

# Building Resource Inventories on a Global Scale

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The International Network of Biosphere Reserves is the flagship of UNESCO's Man and the Biosphere Program (MAB). The network presently includes 311 sites in 81 countries. A foremost mission of the network is to facilitate long-term monitoring of representative ecosystems to improve the scientific basis for solving environmental problems (UNESCO 1971, 1974). To achieve this mission, biosphere reserves rely on protected core areas that are legally protected in their own right as national parks and equivalent reserves. Scientific activities in these areas have traditionally emphasized local management issues. In 1987, only one in nine biosphere reserves reported cooperation with a biosphere reserve in another country (Gregg and Wargo 1988). However, in recent years regional and global issues—such as habitat fragmentation, air pollution, acidic deposition, climatic change and sustainable development—have become major concerns of core area administrators. Such issues have spawned bilateral and multilateral programs involving biosphere reserves. Examples include long-term comparative studies of small watersheds in U.S. and Russian biosphere reserves (Herrmann 1990); the Smithsonian-MAB Program for inventory and monitoring of biodiversity, primarily in tropical developing countries (Gomez-Dallmeier 1992); and ongoing efforts to strengthen cooperation among circumpolar biosphere re-

serves (MAB Northern Science Network 1992). The U.S. National Research Council has recently recommended a stronger role for national parks in understanding environmental change, including improved linkages with research networks such as biosphere reserves (National Research Council 1992).

This paper focuses on a new program to promote cooperation among the 176 biosphere reserves in Canada, the U.S., and 30 European countries (Figure 1).

These sites compose 57% of the 311-site global network, and represent all but two of the world's 14 biomes. They provide exceptional opportunities for biome-based cooperation on regional and global issues in temperate broadleaf forests (64 sites), mixed mountain systems with complex zonation (48 sites), and Mediterranean ecosystems (23 sites). The EuroMAB biosphere reserves in these biomes constitute 43% of the global network (Figure 2).

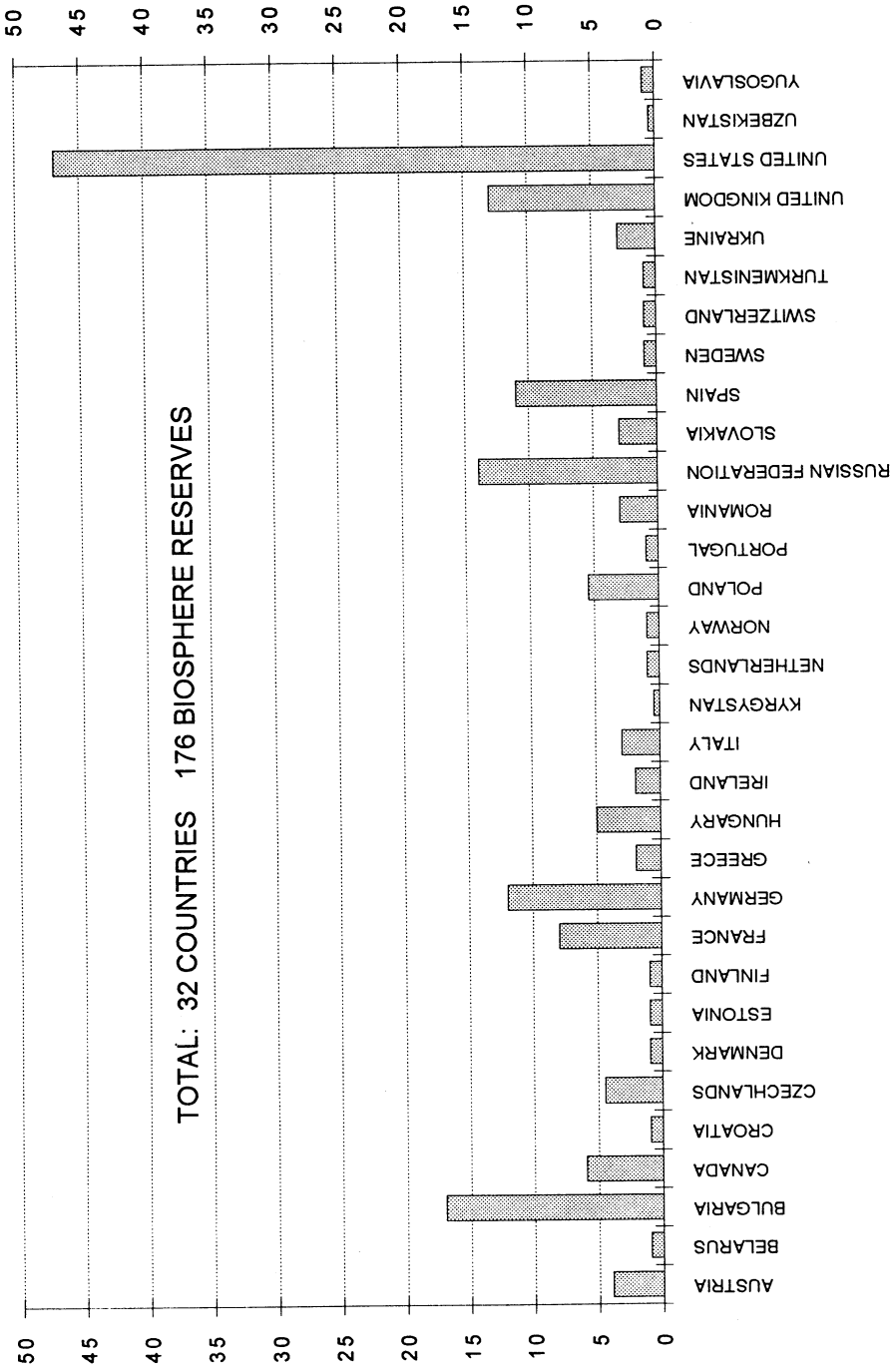
The new program is being coordinated by EuroMAB, an organization established to encourage scientific cooperation among the national MAB organizations of Europe, Canada, and the United States. At its third congress in September 1991, EuroMAB launched the Biosphere Reserve Integrated Monitoring Program (BRIM) to facilitate and support an integrated, long-term ecological monitoring program in biosphere reserves (EuroMAB 1991). The mission of BRIM is to "harmonize" the collection, reporting, and accessibility of data from the biological, physical, and social sciences among EuroMAB biosphere reserves. BRIM would improve the scientific basis for detecting and predicting environmental change, understanding the role of natural and human influences, facilitating information synthesis to address problems at many temporal and spatial scales, and encouraging environmental learning and education.

