has links with more than 500 institutes in 106 countries (79).

In part, due to the success of IBPGR in focusing attention on the need to conserve genetic diversity, the issue has become embroiled in political controversy. IBPGR regards itself as a technical and scientific organization. But a number of critics regard the issue of plant genetic resources as much more politicaI. They maintain that IBPGR is implicitly working for the corporate and agribusiness interests of the industrial world, particularly the United States (36,56). Critics also argue that the current genetic material exchange system is inadequate to ensure that material will continue to be available, particularly to developing countries. The debate has become quite acrimonious, with proponents of IBPGR emphasizing their scientific and pragmatic approach to the issue, and critics emphasizing their fear that multinational corporations will gain control over plant germplasm. Plant patenting and access to plant genetic resources are also important elements in the current controversy (see earlier section) (6).

This entire controversy helped catalyze a move toward deeper FAO involvement in the germplasm area and toward a new international approach (70). FAO argued that it should be taking the lead in plant genetic conserva-

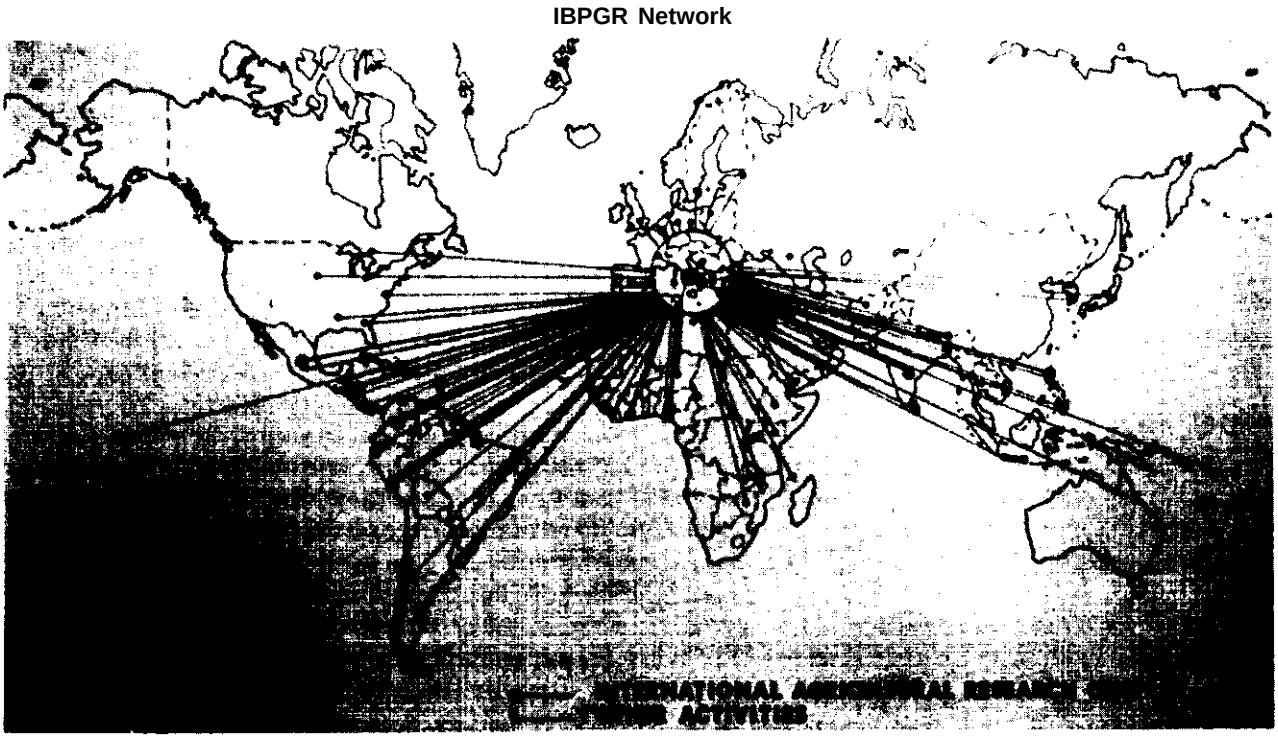

Photo credit IBPGR

The International Board for Plant Genetic Resources has had a catalytic effect on efforts to conserve dwindling plant genetic resources.

tion; it could provide the framework for developing nations to obtain a greater political voice in the international conservation structure. It was further argued that IBPGR was not a formal organization, and it would therefore have only limited legal ability to enforce any commitment to make germplasm available (26). This legal status argument is questionable, however (6). IBPGR proponents responded that the board's technical emphasis works effectively, and it is in fact an asset in surmounting political problems and dealing with nations outside FAO.

