

The International Long Term Ecological Research Network 1998

The International Long Term Ecological Research Network



1998

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Albuquerque New Mexico



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LTER



University of New Mexico

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Preface

The Continuing Development of the International Long Term Ecological Research Network

The U.S. National Science Foundation supported the first International Long Term Ecological Research (ILTER) workshop at Estes Park, Colorado USA in 1993. Scientists from 16 nations met to consider the prospect of long-term ecological research as an "international science." From that meeting, the International LTER (ILTER) network of research sites has grown and flourished.

At the time of the Estes Park meeting the U.S. National Science Foundation announced its intention to support the continued development of the U.S. LTER Network by encouraging:

- ♦ the expansion of site activities to a regional scale
- ♦ the broadening of site research to include the geophysical, social and economic sciences, and
- ♦ the development of more complete site inventories and histories to better understand current conditions and make future projections.

Since the 1993 ILTER workshop the National Science Foundation has increased the number of sites in the US LTER Network to 21 with the addition of two urban sites and a coastal estuarine site with both urban and rural components. In addition, most of the U.S. LTER sites now have regional research programs and two of the sites have been augmented to focus specifically on social and economic issues of the environment. This new focus on human-dominated ecosystems, like the establishment of the ILTER network, offers great promise for advancing ecological and environmental sciences. The National Science Foundation now seeks to increase the focus on microbial ecology, biodiversity and K-12 education at each of the US LTER sites.

The Estes Park ILTER delegates recommended the formation of LTER Programs in other countries. Other actions they recommended were:

- ♦ Facilitate communication and information access for LTER researchers worldwide
- ♦ Develop a global directory of LTER research sites
- ♦ Conduct research on scaling, sampling & standardization, and
- ♦ Foster education, public relations and relationships with decision makers

The response of the National Science Foundation was to charge the U.S. LTER Network Office with catalyzing the ILTER concept by working with other nations to join in building long-term ecological research programs. The Foundation is pleased with the rapid ILTER progress in 5 short years. Today there are 15 nations with their own long-term ecological research programs and in total, more than 200 long-term research sites. Twelve other nations are working to establish national LTER programs and to designate long-term research sites. Fifteen additional countries have recently expressed interest in developing their own networks of long-term research sites.

The US LTER Network now has an open data-sharing policy and, through knowledge networking tools and the World Wide Web, is building information systems to permit easy access to ecological and environmental information and to ensure a high level of communication between the growing

network of US LTER and ILTER scientists. This activity is a response to one of the key concerns expressed at the Estes Park ILTER meeting: Communication and Information Access for LTER Researchers Worldwide. The US LTER Network participated in numerous bilateral data and information management workshops to facilitate data and information sharing and communication for the growing ILTER network.

The recent formation of regional networks by participating ILTER nations in Asia and South America is an encouraging sign. The National Science Foundation looks forward to the results of the ILTER workshop from the 1998 INTECOL meeting in Florence, Italy. ILTER is charting new ground in building "international science" from the ground up.

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I ntroduction

Long-term Research on a Global Scale

James R. Gosz

Chairman, ILTER Network

Long-term data are now recognized as crucial to our understanding of environmental change and management. Historically, these studies have been difficult to maintain because of the dominance of short-term funding programs, a misconception that long-term studies are merely monitoring, and an emphasis on short-term experimentation or hypothesis testing of specific interactions or processes under the assumption of equilibrium conditions. The complexity of the environment and the dynamic nature of environmental conditions require additional research efforts that are not only long term, but address questions of scale dependency, complex assemblages of species and their interactions, and the role of humans in the environment. Long Term Ecological Research (LTER) sites offer this important complement to the more traditional types of ecological research. These sites also provide the opportunities for interdisciplinary research that is fundamental to understanding the environment. Such collaborations are essential for the development of sustainable management of our natural resources.

The need for collaborations among the numerous scientists and high-quality programs that are involved in understanding the various areas of our globe is an even stronger argument for the development of a worldwide network of LTER sites and programs. As a result of an international meeting in 1993 that focused exclusively on networking of long-term ecological research, an International LTER (ILTER) Network was formed with a mission to facilitate international cooperation among scientists engaged in long-term ecological research. Thirty-nine scientists and administrators representing 16 countries participated and developed the initial recommendations for the network. These are repeated here to document the legacy of this activity as well as to evaluate progress for the ILTER Network.

1. Communication and Information Access for LTER Researchers Worldwide

- ♦ Determine the general connectivity status of LTER sites and scientists by country or region
- ♦ After completing a connectivity assessment, organize a clearinghouse system to facilitate technology and skills transfer between sites
- ♦ Create an information server on the global Internet to provide worldwide access to information and data relevant to international long-term ecological research
- ♦ Establish an international LTER (ILTER) server access mechanism (or mechanisms) for researchers in regions presently without access to the international Internet

2. Developing a Global Directory of LTER Research Sites

- ♦ Develop minimum site capabilities or standards for inclusion in an ILTER directory
- ♦ Identify existing and potential LTER sites worldwide
- ♦ Create both electronic and hard copy versions of an ILTER directory to be updated regularly
- ♦ Form a directory working group to help define tasks and secure funding for the creation of an

ILTER directory

3. Developing LTER Programs Worldwide

- ♦ Encourage the pairing of mature and developing sites which share similar ecological settings, and encourage cooperation between pairs of established sites within or between countries
- ♦ Produce an inventory of sources of financial support for ILTER activities and infrastructure at participating sites

4. Scaling, Sampling and Standardization: Some Design Issues

The following questions should be addressed by LTER sites:

- ♦ Will phenomena that occur over long time scales be adequately sampled over appropriate spatial scales?
- ♦ What is the spatial and temporal range over which site data can be legitimately extrapolated, and what methods(s) will be used?
- ♦ How much effort will be required for synthesis and inter-site comparison, and has flexibility for subsequent adjustment of observations been incorporated into the design?
- ♦ Have the selected measurements been adequately tested, and have the required precision and frequency of observations been specified?
- ♦ Does the range of variables selected adequately reflect the full range of driving, state and response variables for the system under investigation?

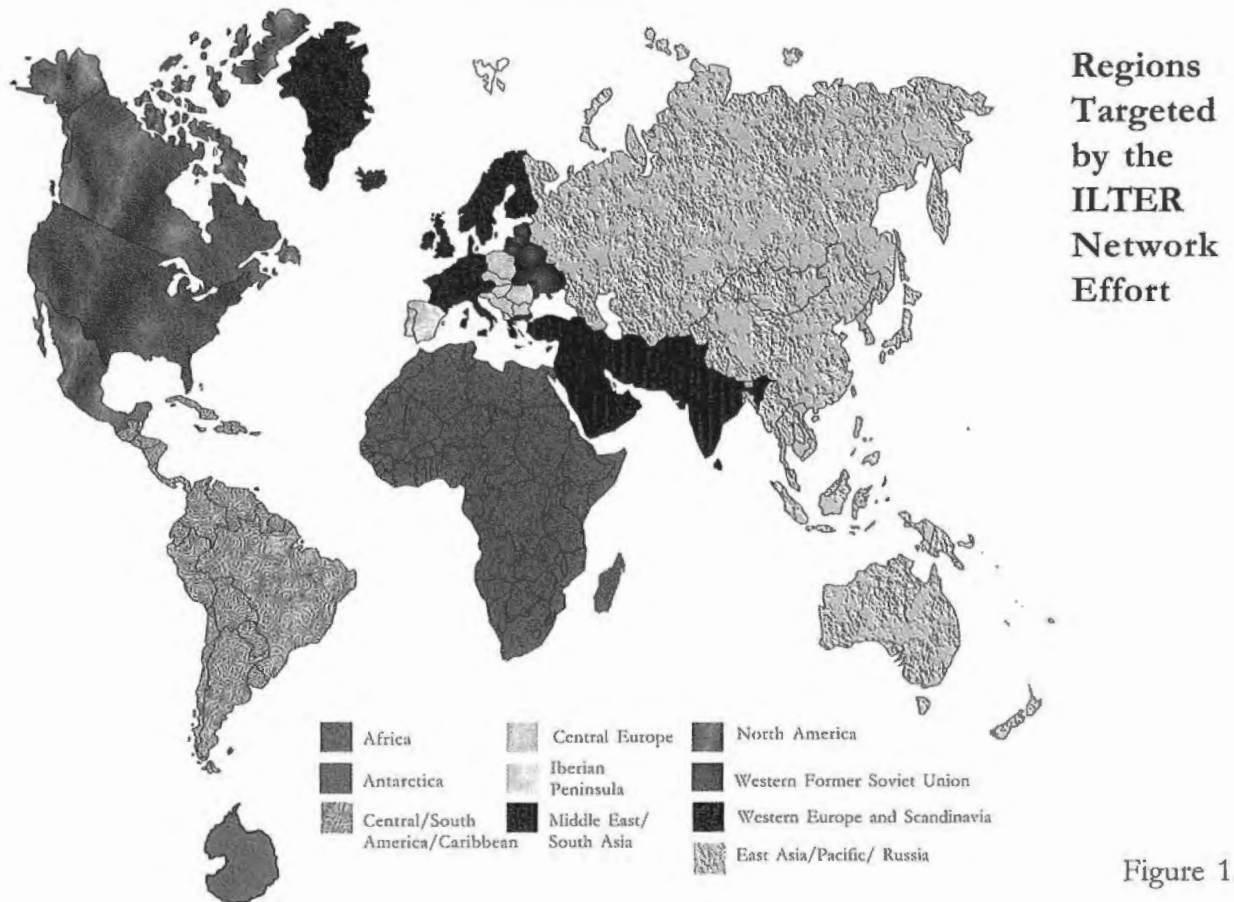
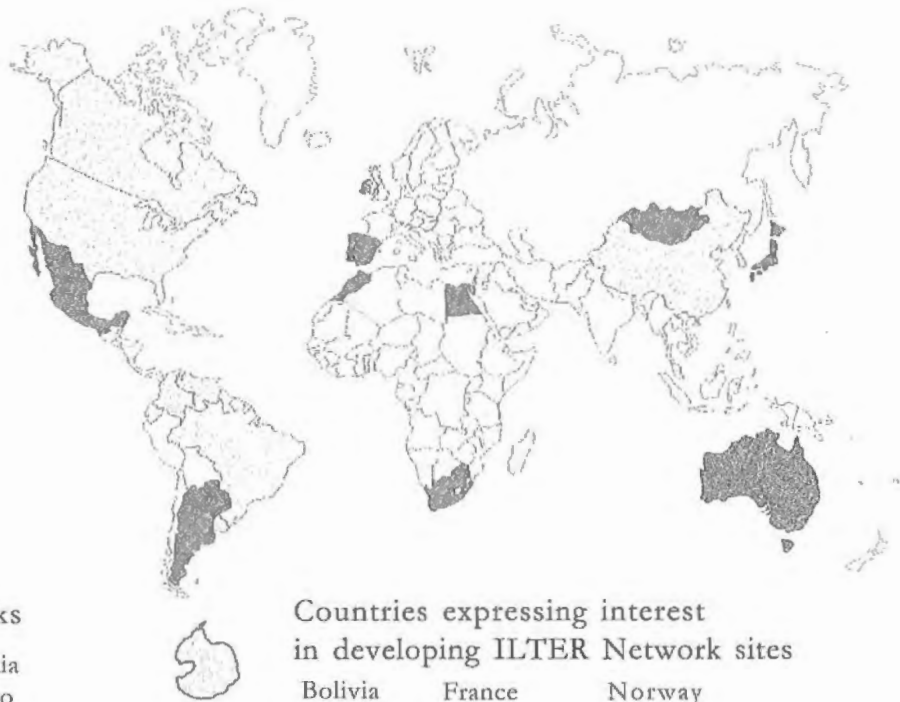


Figure 1.

ILTER Networks

Brazil
Canada
China
China – Taipei
Colombia
Costa Rica
Czech Republic
Hungary
Israel
Korea
Poland
United Kingdom
United States
Uruguay
Venezuela



Developing Networks

Argentina	Mongolia
Australia	Morocco
Egypt	Paraguay
Ireland	Portugal
Japan	South Africa
Mexico	Spain

Countries expressing interest in developing ILTER Network sites

Bolivia	France	Norway
Chile	Indonesia	Panama
Denmark	Italy	Peru
Ecuador	Kenya	Switzerland
Finland	Namibia	Tanzania

Figure 2.

5. Education, Public Relations and Relationships with Decision Makers

- ♦ ILTER sites should be used as sources of information for formal higher education and interdisciplinary curricula development
- ♦ ILTER sites should be used as sources of information for elementary and secondary school curricula development
- ♦ ILTER sites and networks should provide clear and accurate information on LTER research to the general public and decision makers

The ILTER Network Committee has grown substantially and broadened its activities since the initial conference in the United States in 1993. Annual meetings have been held in the U.K. (1994), Hungary (1995), Panama/Costa Rica (1996), Taiwan (1997) and Italy (1998). Reports from these meetings are available on the ILTER World Wide Web site (*please see* <http://www.lternet.edu/ilter>). The committee has established the following mission statements, based primarily on the 1993 conference:

1. Promote and enhance the understanding of long-term ecological phenomena across national and regional boundaries;
2. Promote comparative analysis and synthesis across sites;
3. Facilitate interaction among participating scientists across disciplines and sites;
4. Promote comparability of observations and experiments, integration of research and monitoring,

- and encourage data exchange;
- 5. Enhance training and education in comparative long-term ecological research and its relevant technologies;
- 6. Contribute to the scientific basis for ecosystem management;
- 7. Facilitate international collaboration among comprehensive, site-based, long-term, ecological research programs; and
- 8. Facilitate development of such programs in regions where they currently do not exist.