To implement the program, EuroMAB plans a broad-based network of many biosphere reserves that contribute data sets applicable to a wide range of issues; and smaller in-depth sub-networks of selected biosphere reserves that contribute data sets to address particular problems.

EuroMAB has requested member states to select a national focal point for the program and to join in a follow-up effort to plan a European institution to facilitate and coordinate the BRIM network.

To help develop BRIM, the USNPS worked with the U.S. MAB Secretariat at the Department of State to update and analyze unpublished UNESCO survey data on 160 of the 166 EuroMAB biosphere reserves designated as of mid-1992. The survey contains 62 information categories that cover basic resource information, research topics, and site support capabilities. The database includes all 47 U.S. biosphere reserves that together contain 90 administrative units of which 30 are managed by the USNPS.

The survey results document the basic scientific and operational capabilities of the EuroMAB network. Biological inventory datasets are universally reported, although there are major differences among biological groups. Inventories are best represented for vascular plants (88% of the sites), followed by vertebrates (83%), invertebrates (69%) and non-vascular plants (62%). Monitoring is most frequently reported for climate (83%), vegetation (77%) and surface hydrology (65%). Water quality (58%), freshwater ecosystems (54%), air quality (48%), groundwater hydrology (41%), and precipitation chemistry (38%) are important emphases. More than half the sites report climate and vegetation data spanning ten years or more; 82% report vegetation maps. Nearly three-fourths report population research on rare and endangered species, and the dynamics of wildlife popula-



