

**THE  
GLOBAL TAXONOMY  
INITIATIVE:  
Using Systematic Inventories  
to Meet Country  
and Regional Needs**



**The Center for  
Biodiversity and Conservation  
American Museum of  
Natural History**



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# The Global Taxonomy Initiative: Using Systematic Inventories to Meet Country and Regional Needs

*A Report of the DIVERSITAS/Systematics Agenda 2000 International Workshop  
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## Introduction

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The Conference of the Parties (COP) to the Convention on Biological Diversity (CBD) has endorsed a Global Taxonomy Initiative (GTI) to improve taxonomic knowledge and capacity to further country needs and activities for the conservation, sustainable use, and equitable sharing of the benefits of biodiversity. General recommendations for implementing the GTI were provided to COP IV by a workshop, "Removing the Taxonomic Impediment," held at Darwin, Australia, February 3-5, 1998. Those recommendations, summarized in a report, *The Darwin Declaration*, were endorsed by COP IV (CBD/COP/IV/1/D/3; CBD/COP/IV/ Annex). A second GTI workshop, sponsored by DIVERSITAS, Environment Australia, and GEF-STAP, was held in London, September 10-11, 1998. The report of the London workshop, *The Global Taxonomy Initiative: Shortening the Distance between Discovery and Delivery*, made further recommendations for implementing the GTI.

To build on the findings of the Darwin and London workshops and provide further scientific and technical advice regarding the implementation of the GTI to the COP to the CBD's Advisory Body (CBD-SBSTTA), as well as to the Global Environment Facility (GEF) and its Scientific and Technical Advisory Panel (STAP), an international group of experts was convened by DIVERSITAS and its systematic program element, Systematics

Agenda 2000 International, at the American Museum of Natural History in New York. The objective of the New York workshop was to develop recommendations for undertaking country assessments and national reports of taxonomic knowledge and capacity, for preparing and designing national strategies and action plans to meet the goals of the GTI, and for building regional networks in support of country-driven activities that advance the GTI. A follow-up DIVERSITAS workshop, held in February 1999, was designed to examine taxonomic priorities, gaps, and opportunities for systematic inventories.

A major component of the workshop addressed how systematic inventories can serve as an organizing framework for building taxonomic knowledge and capacity, and thus advancing the GTI. Systematic inventories are the foundation of all taxonomic work. It is through inventories and the building of collection-based infrastructure and scientific capacity that knowledge of biodiversity accumulates. Because many country-driven activities supporting the conservation and sustainable use of biodiversity depend on the scientific results of inventories, and because biological collections are an essential component of those activities, the participants in the workshop endorsed the position that building capacity for inventories was an effective means of meeting many of the objectives of the GTI.

## I.

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### Using Inventories to Build Capacity and Advance the GTI

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Taxonomists discover, describe, and document biodiversity through undertaking inventories. The specimens derived from inventories form the basis for biological collections that constitute a permanent and documented record of biodiversity. Collections, in turn, are a rich source of information for resource management, conservation, and activities promoting sustainable development.

Inventories can be conducted at local, national, regional, or global scales; they can target selected taxonomic groups, or they can attempt to be more comprehensive when sampling biological diversity within a local area. Whatever the geographic scale or target of the inventory, the interpretation of the results of inventories depends on taxonomic knowledge that is ultimately global in scale. Providing accurate identifications of specimens taken locally requires a taxonomic understanding of close relatives living beyond the region in question. Thus, inventories within an individual country must be linked to inventory efforts on the same groups of organisms elsewhere in the region and the world.

This taxonomic process points up the strengths of collections—however large or small—in fostering regional and international scientific cooperation and advancing the GTI. No country can support experts on every taxon in the world, and no natural history museum can house collections of all of Earth's biodiversity. Therefore, cooperative approaches to taxonomic questions that are fundamentally global in nature are essential. Using collections effectively to promote national biodiversity activities also requires improving scientific expertise and infrastructure. It further requires, eventually, the sharing of specimen-based information with other scientific investigators and with biodiversity specialists in other countries, thus building the importance and effectiveness of the CBD's Clearing-House Mechanism.

### **Inventories and Collections Advance the Aims of the CBD**

Inventories, and the collections they support, provide the foundation for national and regional programs of conservation and sustainable development. Through the discovery, description, and documentation of biodiversity, inventories and associated taxonomic activities:

- document patterns of diversity across habitats and ecosystems;
- identify areas of endemism and regions in need of protection and conservation;
- provide baseline data for subsequent monitoring activity;
- identify components of biodiversity that can promote and support the conservation and sustainable use of a nation's natural resources;
- discover new species having medicinal, agricultural, or economic value;
- promote and support tourism;
- provide baseline data for implementing the ecosystem approach to conservation and sustainable development.