The ILTER Network Committee identified a number of target regions to focus on during the first decade (Figure 1). Substantial progress has been made as demonstrated in the current map of countries that have formal LTER Networks, those near to establishment of their Networks and countries that have expressed an interest and are pursuing the development of an LTER Network (Figure 2). This list is dynamic and is continually updated. It is presented here to demonstrate the remarkable progress made from the initial three countries in 1993 to the status of the Network by June 1998.

Each country must assess its own needs and resources if it wishes to involve itself in an LTER program. Each will have a unique set of opportunities and limitations that are best evaluated by the scientists and policy makers of that country. The typical procedure for a country is for the scientists of that country, along with the funding agencies, to decide whether to endorse the premise that ecology and environmental management are significantly benefited by studies of long-term and broad spatial scales. A plan is then developed that establishes the context and mission for such studies, sites and programs are identified that will contribute to this mission, and support is obtained from within that country or international organizations for implementation and continued maintenance. It is anticipated that each country's program will be part of a global network of scientists and of scientific information that will advance our understanding of not only local and regional, but also global issues and provide solutions to environmental problems at these scales. The map shown in Figure 2 demonstrates that many countries believe this an important undertaking.

A more recent development is the formation of Regional LTER Networks. Neighboring countries often have similar concerns and are increasing opportunities for collaboration and providing assistance to other countries in the region that are attempting to develop their own LTER Networks. The East Asian-Pacific Regional LTER Network and the Latin American Regional LTER Network have been formed and are holding their own annual or biennial meetings in addition to the ILTER annual meetings. Both a North American Regional LTER Network and a Central European Regional LTER Network are being planned at this time.

LTER sites in the countries of the ILTER Network now can provide unparalleled opportunities for cross-site and comparative research efforts on many of the world's ecosystems at levels from genes to landscapes. These global LTER sites function as "research platforms" that lead to interdisciplinary research, permit extrapolation to larger areas or regions, provide the scientific basis for management and policy decisions that incorporate social and economic issues, and attract scientists from other sites and networks. The ILTER Network is now well positioned to interact with other international activities such as the International Geosphere Biosphere Program (IGBP) and the Global Terrestrial Observing System (GTOS). We anticipate rapid progress in these interactions in addition to continued expansion of the ILTER Network to other countries of the world.

Brazil

The Brazilian Long Term Ecological Research Program *Present Status and Perspectives*

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Brazil may be the richest country on Earth in biological diversity. The sheer size of the nation, with five highly diverse biomes (Amazonia, Cerrado, Atlantic Forest, Caatinga and the Pantanal, or wetlands), ranging from semi-arid ecosystems to evergreen tropical rain forests, all conspire to make Brazil one of the top megadiversity countries. On the other hand, the threats to the integrity of Brazil's biodiversity do not cease to grow—a dangerous trend given the poor level of knowledge available on the composition, processes and dynamics of its native ecosystems. The investigation of critically important ecological phenomena, relevant to the use and conservation of biological resources demands not only descriptive studies but also monitoring of long-term trends. With this in mind, research agencies, universities and government institutions have proposed the establishment of a Long Term Ecological Research (LTER) Program for Brazil, borrowing from the experience of LTER initiatives in other countries and regions.

The Brazilian LTER will focus on an integrated and commonly agreed-upon research agenda and consist of a network of selected sites representing the various major ecosystems of the country, starting with areas that already host a significant number of ecological investigation programs and maintain adequate on-the-ground research facilities. In the development of the Brazilian LTER network, it is necessary to recognize the important role played by the North American LTER program, sponsored to a large extent by the United States National Science Foundation (NSF). Under the leadership of James Gosz and his colleagues, several preparatory meetings were held over the past two years to familiarize Brazilian scientists with the experience, goals and strategies of the LTER approach to ecological investigation.

The dynamics leading to the creation of the Brazilian LTER were facilitated by a recent initiative within the Brazilian National Research Council (CNPq), represented by the Integrated Ecology Program (IEP). This effort will boost ecological research and higher-level training for investigators on a more systemic basis, under a specific budget line provided by the federal government. Using a similar approach, the IEP will concentrate on a common research agenda, composed of five priority themes, and will serve as a support base for the nascent LTER program.

The Selection of LTER Sites

A coordinating committee assembled by the CNPq identified several criteria to be used in the process of site selection, which will be conducted using as its baseline a large number of candidate



Sediment sampling in Rio Doce State Park

areas distributed throughout the major Brazilian biomes. In addition to choosing sites that already have some data, adequate field facilities, and on-going, well-funded research programs, as well as national and international collaborative working links, the network eventually will incorporate enough sites to represent regional as well as local ecosystem diversity. Unfortunately, this latter criterion is the most difficult to comply with, as the research capacity of the country is heavily concentrated in a limited number of regions, particularly in the southeast. Therefore, it was felt that this has to be seen as a longer-term goal, and the budding LTER should take a more conservative approach to its early phase, focusing on a small number of well-developed sites.

Moreover, it was decided that special consideration would be given to sites that

were part of the Brazilian protected areas system, as they would provide security for the hosting of long-term research activities.

After an elaborate process of consultation with the scientific community involving several meetings of the Committee, four larger workshops that took place in Puerto Rico, Panama and Costa Rica, and finally Foz do Iguaçu, Brazil, a list of candidate sites was compiled covering virtually all major Brazilian biomes. The site proposals were accompanied by information on the general ecological setting, past studies and ongoing research programs.

As initially proposed, the Brazilian LTER Program (B-LTER) will constitute a collaborative effort among scientists and students working in distinct areas all over the country, focusing on a common research agenda, and dependent upon a special line of support from four major governmental agencies. The main research topics will be (a) conservation of biodiversity, (b) pattern and control of primary and secondary productivity, (c) population dynamics and organization of communities and ecosystems, (d) nutrient dynamics, and (e) effects of natural and human disturbance. Support for the program will total some US\$20 million over the next 10 years, to be disbursed on a competitive basis. The first call for proposals by candidate sites and research groups was divulged in September 1997, with a deadline of 30 January 1998.

The Proposed Sites: General Characteristics and Major Research

After six months of preparatory work, the B-LTER Steering Committee identified 18 candidate sites covering most of the regions of the country—four in the Amazon, three in northeastern Brazil, three in the Cerrado savannas of central Brazil, five in the southeast, and three in the southern region, including two coastal areas. According to adopted criteria, some of the proposed sites did not fulfill the basic requirements considered essential to ensure the continuation of long-term research activities. It was thus decided to group the proposed sites into two categories: (a) sites capable of hosting the program immediately and, (b) sites to be included in the future after strategic investments. Table 1 provides some basic information on the proposed sites, and Figure 1 shows the geographical distribution

of these areas throughout the country.

Information Management

At present some of the sites possess separate databases, which are organized quite differently. The improvement and compatibility of databases for all the sites shall be one of the main tasks of the program. The committee has conducted an extensive analysis of the prospects for the development of a network of sites, beginning with a limited number of areas that already have baseline information, adequate infrastructure and active research groups. This information will be organized and made available in a database system to be housed at the Brazilian National Research Council (CNPq). Furthermore, the coordinating committee will be in charge of organizing annual meetings to discuss the progress of the initiative and to provide for mid-term assessments of the program. Effort will also be made to develop a system to widely divulge the results of the research being supported with funds originating at the B-LTER.

Cross-site Research

A close examination of the current research conducted at several of the proposed sites reveals a concerted effort toward the assessment of biodiversity, the characterization of the basic ecological processes such as primary and secondary productivity, and the evaluation of the major nutrient cycles, namely nitrogen and phosphorus. These research topics will permit cross-site comparisons within the major program. Furthermore, regional aspects will also be considered, along with other relevant issues, such as socioeconomic studies and environmental education, which, until recently, have not been integrated with ecological research programs.

Network Management

The coordination of the Brazilian LTER program has been handled by the Ministry of Science and Technology's National Research Council (CNPq/MCT) through a selected committee of affiliated scientists. Three other government agencies joined the effort as it was being developed, including the Brazilian Ministry of the Environment (MMA), the Higher Level Training Agency of the Ministry of Education (CAPES/MEC), and the Agency for Studies and Projects of the Ministry of Planning and Budget (FINEP/MPO). The interest of these agencies strengthens the program even further.

Each of the selected sites will have a scientific coordinating body responsible for overseeing specific research projects. The data generated under the auspices of the B-LTER will be systematized in a local data bank under the responsibility of the scientific coordinator. The local databases will be networked with a central data management system, likely to be located at CNPq in Brasília. Although several of the sites already possess a basic database system, the network will attempt to integrate the systems, facilitating the exchange of information within the larger international LTER network. Toward this goal, CNPq will provide basic hardware and information systems management training to site personnel.

Establishing Partnerships

Despite the central coordinating role of the government agencies that are in charge of the B-LTER Program, additional partnerships must be established, particularly with other national and international agencies and institutions already active in a number of the proposed sites throughout Brazil. A long-term programmatic integration of the Brazilian initiative with those of other countries and regions (e.g., US LTER, Latin American LTER, among others) will also be pursued, together with the attraction of selected research groups in key countries with a strong tradition in the priority research lines envisioned in the B-LTER. Toward this direction, an exchange program of visiting scientists is scheduled to begin in the second half of 1998.

Leveraging other LTER Networks

During the past five years there has been an increasing interest in the establishment of additional long-term ecological research programs from a number of countries and regions. In this context, the

catalytic role of the US LTER Network, directed by Dr. James Gosz and his collaborators, should be recognized. Their experience and guidance have been fundamental in the fulfillment of the first goals of the B-LTER in a period of less than two years. As a direct result of the Brazilian initiative, the first discussions that led to the creation of a regional Latin American LTER network were held in workshops at San Juan, Panama City, La Selva and Foz do Iguaçu, providing a significant leverage to the B-LTER itself. Given that Brazil has borders with most South American countries and that several biomes are shared by different nations, the integration of efforts will be essential for the success of all individual programs.

The Foz do Iguaçu workshop, held in June of 1997, was a landmark event for the launching of the Latin American initiative. Integrated mission statements were developed and preliminary proposals for funding of the network were drafted. Furthermore, as a consequence of that meeting, a working group on connectivity issues was established, with the aim of discussing the basic needs for this regional network. This working group will receive guidance from the US-LTER Network Office. Recently (December 1997) a workshop on data processing and connectivity was held in Albuquerque, New Mexico, to define the first steps to be taken on a country by country basis. The progress of this initiative was presented at the Fourth Regional Latin American LTER meeting held in June 1998 at Puerto Ordaz in Venezuela.

Recent Developments

Following the workshop held in Foz do Iguaçu, Brazil, and three meetings of the Brazilian steering committee, there were several concrete achievements:

a) A joint agreement between CNPq, CAPES, MMA, and FINEP, which led to a national call for proposals of candidate sites from across the nation. This first call for proposals ended 30 January 1998, with 23 institutions presenting detailed projects for inclusion in the initial network of B-LTER sites. The selection process will take place in the period March/April 1998, and the approved proposals will be funded beginning in July.

b) Drafting of the final mission statement of the B-LTER Program, as follows:

"The mission of the B-LTER Program is to promote the organization and consolidation of the knowledge of the Brazilian ecosystems, to generate information and instruments needed for the assessment of Brazilian biological diversity, to integrate groups and research activities generating opportunities for the development of comparative studies and synthesis that will allow for the sustainable use of natural resources, the solution of environmental problems, and the enhancement of the standard of living of the Brazilian population. Part of the mission will be associated with the generation of methodologies to provide immediate guidance to conservation programs and to for the definition of public policies, in addition to fulfilling the agreements contained in Agenda 21, the Biodiversity Convention and the Framework Convention on Climate Change."

c) A decision to participate with other Latin American countries in the creation of the Latin American Network of LTER programs, pursuing joint objectives that reflect regional priorities.

d) A decision to work with other Latin American countries in the design of a pilot regionalization project.

e) A decision to seek international cooperation in order to conduct joint research projects in selected sites under a common agenda and to build a mechanism to allow access to international financial support.

Characteristics of Proposed Sites in the Brazilian LTER Program

Site 1 Tropical rain forest

1.1 Reserva Florestal Adolpho Ducke, Manaus - Amazonas

Affiliation: Dr. Flávio Luizão/ Instituto Nacional de Pesquisas da Amazonia - INPA

Location (latitude, longitude, altitude, size): 30° 05'S, 60° 00'W; 50-100 m, 10000ha.

Biome Type: Tropical rain forest:

Research Topics: Tree phenological studies, biodiversity assessments, population/community ecology, climatological studies and major effects of forest fragmentation and regeneration.

1.2 Biological Dynamics of Forest Fragments, Manaus—Amazonas Affiliation: Dr. Claude Gascon/Instituto Nacional de Pesquisas da Amazônia - INPA and Smithsonian Institution

Location: 02° 30'S, 60 W, 80-110 m, 3500 ha

Biome Type: Tropical rain forest, dense tropical forest.

Research Topics: tropical ecology covering basic studies of several taxonomic groups; effects of fragmentation on populations, communities and ecological processes and forest regeneration, including research on both natural forest and pasture lands.

Site 2. Reserva de Desenvolvimento Sustentado de Mamirauá, Tefé—Amazonas

Affiliation: Dr. José Marcio Ayres/Sociedade Civil Mamirauá and Governo do Estado do Amazonas

Location (latitude, longitude, altitude, size): 02° 58' S, 64° 55', 50 m, 1124000 ha

Biome Type: Tropical rain forest, matas de Varzea Amazonica, restingas and chavascais

Research Topics: Water level fluctuations, physical and chemical monitoring of the waters, biodiversity assessments, agro-ecology and silviculture, socio-economic studies including the participation of local populations, monitoring of indicators of quality of living, sustainable use of natural resources.