The alternative approach that evolved consisted of an undertaking and a new commission. The *International undertaking on Plant Genetic Resources* was negotiated within the framework of the FAO. (The United States and a number of other developed countries reserved their positions.) The undertaking was nonbinding, probably to increase participation in such a controversial area. It called for an international germplasm conservation network under the auspices of the FAO, stated a duty of each nation to make all plant genetic material—including advanced breeding material—freely available, and called for development of a procedure under which a germplasm conservation center could be placed under the auspices of FAO. IBPGR was to continue its current work, but it would be monitored by FAO (6).

The other part of the new FAO system is the *Commission on Plant Genetic Resources,* a group established to meet biannually to review progress in germplasm conservation. The commission held its first meeting in March 1985, with the United States present as an observer, Much of the discussion focused on concerns expressed in the FAO undertaking and on issues that had regularly been dealt with by IBPGR, such as base collections, training, and information systems. In addition, discussions and resolutions paid significant attention to on-site conservation and emphasized the impor-

tance of this area, which has received little attention from IBPGR.

It is not yet clear whether a practical and cooperative division of responsibilities between the two entities can be developed. One approach that has been suggested is to have each entity assume different responsibilities, such as giving IBPGR responsibility for offsite maintenance and letting FAO focus on onsite genebanks. An alternative would be to have IBPGR assume responsibility for technical aspects of germplasm collection and maintenance and give FAO responsibility for legal and political factors (28).

Botanic gardens and arboretums are increasingly viewed as important for conservation of wild plant species. Efforts to establish an international network of botanic gardens for the purpose of conserving threatened plant species were formalized in an international conference at the Royal Botanical Garden at Kew (United Kingdom) in 1978. IUCN'S Species Survival Commission set up a Botanical Gardens Conservation Coordinating Body (BGCCB). This body, established in 1979, is coordinated by the Threatened Plants Unit of IUCN'S Conservation Monitoring Center and now has 136 members, In addition, the Moscow Botanic Garden coordinates for BGCCB the response of 116 gardens in the Soviet Union (51). The function of such a network was reviewed at an IUCN conference in Las Palmas in 1985. Representatives of the botanic gardens meetings recommended a new conservation secretariat with IUCN support to coordinate their conservation activities and the establishment of a Botanic Garden Conservation Strategy (39).

Representation of developing nations is poor in BGCCB. The Montevideo Botanic Garden is the only South American member, for example, Efforts are being made to involve more developing-country institutions and to encourage twinning arrangements between institutions, whereby expertise in seed maintenance, curation, and fund raising could be promoted. Mechanisms to fund such activities, however, are not well established (39).

The planning of conservation collections by collaborating botanic gardens is encouraged by BGCCB by drawing attention to rare and threatened species that are poorly represented or not in cultivation at all. This is done through the provision of reports and an annual computer printout for each member garden, detailing the conservation plans IUCN has been provided by the garden. The printouts allow an analysis of the garden's holdings in relation to other gardens. Members are encouraged to propagate and distribute species that are represented, especially if they are endangered or extinct in the wild. BGCCB also has circulated lists of threatened plants to its members and stores the information on holdings in the CMC database (51),

IUCN has located 3,948 threatened plant species in cultivation by members of BGCCB, which is at least one-quarter of the known threatened plants in the CMC computerized database (78). However, these collections constitute only a tiny proportion of the genetic range of threatened species, They also represent only a small proportion of the biological diversity maintained by botanic gardens, which implies that greater emphasis on cultivation of rare and threatened species could be undertaken (51). Although it maybe theoretically possible for the botanic gardens of the world to grow the estimated 25,000 to 40,000 threatened species of flowering plants, cultivating sufficient populations to maintain diversity is unrealistic. Consequently, protecting a diversity of wild species will rest on maintaining them in the wild.

Animal Diversity

Just as institutions split offsite maintenance of plants into agricultural and nonagricultural species, offsite maintenance of animals is broken down into categories of domesticated and wild species. The former category has fallen under international agricultural institutions, such as FAO or regional institutions, such as the International Livestock Centre for Africa. Responsibility for offsite maintenance of wild species has been almost exclusively assumed by an international network of zoos.

