ECOLOGY

Toward a Global Biodiversity Observing System

Tracking biodiversity change is increasingly important in sustaining ecosystems and ultimately human well-being.

R. J. Scholes,[1*] G. M. Mace,[2] W. Turner,[3] G. N. Geller,[4] N. Jürgens,[5] A. Larigauderie,[6] D. Muchoney,[7] B. A. Walther,[6] H. A. Mooney[8]

Biodiversity is a composite term used to embrace the variety of types, forms, spatial arrangements, processes, and interactions of biological systems at all scales and levels of organization, from genes to species and ecosystems (*1*), along with the evolutionary history that led to their existence (*2*). In part because of this complexity, universally applicable measures of biodiversity have proven elusive. Commonly used measures, such as the number of species present, are strongly scale-dependent and only reveal a change after species have been lost. Indices incorporating several proxy signals are potentially sensitive, but their arbitrariness obscures underlying trends and mechanisms. Integrated measures (*3*, *4*) are both sensitive and achievable, but more research is needed to construct the globally robust relations between population data, genetic variation, and ecosystem condition that they require.

The need for national to global-scale biodiversity measurements has been highlighted by the adoption of a target to "reduce the rate of loss of biodiversity by 2010" by the 190 countries that are parties to the Convention on Biological Diversity (CBD) (*5*, *6*). As we approach the target date, it is clear that this intention may suffer if we cannot effectively assess progress. The recent Conference of Parties to the CBD in Bonn, Germany, reinforced commitment to the goal, while acknowledging that much still needs to be done to reach it. Despite the absence of comprehensive data, there is little dispute that biodiversity continues to decline with uncertain, but potentially serious, consequences for society (*7*).

Unlike, for instance, the Framework Convention on Climate Change, there is no widely accepted and globally available set of measures to assess biodiversity. Consequently, the community has fallen back on a range of existing data sets gathered for other purposes. Currently, in the CBD process alone, there are ~40 measures reflecting 22 headline indicators in seven focal areas (see Biodiversity Indicator Partnership, www. twentyten.net). It seems unlikely that this set will provide clear messages to decision-makers (*8*).

There is no general shortage of biodiversity data, although it is uneven in its spatial, temporal, and topical coverage. The problem lies in the diversity of the data and the fact that it is physically dispersed and unorganized (*9*). The solution is to organize the information, to unblock the delivery pipeline between suppliers and users, and to create systems whereby data of different kinds, from many sources, can be combined. This will improve our understanding of biodiversity and will allow the development of fit-for-purpose measures of its condition over time. The proposed Group on Earth Observations Biodiversity Observation Network (GEO BON) is a new global partnership to help collect, manage, analyze, and report data relating to the status of the world's biodiversity.

The Group on Earth Observations (GEO) was launched in 2002 in response to the widely identified need for adequate information to support environmental decision-making. GEO is a voluntary partnership of 73 national governments and 46 participating organizations. It provides a framework within which these partners can coordinate their strategies and investments for Earth observation. The GEO members are establishing a Global Earth Observation System of Systems (GEOSS, www.earthobservations.org) that provides access to data, services, analytical tools, and modeling capabilities through a Web-based GEO Portal (www.geoportal.org). GEOSS has identified nine priority "societal benefit areas" in its first decade. Biodiversity is one of them. U.S. National Aeronautics and Space Administration (NASA) and DIVERSITAS, the international programme of biodiversity science, accepted the task of leading the planning phase of GEO BON, in collaboration with the GEO Secretariat.

No single organization could build a "system of systems" such as the one envisaged. Many local, national, and international activities exist to record various genes, species, and ecosystems, as well as the services they provide to society. GEO BON aims to create a global network from these efforts by linking and supporting them within a scientifically robust framework. For example, GEO BON will facilitate the combination of top-down measures of ecosystem integrity from satellite observations with a host of bottom-up measures of ecosystem processes, population trends of key organisms, and the genetic basis of biodiversity arising from the latest field-based and molecular survey methods. The role of GEO BON is to guide data collection, standardization, and information exchange. The participating organizations retain their mandates and data ownership, but agree to collaborate in making part of their information accessible to others.

The process to develop a GEO BON took shape in April 2008, when some 100 biodiver-

[1]Council of Scientific and Industrial Research (CSIR), Natural Resources and Environment, Post Office Box 395, Pretoria 0001, South Africa. [2]Centre for Population Biology, National Environment Research Council, Imperial College London, Silwood Park, Ascot, Berkshire, SL5 7PY, UK. [3]Earth Science Division, U.S. National Aeronautics and Space Administration (NASA) Headquarters, 300 E Street S.W., Washington, DC 20546–0001, USA. [4]NASA Ecological Forecasting Program, Jet Propulsion Laboratory, California Institute of Technology, MS171-264, 4800 Oak Grove Drive, Pasadena, CA 91109–8099, USA. [5]University of Hamburg, BioCentre Klein Flottbek and Botanical Garden, Ohnhorststrasse 18, 22609 Hamburg, Germany. [6]DIVERSITAS, Muséum National d'Histoire Naturelle, Maison Buffon, 57, rue Cuvier–Case Postale 41, 75231 Paris, Cedex 05, France. [7]Group on Earth Observations (GEO), 7 bis, avenue de la Paix, Case Postale 2300, CH-1211 Geneva 2, Switzerland. [8]Department of Biological Sciences, Stanford University, Stanford, CA 94305, USA.

*Author for correspondence. E-mail: bscholes@csir.co.za.