The Brazilian Long Term Ecological Research Network *Proposed Sites*

1.1 - Reserva Florestal Adolpho Ducke, Manaus - Amazonas

1.2 - Areas of the project Biological Dynamics of Forest Fragments, Manaus - Amazonas

2. - Reserva de Desenvolvimento Sustentado de Mamirauá, Tefé - Amazonas

3.1 - Base de Estudos do Pantanal da Universidade Federal de Mato Grosso do Sul, Corumbá - Mato Grosso do Sul

3.2 - Campo Experimental de Nhumirim, Corumbá - Mato Grosso do Sul

4. - IBGE Ecological Reserve, Brasília - Distrito Federal

5.1 - Parque Estadual do Rio Doce, Marliéria - Minas Gerais

5.2 - Estação Biológica de Caratinga, Caratinga - Minas Gerais

6.1 - Estação Ecológica do Jataí, Luiz Antônio - São Paulo

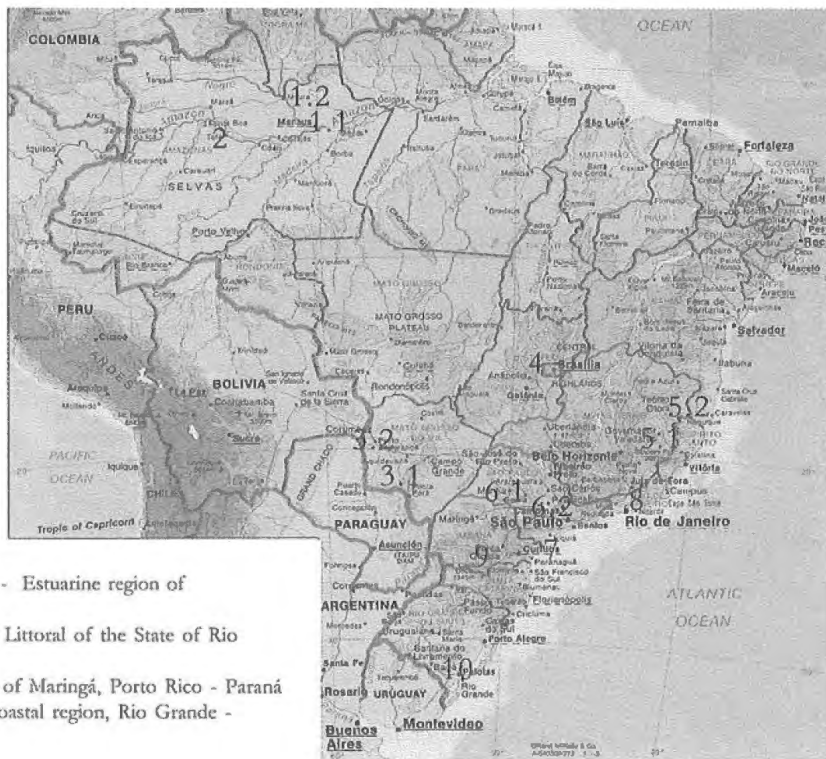
6.2 - Ribeirão do Lobo watershed, Itirapina - São Paulo

7 - Coastal area of the State of São Paulo - Estuarine region of Cananéia-Iguape

8 - Sandy Coastal Plains of the Northern Littoral of the State of Rio de Janeiro, Macaé - Rio de Janeiro

9 - Research Base of the State University of Maringá, Porto Rico - Paraná

10 - Patos Lagoon estuary and adjacent coastal region, Rio Grande - Rio Grande do Sul



Site 3. Pantanal (Wetlands)

3.1 - Base de Estudos do Pantanal da Universidade Federal de Mato Grosso do Sul, Corumbá—Mato Grosso do Sul

Affiliation: Prof. Masao Uetenabaro/ Universidade Federal do Mato Grosso do Sul

Location (latitude, longitude, altitude, size): 19° 34' S, 57° 01' W, 80-150 m, 625 ha

Biome Type: Cerrado (uplands)/Pantanal

Research Topics: Atmospheric gases, hydrologic dynamics and soils, hydrology, population and community ecology.

3.2 - Campo Experimental de Nhumirim, Corumbá—Mato Grosso do Sul

Affiliation: Marcos Coutinho/CPAP - Empresa Brasileira de Pesquisas Agropecuárias

Location (latitude, longitude, altitude, size): 18° 59' S, 56° 39' W, 80-150 m, 4310 ha

Biome Type: Cerrado (uplands)/Pantanal

Research Topics: Management and monitoring of wildlife populations, management of plant resources, management of cattle, impact evaluation of pasturelands.

Site 4. IBGE Ecological Reserve, Brasília—Distrito Federal

Affiliation: Carlos Klink/ Universidade de Brasília

Location (latitude, longitude, altitude, size): 15° 56' S; 47° 53' W, 1100 m, 1350 ha

Biome Type: Cerrado (uplands):

Research Topics: Populations and communities of plants and animals, biological diversity of grasslands, soil ecology, management of mammals for sustainable exploitation and conservation.

Site 5. Interior Atlantic Forest

5.1 - Parque Estadual do Rio Doce, Marliéria - Minas Gerais

Affiliation: Dr Francisco Barbosa

Universidade Federal de Minas Gerais e Instituto Estadual de Floresta

Location (latitude, longitude, altitude, size): 19° 48' S, 42° 28' W, 230-515m, 35974 ha.

Biome Type: Atlantic forest, seasonal semi-deciduous forest

Research Topics: Geological and geomorphological studies, biodiversity assessment of the aquatic and terrestrial regional flora and fauna and conservation and management studies.

5.2 - Estação Biológica de Caratinga, Caratinga - Minas Gerais

Affiliation: Dr Gustavo Fonseca/ Universidade Federal de Minas Gerais and Conservation International-Brazil.

Location (latitude, longitude, altitude, size): 19° 50' S, 41° 50' W, 400-680 m, 890 ha

Biome Type: Atlantic forest, seasonal semi-deciduous forest

Research Topics: Biodiversity conservation, restoration of degraded areas, environmental education and restoration of the surrounded areas through mainly diffusion of sustainable agriculture techniques.



Mamirauá, Amazon during high waters

Site 6 - Rio Mogi-Guaçu watershed

6.1 - Estação Ecológica do Jataí, Luiz Antônio - São Paulo

Affiliation: Dr José Eduardo dos Santos/ Universidade Federal de São Carlos

Location (latitude, longitude, altitude, size): 21° 33'S, 47 ° 51'W, 600 m, 4532 ha

Biome Type: Cerrado (uplands)

Research Topics: Studies on functional valuation of the landscape, biodiversity conservation, ecological processes, human ecology and environmental education.

6.2 - Ribeirão do Lobo watershed, Itirapina - São Paulo

Affiliation: Dr Odete Rocha and Dr Evaldo Espíndola/ Universidade Federal de São Carlos and Universidade de São Paulo

Location (latitude, longitude, altitude, size): 47 ° 46'S, 22° 10'W, 770 m, 22700 ha.

Biome Type: Cerrado (uplands).

Research Topics: Population ecology, ecophysiology, ecology and management of reservoirs, nutrient fluxes, modeling.

Site 7. Coastal area of the State of São Paulo—Estuarine region of Cananéia-Iguape

Affiliation: Director of Instituto Oceanográfico/Universidade de São Paulo

Location (latitude, longitude, altitude, size): 25° 00' S, 47°55' W, 0 m, 234000 ha.

Biome Type: Coastal Waters

Research Topics: Sustainable use of living resources, large and medium-scales oceanic circulation, ocean-atmosphere interactions, estuary hydrodynamics, marine sedimentology, nutrient cycling, marine organic chemistry.

Site 8. Sandy Coastal Plains of the Northern Littoral of the State of Rio de Janeiro, Macaé—Rio de Janeiro

Affiliation: Dr. Francisco de Assis Esteves/Universidade Federal do Rio de Janeiro.

Location (latitude, longitude, altitude, size): 22° 19' S, 41 ° 44'W, 0 m, 11000 ha.

Biome Type: Atlantic forest/restingas and manguezais (mangroves)

Research Topics: Ecological processes within aquatic environments, monitoring of the water quality of the lagoons, ecology of fish communities, phytosociology, ecophysiology, plant population studies, and impact evaluation.

Site 9. Research Base of the State University of Maringá, Porto Rico—Paraná

Affiliation: Dr. Gilberto César Pavanelli/Universidade Estadual de Maringá

Location (latitude, longitude, altitude, size): 22° 50' S; 53° 40' W, 230 m, (area not provided)

Biome Type: Atlantic forest/restinga, lagoons and mangroves

Research Topics: Structure and functioning of aquatic ecosystems, studies on plankton, benthon, fish, and macrophyte communities

Site 10. Patos Lagoon estuary and adjacent coastal region, Rio Grande - Rio Grande do Sul

Affiliation: Dr. Ulrich Seeliger/ Fundação Universidade do Rio Grande

Location (latitude, longitude, altitude, size): 32° 2' S; 52° 05' W, 0 m, 110000 ha.

Biome Type: Coastal waters.

Research Topics: Ecological studies related to plankton (including ichthyoplankton) and benthos production, submerged macrophytes, monitoring of eutrophication, dune vegetation.



Canada's Ecological Monitoring and Assessment Network (EMAN)

From coast to coast to coast, the Canadian environment is being subjected to a variety of stresses and continuous change in the physical and chemical characteristics of our atmosphere. How these changes will alter the biological components of ecosystems is a major concern to Canadians, because large parts of our economy are based on the sustainable use of our fisheries, forestry and agricultural resources.

While some of the stressors and changes are due to natural processes, many are the result of collective human behavior. The effects of human-induced changes can be reduced or eliminated by appropriate pollution control and resource management policies. Environmental issues have become more scientifically complex and the appropriate control programs can be costly and socially disruptive, so it is necessary to provide all Canadians with more comprehensive and reliable scientific information than has been needed when dealing with less complicated problems in the past. This requires long-term, multi-disciplinary studies at individual sites plus the ability to compose data from sites in different locations.

The Canadian Environmental Protection Act of 1997 gives the authority for Environment Canada to establish, operate, and maintain a system for monitoring environmental quality. In addition, the Act allows for Environment Canada to conduct a wide range of research and study on pollution prevention and the ecological effects of contaminants, leading to the formulation of plans for pollution prevention and/or pollution abatement. These studies may be carried out in cooperation with a wide range of partners including other governmental organizations within Canada, foreign governments and aboriginal people. The information gathered from monitoring may be published in a number of forms, including periodic reports on the state of the Canadian environment.

Further to the Act, many of the international conventions and protocols to which Canada is a party also call for the conduct of monitoring and periodic assessment of environmental conditions.

Understanding how ecosystems are changing and developing the scientific information required by decision-makers is beyond the resources and abilities of any single department or agency. Consequently, it is necessary to develop partnerships within all components of the Canadian and international environmental science community. This is necessary to maximize the quality of the science and the efficiency of conducting the work at a time of economic restraint.

It is against this backdrop of meeting the environmental challenges that Environment Canada has enhanced its coordinating capabilities to promote and assist in mobilizing a collective Canadian scientific effort. This program has four overall objectives:

1. To provide a national perspective on how Canadian ecosystems are being affected by the multitude of stresses on the environment;

2. To provide scientifically defensible rationales for pollution control and resource management policies;
3. To evaluate and report to Canadians on the effectiveness of these policies;
4. To identify new issues at the earliest possible stage.

The following list illustrates some of the ecological stresses that are occurring:

- ♦ The atmospheric concentration of carbon dioxide has been increasing exponentially for the last one hundred years, and this seems certain to continue into the foreseeable future.
- ♦ Ultra-violet B radiation is increasing as a result of stratospheric ozone depletion, and even under the most optimistic international control scenarios, it is believed that ozone depletion will increase for the next five years and the ozone layer will not return to normal conditions until after the year 2020.
- ♦ Large areas of Canada are subjected to increased deposition of nitrogen from burning of fossil fuels and agricultural activities.
- ♦ Parts of eastern Canada also receive high levels of sulphate deposition, and the combination of sulphate and nitrogen results in acid rain falling on acid sensitive soils from Ontario eastward to Newfoundland.

The Ecological Monitoring and Assessment Network (EMAN) is a network of people working at long-term, multidisciplinary research and monitoring sites located over the entire country, with the objective of understanding *which* changes are occurring in the ecosystems and *why*. The Network is building on existing sites, which have been established over the years for a number of reasons. For example, the Last Mountain Lake site was established in 1887 as a national wildlife area. The



Limnocorrals for studies of nutrients in Lake St. Hippolyte in Quebec.

Experimental Lakes Area in Ontario was set up in the 1960s to conduct whole-lake manipulation experiments on the causes of eutrophication. Studies at Kejimikujik National Park also began in the 1960s, looking at nutrient processes in surface waters. In the mid 1970s, the Ontario Ministry of Housing established the Resource Centre at Dorset to study the effects of cottage development on lakes. Many other sites have been established across the country to look at a variety of research questions and environmental factors. As new issues have emerged, other sites, such as Turkey Lakes in Ontario and Dushenay in Quebec, were established in response to the need for more information on acid rain.

As of the end of 1997, about 95 sites are included in the EMAN Network. Each site is characterized by long-term studies, although not all sites have a full suite of multidisciplinary activities. Study sites within the same ecozone are grouped into Ecological Science Cooperatives so that all work undertaken can contribute to understanding what is changing in the ecosystem and why.