Concern over loss of genetic diversity in agricultural animals has been much less pronounced than that for agricultural plants. Consequently, no analog to IBPGR currently exists. Growing concern over the loss of potentially valuable genetic diversity for livestock, however, has prompted limited efforts in this area.

FAO and UNEP launched a pilot project in 1973 to conserve animal genetic resources. Initial efforts focused on developing a preliminary list of endangered breeds and of those with economic potential, especially for developing countries. A 1980 FAO/UNEP Technical Consultation extended this work by defining requirements for creating "supranational infrastructure resources for animal breeding and genetics" (37). These covered a range of efforts to develop animal genetic resources. of particular significance were guidelines in the following areas (37):

- databanks for animal genetic resources, which would also identify endangered breeds;
- genebanks to store semen and embryos of endangered breeds; and
- training of scientists and administrators in genetic resources conservation and use,

Endangered livestock breeds can be maintained either in living collections or through cryogenic storage of semen or embryos (see ch. 6). Although the former option has proved viable in certain European countries (34), widespread success is unlikely. Thus, cryogenic storage will become increasingly important as threats to livestock increase. Concern over loss of livestock diversity is greatest for developing countries, but creating cryogenic genebanks in many countries would be very difficult. Thus, the value of establishing supranational storage facilities becomes apparent.

International networking for conservation of living collections of wild animals is largely restricted to the zoological community, although IUCN'S Species Survival Commission has been involved in formulating conservation plans that include captive breeding (51), Zoos have traditionally been established for public education and entertainment, But in recent years, a number of larger zoos have concentrated on breeding rare or endangered species, usually birds and mammals. These efforts have also extended to the creation of regional and international networks to enhance the effectiveness and collective conservation potential of the zoological community.

An International Species Inventory System (ISIS) was created in 1974 in response to major problems of inbreeding in zoo populations and in recognition of the fact that, for an increasing number of wild animals, captive populations held the best hope for survival of the species. Coverage has grown from 55 facilities to 211 as of 1985. About 65,000 1iving specimens of 2,300 species are included. Information currently comes from facilities in 14 countries, but coverage is best for U.S. and Canadian institutions (see ch, 9). The system is not restricted to endangered species (25),

ISIS publishes biannual survey reports. These include information on the sex ratio and age distribution; the proportion of captive-bred; and the birth, death, and import trends for all mammals and birds held in captivity by the members. The system has also recently begun to incorporate information on holdings of reptiles and amphibians (25).

The American Association of Zoological Parks and Aquariums (AAZPA) setup the Species Survival Plan (29) in September 1980, AAZPA has identified certain species in need of immediate attention and has established a committee for each, consisting of a species coordinator and propagation group. A major committee function is to provide direction for maintenance of studbooks.

A studbook is an international register that lists and records all captive individuals of species that are rare or endangered in the wild. The concept, initially developed for the selective breeding of domesticated animals, was first used on a wild species (the European bison) in *1932*. Studbooks are now kept for about *40* endangered species and are a valuable tool in international cooperation in captive breeding, permitting intelligent recommendations to zoos around the world concerning such things as

optimal pairings, trades, and management (24). Official studbooks are those recognized and endorsed by IUCN'S Survival Commission and the International Union of Directors of Zoological Gardens, and they are coordinated by the editor of the International Zoo Yearbook.

Microbial Diversity

A directory of institutions maintaining microbial culture collections was published in 1972, under the sponsorship of UNESCO, the World Health Organization, and the Commonwealth Scientific and Industrial Research Organization. The directory was revised and updated in 1982 [55) and remains the primary comprehensive source of information on international culture collections. In addition, the American Phytopathological Society convened a panel of scientists to discuss the importance and future of microbial culture collections (l). Information from these sources indicates that probably 1,200 to 1,550 collections exist throughout the world. A brief history of several of the more important collections is available (64).

In 1985, UNEP, the International Cell Research Organization, and UNESCO recognized the need for moderately sized culture collections. Each collection as envisioned would have a special purpose and together they would form a network of collections around the world (6). The establishment of these microbiological resource centers (M IRCENS) began at that time and the specialized collections are now located in 15 locations (17): including Brisbane, Australia; Stockholm, Sweden; Bangkok, Thailand; Nairobi, Kenya; Porto Alegre, Brazil; Guatemala City, Guatemala; Cairo, Egypt; Paia, Hawaii, United States; and Dakar, Senegal (32).