**Figure 1. Number of EuroMAB biosphere reserves by country**

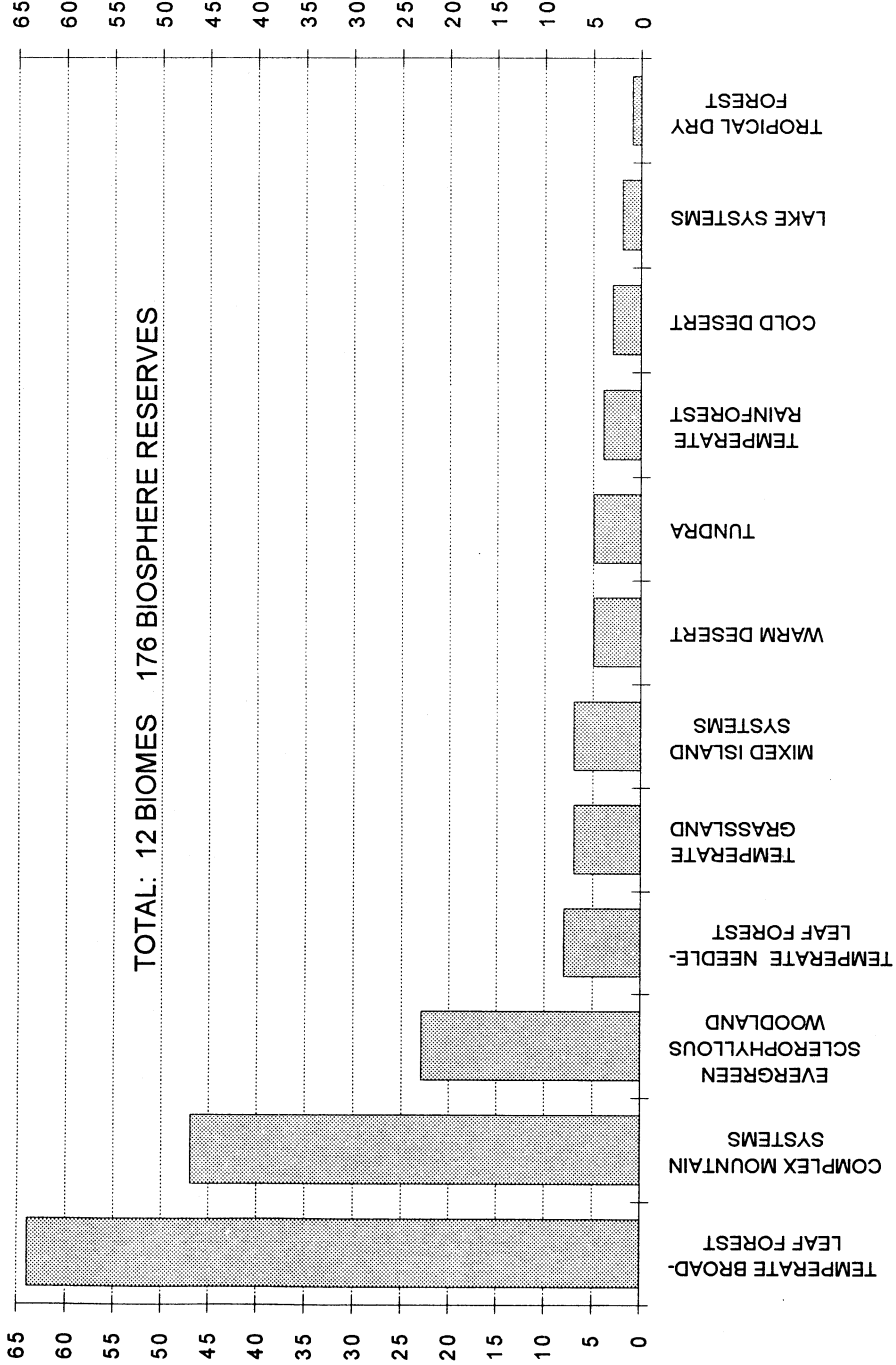


Figure 2. Number of EuroMAB biosphere reserves by biome

tions. Basic research on ecosystem cycles and processes is well represented, particularly work on ecological succession (69%) and comparative ecological research (63%). More than a third report work on fire history (43%), the hydrological cycle (42%), biogeochemical cycling (34%), and ecosystem modeling (39%)—areas likely to provide good opportunities for cooperation in understanding ecosystem responses to global change. EuroMAB reserves report considerable infrastructure for inventory and monitoring: weather stations (77%), hydrological stations (54%), curatorial facilities (45%), permanent vegetation plots (44%), air pollution stations (42%), and small watershed research sites (28%). Nearly two-thirds have a permanent research staff.