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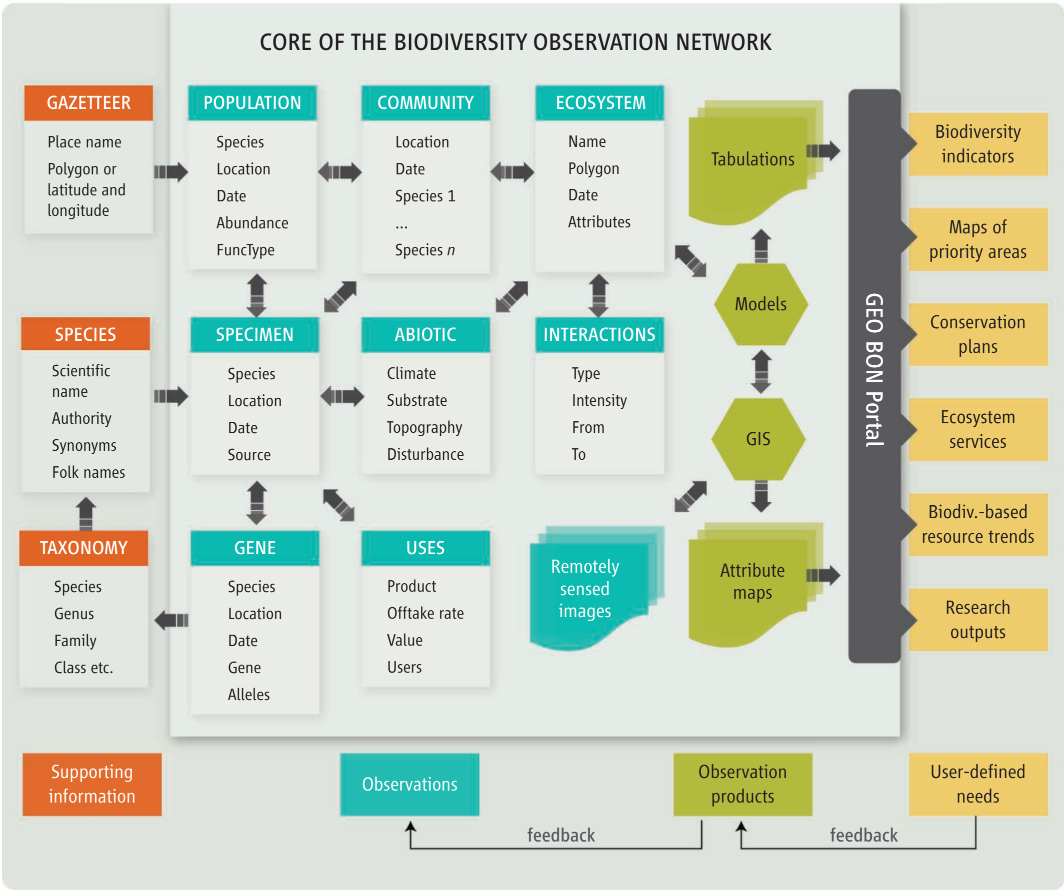

Integrated biodiversity observation system. The core data types, observation products, and end uses of an integrated biodiversity observation system are shown. Most of the elements already exist, but are incomplete or dispersed among a wide range of partners. The proposed implementation strategy involves linking them by using data-sharing protocols, followed by incremental, needs-led, and opportunistic growth. GIS, geographic information systems.

sity specialists representing over 60 scientific and intergovernmental organizations met at Potsdam, Germany, to complete the concept document. Seven working groups have been formed to draft an initial Implementation Plan by the end of the year. The key concept is a shared and interoperable system bringing data of different types and from many sources to bear on the information needs as defined by users (see figure, above). The primary data would include historical and future records from specimen collections in museums and herbaria, but also field observations by researchers, conservation and natural resource management agencies, and lay experts. A hierarchical sampling approach, involving millions of point observations of relatively simple data (e.g., the presence or absence of a species), thousands of records of abundance or community composition, and hundreds of detailed studies on individual ecosystems, bound together with models, remote sensing, and spatial analysis, would enable both global coverage and local relevance while remaining feasible and affordable. The supporting information and data-description protocols that allow this information to be shared among many independent sources are already relatively well-developed, thanks to the efforts, among others, of the Global Biodiversity Information Facility. They need to be expanded beyond collection records to include ecological observations. A biodiversity gateway on the GEO Portal, providing users easy access to data and the tools they need to understand it, will be an important part of the operational system.

The GEO BON initiative was noted by the Conference of Parties of the CBD at its May 2008 meeting, which requested the secretariat to "continue collaborating with the Biodiversity Observation Network with a view to promoting coherent biodiversity observation with regard to data architecture, scales and standards, observatory network planning, and strategic planning for its implementation" (*10*). Actions driven by the desire to adapt to and mitigate climate change, such as expansion of biofuel plantings and payments for avoided deforestation, emphasize the importance of reliable biodiversity information for other international conventions as well.

There are challenges ahead, including overcoming a tradition of data restriction within the biodiversity field. The initiative will require new kinds of cooperation among governments and nongovernmental organizations and between data providers and users of the information. The yardstick of success is not a cheaper global biodiversity observation system, but a more useful one and, thus, an improved cost-benefit relation. By analogy to the Global Climate Observing System (*11*), which is in more advanced implementation, it is estimated that the final total cost of a GEO BON could amount to €200 million to €500 million (U.S. $309 million to U.S. $772 million) per year. Because much of this is already committed in national agencies, the additional cost of global networking and gap-filling will be much more modest. The costs would be spread across many nations and organizations and phased in over a number of years, leveraging the existing expenditure in partial and stand-alone systems. The potential benefits are worth the extra effort.

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