Details of the site locations and other relevant information can be found on the World Wide Web
<http://www.cciw.ca/eman/>



A floating tent laboratory, which houses equipment that measures gas fluxes across the surface of lake St. Hippolyte in Quebec—one of the 95 long-term monitoring and research sites of EMAN.



The Chinese Ecosystem Research Network (CERN)

Zhao Shidong

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An increasing shortage of resources and environmental problems have spurred the establishment of ecological research and monitoring networks on a national, regional and global scale for long-term and large spatial scale observations. Under the support of the Chinese Academy of Sciences (CAS) and the World Bank, the Chinese Ecosystem Research Network (CERN) was established in 1988 to further the ecological research effort in China.

The Chinese Ecosystem Research Network consists of 29 field stations, which include agriculture, forest, grassland, and lake and bay ecosystems. In order to improve data management, five disciplinary sub-centers (hydrology, soil, atmosphere, biology, and aquatic ecosystems) and one Synthesis Center were also established. More than 1,000 scientists and technicians from 21 institutes of CAS are involved in the project.

Since the founding of the Chinese Academy of Sciences in the early 1950s, more than one hundred field stations have been established across the country, covering various ecosystems. The purposes of these stations were to improve productivity of agriculture, forestry, animal husbandry and fisheries and to observe and study specific natural phenomena, including glaciology, tundra, and landslides. Over the past forty years, these stations have made significant contributions to the reasonable utilization of the local natural resources and the solving of the local environmental problems as well as advancing ecological research.

Design Features of CERN

Between 1988 and 1992, scientific personnel from the concerned institutes of CAS carefully examined the newest development trends of ecosystem research, particularly the use of network-level research, to satisfy the various demands of modern ecosystem research. Efforts were also made to develop a deep insight into the design and operation of existing and forming ecological research networks around the world, such as the Long Term Ecological Research (LTER) Network in the United States.

Based on detailed investigations and extensive discussions, including consideration of the specific features of the Chinese situation, the overall design of the project was finally worked out in 1992. This design was fully reflected in the project proposal submitted to the World Bank at the beginning of 1993.

The design of CERN science incorporates a "top-down" approach:

- 1) All of the units of the network follow unified principles, and major activities, including research and monitoring, are supported by central funds.

- 2) The purpose of the Network is to direct service to the sustainable utilization of natural resources and protection of the environment.
- 3) The Network enforces the unification and standardization of methodologies and instrumentation for all monitoring and observation.
- 4) Data collection is subject to the standardization of data formats, data quality control, data sharing, data synthesis and analysis.
- 5) Research methodology will support cross-site and multi-disciplinary research, including the involvement of social sciences and networking, based on unified objectives and methodology.
- 6) Demonstration projects on the sustainable ecosystem is a priority for all of the stations.

In the past several years, through expert evaluation, this design has proven to be both advanced and feasible. It has laid a solid scientific foundation and structure for the realization of the overall objectives of CERN and of the various tasks concerned.

Goals and Objectives

The long-term goal of the Network is to understand the status of the various major ecosystems through monitoring and observation, using modern methodologies such as remote sensing, Geographic Information Systems (GIS) and mathematical models, thus contributing to the improvement of our living environment, the sustainable utilization of natural resources and the general advancement of ecosystem research.

Objectives include:

- 1) To conduct long-term monitoring of environmental factors such as water, soil and air, as well as agriculture, forestry, and grassland, lake and bay ecosystems.
- 2) To conduct thorough investigations of the structure, function and dynamics of the ecosystems and the approaches and methods for the sustainable utilization of these systems.
- 3) To provide the optimal managerial models to the people of local communities for the sustainable utilization of the local natural resources and the improvement of the local living environment.
- 4) To provide the scientific foundations to the decision-makers at various administrative levels concerning the utilization of natural resources and the environment.
- 5) To contribute to the solution of global ecological and environmental issues through active participation in international ecological research projects.

Progress

The program "Construction of CERN" managed by the Chinese Academy of Sciences, which is a part of the project "China Environmental Technical Assistance" (A-1) supported by the World Bank, began in November 1993. Through the efforts for the past several years, significant achievements in all of the aspects of CERN have been made.

1) Research

The project "Structure, Function and Approaches for Improving Productivity of Ecosystems in China" was completed in 1996. The final review took place in the spring of 1996, and the evaluation for this project was good. This project is a portion of the CERN long-term research project and has provided a solid basis for future projects.

The most important task over the past two years has been to write proposals and acquire funds for the next several years. More than ten proposals have been submitted to various agencies to acquire funds for research, mainly dealing with basic research on the structure and function of ecosystems and the applied research related to degradation of these ecosystems. Funds are being sought to establish a Chinese Ecosystem Research and Monitoring Network consisting of 56 ecological research stations not only from the Chinese Academy of Sciences but also from other ministries. So far, we have acquired funds for following projects:

- ◆ "Mechanisms of Formation and Sustainability of Ecosystem Productivity" was funded by CAS

for 1997-2000 (Chinese New Yuan (CNY) 9 million). It will play a key role in continuing the goals of CERN. The major research components include:

- ♦ Productivity of agricultural ecosystems in relation to water and major elements (N, P, K and C);
- ♦ Productivity of forest ecosystems and responses to climate changes;
- ♦ Productivity of grassland ecosystems and responses to climate changes;
- ♦ Processes in aquatic ecosystems with special reference to trophic dynamics;
- ♦ Information systems, including databases, GIS and data management issues;
- ♦ Theories and strategies of maintaining sustainability of agriculture and animal husbandry.
- ♦ The "Water Cycle and Geographic Pattern Studies of Agricultural Ecosystems in Northern China"

project may be supported by the Chinese National Foundation of Natural Sciences (CNFNS). Total funding is CNY 5 million for 1998-2002. CERN will be the leading organization.

♦ The "Interaction between Agro-ecosystems and Global Change" project may also be supported by the CNFNS. Total funding is CNY 5 million for 1998-2002. CERN will be one of the major organizations involved in this project.

All stations of CERN have obtained research funds from various agencies, totalling CNY 50 million. The infrastructure made possible by the World Bank loan and the Chinese government played an important role in acquiring these funds.

Another important ongoing activity is the application for the CAS Open Lab, called Ecosystem Analysis and Resource Management, located in the Synthesis Research Center of CERN. Endorsement of this project by CAS will greatly improve the function of the Synthesis Research Center.

2) Monitoring

To assure the quality of ecological monitoring, a catalog of core data sets will be published, including the 3100 historical data sets from all of the stations. A series outlining standard protocols for ecosystem and environmental measurements will also be published by late 1999, including the following manuals:

- ♦ Observation and Analysis of Soil*
- ♦ Observation and Analysis of Water
- ♦ Observation and Analysis of Meteorology and Atmosphere
- ♦ Surveying, Observation and Analysis of Terrestrial Community
- ♦ Observation and Analysis of Lakes
- ♦ Observation and Analysis of Bays
- ♦ Manual for Observation and Analysis of Agricultural Ecosystems*
- ♦ Manual for Observation and Analysis of Forest Ecosystems
- ♦ Manual for Observation and Analysis of Grassland Ecosystems
- ♦ Manual for Observation and Analysis of Lake Ecosystems
- ♦ Manual for Observation and Analysis of Bay Ecosystems

** already published*

The variables for observation will be revised based on the needs and requirements of data providers and users. Monitoring activities will begin in 1998.

3) Construction of the Information System

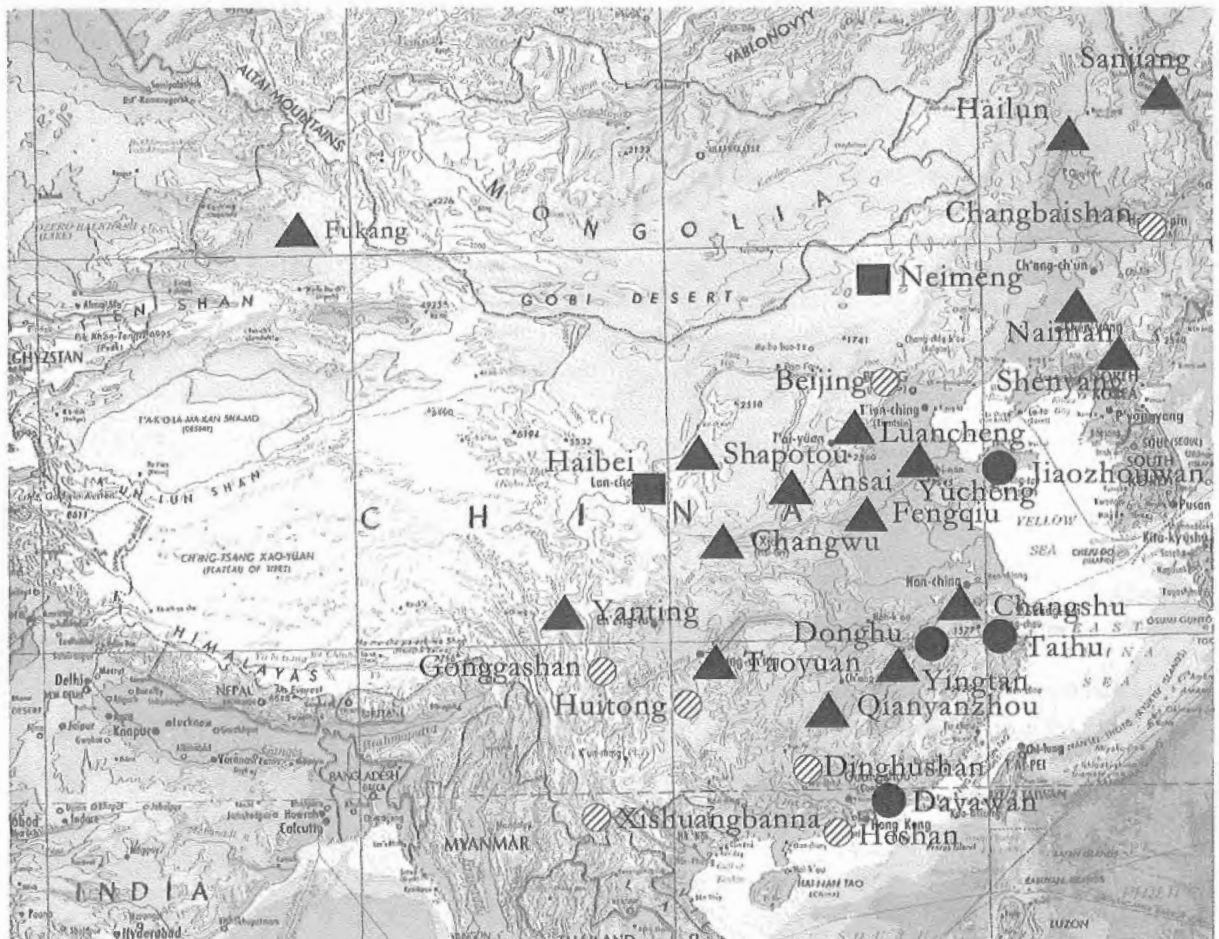
All of the units (stations, sub-centers and synthesis center) have been equipped with advanced computer systems. The installation of the computer system in the Synthesis Research Center is complete and linked with the Internet, which has greatly advanced the research and training activities of CERN.

- ♦ The linkage between the Synthesis Research Center and sub-centers and the home institutes of stations also is complete.
- ♦ The linkage between the Synthesis Research Center and stations is now in progress.
- ♦ Design of databases for stations, sub-centers and the synthesis center is in progress.

- ♦ The archives of the historical data at stations, sub-centers and the synthesis center is complete.
- ♦ A catalog of core data of CERN consisting of 3100 databases will be published and posted on the Internet.
- ♦ The CERN Website is available on the Internet. The homepages for the stations and sub-centers will soon be completed.

The Chinese Ecosystem Research Network

- ▲ Agro-ecological Station ● Hydro-ecological Station
 ■ Grass-ecological Station ▨ Forest-ecological Station



- ♦ For data management and data sharing, a metadata standard was constructed according to the various disciplines of CERN. A set of data operation tools was also built for the users and administrators to query and manage the metadata.

- ♦ Several training courses for database and website management were held and more are planned for the future. All play an important role in improving data management activities of CERN.

4) Infrastructure

The available field facilities supported by CERN include a significant installation of monitoring and testing equipment, including laboratories and dormitories, permanent plots for observing succession of vegetation, a nursery, a greenhouse, a fish pond, and other facilities essential for ecological monitoring and research.

With this infrastructure in place, all of the stations are prepared to monitor and conduct research on ecosystem structure, function and dynamics. This infrastructure provides a solid basis for the future development of all the stations.

All CERN construction funded by the Chinese government is complete and the final review will take place at the end of 1998.