In early 1992, EuroMAB representatives identified six project areas for further development by country representatives:

- Preparation of a EuroMAB biosphere reserve directory;
- A pilot biological inventory project to obtain and share basic data on flora and fauna;
- A meta-database and recommended standards for permanent vegetation plots;
- A pilot project on ecological processes and global change;
- Projects on human systems, including guidelines for characterizing the socioeconomic environment of biosphere reserves and an annotated bibliography of case studies of creative approaches for facilitating cooperation in different cultural, legal, and institutional contexts; and
- Organization of the EuroMAB Network, including consideration of a regional EuroMAB center for network coordination, national cen-

ters for coordinating the participation of the biosphere reserves of individual countries, and development of compatible communication and data-sharing systems.

The USNPS, through the U.S. MAB Program, is providing technical assistance to EuroMAB on the directory and biological inventory projects. The directory will be a basic reference for the EuroMAB Biosphere Reserve network. It includes a national contact and country location map for biosphere reserves; basic site information on each biosphere reserve, including geographic coordinates, biogeographic province, administrator(s), contact(s), and principal research themes; and the results of an updated and expanded survey of basic resource information, research programs, and site support capabilities (71 information categories, see Table 1). The directory is expected to be available in hard copy and on computer disk in early 1993.

The second project—the development of biological inventory databases—will demonstrate the value of the broad based network. The integrated databases will support the conservation, scientific, educational, and sustainable development functions of biosphere reserves. The data are widely available in almost all biosphere reserves. Their usefulness and applications are generally appreciated. Perhaps most importantly, many administrators of core areas and multiple use components of biosphere reserves are expanding biological inventory programs in efforts to address biodiversity, sustainable development, and environmental issues. These factors favor broad participation in the project.

To develop a plan for documenting and completing biological inventories in biosphere reserves, EuroMAB specialists agreed on the need to summarize existing knowl-

**Table 1. Categories of survey information for EuroMAB biosphere reserves**

**Biological Inventory**

- Invertebrates
- Mammals
- Birds
- Nonvascular Plants
- Vascular Plants
- Vertebrates Other Than Mammals
- Biological Survey and Collections

**Resource Maps**

- Geological
- Land Use
- Soils
- Regional Land Tenure (ownership)
- Topographic
- Vegetation
- Geographic Information System

**Research on Ecosystem Cycles and Processes**

- Biogeochemical Cycles
- Comparative Ecological Research
- Ecological Succession
- Ecosystem Modeling
- Fire History Effects
- Hydrological Cycle
- Paleoecology
- Sedimentation

**Research on Pollution**

- Acidic Deposition
- Atmospheric Pollutants
- Pesticides
- Water Pollutants

**Research on Management Practices**

- Agricultural
- Appropriate Rural Technology
- Assessment of Resource Production Technologies
- Ecosystem Restoration
- Genetic Resource Management
- Mining Reclamation
- Rangeland Management

**Permanent Research Staff**

**Ecological Monitoring**

- Air Quality
- Climate
- Freshwater Ecosystems
- Groundwater Hydrology
- Marine Ecosystems
- Precipitation Chemistry
- Surface Hydrology
- Vegetation Data
- Water Quality

**Historical Records**

- Aerial Photography
- Bibliography
- History of Scientific Study

**Research on Species Populations**

- Pests and Diseases
- Rare & Endangered Species
- Wildlife Population Dynamics

**Research on Human Systems**

- Archeology
- Cultural Anthropology
- Demography & Settlement Patterns
- Ethnobiology
- Resource Economics
- Land Tenure, Use & Management Systems
- Traditional Land Use Systems

**Infrastructure**

- Conference Facilities
- Curatorial Facility
- Laboratory
- Library
- Lodging for Scientists
- Road Access

**Monitoring and Research Facilities**

- Air Pollution Station
- Hydrological Station
- Permanent Plots (Lake/Stream)
- Permanent Plots (Vegetation)
- Watershed Research Site
- Weather Station

edge. The experience of the USNPS proved to be especially relevant to this task. In 1990, the USNPS established a goal to complete, by the year 2000, inventories of vascular plants and vertebrate animals in the 240 units of the National Park System containing significant natural resources. To support this effort, the USNPS developed several databases to summarize the present status of biological inventories and to systematically record data on actual species occurrences. These databases are now operational, and are technically supported through cooperating universities (Stohlgren, Ruggiero, Quinn, and Waggoner 1991; Ruggiero, Stohlgren, and Waggoner 1992).