All countries benefit from having institutions housing reference collections of their biodiversity, and many of the benefits can be realized even if those collections are primarily of local or regional significance. Natural history collections of all kinds, especially including museums, herbaria, and repositories of genetic resources, enable national governments to:

- support the needs of applied biology, especially agriculture, forestry and fisheries, and the health sciences (parasitology, epidemiology, diagnostics);
- provide reliable taxonomic support for resource management, including monitoring trade in biodiversity;
- provide scientific support for meeting national obligations to international conventions such as CITES, RAMSAR, IPPC, as well as the CBD;
- support sustainable economic activities in biotechnology, bioprospecting, and pharmaceutical development;

- provide capacity for public and formal science and environmental education programs;
- promote public awareness of nature and biodiversity through exhibits and other activities.

### **Workshop Recommendations for Advancing the GTI**

The participants of the workshop recognized the critical role that inventories, and the taxonomy that derives from them, play in building national, regional, and global taxonomic capacity. Yet, nations vary greatly in their taxonomic infrastructure and human resources to support inventories and associated scientific activities, their preparedness to undertake inventories, and their capacity to develop and implement strategies and action plans to participate in the GTI.

The workshop participants therefore agreed that a critical need exists to provide scientific and technical advice to governments and the CBD on undertaking assessments of taxonomic capacity, preparing, designing and implementing national strategies to support the GTI, and creating regional networks in support of the GTI. To this end, and building on the recommendations provided in *The Darwin Declaration*, the New York Workshop makes the following key recommendations:

- that Parties to the CBD undertake an assessment of national taxonomic capacity as part of the national reporting process, following some of the guidelines outlined in this report.
- that Parties to the CBD develop a taxonomic strategy and action plan to strengthen national capacity to participate in the GTI, following some of the guidelines outlined in this report.
- that Parties to the CBD develop initiatives to implement their taxonomic strategy and action plan, following some of the guidelines outlined in this report.
- that regional workshops be held, within the context of national needs and capabilities, to develop action plans to help create, enhance, and sustain new or preexisting regional taxonomic networks that promote the GTI. It is proposed that these workshops be organized through DIVERSITAS, with the co-sponsorship of UNEP.

The implementation of these recommendations, the New York Workshop noted, may require some rethinking on the part of funding agencies. The participants therefore endorsed the assessment of the London Workshop on this issue:

*Implementing programs with a primary taxonomic focus under the GEF will require some examination and elaboration of the Operational Programme and Operational Strategy of the GEF. It will require, in particular, moving from the purely ecosystem focus of the programs to embrace taxonomic support as a primary underpinning theme.*

## II.

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### Recommendations and Advice for Assessing Taxonomic Capacity

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#### A. Using assessment to build taxonomic capacity

Following recommendations contained in *The Darwin Declaration*, COP IV endorsed the Global Taxonomy Initiative to increase taxonomic capacity and knowledge at the national, regional, and international levels. Taxonomic capacity varies greatly from country to country, and thus degree of participation in the GTI will be predicated on existing capacity and how that capacity might be expected to change in the future.

Because countries vary in capacity, each must take their unique characteristics into account when designing and implementing strategies and action plans. Yet, most countries, including those with relatively high capacity, lack a comprehensive assessment of current taxonomic knowledge, infrastructure, and human resources. This information is essential for identifying gaps, prioritizing taxonomic effort and capacity building, and meeting national needs. Thus, participants in the DIVERSITAS Workshop agreed that:

- the lack of basic information about taxonomic capacity at the national, regional, and international levels is a fundamental impediment to the effective implementation of the GTI; therefore
- parties to the CBD should undertake an assessment of national taxonomic capacity as part of the national reporting process.

These recommendations follow up on the recognition by the London Workshop for a needs assessment within each developing country. Taxonomic assessments should build on preexisting information and be undertaken within the context of national goals and existing national biodiversity strategies, action plans, and reporting procedures. As noted in the report from the London Workshop: “Countries must use their National Biodiversity Action Plans to develop their components of the GTI, and integrate them with other elements to implement the CBD...”

The New York Workshop agreed that assessments of national taxonomic capacity will necessarily include four components: (1) an evaluation of existing taxonomic knowledge about national biodiversity;

(2) a compilation of current national taxonomic infrastructure; (3) a compilation of current national human resources in taxonomy; and (4) an evaluation of the national user community for taxonomic data.

#### B. Assessing available taxonomic knowledge

Taxonomic information exists for all countries, but much of it is scattered in a myriad different sources, is of uneven quality, and may not be easily available electronically. Key categories of taxonomic information to be documented include:

##### 1. Information on species known or assumed to occur in the nation or region

For relatively well-known groups such as vertebrates, vascular plants, and some invertebrates, this task may be straightforward because of reliable field guides, taxonomic monographs, checklists, or other sources. For some groups, species information may be available in electronic databases. Initiatives linking species databases on all groups of organisms, such as DIVERSITAS' Species 2000, will eventually facilitate compiling such lists. In addition to species lists, countries should attempt to collate data about species discussed in monographs, primary taxonomic literature, faunal or floristic lists, reports, or electronic databases and the representation of these sources in-country (or wherever internationally they might be found).