MIRCENS were established to develop and enhance an infrastructure for a world network of regional and interregional laboratories. This network provides a base of knowledge in microbiology and biotechnology to support the biotechnology industry in developed and developing countries. Activities of MI RCENS include collection, maintenance, testing and distribution of Rhizobium, and training of personnel (46). Training has perhaps been the most important activity towards developing research capabilities and diffusion of technology, especially in developing countries (16). Though each MIRCEN works according to its own set of priorities, they share a common goal of working together to strengthen the network and advance the knowledge in microbiology and biotechnology. In doing so, MI RCENS provide incentives to develop and maintain offsite microbial collections in support of national programs. They also offer a framework that could provide a secure custodial system for national and international microbial resources.

NEEDS AND OPPORTUNITIES

The United States has historically played an important leadership role in international conservation initiatives. The establishment of Yellowstone Park in 1872 heralded the international movement to create national parks worldwide. The United States also was a central actor in the *1972* Stockholm Conference on the Human Environment, in the creation of the United Nations Environment Programme, the World Heritage Convention, and numerous other initiatives (see previous sections). In recent years, U.S. leadership in international conservation has waned, which is reflected in funding and personnel support for international programs. A number of opportunities exist whereby the United States could reestablish itself as a leading actor in international efforts to promote the maintenance of biological diversity.

Onsite Activities

A major problem in developing a coherent strategy to address concerns over loss of biological diversity is the uncertainty that surrounds the issue. Estimates of the scope of species diversity vary by orders of magnitude, which illustrates obvious impediments to defining and addressing the problem. Further, lim-

ited and unreliable data on the rates and impacts of habitat conversion exacerbate the problem of refining a strategy and determining the level of resources that should be directed to address concerns. Clearly, biological diversity in certain regions is acutely threatened and deserves priority attention. However, attention is also needed on gaining a better grasp on defining the scope of diversity and the degree to which it is threatened.

Many questions remain even as understanding of the magnitude of threats to diversity continues to improve. Critics suggest that a better grasp of the situation is needed before large amounts of resources are devoted to the problem (66). It should be noted, however, that funds currently spent on diversity maintenance are relatively small and are not likely to increase dramatically. More important perhaps is the realization that funding, both public and private, continues to be directed to well-defined threats. That is, the situation as it currently exists is essentially reactionary—responding to acute threats that have already materialized. Recognition of the importance of biological diversity has yet to assume the prominence that would make most national governments take systematic and preemptive approaches to threatened diversity, which in the long run might prove less costly. Increased attention and recognition of national and regional conservation strategies as important elements of integrated development planning may represent movement to adopt this approach.

Considerable discussion among international conservation organizations has been directed toward the need to develop an international network of protected areas that would include representative and unique ecosystems. To date, however, organizing, implementing, and supporting such a system remains difficult. Efforts to establish such a system have not suffered from lack of creativity, as reflected in two large-scale proposals: one to create a major international program to finance the preservation of 10 percent of the remaining tropical forests (65) and another to establish a world conservation bank (69).

It maybe possible to establish an international network of protected areas within the framework of existing programs, specifically UNESCO's Man in the Biosphere and World Heritage programs. To do so, however, would require adopting a more organized and strategic policy, further invigorating both programs, and providing increased resources. This would require a more concerted effort on the part of national governments, intergovernmental agencies, and the participation of specific international nongovernmental groups (especially IUCN).

Two other issues are prominent with respect to the effectiveness of international laws and programs (47). First, there is debate over the value of a global treaty to fill what some perceive as a serious gap in hard law. Second, alternatives to conventional protected areas need to be considered to provide protection beyond such areas or at sites where the conventional approach is not feasible.

The notion of a world treaty to conserve genetic resources of wild species was proposed at the IUCN World National Parks Congress in *1982*. A similar recommendation by the World Resources Institute was proposed for the U.S. Government to develop an international convention. However, one key question that needs to be addressed before implementation is whether a new global treaty could be adopted and enforced in time to address the problem. In addition, consideration must be given to financial and technical resources still needed for treaties that currently play a role in resource conservation.

Existing treaties have been difficult to implement because of a lack of administrative machinery (e. g., well-funded and staffed secretariats); lack of financial support for on-the-ground programs (e.g., equipment, training, and staff); and lack of reciprocal obligations that serve as incentives to comply (21), A possible exception is CITES, which has mechanisms to facilitate reciprocal trade controls and a technical secretariat, although inadequately funded.