5) International Cooperation

CERN has developed excellent relationships with ecological networks and research programs around the world. The following activities are especially important:

- ♦ Developed close relationships with US LTER Network and UK ECN;
- ♦ Became an active member of GTOS and joined ILTER;
- ♦ Discussed activities with American scientists dealing with biogeochemical cycling of terrestrial ecosystems and modeling global change;
- ♦ Continued planning activities on land-use change in the region of temperate East Asia. In order to conduct this task, the second Land Use Change of Temperate East Asia Conference (LUTEA) took place at the Synthesis Research Center of CERN in March 1998. About 20 foreign scientists and representatives of international research programs such as International Human Dimensions Program (IHDP) and 60 Chinese scientists attended this meeting;
- ♦ Held a joint workshop with the Royal Swedish Academy of Sciences titled "Ecosystem Research and Management Dealing with Agriculture, Forest, Grassland and Aquatic Ecosystems," for exchanging experiences of ecological research. Ten or more Chinese scientists and an equal number of Swedish scientists will attend this meeting in Stockholm, Sweden in May 1998. Some papers will be published as a special volume on AMBIO. Developing joint research projects for Swedish and Chinese scientists is another possible product of this meeting.
- ♦ International Symposium of Information Systems sponsored by CIESIN, other international organizations and CERN, will be held in the Synthesis Center in September 1998. Approximately 25 international experts on information systems and 40 domestic data managers from CERN stations and centers will attend this meeting.
- ♦ Many CERN stations have developed working relationships with foreign scientists or stations.
- ♦ An international symposium titled "The Theory, Approach and Method of Long-term Ecological Research," combining the final evaluation of this project and the regional activities of ILTER, will be hosted by CERN in Beijing in 1999.

If you need more information on CERN, please contact the Web Site: <http://www.cern.ac.cn>, or Zhao Shidong through the following address: CERN Secretariat, Commission for Integrated Survey of Natural Resources, Chinese Academy of Sciences, 3 Datun Road, P.O.Box 9717, Beijing 100101, P.R.CHINA Phone: +86 10 6494 8463, Fax: +86 10 6493 1970, Email: zhaosd@cern.ac.cn

C_{hina} — T_{aipei}

The Taiwan Ecological Research Network

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Only recently has the importance of environmental sustainability become appreciated worldwide. However, our knowledge about the environment in which we dwell is still rather rudimentary. This situation is exacerbated by the paucity of practical information on how to protect, conserve, use and sustain the ecosystems upon which we depend. Although the sciences of ecology and environment are relatively new, they are rapidly evolving to provide the necessary information. Unfortunately, the development of these sciences has been in some ways directly proportional to the degradation of these environments and ecosystems.

The notion that certain ecological processes can only be sufficiently understood through long-term studies has been discussed frequently in the literature (e.g., Risser, 1991 and Franklin, 1988). Franklin (1988) noted that ecological phenomena that involve slow processes, rare events or episodic phenomena with high temporal and spatial variability, subtle processes, and complex phenomena often require extended and uninterrupted research to document properly. The importance of contributions of long-term studies to our understanding of ecological phenomena is exemplified by agricultural plots at Rothamsted Experimental Station in the United Kingdom (Johnston, 1991), forest productivity studies in Sweden and the watershed research at Coweeta and Hubbard Brook Experimental Forests in the United States (Risser, 1991).

The study of ecology in Taiwan (China–Taipei) has a long history dating to the turn of the century. However, these early projects often suffered from both limited interest—restricted to a few individual scholars—as well as the lack of a coherent system of documentation and data collection. Only in 1992 did the Taiwanese scientific community commence integrated, multidisciplinary and ecosystem approaches to ecological study. A group of scientists with widely varying academic backgrounds submitted a long-term ecological research proposal to the Taiwan National Science Council (NSC) in 1990. Funding for the program, known formally as the Taiwan Ecological Research Network (TERN), began in 1992 (King and Hsia, 1997). TERN is a long-term, multidisciplinary and integrated program focusing on a few designated ecological sites. Currently included in the TERN network are five inland

sites with varying climates, biome types, topographical features and kinds of disturbance. All five sites have experienced relatively light anthropogenic disturbance. Future plans for the network include the possible establishment of sites in coastal and urban ecosystems.

Activities of the TERN program include funding research projects (ca. sixty per year), which are carried out at the five TERN sites, organizing ecological research conferences at local, East Asia/Pacific Regional and international levels, promoting a student-exchange program to visit sites outside and within Taiwan, as well as encouraging international cross-site studies.

Objectives

The objectives of the TERN program are determined based on ecological significance, practical constraints such as availability of staff and funding, as well as priority and urgency of ecological and environmental issues. The objectives of the TERN program are described elsewhere (King and Hsia, 1997) and are repeated here with minor modification. The principal objective of the TERN program is to understand long-term ecological phenomena and processes within Taiwan's dominant ecosystems. TERN's major concern is to gather baseline data on the productivity, diversity, structure, function/process, and stability of Taiwan's major ecological systems. The TERN program focuses on the long-term impacts of major disturbances (such as natural erosion, typhoon, monsoon, pollution and land use) at the research sites. The results of the long-term studies aid in understanding Taiwan's ecosystems, and the subsequent construction of ecological models may eventually be used to predict and ameliorate environmental disturbances at local, regional, and global levels. This information will also provide the insight necessary for sustainable ecosystem management and sound policy development. More specific objectives include:

- ♦ Understanding phenomena, processes and mechanisms of ecosystem dynamics;
- ♦ Studying the major natural and human disturbances which affect ecosystem dynamics and ecosystem responses;
- ♦ Identifying ecological processes to address environmental changes;
- ♦ Providing science-based information to decision makers in formulating environmental policy;
- ♦ Training young scientists in ecology and using the long-term sites as resources for education;
- ♦ Incorporating the research results into ecology curriculums at all levels of education, particularly in the field of subtropical forest ecology;
- ♦ Sharing research ideas and base-line data with scientists from other ecological sites through meetings and international networking; and
- ♦ Promoting collaborative research projects with scientists from other ecological sites, particularly sites with similar ecological settings.

The TERN program has adapted the US LTER's core areas in general with few modifications (Callahan, 1991).

Description of Site Characteristics

Taiwan is located off the southeastern coast of mainland China, separating the East and South China Seas, and borders the Pacific Ocean in the east. The climate



A wetland plot at Nan-jen-shan forest/lake site (TERN) 23

is warm (average annual temperature is 18°C) and humid (average annual precipitation is 2500 mm). This small (36,000 km²) and very mountainous island has approximately one third of its land area higher than 1000m above sea level. The central mountain range, which runs from north to south, reaches a maximum height of about 4000m. This range forms a great barrier to air parcel movement and thus represents one of the important factors that regulates the climate and ecology of both the west and east slopes. Associated with this disruption of air circulation, Taiwan experiences almost annual summer typhoon landfall. The high winds and heavy rain associated with typhoons represent a major disturbance to Taiwanese ecosystems. For example, from 31 July–1 August 1996, typhoon Herb contributed nearly 2000mm rainfall in the Mt. Alishan area in the central range of Taiwan. Other major natural disturbances are frequent landslides and a high rate of soil erosion resulting from fast crustal up-lifting associated with weakly consolidated sedimentary rock formations.

Changing land-use patterns and pollution are two major anthropogenic impacts that influence both natural ecosystems as well as populated urban areas. Little systematical research has been done in

Taiwan to explore the effects of these disturbances on the impacted systems.

Forests cover about 60 percent of the total land area of the island of Taiwan and thus constitute the predominant terrestrial ecosystem. Due to the rapid uplifting of the island, lakes are relatively few and of small areal extent. Therefore, the five TERN sites include four forest sites and one alpine lake site (Figure 1). The sites differ in geography, geology, climate, and vegetation type and represent the range of important ecosystems of Taiwan. A brief description of each site follows:

Fu-shan Forest site (FSF)

Site Location: Fu-shan Experimental Forest, Fu-shan Research Branch, Taiwan Forestry Research Institute (TFRI), I-lan Hsien, I-lan,

Taiwan

Principal contact/Institution: Dr. Fu-wen Horng/Taiwan Forestry Research Institute, Taipei, Taiwan

Latitude, longitude, elevation, size (ha): 24° 46'N, 121°43'E, 400–1400 m, 1100 ha

Principal biome/main communities: Subtropical mixed evergreen hardwood forest/Fagaceae and Lauranceae Forest
Research Topics: Long-term monitoring of environmental variables; soil erosion and

TERN The Taiwan Long Term Ecological Research Network



A. Fu-shan

B. Guan-dau-hi

C. Nan-jen-shan

D. Ta-ta-chia

E. Yuan-yang Lake

Nan-jen-shan
forest/lake site
(TERN)



channel sedimentation; leaf-area indices; patterns and frequencies of typhoon disturbance; dynamics of animal (mammal, bird, amphibian, reptile, fish and insect) communities; ecosystems response to typhoon disturbance and acidic deposition at various trophic levels; ecological modeling and data management.

Infrastructure: Two gauged weirs of two small forest watersheds (57 and 97 ha, respectively); two observing towers, 110 power supply, laboratories and library; accommodation for 50 persons.

History of site/type of data: The Fu-shan forest research branch of TFRI was established in 1990, and the Fu-shan TERN site, within Ha-pen Nature Preserve (established 1986), was designated in 1992. Maps of geology, topography and soils; air temperature and humidity, precipitation, solar radiation, wind speed and direction, soil moisture regime; chemical composition of precipitation, throughfall, stemflow, soil solution and streamwater, plant tissue, litterfall, soils; leaf area indices; vegetation composition, above-ground biomass, tree growth/mortality, litterfall and decomposition; phenology; species composition of flora, fauna.

Partnerships: National Central University, National Dong-hua University, National Science Council, National Taiwan University, Taiwan Forestry Research Institute

Guan-dau-shi Forest Site (GDS)

Site Location: Guan-dau-shi Experimental Forest/Nanto Hsien, Taiwan

Principal contact/Institution: Dr. Ming-yih Chen/Department of Botany, National Chung-hsing University, Taichung, Taiwan

Latitude, longitude, elevation, size (ha): 24°04' N, 121°30'E, 1100-1700 m, 47 ha

Principal biome/main communities: Subtropical mixed evergreen hardwood forest, Fagaceae and Lauranceae forest

Research Topics: Long-term monitoring of environmental variables; hydrological modeling; plant succession after fire disturbance; pollination; epiphytes; ecosystem phenomena and processes; soil ecology; ecosystem response to acidic deposition at various trophic levels; ecological modeling and data management; human impact recreational activities.

Infrastructure: One gauged weir in a small forest watershed (47 ha), weather stations, observing towers, 110-power supply, laboratories and accommodation for 150 persons.

History of site/type of data: Site was designated in 1994. Maps of geology, topography; air temperature,

humidity, precipitation, solar radiation, wind speed and direction; chemical composition of precipitation, throughfall, stemflow, soil solution, streamwater, soils; vegetation composition, tree growth/mortality, litterfall and decomposition; phenology; species composition of flora, fauna.

Application of LTER Research: The GDS Forest site is used as a field site for forestry students from National Chung-hsing University.

Partnerships: NSC, National Chung-hsing University, National Chang-hwa University of Education, National Chiayi Institute of Agriculture, National Tsing Hua University

Nan-jen-shan Forest/Lake Site (NJS)

Site Location: Nan-jen-shan Nature Reserve, National Keng-ting Park, Heng-chun, Taiwan

Principal contact/Institution: Dr. Yau-lun Kuo, Department of Forest Resources, National Pingtung University of Science and Technology, Pingtung, Taiwan

Latitude, longitude, elevation, size (ha): 22°05'N, 120°50'E, 200-500 m, 430 ha

Principal biome/main communities: Subtropical monsoon forest, Lauranceae forest

Research Topics: Long-term monitoring of environmental variables, plant succession, ecosystem phenomena and processes; environmental stress (monsoon and seasonal drought and forest/lake ecosystem responses); ecological modeling and data management.

Infrastructure: Four weather stations; three observing towers; accommodation for 20 persons

History of site/type of data: Site was designated in 1995. Maps of geology, topography; air temperature, precipitation, solar radiation, wind speed and direction; soil temperature; chemical composition of precipitation, soil solution, pond water, soils; vegetation composition, tree growth/mortality, canopy photosynthesis, litterfall and decomposition; composition of flora and fauna.

Ta-ta-chia Forest Site (TTC)

Site Location: University Experimental Forest, National Taiwan University, Taiwan

Principal contact/Institution: Dr. Kou-chung Lee, Department of Forestry, National Taiwan University, Taiwan

Latitude, longitude, elevation, size (ha): 23°28' N, 120°52'E, 2000-3200 m, 100 ha



Bulk precipitation collectors in an opening at Fu-shan forest site (TERN).

Principal biome/main communities: Montane evergreen coniferous forest, hemlock and spruce forest and Yushan cane grassland

Research Topics: Long-term monitoring of environmental variables; plant succession; ecosystem phenomena and processes; dynamics of animal communities; soil nutrient movement; human impacts (recreational activities); ecological modeling and data management.

History of site/type of data: Site was designated in 1995/ Maps of geology, geography, vegetation

Partnerships: NSC, Academia Sinica, National Taiwan University, Chinese Culture University, Yushan National Park

Yuan-yang Lake Site (YYL)

Site Location: Yuan-yang Lake Nature Preserve/Forest Development Administration, Vocational Assistance Commission for Retired Servicemen, I-lan Hsien, I-lan, Taiwan

Principal contact/Institution: Dr. Jiunn-tzong Wu/Institute of Botany, Academia Sinica, Taipei, Taiwan

Latitude, longitude, elevation, size (ha): 24° 35'N, 121°24'E, 1650-2430 m, 374 ha watershed with 3.3 ha lake

Principal biome/main communities: Temperate forest/Cypress forests and marsh community

Research Topics: long-term monitoring of environmental variables; vegetational succession; nutrient status and cycling; lake chemistry; primary productivity; ecological modeling and data management.

History of site/type of data: Yuan-yang Lake Nature Preserve was designated in 1992 under the Culture Heritage Preservation Act in 1986. Maps of geology, topography; air temperature and humidity, precipitation, wind speed and direction; chemical composition of precipitation, throughfall, stemflow, lake water, litterfall, soils; vegetation composition, biomass of aquatic macrophyte tissues; carbon isotope ratio ($\delta^{13}\text{C}$) of canopy air, vegetation, soil and litter layer; species composition of flora, fauna.