##### 2. Species representation in national and international natural history collections

Specimens in natural history collections provide the most reliable record documenting the distribution of a species nationally and regionally. Within the context of national needs and priorities, countries will want to identify collections that contain specimens of its biodiversity. This task may be easy if there is long-term scientific involvement of one or more international institutions within the country, or because of the existence of monographic work referring to specimens in particular museums or herbaria. Increasingly, collections are being databased, and thus information on specimens may be readily available. Countries need to locate collections considered to be most critical for meeting national needs. Indexes to many collections are already available on the World Wide Web (WWW), and the number is growing rapidly.

### 3. *Data associated with specimens in collections*

Information associated with specimens in natural history collections may facilitate conservation and sustainable use of biodiversity. Such associated information often includes: date of collection, precise geographic location (latitude, longitude, altitude), sex, breeding condition, habitat type, host identification, food preferences, soil or sediment type, as well as other types of information such as abundance, song types, behavioral displays, and genetic tissue samples. If this information is not accessible as electronic databases or published monographs and reports, countries may wish to consider plans to gather this information when developing national strategies and action plans.

### C. *Assessing available taxonomic infrastructure*

A survey of scientific infrastructure supporting taxonomic research is a key element of any national taxonomic assessment. Three broad categories of taxonomic infrastructure include collections facilities, libraries, and associated scientific support infrastructure.

#### 1. *Collections facilities*

Collections facilities include museums, herbaria, zoos, botanical gardens, culture collections, and seed banks. These facilities might be housed in stand-alone institutions, universities, private institutions, or governmental agencies such as agricultural research stations. As part of any assessment, the following information should be gathered for each collection:

- taxonomic coverage and the type of specimens housed;
- quality of collection (whether it is identified, sorted, available for research);
- capacity for growth;
- quality of the facilities and curation (adequacy of cabinets, supplies, maintenance, specimen preparation areas, curatorial and staff office and research space);
- security (whether the collection is protected from fire, pests, and other adverse conditions);
- information availability and communications infrastructure (printed catalogues, whether collection is electronically managed, whether the collection is linked electronically to other collections and to systematic databases);

- institutional structure (relevant policies, quality of business management; budgetary support);
- institutional long-term planning.

#### 2. *Libraries*

Taxonomic research requires access to libraries with reference collections in the life and earth sciences. In compiling national taxonomic assessments, libraries in natural history institutions, universities, agricultural or medical research centers, and other agencies should be surveyed for their capacity to support taxonomic research. General information to be gathered will include:

- numbers and kinds of libraries;
- extent of holdings (books, monographs, electronic databases);
- communications capabilities (electronic access to holdings; electronic linkages to other libraries).

#### 3. *Associated scientific support (policies, infrastructure)*

All scientific research, including taxonomy, requires a broad range of general support infrastructure. In preparing national taxonomic assessments, each nation may wish to consider the following broad categories:

- universities, relevant governmental and nongovernmental institutions, field stations, etc.);
- computing capacity and quality;
- molecular, biochemical, morphological, cytological and other laboratory facilities;
- general research equipment available (microscopes, field vehicles, etc.);
- ocean-going ships, other research vessels, and sorting gear;
- existing strategies and frameworks to develop and promote in-country research (funding procedures, agencies, project evaluation, legislation, permit access policies, multilateral institutional agreements).

### D. *Assessing available human resources supporting taxonomy*

National strategies and action plans to contribute to the GTI will often depend on strengthening the human resources supporting taxonomy. No country

has all the taxonomists it needs, nor taxonomists expert in all groups. Therefore, countries will want to assess current human resources in light of national goals and needs. The DIVERSITAS Workshop recommends that national taxonomic assessments gather the following types of information in order to evaluate capacity in human resources:

*1. Professional research staff in each taxonomic institution (curators, research scientists)*

- Numbers
- Taxonomic coverage (expertise)
- Status: training, age, participation in professional activities within country and internationally

*2. Support staff*

- Professional collection managers
- Technicians
- Students (undergraduate, graduate, and postdoctoral)
- Parataxonomists (nonprofessionals having some curatorial or research responsibilities)
- Collectors
- Interns and trainees
- Volunteers (retired scientists, trained laypersons)

*3. Capacity for education and training in taxonomy*

- What education or training is available (taxonomic coverage, content)
- Level of education available (B.S., M.S., Ph.D., parataxonomy training)
- Numbers and kinds of trainees
- Type of training (degree granting, undergraduate, graduate, postgraduate, etc.)
- Facilities for training
- Prospects for productive employment (institutions, number and kind of posts available)

While national human resources in taxonomy are being evaluated, countries should assess human resources at the international level that may have a relevant role in building in-country capacity. Critical areas of needed information include:

- a list of in-country specialists working in foreign countries;

- a list of foreign taxonomists working in-country;
- a list of foreign taxonomists expert in relevant groups;
- the availability of training opportunities in foreign countries.