Creating protected areas is the conventional approach in most international conservation

programs. The modern interpretation of protected areas includes the full range of conservation uses, from strict protection to multiple use (44). The question of alternatives and supportive measures outside protected areas has also become a growing concern. The 1984 State of the Environment Report of the Organisation for Economic Cooperation and Development (O EC D), for example, urges that protected areas are not enough. Environmentally sensitive policies for nondesignated lands are also needed (60). This conclusion is reinforced by IUCN'S Commission on Ecology:

> The idea of basing conservation on the fate of particular species or even on the maintenance of a natural diversity of species will become even less tenable as the number of threatened species increases and their refuges disappear. Natural areas will have to be designed in conduction with the goals of regional development and justified on the basis of ecological processes operating within the entire developed region and not just within natural areas.

Land-use planning may help integrate environmentally sensitive policies in nondesignated areas. Control options to safeguard genetic diversity outside protected areas could also be explored (21,22). Where private land is involved, general controls could be enforced by imposing restrictions on land use or by instituting a permit system. These practices are commonly used for nature conservation and environmental protection in many western countries, particularly Europe. Permits could be required for all activities likely to harm certain natural habitats or ecosystems. This approach requires legislation to authorize the requirement, procedures, decisions on the conditions to be imposed, and activities excluded from the permit requirement.

Nonstatutory protection of specific sites could be achieved through voluntary agreements between the landowner and conservation authorities. Such agreements are more attractive when the landowner is offered certain incentives, such as tax subsidies or deductions, for preserving sites. In the United States, such "conservation easements" are valuable mechanisms for conserving private lands (77).

Zoning ordinances could become a powerful conservation tool if extended not only to construction but to all changes in land use, including agriculture. Programs to preserve areas where only small natural or seminatural sites remain within cultivated fields, for example, are also important. Such efforts can help maintain at least a minimum amount of natural vegetation in hedgerows, tree groves, riparian, and other areas. Giving conservation advice to farmers about the value of protected lands would be an important component of such controls.

In many countries, however, land management agencies have little or no authority to oversee activities of other agencies or to veto actions that would be detrimental to maintaining the land's natural condition. Although a variety of land-use planning tools are being considered, two prerequisites exist for using them:

1. to strengthen the technical capacity to identify, inventory, and monitor valuable natural areas; and
2. to provide the legal authority to protect such areas.

Offsite Activities

Offsite maintenance of biological diversity is assuming increased prominence due to concern over 1oss of genetic resources. Its prominence is also the result of a greater appreciation of the important role that offsite maintenance of wild species can play in conserving species diversity, especially when linked to onsite programs. However, a number of major resources remain unprotected in the existing framework, These include medicinal plants; some industrial plants, such as rubber; a number of animals, including wild and domesticated varieties and possibly some marine species, for which commercial breeding techniques are evolving (58).

To cover existing gaps in maintaining plant genetic resources, efforts could be made to extend IBPGR's mandate to assume responsibilities for medicinal plants, industrial plants, and

minor crops. IBPGR has already expressed reluctance to assume principal responsibility for these areas, noting that in many cases, such efforts should be relegated to national programs (79). Another option, however, is creation of a new group to cover these particular interests. Such an effort should try to establish some organizational affiliation capitalizing on the expertise already acquired by IBPGR.

Perhaps the most blatant gap, however, is in the area of animal genetic resources. Although FAO and UNEP have initiated investigations in this area, no national, regional, or international programs have yet emerged. An international board on animal resources could be established, with a mandate and approach similar to IBPGR's, But instead of establishing a network of national programs, a more reasonable approach might include creating a network of regional programs, promoting conservation of animal germplasm and monitoring endangered livestock breeds.

Additional international exchange of information is also needed, particularly with respect to what is conserved in smaller collections, such as those maintained by university faculty or private breeders. This exchange often occurs informally through working networks of researchers. In some cases, however, improved data management systems may be appropriate.

integration

Diversity maintenance programs require complementary efforts between onsite and offsite conservation, and finding the balance of emphasis is key. The first session of the FAO Commission on Plant Genetic Resources discussed building this integration by establishing national plant genetic resource centers that would be closely linked to offsite genebanks and protected area management (41). Such efforts will require improved cooperation at international and national levels, along with creative use of existing laws and programs to meet emerging management and scientific needs.

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