Partnerships: Academia Sinica, National Science Council, Vocational Assistance Commission for Retired Servicemen.



Costa Rican Network for Long Term Ecological Research

The Costa Rican Network for Long Term Ecological Research was established in January 1998, with the support of the Ministry of Science and Technology. The Network was initiated with the participation of four academic institutions: Organization for Tropical Studies, University of Costa Rica, Tropical Science Center and National University. These institutions have selected five field sites as the founding sites. The network is administered by a Coordinating Committee with representatives of each site within the network.

The Costa Rican LTER Network was originated as an initiative of the involved academic institutions, with the political support of the government. Currently in its formative stage, the network is working toward consolidation through meetings with administrative authorities within each institution and involvement of researchers associated with this effort. The network is about to establish a web server with specific information about the sites.

Description of Program

The Costa Rican Network is currently composed of five sites:

- a) The Marine Research Station at Punta Morales, operated by the National University;
- b) The Biological Reserve Alberto M. Brenes at San Ramón, operated by the University of Costa Rica;
- d) The Cloud Forest Reserve Monteverde, operated by the Tropical Science Center;
- e) The La Selva Biological Station, operated by the Organization for Tropical Studies; and
- f) The Las Cruces Biological Station, also operated by the Organization for Tropical Studies.

The network has taken advantage of the experience of the Organization for Tropical Studies in the area of data management at field stations. A recently developed system for making datasets and metadata available on the web is being incorporated at each site. This highly flexible system has a search engine that browses through unstructured and structured text, numeric tabular datasets and relational datasets.

The network is also well along in the establishment of minimum standards for metadata generated at each site.

While continuing work on the definition of core areas, the sites are reaching a common ground on climatic data, site specific collections and permanent plot data.

Site Characteristics

Marine Research Station at Punta Morales

Site Location: Eastern shore of the inner Gulf of Nicoya, on the Pacific Coast.

Principal Contact: M.Sc. Ignacio Escorriola, Marine Research Station, ecmar@irazu.una.ac.cr, Phones (506) 6612394, (506) 2773313.

Latitude, longitude, elevation, area: 10°N, 85°W, 2m, 327 ha.

Principal Biome/Main Communities: Mangrove forests, estuaries, tidal flats.

Research Topics: Zooplankton and phytoplankton monitoring. Macrobenthos structure in intertidal mudflats. Fisheries community analysis.

History of Site/Type of data collected: The station was opened in 1982. Originally built and administered by the National Council on Science and Technology, this station was later handed over to the National University. It has become one of the main research sites for marine and estuarine studies in Costa Rica, both for national and international researchers. Beside biological inventories and data on population and community dynamics, the site has long-term data on tidal activity.

Biological Reserve Alberto M. Brenes at San Ramón

Site Location: 50 km NE of San Ramón city on the Continental Divide

Principal Contact: M.Sc. Rodolfo Ortiz, Universidad de Costa Rica, Sede de Occidente, rortizv@cariari.ucr.ac.cr, phone (506) 445-5533.

Latitude, longitude, elevation, area: 10°13'N, 85°37'W, 850-1500 m.a.s.l., 7800 ha.

Principal Biome/Main Communities: Premontane wet forest, montane forest.

Research Topics: Soil ecology, altitudinal distribution of plant species, plant taxonomy and population ecology of plants.

History of Site: This reserve was created in 1975 and since then has been administered by the University of Costa Rica. As one of the few protected areas within the premontane belt, the site has attracted researchers mainly from Costa Rica, Germany and the US. The site has received considerable support from the Volkswagen Foundation in Germany. Nearly 100 research projects have been conducted at this station.

Type of data collected: Long term data from permanent plots, meteorological data, species inventories and phenological data are available from this site.

Cloud Forest Reserve Monteverde

Established in 1972, the Monteverde Preserve covers over 10,500 hectares, more than 90 percent of which is virgin forest. It contains an extremely high biological diversity, including more than 2,500 plant species (among them 420 different kinds of orchids), 100 species of mammals, 400 bird species, 120 reptilian and amphibian species, and thousands of insects.

Site Location: The Reserve is located in the Tilarán Range on the continental divide, about 40km west of the Inter-American Highway.

Principal Contact: Dr. Robert Carlson, Director. Phone: (506) 6455122, Fax 645 5034, e-mail: montever@cct.or.cr, P.O. Box 55-5655, Monteverde, Punta Arenas.

Latitude, longitude, elevation, area: 10°18'N, 84°47'W. Elevation 700-1800 m, 10,500 ha.

Principal Biome/Main Communities: With a mean temperature range between 22-16°C and mean annual precipitation ranging from 2600-7000 mm, the Reserve has a wide variety of environments. Wet premontane forest, wet montane forest, and rainy premontane forest are the main life zones. Within them, dwarf forest, forested swamps, rain forest are abundant. Endemism is high in the area, with a high diversity of epiphytes.

Research Topics: Nutrient cycling in epiphytes; amphibian population decline; avian ecology; butterfly migration; global change impact on forest dynamics; forest regeneration; precipitation data.

History of Site/Type of data collected: The reserve was established in 1972 by the Tropical Science Center as a reaction to the fast deforestation process in the region. A gradual expansion of the Reserve area has been achieved with the support of a wide range of institutions and individuals. This is a very well studied area that has attracted a large number of researchers over the past 30 years.

La Selva Biological Station

Site Location: La Selva, situated at the confluence of two major rivers in the Caribbean lowlands of northern Costa Rica, comprises 1,600 hectares (3,900 acres) of tropical wet forests and disturbed lands. It averages 4 m (over 13 feet!) of rainfall that is spread rather evenly throughout the year. The station is bordered on the south by Braulio Carrillo National Park, which contains more than 46,000 hectares of forest land and is the core conservation unit of the 91,000-hectare Cordillera Volcánica Central Biosphere Reserve.

Principal Contact: Dr. Robert Matlock, Scientific Director, La Selva Biological Station, Organization for Tropical Studies, Puerto Viejo de Sarapiquí, Costa Rica, Tel.: (506) 766-6565 Fax: (506) 766-6535 internet: rmatlock@sloth.ots.ac.cr Surface Mail: US: Interlink 341, P.O. Box 02-5635, Miami, FL 33152, USA, Costa Rica: Apartado 676-2050, San Pedro, Costa Rica, Centroamerica

Elevation, area: 37-130 m 1600 ha

Principal Biome/Main Communities: Located within the tropical wet forest and the tropical premontane wet forest, about 73 percent of the area is primary tropical rain forest.

Research Topics: Forest dynamics; long-term permanent plots; carbon budgets and fluxes in the forest; nutrient dynamics; native species trials; stream ecology; agroecological research; avian ecology.

History of Site/Type of data collected: La Selva was originally established in 1954 by Dr. Leslie Holdridge as a farm dedicated to experimentation on mixed plantations for the improvement of natural resources management. It was purchased in 1968 by the Organization for Tropical Studies and declared a private

Costa Rica LTER Sites



A. Punta Morales

B. Brenes Biological Reserve

C. Reserve Monteverde

D. La Selva

E. Las Cruces

biological reserve and station. Since then it has become one of the most important sites in the world for research on tropical rain forests. More than 240 scientific papers are published yearly out of the research conducted at the site.

Las Cruces Biological Station

Site Location: Las Cruces is located near the Panamanian border on Costa Rica's southern Pacific coastal range, about 6 km south of San Vito de Java. The grounds surrounding the buildings have 8 ha of cultivated collections and 4 ha of fallow and experimental plots.

Principal Contact: Dr. Luis Diego Gómez, director, Estacion Las Cruces & Wilson Botanic Garden, Organization for Tropical Studies, Inc. E-Mail: ldgomez@hortus.ots.ac.cr Facsimile: ++ (506)- 773-3665 Telephone: ++ (506) 773-4004, P.O.Box 73- 8257 Coto Brus, Costa Rica

Latitude, longitude, elevation, area: 8° 47' 28" N, 82° 57' 26" W; 1,120–1,385m; 235 ha

Principal Biome/Main Communities: This station is home to the Wilson Botanical Garden featuring beautifully diverse plantings of tropical and subtropical ornamentals, representatives of unusual plant families and rare and endangered plants from Costa Rica and elsewhere. Particularly well represented are ferns, aroids, bromeliads, gingers, heliconias, marantas, and palms. More than 1,000 genera in 212 plant families can be seen along trails that wind around palm-covered hillsides, through agave and lily beds, under rain forest canopy, through banana and heliconia groves, or to strategic overlooks on the rolling grounds. This station also includes approximately 240 ha of premontane/montane forests adjacent to the garden.

Research Topics: Horticultural research; forest fragmentation analysis; forest regeneration; butterfly ecology.

History of Site/Type of data collected: The Las Cruces Station originally began as the Las Cruces Tropical Botanical Garden. In 1962 Robert and Catherine Wilson purchased an abandoned pastureland and through years of dedicated effort transformed it into an impressive garden. The Wilsons added adjacent forested properties and chose to treat them as a biological reserve. In 1973 the Garden became the property of the Organization for Tropical Studies, which later bought adjacent forested properties to take the station to its present condition. The area has GIS coverage, meteorological data, phenological data and horticultural/botanical databases.

Information Management remains variable among the sites. Some sites have in-house data managers while for others this task remains part of the administrative duties.

Network Management

The Network is coordinated by Dr. Jorge A. Jiménez,
P.O. Box 676-2050, San Pedro de Montes de Oca. Phone: (506) 240-6696, e-mail: jjimenez@ns.ots.ac.cr



The Long Term Ecological Research Program

The geographic location of the Czech Republic (CR) between the Hercynian Platform, the Alpine Carpathian System and the Fenno-Sarmathian Platform determines a high diversity of ecosystems, both in abiotic (geology, microclimate) and biotic components (Jenik and Price 1995). In the eastern part of CR, Moravia is an important divide between the Bohemian Massif to the west and the Western Carpathians to the east. Moravia opens southward to the Panonian lowlands, providing an important migration route. The intensification of industrial and agricultural activities in densely populated middle Europe has resulted in rapid ecosystem changes due to eutrophication and acidification. Since the 1990s, both industry and agriculture have been reduced because of political and subsequent economic changes. Reduced emissions of S and N oxides and decreased fertilizer doses, together with relatively large areas of abandoned agricultural land (meadows and fields) are recent factors causing ecosystem changes.

Ecological research as well as nature protection have a long-standing tradition in the CR. Long-term data on biotic and abiotic parameters were gathered both by research institutions and universities dealing with specific topics, and by governmental and regional organizations as routine monitoring. However, most of these data are neither freely available nor computerized; these data are scattered and, especially the information from routine monitoring, have not been fully utilized in ecosystems evaluation.

Initially, scientists from the ILTER program promoted the establishment of a Czech LTER network. In June 1995, a group from the US LTER, led by Dr. James R. Gosz, visited CR and together with the Czech National Committee for Man and the Biosphere Program (MAB), lead by J. Jenik, discussed the possibility of organizing a network based on existing sites with a long-standing history of research, and with institutions capable of continuing the investigations. In November 1995, Czech ecologists invited by the LTER program visited the National Science Foundation (NSF) in Washington, DC and several LTER sites in the United States to learn about NSF activities in ecosystem research, LTER and international cooperation. The CZ-LTER Committee and network of sites was established by the Czech National MAB Committee in 1996. It consists of seven sites (six of them are UNESCO Biosphere Reserves (BR)). All sites are connected to the Internet and five have their own World Wide Web sites. Series of various long-term data are available at all the sites.

Description of the program, objectives and core areas

The present effort focuses on: 1) inventorying, computerizing and evaluating existing data at individual sites, 2) monitoring of existing experimental plots, 3) identifying research problems specific to each site and 4) mutual cooperation. It is recognized that public relations efforts are important to show the usefulness of LTER to policy and decision-makers in CR and to ensure continued funding. A joint project – “Evaluation and prognosis of ecosystem changes based on analysis of long-term data series” –

for all the sites for a period of three years (1998-2000) was accepted by the Grant Agency of CR.

In meeting the goals of the project, available long-term data series will be used to: a) assess the extent and causes of deterioration of ecosystem function, b) identify any impacts of recent environmental changes connected with the political and economic transition in Central Europe, and (c) to establish a prognosis of the future development of these ecosystems. Methods include:

assessment of the present status, elaboration of historical and contemporary data and their incorporation into the electronic network.