*E. Assessing national or regional priorities for taxonomic information*

When designing and implementing national strategies and action plans, it is important to determine what taxonomic information is needed by a country or region. The results of this determination can then be compared to assessments of current knowledge, infrastructure, and human resources to help set goals and priorities for building capacity. If countries are involved in regional taxonomic networks with other countries, it is also important to assess needs within the context of meeting obligations to those collaborations, especially when participation may include complementarity and sharing of research effort.

There are many user groups for taxonomic information, some of the most important being:

- Applied health and medical research
- Biotechnology
- Agriculture, horticulture, forestry, and fisheries agencies
- Forest products industries
- Conservation and resource managers
- Agencies involved in environmental protection
- Ecotourism
- Research community (biological science, global change, environmental science)

Each user-group should be surveyed for current and expected future needs for taxonomic information. Some of the questions that might be asked include:

- What taxonomic groups are considered to be most critical?
- What kinds of taxonomic knowledge about those groups is most essential?
- What gaps in knowledge need to be filled?
- What kinds of problems need to be solved with taxonomic information?
- Where does the user-group currently obtain taxonomic information?



### III.

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## Recommendations and Advice for Preparing and Implementing National Strategies and Action Plans to Support the GTI

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### A. Framework for preparing a national strategy to implement the GTI

All nations can and should contribute to the Global Taxonomy Initiative. Taxonomic information is fundamentally a global resource; consequently, for a GTI to be successful—that is, if taxonomic knowledge is to provide shared benefits to all nations—then it is essential that all countries participate to the maximal extent possible. Preparing national strategies and action plans will be a key mechanism for enhancing taxonomic capacity and realizing an effective GTI.

All national strategies and action plans will build on assessments of existing capacity. For purposes of this report and recommendations, the Workshop recognized three broad categories of current taxonomic capacity:

- *High capacity*: the country has multiple taxonomic research institutions (museums, herbaria, and so on), many of which have collections of global importance and have generally adequate support personnel and infrastructure (including communications systems and libraries); many active taxonomists broadly serve country needs and contribute to international needs as well; and significant ongoing training capabilities exist;
- *Medium capacity*: the country has only a few taxonomic research institutions, some with collections of national importance, but few of global importance, with poorly or medium developed support and infrastructural capacity; small numbers of active taxonomists inadequately serving country needs and contributing relatively little internationally; and poorly developed ongoing training capabilities; and
- *Low capacity*: the country has very few, if any, taxonomic research institutions, with collections that are inadequate nationally; with little if any support and infrastructural capacity; few or no active taxonomists; little if any training capabilities; and relies exclusively, or nearly so, on taxonomic information generated outside the country.

These different capacities give rise to varying country needs, forms of capacity building, and expectations of how a country can, and should, contribute most effectively to the GTI.

Even countries with high taxonomic capacity typically lack sufficient taxonomic information to fulfill all needs, because of inadequacies in infrastructure, support, or training. Yet, because high capacity countries have an obligation, as repositories of collections of global significance, to contribute proportionately more to the GTI, strategies and action plans for these countries should also include programs to address the following global impediments:

- development, production, and electronic dissemination of collections-based information;
- development, production, and electronic dissemination of taxonomic literature;
- development, production, and dissemination of advanced technologies in taxonomy;
- development and expansion of global training programs in taxonomy;
- active involvement in building global taxonomic infrastructure to meet country needs.

For countries with medium taxonomic capacity, having improved infrastructure, increased representation of national and regional biodiversity in collections, and additional professional taxonomists, along with highly trained support staff, will not only help meet national objectives for conservation and sustainable use of biodiversity, but contribute to global needs as well. Much of this can be realized through the identification and strengthening of programs at current research centers.

Countries of low taxonomic capacity must take a critical look at their national goals for conservation and sustainable use of biodiversity, and decide which components of taxonomic capacity-building will best achieve those goals. It is in the interest of all countries to have basic reference collections of their biodiversity, especially as those collections relate to important societal needs. Building those reference collections may be a key priority. At the same time, considerable taxonomic information about all countries exists somewhere in collections and libraries, but taxonomic expertise is required to collate and evaluate that information if it is to be maximally useful in meeting national needs. Hence, the presence of one or more taxonomic research centers housing professional taxonomists, along with basic reference

collections, global informatics capabilities, and libraries, should be the goal of every country. With planning, this goal can be achieved incrementally and cost-effectively.