EuroMAB specialists recommended some minor modifications of the USNPS database structures so they could be tested in EuroMAB biosphere reserves. The *Biological Inventory Status* (MABBIS) database describes the present status of inventories for vascular plants, mammals, birds, reptiles, amphibians, and fish in a biosphere reserve. To develop this database, specialists for each group score the inventory for the group with respect to several categories of completeness. The scores are assigned on a scale of 1 (most complete) to 6 or 7 (least complete) based on actual species occurrences in the biosphere reserve. *Taxonomic completeness* refers to the coverage of the group's major taxa, such as families. *Geographic completeness* indicates how much of the area has been covered. *Ecological completeness* indicates how well the reserve's major ecological communities or habitat types are represented. *Seasonal completeness* indicates the extent to which appropriate seasons are included. A composite score, representing the sum of taxonomic, geographic, and ecological completeness scores, provides an indication of overall completeness of each group's inventory.

The *MABFLORA* and *MAB-FAUNA* databases provide frameworks for systematically recording data on actual species occurrences. These identically structured databases will contain species listings and associated data for each biosphere reserve based on documented occurrences of plant and animal species. For each species, the database will include information on taxonomy, source of nomenclature, and common name; geographic origin and special status of the species; presence, documentation of occurrence, distribution, resident status, and abundance within the biosphere reserve; available biosphere reserve databases; and reference citations. The databases are designed for widely available dBASE software that enables easy updating, sorting, and analysis.

Databases for vertebrates are now being developed in one biosphere reserve in each of ten countries (Canada, the Czech Republic, France, Germany, Romania, Russia, Spain, Sweden, the United Kingdom, and the United States). Each national contact for BRIM has received step-by-step guidelines for entering data into the database, and a computer disk containing the dBASE data format. The project will identify technical issues and operational problems in building the basic databases using standard software and protocols, given the considerable differences of language, institutional conditions, and technical capabilities in the EuroMAB biosphere reserves. The project will enable EuroMAB to consider how to expand the participation of biosphere reserves in building the databases, and the training and technical support required.

The USNPS is using its operational databases to prepare a preliminary inventory of the potential flora and fauna of the National Park System, aggregated at park, biome, and national levels; to assess the biologi-

cal similarity of parks; and to prepare a strategy for acquiring and managing new biological inventory data that will be collected during the remainder of the decade. Similar applications should be possible for the EuroMAB network.

The BRIM projects foster international recognition of the value of the biosphere reserve network. They are linking disparate land management units in different countries toward a common purpose of identifying contacts and sharing information on their datasets, programs, facilities, and management approaches. Such information will help managers and specialists to identify opportunities for cooperation. UNESCO's MAB International Coordinating Council has identified BRIM and other regional networks as an important focus for cooperation in a concentration within the MAB Program (UNESCO 1993). Comparative studies, especially among biosphere reserves in the same biome, are urgently needed to detect significant environmental changes and discover ways to maintain natural processes and native species in a changing global environment. The BRIM projects should facilitate such efforts.

At the international level, developing a functional network is probably the greatest challenge of implementing the biosphere reserve

concept (Gregg and Goigle 1984). EuroMAB is providing an aegis for international testing of methodologies developed to meet national needs, such as the USNPS biological inventory databases. In the future, EuroMAB may facilitate intergovernmental adoption of protocols for obtaining reliable scientific information from the many different types of land management units that participate in biosphere reserves.

For the USNPS, BRIM provides special opportunities. The USNPS participates in more biosphere reserves (25) in more biomes than any governmental entity in the world. It shares these biomes with 30 European countries that administer biosphere reserves—countries with vastly different land management systems, cultural traditions, land use histories, environmental conditions, and scientific capabilities. The USNPS has much to contribute to and learn from common efforts to understand the complex factors involved in the interaction of nature and human societies. Integrated regional approaches linking parks and their surrounding biogeocultural areas will be required. BRIM is an important step in marshaling the scientific knowledge and practical experience to enable biosphere reserves to fulfill their promise as the standard-bearers for demonstrating these approaches.

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