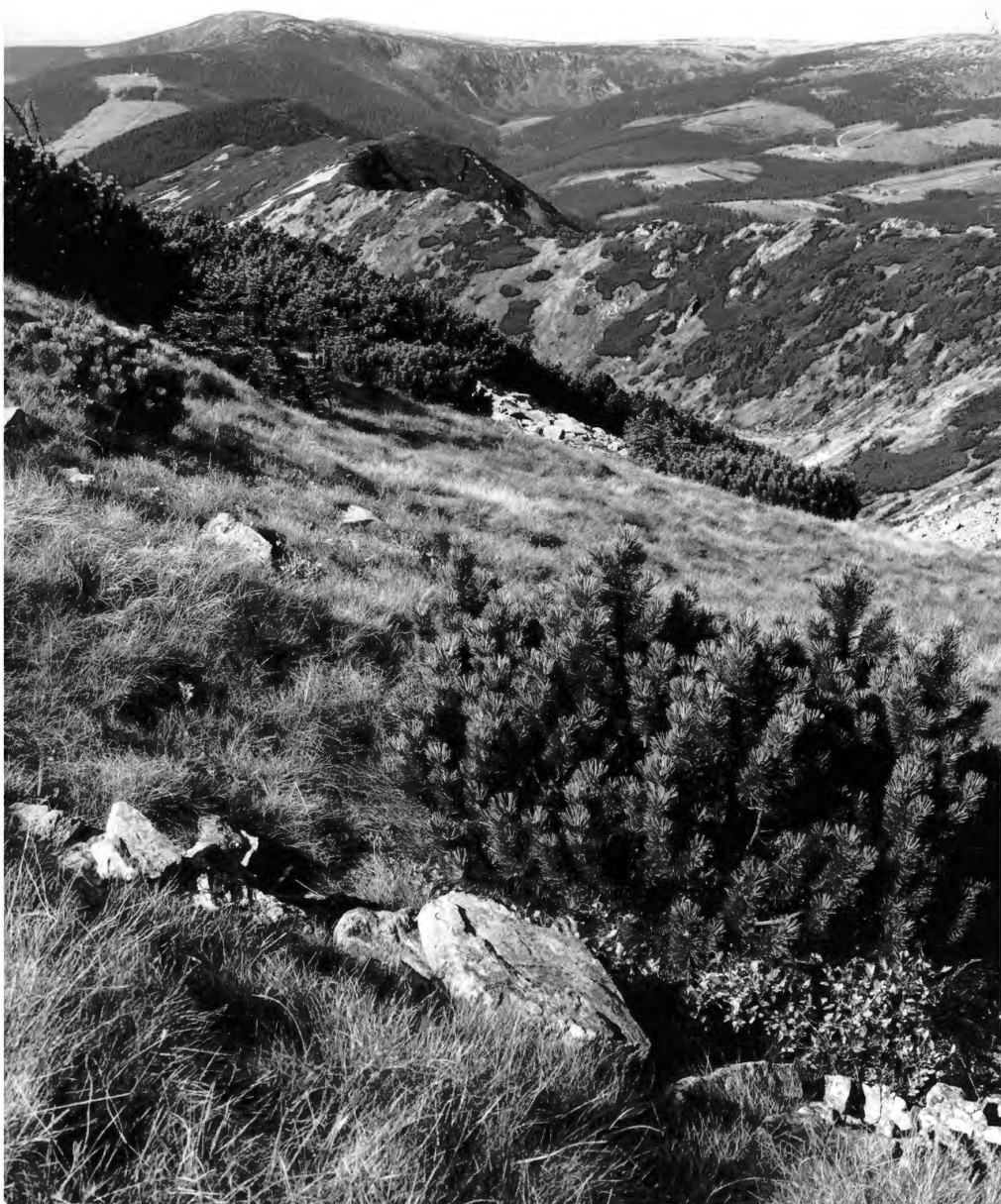
The sites include:

1) Reservoir series in the upper and middle Vltava River watershed

2) National Park and UNESCO/MAB BR Krkonoše and Sumava

3) Protected Landscape Area (PLA) and BR Krivoklatsko, Trebonsko, Palava and Bílé Karpaty.

Biomes evaluated across the sites are as follows: aquatic ecosystems (reservoirs, lakes, streams, brooks), wetlands (ponds, mires, peat bogs), grasslands (mountain and alluvial meadows, steppe), and forests (mountain, floodplain, dry). Main human impacts to be considered include nutrient loading (fertilization,



Krkonoše Mountains (K. Hník)

emissions, eutrophication), S and N oxide emissions (trans-boundary pollution and acidification), land-use and management changes, resultant micro- and meso-climate changes, and biodiversity changes.

Table of sites

Site name/location, acronym: Krkonose and Karkonosze Bilateral BR (Giant Mountains NP), northern Bohemia, KRK.

Principal contact/institution: Krkonose NP Administration, Vrchlabí, CZ 54311

Latitude, longitude, elevation, size: 50°40'N, 15°38'E, 480-1602 m, 54800 ha

Principal biome/main communities: Complex mountain system, arctic-alpine tundra, subarctic mires, alpine meadows, glacial corries (cirques), mountain spruce forests, mixed beech-spruce forests, peatbogs, spruce plantations, flower-rich secondary mountain meadows.

Research topics: Anemo-orographic systems; response of selected ecosystems/ communities/ species to air pollution (fungi, lichens); complex studies in tundra habitats (geomorphology, snow and avalanche activity, palynology, plant and animal communities, ecological classification, bioindication of disturbance); restoration and management of forests and montane meadows.

History of site/ types of data collected: First scientific expedition 1786; intensive inventories, monitoring, research since 1960s; Ramsar Site-subarctic mires, CORINE Biotope – arctic-alpine tundra; GEF Biodiversity Project 1994-97 Permanent plots: vascular plants since 1967, nonvascular plants since 1981; invertebrates since 1982, vertebrates since 1983. Hydrology since 1904, soil, geology, climate since 1932. Geographic Information System (ARC/INFO).

Site name, location, acronym: Vltava River watershed/central and southern Bohemia/ REV

Principal contact/institution: Dr. Vera Straskrbova/ Hydrobiological Institute AS CR, Na sadkách 7, C. Budejovice, CZ 37005

Latitude, longitude, elevation, size: 49°30'N, 14°30'E 270-500 m, >150 km of river impounded

Principal biome/main communities: Upper and middle reaches of river, main-stem reservoirs, mostly

canyon-shaped and elongated, with steep banks, with longitudinal heterogeneity. Lacustrine part and transition zone between river and reservoir.

Research topics: Eutrophication and nutrient loading from watersheds; internal loading from sediments; biotic interactions in pelagic assemblages; bio-

Czech Republic LTER Sites



KRK Krkonose
KRI Krivoklatsko
REV Reservoirs in the
Vltava River Watershed
SUM Šumava
TRE Trebon Basin
PAL Pálava
BIK Bílé Karpaty

manipulation/control of fish-stock; fish behavior and food; microbial loop; seasonal and inter-annual dynamics of plankton; effect of flushing rate variations on limnology and water quality.

History of site/ types of data collected: Large reservoirs in cascade (Slapy, Lipno and Orlik) dammed in 1954, 1959 and 1960; smaller drinking water reservoir Rimov in 1979. Regular monitoring: Slapy Reservoir since 1958 (field station since 1960), Rimov Reservoir since 1979 (field station since 1997); chemistry, bacteria, phytoplankton, fish, zooplankton, temperature, oxygen, pH, precipitation chemistry.

Site name, location, acronym: Krivoklatsko PLA and BR central Bohemia KRI

Principal contact/institution: Dr. Petr Hula/Krivoklatsko PLA Administration, Zbecno 5, CZ 27024

Latitude, longitude, elevation, size: 50° 00'N, 13° 52'E, 223 - 616 m, 62792 ha

Principal biome/main communities: Temperate broad-leaf forest/ highly diversified pattern of forest communities; broad-leaf and mixed coniferous forests, riparian stands, rock formations, top balds, meadows, agricultural land, spruce monocultures

Research topics: Synecological monitoring; climax forest ecosystems: impact of grazing on vegetation cover; mapping of the potential natural vegetation cover; limnology of reservoir and small streams; management towards conservation of biodiversity; anthropogenic impact on ecosystem change; geochemical cycles in landscape.

History of site/ types of data collected: BR since 1977, PLA since 1978/ Long-term records on forestry and game; Zoological and botanical inventories since beginning of 20th century (mosses, *Lepidoptera*); microclimate and fauna of stone debris since 1993; permanent monitoring plots for meteorological variables since 1974, soil, flora and fauna since 1993, hydrology since 1990, air quality.

Site name, location, acronym: Trebon Basin PLA and BR, southern Bohemia/ TRE

Principal contact/institution: Ing. Miroslav Hatle PhD/Trebon Basin PLA Administration, Valy 121, Trebon, CZ 379 01

Latitude, longitude, elevation, size: 49° 00'N, 14° 50'E, 407-613 m, 70000 ha

Principal biome/ main communities: Temperate broad-leaf forests fir-oak and pine woods, wetlands/ fishpond littoral zones, peat bogs, marshes, floodplain forests, old man-made fishponds, sandbanks, sand dunes.

Research topics: Wetland ecology—hydrobiology, nutrient cycling, and research of aquatic and forest ecosystems – emission damages, ecosystem management and conservation studies, biology of endangered bird and mammal species, relation of waterfowl population fluctuations and fish-farming practices.

History of site/ types of data collected: BR since 1977; PLA since 1979; 2 Ramsar Sites (1990, 1993); Bird life International Area; Research by local branch of Institute of Botany ASCR. Temperatures since 1876, hydrology since 1945, microclimatology, water chemistry, fishponds over 20 years, soil mapping, bird census since 1960, geological maps; mammals, insects; forestry plots since 1938; air emission.

Site name, location, acronym: Sumava BR (PLA and NP) Bohemian Forest, SUM

Principal contact/institution: Dr. Iva Buřkova/Sumava NP Administration, Kasperské Hory, CZ 34192

Latitude, longitude, elevation, size: 49°01' N, 13°45' E, 470 - 1378 m, 167000 ha

Principal biome/ main communities: Complex mountain systems/ beech forests, mixed mountain forests, mountain spruce taiga forests, grasslands, wetlands, peatlands, glacial cirques and lakes

Research topics: Detection of ecosystem change; evaluation of management practices; trans-boundary flora of the Bohemian Forest; acidified lakes—hydrobiology and hydrochemistry, stratigraphy of sediments; bioindication of mire disturbance; forest decline and re-establishment; reintroduction of lynx.

History of site/ types of data collected: The primeval mountain mixed forest of Boubinsky prales (primeval forest) as a Nature Reserve in 1858; PLA since 1963; BR since 1990; Sumava NP since 1991; GEF

Biodiversity Project 1994-96, scientific studies since 1920s, intensified research since 1990; monitoring plots of vascular plants, vertebrate and invertebrate fauna, hydrology, climate; GIS and specialized databases.

Site name, location, acronym: Palava BR and Palava PLA/southern Moravia/ PAL

Principal contact: Dr. Josef Chytil, Palava PLA Administration, Namesti 32, Mikulov, CZ 69201

Latitude, longitude, elevation, size: 48°50' N, 16°40' E, 163 - 550 m, 83300 ha

Principal biome/main communities: Temperate broad-leaf forests, Pannonian vegetation with species of sub-Mediterranean and Pontic-south Siberian origin/forest, steppe-forest, steppe-rock community, flood-plain forests, inundated meadows, halophilous vegetation, agricultural land, viticulture

Research topics: Terrestrial invertebrates; floodplain forest ecology and management; ecological optimization of landscape management; detection of ecosystem change; impact of grazing on the vegetation cover; biological control of pests in vineyards; study of halophilous plant ecosystems.

History of site/ types of data collected: PLA since 1976; BR since 1986; Ramsar site; GEF Biodiversity Project 1994-96/ Research by institutes of Academy of Sciences/CR (Archeology, Botany, Geography, Biology, Soil, Landscape), and from Masaryk U and U of Agriculture in Brno: extensive prodrome to terrestrial invertebrates, plots for monitoring of plants since 1985, vertebrate (since 1950) and invertebrate fauna, hydrology, soil and climate; specialized databases.

Site name, location, acronym: Bile Karpaty BR/ Bile Karpaty PLA/ eastern Moravia/ BIK

Principal contact/institution: Ing. Jan W. Jongepier/ Bile Karpaty PLA Administration, Bartolomejske n. 47, Veseli n. Mor. CZ 69801 49°00' N, 17°52' E, 240 - 912 m, 71500 ha

Principal biome/main communities: Temperate broad-leaf forest/ oak and beechwoods, orchid meadows with solitary oaks, springs, brooks, orchards, arable land, vineyards

Research topics: Dynamics of grassland ecosystems; succession, impact of grazing, sustainable management towards conservation of biological diversity; restoration of species-rich meadows.

History of site/ types of data collected: PLA since 1980, BR since 1996, research by Institutes of ASCR, Mendel Agricultural U and Masaryk U in Brno; meteorological data, grassland vegetation monitored since 1989 including biomass and primary production, phytocoenological data; permanent plots in a virgin forest including changes in the tree layer and undergrowth monitored since 1978.



Peatlands in
Šumava NP
(Photo:
S. Kucera)

Information Management

Each site elaborates its databases separately. Currently the state of the databases varies widely, depending on the topics, the history of the particular research and the qualifications of staff members. Not all the sites have data managers yet. The ongoing aims of the project include creating inventories of the data and improving the quality and compatibility of databases at all sites, as well as making the information available on the Internet.

Cross-site Research

Several biotic communities will be compared across the sites in the framework of the continuing project, including 1) mountain forests - KRK, SUM, 2) temperate broad-leaf forests - KRI, TRE, PAL, BIK, 3) grasslands - KRK, KRI, SUM, PAL, BIK 4) peatlands - KRK, SUM, 5) wetlands and fishponds - TRE, PAL, 6) lakes, reservoirs, brooks - REV, KRI, SUM.

Network Management

The Czech network is managed by the CZ-LTER Committee and the Czech National MAB Committee. The CZ-LTER Committee organizes meetings of Czech LTER scientists and site managers once or twice each year. An additional two meetings per year are organized by the Ministry of Environment of CR for representatives of Czech BR and PLA. The chair of the CZ-LTER Committee and the Secretary also participate in these meetings to discuss the CZ-LTER agenda. The Chair of the CZ-LTER Committee coordinates the on-going joint project.

Application of LTER Research

Many scientists engaged in LTER are university teachers, and students participate in inventories, monitoring or surveys.