The DIVERSITAS Workshop recognized the following basic steps in preparing national taxonomic strategies and action plans:

- completion of an assessment of taxonomic capacity;
- a clear understanding of national needs for taxonomic information within the context of national goals for the conservation and sustainable use of biodiversity;
- adopting a planning process that is participatory, inclusive, and transparent;
- adopting an action plan that is achievable and sustainable.

*Within the context of the foregoing principles, the DIVERSITAS Workshop recommends that each Party to the CBD convene one or more workshops or forums, involving relevant stakeholders, with the goal of producing a national taxonomic strategy and action plan.*

These workshops and planning sessions can be the venue for establishing formal communications among taxonomists, as well as all recognized and potential users of taxonomic information. Agreement that taxonomy is a crucial science for achieving the country's goals in conservation and sustainable use of biodiversity should be a primary foundation for the workshop and its organization. The workshop might wish to take advantage of taxonomic resources available at an international level (including the participation of foreign expertise as deemed necessary). It is important that the workshop be organized to establish realistic goals and strategies that stress the long-term effectiveness of any recommendations. Consideration of how government and international support can catalyze the outcomes of the workshop will be a key component of implementing the action plan.

The following sections summarize some, but not necessarily all, issues that may require consideration.

## **B. Strategies for increasing access to available knowledge**

*The New York Workshop recommends that the single most important mechanism for increasing the delivery of taxonomic information to all countries is to ensure that all taxonomic research institutions are connected, at low cost to those institutions, to the WWW and the Internet.*

*The Workshop recommends that donors, especially the GEF, support such activity to the extent possible and appropriate.*

Thousands of taxonomic databases of many different kinds are currently available, either directly on the WWW and the Internet, or indirectly from the owners of those databases. Ongoing initiatives such as the Biodiversity Informatics Subgroup of the OECD Megascience Forum, which the New York Workshop strongly endorsed, will have the effect of making many more databases available.

Taxonomic research institutions in high-capacity countries should undertake assessments and develop programs, individually and collectively, to make taxonomic information in their care more readily available electronically. The electronic capture of specimen-based data should be accelerated. Publications such as monographs, checklists, and literature reviews should be released in electronic as well as hard-copy form. Library holdings in these research institutions should be made electronically available on the WWW. For their part, taxonomists should make databases available to co-workers in other countries through electronic means.

A key element of a taxonomic strategy and action plan is to develop a database of the specimen-based information for all taxa, or a prioritized subset of taxa, housed in the world's natural history institutions. Action plans therefore need to incorporate means to:

- ensure that proper hardware and software exist for database management of specimen-based records;
- facilitate the sharing of information in the database among national research centers;
- locate and assess the national relevance of specimens housed in the world's natural history institutions;
- obtain this specimen-based information, either from these institutions or by undertaking the databasing effort directly.

National priorities and needs will largely determine how databasing priorities will be set. Once specimen-based records are obtained, expertise will be required to interpret and use these data.

This generally calls for sophisticated expertise in geographic information systems as well as for professional taxonomic training in the priority taxa. These considerations should be taken into account when developing human resource expertise in taxonomy.

Databasing collections, within a prioritized context, can often be accomplished in a cost-effective manner relative to the long-term value of the information that is gathered. A leading example of this approach has been the efforts of Mexico's CONABIO to database specimens in North American and European collections for prioritized target taxa and to apply these data to conservation.

National action plans should include the development of a database of taxonomic expertise for all relevant taxa. If collaborations within-country and with foreign institutions are already extensive, the identification of relevant taxonomic expertise may be straightforward. Access to the WWW is the most effective means of identifying expertise. Many professional societies and natural history institutions have Web pages that point to expertise of members or staff, and such lists are increasing. Efforts are ongoing in many countries and regions to database expertise, and those lists are being made available electronically. Nations with high capacity should increase efforts to create or enhance these databases.

### *C. Strategies for increasing taxonomic infrastructure*

*The New York Workshop recommends that donor institutions such as the GEF may wish to encourage countries to include work plans for building or improving taxonomic infrastructure in proposals to support biodiversity activities, as appropriate.*

Building or improving taxonomic infrastructure is at the heart of using taxonomic information to conserve biodiversity, use it sustainably, and contribute to the GTI. Infrastructure, primarily in the form of collections sited at natural history institutions, creates the locus for professional and paraprofessional employment, for formal training in taxonomy and other educational activities, and for applying systematic knowledge to societal problem-solving.

Taxonomic infrastructure will be expanded only

when decision-makers and funders recognize that the research and educational programs supported by systematics are critical to perceived needs. It is therefore essential that the staffs of these institutions articulate clearly and forcefully the essential role of collections and taxonomy in environmental problem-solving and management. At the same time, institutions housing collections must work together in this effort rather than against one another. Collaboration is critical for identifying shared needs and common solutions to improving infrastructure.

In designing strategies and action plans, working groups might examine the national taxonomic assessments of infrastructural resources to identify areas of complementarity and overlap, as well as important gaps within and among institutions. Priorities within and among institutions could then be identified. The workshop noted that one of the more important factors is the degree and kind of governmental commitment supporting the expansion of taxonomic infrastructure and maintaining it over the long term.

Implementation of capacity-building in taxonomy is likely to be more successful when it is linked to a broader plan for conserving and sustainably using biodiversity. Increased systematic knowledge needs to be integrated with all programs concerned with ecosystem management and monitoring, applied research including bioprospecting, and conservation. Thus, improving taxonomic capacity is a logical component of aid packages for these other activities.

Some governments have recognized the importance of expanding their infrastructure for taxonomy and have embarked on programs with funding from GEF and other donors to increase and upgrade collection space, train more professional systematists and collection managers, increase their capacity to manage systematic information, and engage in a more active program of field collecting. Many countries with medium levels of taxonomic capacity could substantially improve research facilities by following this model.

Some countries with low levels of systematic capacity have benefitted from aid packages from international donors that were specifically designated for constructing natural history collections, establishing modern communication systems, and implementing training programs. This increased capacity has allowed recipient nations to expand inventory activities that support a variety of biodiversity programs. A key element that helps ensure the success of this

approach is the commitment on the part of recipient governments to finance future operating costs of the facility, including salaries of professional systematists and their support staff.

Building or improving capacity through inter-institutional collaborations is another viable mechanism for low-capacity countries. Institutions in these countries often enter into partnerships with high-capacity institutions that are beneficial to both. In exchange for facilitating scientific activities, the high capacity institution may provide help or advice in upgrading facilities, expanding biodiversity collections, and offering training.

*The DIVERSITAS Workshop recommends that national governments and authorities develop policies that facilitate the efforts of their institutions to establish scientific collaborations with other international institutions and organizations.*

If a country has little or no natural history collections infrastructure, collaborations with regional governments can begin the process of building collections and enhancing training. The benefits of regional partnerships will be discussed below.

#### *D. Strategies for increasing human resources for taxonomy*

The training of professional systematists goes hand-in-hand with the problem of finding positions in systematics research institutions where their training can benefit science and society. Many training opportunities exist within universities and research institutions in the developed countries. Employment opportunities, on the other hand, depend on the existence of institutions that support jobs, including research collections, universities, and governmental or nongovernmental agencies. Building employment opportunities—creating taxonomic infrastructure—should be seen as perhaps the major challenge to meeting the needs of the GTI.

National strategies and action plans need to view training within the context of available and projected infrastructure, gaps in research needs, and national goals and priorities for biodiversity activities. Thus, priorities also have to be set for training objectives.

In training professional systematists, an international perspective is essential. Many nations with low or medium capacity, and with few if any opportunities

for training in modern systematic biology, will want to seek training opportunities for prospective students in other countries. Establishing scholarship programs to send students to international research centers for training should be a high priority. Donors to these countries should encourage training programs in their aid packages for biodiversity. Some ongoing GEF projects have substantial training components that can serve as models and need to be expanded.

For their part, taxonomic research institutions in developed countries should broaden aid programs for students from countries rich in biodiversity. Governments in developed countries need to make more resources available for this purpose. Major opportunities exist for training professional systematists within the framework of regional systematic networks. Aid packages to support these networks can include training components that are sited at those institutions with the highest capacity.

An important aspect of human resources in taxonomy is the support, technical, and paraprofessional staffs of systematic research centers. These personnel are critical for collection management and maintenance and for the increased productivity of the professional research staffs. Generally, these personnel will be tied to the country of origin, even if the professional systematists have a more regional/global perspective. Professional and paraprofessional training is hands-on and is accomplished most effectively by activities taking place within research collections. This may require input from the international taxonomic community. Many institutions and individual systematists in developed countries are engaged in such activities. Once again, aid packages for biodiversity studies could include resources to enable training of support staff.

#### *E. Strategies for implementing the GTI through inventories*

Over the long term, planning and implementing systematic inventories provide an effective framework for meeting country needs and for visualizing action plans and priorities that enhance infrastructure and human resources in taxonomy. Well-designed programs of inventory- and capacity-building are now being implemented by national governments and regional networks. The DIVERSITAS Workshop noted the following issues concerning the design and implementation of inventories.

Although every nation has an obligation, under the Convention, to inventory its biodiversity, no nation is prepared today to inventory its entire biota. It should be every nation's goal, however, to understand its biodiversity within the context of its current capacity in order to further the goals of conservation and sustainable use. It is crucial, therefore, that each nation begin the process by giving highest priority to those groups of organisms that are nationally important resources. Examples might include:

- species being used commercially, along with species associated with them such as pollinators, soil organisms, pests and parasites, and other ecologically relevant taxa;
- species of protected areas or areas being considered for conservation;
- species in ecologically critical habitats and ecosystems, where an inventory of taxa is important for understanding how ecosystem services are delivered, maintained, and managed;
- taxa, the understanding of which is essential for critical societal needs in health services, agriculture, fisheries, and forestry;
- species important for developing new genetic resources and biotechnology products;
- species groups of critical importance such as indicators, keystone species, invasives, and endangered taxa.

In assessing the relative importance and feasibility of inventorying various groups of organisms, it is worth remembering that the only groups of organisms about which we know very much are vertebrates and vascular plants, which together probably represent less than 3% of the total world biota, and that no one even knows whether vertebrates and green plants provide a reasonable basis for extrapolations about the other 97% of the total world biota. It is important, therefore, that nations give serious consideration to inventorying some groups of organisms that are much more diverse than vertebrates or plants—that is, to groups of non-vertebrate animals, fungi, protists, bacteria, and viruses—many of which are of high relevance for the priorities noted above.

The groups targeted must, of course, be feasible to inventory. Such groups would meet the following criteria:

- available knowledge about the group is accessible, ideally through printed or electronic taxonomic catalogs;
- taxonomic experts on the group are available, either in-country or through international collaborations; and
- specimens can be collected easily by appropriate methods, quickly and inexpensively prepared for study, and durably maintained in collections.

Ideally, the set of taxa chosen should include inhabitants of terrestrial, fresh-water, and marine ecosystems, and should together represent many different ecological roles. For each group targeted, infrastructure and planning needs may include:

- searching the literature for published records;
- searching existing museum collections, internationally, for relevant specimen and locality data;
- establishing sorting centers that can efficiently process mass-collected samples;
- establishing new national collections and museums (or enhancing existing ones) to handle newly collected and sorted specimens, including those for nontarget organisms;
- establishing geographic information systems (GIS) for mapping existing and new knowledge about taxa and habitats, including agroecosystems and other habitats of economic significance, endangered habitats, conserved wildlands, relatively unexplored areas, and areas involved in current land-use decisions;
- establishing new electronic databases (or enhancing existing ones) capable of handling and synthesizing large quantities of specimen data, and making extrapolations from those data;
- employing and training in-country expertise to accomplish all of the above activities.

For each group targeted, a sampling strategy can be devised and implemented, taking into account the existing knowledge base and striving to fill the gaps in it. The goal is to maximize complementarity among areas by first sampling widely among the richest biomes, then to sample more deeply among the most distinct ones.

In many cases, significant economies of scale can be achieved by adopting a regional rather than a single-nation approach to inventorying particular

groups of organisms. Providing accurate species identifications, especially within highly diverse groups of organisms, usually requires comparisons with species inhabiting neighboring and other countries. The most rigorous and useful taxonomic analyses (revisions and monographs) are best implemented globally, rather than within political boundaries.

Effective data management will be crucial to achieving the inventory's goals. The data model used must include at least the following kinds of information: the relevant parts of the taxonomic hierarchy (family, genus, species, author, year, etc.), locality (state or province, detailed locality), geographic coordinates, date, unique specimen number, habitat, altitude, depth, soil or sediment type, collecting method, collector, sex/life stage, host, identifier name and date, and repository. Effective quality control will require that all species, whether identified or not, have publicly accessible diagnostic information; periodic data backup and verification, as well as peer/expert review, are essential.

Throughout the process, focus must be maintained on the inventory's products, which will include at least some of the following:

- Web pages for each species, with diagnoses, illustrations, distribution and ecological information, which will allow information to be shared quickly and economically;
- field guides, floras, faunas, and other area-specific publications, checklists, revisions, monographs, and other taxon-specific publications;
- interpretive material, including geographic analyses identifying areas of endemism, special richness, and conservation priority;
- national collections of authoritatively identified material, ready for use in projects ranging from bioprospecting to land use decisions; and
- national databases including all available information on the targeted groups of organisms, with interactive identification tools.

Production of interim taxonomic publications is important inside and outside the country because it triggers funding and further research.

#### *E. Ensuring the sustainability of recommended programs and actions*

Successful implementation of national taxonomic strategies and action plans will include financial and institutional mechanisms for the long-term sustainability of the work plan. In addition, it is important to obtain support from a diverse user-community of taxonomic information and to develop mechanisms to disseminate that information broadly. Successful implementation can also result from advanced budgeting, a diverse funding base, and from careful planning in which costs of research and collections programs might involve shared workforces and other resources.

#### *G. Ensuring rights and obligations in promoting the GTI*

The DIVERSITAS Workshop also briefly considered the important and complex issues relating to the rights and obligations of nations and of collections-based institutions in promoting the GTI. Governments have property rights to their biodiversity which must be respected by the international scientific community. The Workshop noted that custodians of collections have obligations to (1) join with countries to find mechanisms to make information on specimens housed in the world's collections easily accessible, especially to the countries of origin; (2) respect countries' rights under international treaties and conventions; (3) use those collections to promote the conservation, sustainable use, and mutual sharing of benefits for all countries; and (4) abide by all national and international legal instruments governing the collecting, export/import, and exchange of biological specimens.

The Workshop also noted that countries would benefit from collegial partnerships with collections-based institutions to promote and facilitate an understanding of biodiversity through inventories and other scientific activities.

## IV.

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### Recommendations for Building Regional Networks to Support the GTI

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#### *A. Meeting country needs through regional networks*

The New York Workshop noted and strongly endorsed the call from COP IV (IV/5/B6/Operational objective 6.2) that “Special consideration should be given to regional perspectives and the setting up of regional centres of taxonomic expertise, as well as to the taxonomy efforts of other intergovernmental programmes, agencies and relevant institutions.”

Although CBD implementation is through country-driven activities, the Workshop noted that taxonomic knowledge is a transnational issue and, therefore, regional approaches to the GTI are essential. The Workshop gave considerable attention to the value and importance of regional cooperation. It considered examples of ongoing regional efforts and tried to draw common themes underlying their success.

The Workshop found many reasons to support and expand cooperation, but recognized that the key rationale is fundamentally a scientific one: taxonomic problem-solving is a global endeavor requiring knowledge of species whose distributions and relationships to other species are almost always transnational in nature. The Workshop identified other important reasons why a regional approach to building taxonomic capacity and implementing the GTI should be encouraged:

- because taxonomic expertise, infrastructure, and taxonomic representation in collections are distributed across many countries, and sharing these resources avoids duplication of effort and costs.
- because taxonomic problem-solving may involve shared scientific and management issues, such as might arise when ecosystems and their services, migration routes for animals, protected areas, fishing grounds, or the ranges of endangered species cross international

boundaries. Some large islands, lakes, mountain ecosystems, wetlands, river systems, and coastal marine ecosystems are shared by two or more countries, thus making cooperation beneficial. Inventory in the deep ocean outside of Exclusive Economic Zones and beyond national jurisdiction would also benefit from cooperative approaches.

- because taxonomic capacity (infrastructure, human resources) cannot be replicated in each country for financial or technical reasons. The Workshop noted again that no country can encompass the full range of taxonomic resources; thus international cooperation is required for taxonomic problem-solving.

It follows that regional taxonomic networks can better use available taxonomic expertise and infrastructure to solve scientific problems, especially when directed toward common problems associated with shared resources, and can do so more efficiently and cost-effectively than if attempted individually. In addition, there are other potential benefits from regional networks:

- They allow for building capacity across a region, not just within a single country, and that capacity-building can be designed to enhance future cooperative research efforts.
- Cooperative projects result in greater impacts through synergies in both inputs and outputs.
- There is greater stability and relevance of the outputs because of synergies in design and funding.
- The project responsibilities and tasks can be distributed more widely, thereby creating economies of scale and better use of existing resources.
- Many donors see the advantages of such networks, and thus they permit stronger, more competitive proposals.
- There may be added benefits from synergies created by language or cultural similarity.

### *B. Creating and sustaining regional taxonomic networks*

The DIVERSITAS Workshop noted that the nature of the institutional framework within each cooperating country is critical for building regional networks. Successful regional collaborations require that:

- the collaboration should be long-term and driven by clear, shared objectives and goals, and be characterized by sound planning.
- the partners must determine an equitable sharing of project costs and must have a means of sustaining the project once initial donor funding ends.
- there must be good inter-country communication and the implementing agencies and institutions must share flexibility and a willingness to cooperate.

Mindful of the importance of meeting national goals for conservation and sustainable use of biodiversity, participants in the DIVERSITAS Workshop were in unanimous agreement that regional networks offer among the best opportunities for advancing the GTI and providing critical taxonomic knowledge to the world user community. Yet, because of the many complexities that are peculiar to different regional situations, the Workshop believes that much more discussion and exchange of ideas are necessary in order to ensure successful efforts in building regional taxonomic networks.

The Workshop therefore recognized the need for regional workshops that would address issues surrounding taxonomic networks within the framework of ongoing and future efforts to build taxonomic capacity within each country. Exploratory committees were created to initiate national discussions within the regions of Latin America, Africa, and Asia, with the goal being to convene regional meetings in 1999, and the Workshop encourages other regions (such as Oceania/Australasia) to consider parallel efforts.

*Thus, the New York Workshop recommends that regional intergovernmental workshops be held, within the context of national needs and capabilities, to develop action plans to help create, enhance, and sustain new or preexisting regional taxonomic networks that promote the GTI. It is proposed that these workshops be organized through DIVERSITAS, with the co-sponsorship of UNEP.*



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