Partnerships

Research on sites is carried out by the institutes of Academy of Sciences/CR, mainly the Hydrobiological Institute, Institute of Botany and Institute of Landscape Ecology, and by universities, mainly the faculties of sciences of Charles University, Prague, of the University of South Bohemia, C. Budejovice, of the Masaryk University, Brno, and of Mendel Agricultural University, Brno.

Collaboration among Networks

Collaboration on environmental problems common for middle European post-communist countries is planned with the LTER networks of Poland and Hungary.

Principal contacts

Viera Straskrabová, Head of CZ-LTER Committee,
Hydrobiological Institute AS CR, and Faculty of Sciences, University of South Bohemia,
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Eva Jelinková, Secretary of CZ-LTER Committee and Czech National MAB Committee,
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telephone ++420-2-24220384 fax ++420-2-24240531 e-mail <mab@kav.cas.cz>

Jan Kvet, Head of Czech National MAB Committee,
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Home page of CZ-LTER: <http://www.jcu.cz/~hbu/cz_lter.htm>

Hungary

LTER in Hungary

Edit Kovács-Láng¹, Sándor Herodek² and János A. Tóth³

¹Institute of Ecology and Botany of HAS

²Balaton Limnological Research Institute of HAS

³Ecology Department of KLTE University

Long-term ecological research motivated either by environmental problems or by scientific purposes has a long tradition in Hungary. Eutrophication of Lake Balaton, the maintenance of proper water quality of the Danube River, and the need to predict insect pest activity for agriculture and forestry have initiated many long-term biodiversity studies. Since the 1970s, international scientific programs such as IBP and MAB have stimulated many productivity and ecosystems studies.

The demand for developing a nation-wide network to integrate the results of formerly separate long-term studies arose in the 1990s. The major impetus emanated from cooperation with US LTER scientists, supported by NSF, and the Hungarian Academy of Sciences (HAS) ("Development of Hungarian-American collaborative research efforts: Biodiversity and Long Term Ecosystem Research 1994").

In 1997 the Hungarian Academy of Sciences initiated the development of a national ecological research network to increase the effectiveness of the research work. Site-based long-term ecological monitoring and research has a central role in the scientific program. Three research sites, representing Hungary's various biomes and maintaining a solid scientific background from earlier research activity, will serve as LTER sites and take part in regional and global networking activities.

These are:

Lake Balaton LTER site

Síkfőkút oak forest LTER site

Kiskunság forest-steppe LTER site

The goals of the program include studying the long-term dynamics of space and time on the vegetation, the effects of global change on structure and dynamics of ecosystems, and the regulatory mechanisms and the role of biodiversity in ecosystem functions.

Site name/location: Lake Balaton LTER Site, Tihany, Hungary

Principal contact: Dr. Sándor Herodek, Director, Balaton Limnological Research Institute of the Hungarian Academy of Sciences, H-8237 Tihany, PO. Box 35. tel: +36 87-448-244; fax: +36 87-448-006; e-mail: intezet@tres.blki.hu

Location: 46° 42' 47" 04' N, 17° 15' 18" 10' E; 104.8 m above sea level (Adriatic)

Site Description: Lake Balaton was formed mainly by tectonic forces about 10,000 years ago. Prior to the opening of the Sió canal in 1863, the water level was three meters higher and the surface area was about one and half times greater than at present. With a surface area of 593 km², Lake Balaton is the largest lake in Central Europe, but the mean depth is only 3.2 m. The main inflow, the Zala River,

empties into the southwestern end of the lake, while the Sió canal drains the water from the eastern basin into the River Danube. The lake is covered by ice in winter. In summer the average water temperature is 23° C. Strong wave action churns up sediment, rendering the transparency low. The major ions of the water are Ca^{2+} , Mg^{2+} and HCO_3^- . The pH is 8.4, rising to higher values during periods of intense primary production. Oxygen deficiency occurs temporarily in the western part of the lake during calm summer periods accompanied by algal blooms. The distribution of macrophytes is restricted to a relatively narrow belt by strong wave action. Only three percent of the lake surface is covered by vegetation and even less by submerged macrophytes. The major primary producers are phytoplankton. Zooplankton is not abundant. Zoobenthos represent an important food for fish. The annual commercial fish catch is 1200 tons.

The southern shore of the lake consists of sandy beach, while on the northern shore there are mountains of volcanic origin with old ruins on their tops and vineyards on their slopes. The picturesque landscape and the water—ideal for swimming and other water sports—attracts two million tourists annually. The sewage discharge from rapidly developing towns in the watershed, the growing use of fertilizers in agriculture and large animal farms has increased the nutrient loading to the lake over recent decades. A rapid eutrophication became apparent by increased production and biomass of phytoplankton. Blooms of blue-green algae are frequent in the most polluted western part of the lake. A eutrophication control program has been formulated based on intensive scientific research. Most of the municipal sewage is now diverted from recreational areas. Phosphorus removal was introduced at other sewage treatment plants. A reservoir was constructed to retain the nutrients carried by the Zala River. Pollution due to animal byproducts was reduced, and a soil-protection program is in progress.

Research History

The first large-scale research program (1891-1918) resulted in a series of monographs on the geology, geography, meteorology, hydrology, zoology and botany of Lake Balaton and its surroundings. In 1927 the Balaton Limnological Research Institute of the Hungarian Academy of Sciences was established on the shore of the lake. Water chemists, microbiologists, algologists, botanists, zoologists and ichthyologists here study the ecology of the lake. Between 1927 and 1977 most of the work of the Institute was published in *Annal. Biol. Tihany*. Recently, the papers have appeared in international journals. For a review of the last 17 years see: Salánki J. and Nemcsók J. (Eds) *The Results of Lake Balaton Research 1981-1997*. The present staff consists of 28 scientists.

The main fields of research are:

- Eutrophication processes of Lake Balaton
- Feeding, population dynamics and production of aquatic invertebrates
- Biological role and dynamics of fish populations
- Monitoring lake pollution
- Mechanisms of the biological effects of heavy metals and organic pollutants.

Types of data collected:

- ♦ Meteorological and hydrological data are available for the entire century;
- ♦ Fortnightly monitoring of water chemistry (pH, main ions, TOC, BOD, P and N forms, etc.) at 12 stations began in 1975;
- ♦ Quantitative phytoplankton monitoring at monthly or fortnightly intervals started in 1945 in the eastern basin of the lake, and in 1965 in the whole lake. The cell numbers of the different species are stored on a computer database containing more than 100,000 entries;
- ♦ Zooplankton was monitored in a similar way;
- ♦ Fish yields have been recorded since 1905;
- ♦ Less data are available from the benthic and littoral invertebrates;

- ♦ Studies of the distribution of macrophytes began in the last century, but more quantitative data were obtained in the last few decades;
- ♦ Data on watershed development (urbanization, tourism, water use, sewage treatment, land use, fertilizer application) are also collected.

Access to site: By car from Budapest (140 km) or by train from Budapest to Balatonfüred (132 km) and by bus from Balatonfüred to Tihany (9 km).

Housing available: The Institute has a guest house with 15 rooms and two apartments. For visitors accompanied by family double room flats are also available. The Institute has a two-ha lakeshore park.

Research facilities: Research vessel, motor boats, collecting devices, aquaria, chemical laboratory, isotope laboratory, mass spectrometer laboratory, morphological laboratory with electron microscope, algological laboratory with culturing devices, zoological laboratory with physiological equipment, ichthyological laboratory, library.

Site name/location Síkfőkút LTER Site, Eger, Hungary

Principal contact/Institution: Dr. Pál Jakucs, Ecological Institute, Kossuth Lajos University, H-4010 Debrecen, PO. Box 71

Latitude, longitude, elevation, size (ha): 47° 9' N, 20° 46' E, 320-340 m above sea level, 64 ha

Principal biome/main communities: Temperate deciduous oak forest dominated by *Quercus petraea* and *Quercus cerris*.

Research topics: Long-term monitoring of environmental variables; description of the changes in forest structure, tree-, shrub- and herb- layer dynamics; determination of the biomass and production of trophic levels; analysis of the efficiency of energy flow through the food chains; studying the circulation of elements between the compartments of the ecosystem; animal-plant interactions; causes of recent



- A. Lake Balaton
- B. Síkfőkút Forest
- C. Kiskunság Forest -
Steppe

Hungary
Long
Term
Ecological
Research
Sites

oak decline; studying the relationship of climatic change and forest decline; structure and role of forest ecotone; mechanism of water transport in trees.

History of site/types of data collected: The Síkfőkút Project was established in 1972 by Pál Jakucs as a model area for the typical forest community of sessile oak and turkey oak. Currently 64 hectares of the area is under protection and is part of Bükk National Park.

The long-term research can be divided into three main phases: In the first period (1972-1979) the research was connected with the IBP and MAB international programs and concentrated on the structure, production and function of the ecosystem. The results were summarized in the book *Ecology of an oak forest in Hungary: Results of Síkfőkút Project*, edited by Pál Jakucs (Akadémiai Kiadó, Budapest, 1985).

In the second phase of the research (1979-90) a new type of forest decay received a lot of attention. Beginning in 1979-80 through present, a large-scale decline of *Quercus petraea* appeared, with serious consequences for the structure of the shrub and herb layer. Research involved studies on the potential causes of the sessile oak decline (climate change, acidic rain, soil changes, toxic elements, e.g., Al ions, mycorrhiza, pathogenic microorganisms: *Ceratocystis* sp., and *Armillaria mellea*).

In the third phase, studies on the ecological state and function of the declining forest have dominated, in addition to continuous monitoring of the background environmental factors. The main emphasis is on the dynamics and structure of understory layers, the ecophysiology of declining oak trees, the behavior of dominant plant species in canopy gaps and ecotones, the dominance pattern and role of phytophagous insects, litter decomposition, and the role of soil microorganisms. There are efforts to collect information on the changes in diversity of the flora and fauna.

The following data are available (dating from 1973): Structure of the forest, shrub and herb layer dynamics, phytomass and primary production, energy and nutrient content of primary producers, growth and pigment investigations, elemental content of stemflow, throughflow and input precipitation, leaf litter decomposition and element release during decomposition, nutrient content of soil, activity of soil bacteria and fungi, fauna investigations, function of phytophaga, dynamics and causes of recent oak decline.

Access to site:

The Síkfőkút Project research site is located 150 km from Budapest and it can be reached easily by train and bus or by car.

Housing available on site:

There are two small research houses located at the research area providing accommodations for eight persons. There is a University guesthouse at Noszvaj village, six km from the research area, suitable for 30 people and/or a small conference. There is training center at Noszvaj village (located at



Understory growth and litter layer in forests of the Pilis Biosphere Reserve, Hungary (Photo: D. Coffin)

the De La Motte castle), providing excellent facilities for conferences and workshops, as well as recreation and informal programs.

Research facilities:

The research area is supplied with basic equipment for field research and monitoring studies. Telephone line (tel: 36-36-311-050). Power supply (220 V and 380 V). Meteorological station (inside the forest and in the open area nearby the forest stand) and monitoring system. Portable ecophysiological laboratory system. Light and malaise traps. The approximate number of affiliated scientists who regularly work there is 30.

Site name/location: KISKUN LTER Site Orgovány, 20 km SE of city Kecskemét, Hungary

Principal contact/Institution: Dr. Edit Kovács-Láng, Institute of Ecology and Botany of Hungarian Academy of Sciences. H-2163 Vácraót, Tel: 36-28-360-122, Fax: 36-28-360-110 E-mail: lange@botanika.botanika.hu

Latitude, longitude, elevation, size (ha): 46°48' N, 19°28' E, 120 m above sea level, 3700 ha

Principal biome/main communities: Forest steppe, composed of juniper-poplar woodland, open sand steppe, wet meadows, pine plantations, old agricultural fields, orchards.

Research topics: Monitoring of climatic variables; analysis of the hierarchical mosaic structure of the semi-natural land at different scales; landscape and land-use history; analysis of biodiversity; pattern and control of primary production; effects of and interaction among climate change, land-use change, and the decrease of the water table; mechanisms of competition, patterns and effects of disturbances (fire, herbivory, invasion); the role of population interactions in structuring ecological communities; comparative analysis of host-parasitoid systems in orchard types under various pest management; long-term fluctuation patterns of various insect groups based on light trap collections; restoration studies and experiments.

History of Site: Floral and faunal surveys in the Kiskunság Region started in the last century and resulted in two publications, *Fauna of Kiskunság* (1986) and *Flora of Kiskunság* (1993). Since the 1950s phytosociological studies have concentrated on the characterization and classification of the vegetation types. From the late 1960s, motivated by IBP, studies on primary and secondary productivity, turnover of organic matter and mineral elements have been emphasized. The Budapest and Szeged Universities, in collaboration with the Kiskunság National Park, established two small research houses in response to the need for studies of fine-scale pattern detection, population interactions, ecophysiology of plant



Ecologists
examine
insects at the
sand grassland
in Kiskunság
National Park
near Bocsa,
Hungary
(Photo: D.
Coffin)

species, activity of herbivores, and population dynamics of insects. The KISKUN LTER Program began in 1994 to focus on and coordinate the numerous independent studies carried out in Kiskunság. A major driving force in selection was the sensitivity of the transitional biome type to climate change. Recently the KISKUN LTER Program has been supported by 26 different research grants. In 1997 Kiskunság National Park provided the Program with a 3700 ha study area, which represents the heterogeneous landscape of the region. The security of the long-term studies is ensured through cooperation between the national park and the institutes concerned. Site infrastructure is under development according to LTER standards.

Types of data collected: Flora, fauna, soil maps, vegetation maps, basic climate data, depth of water table, vegetation composition, plant biogeography, spatial pattern of the vegetation, phenology, plant biomass allocation and dynamics, plant ecophysiological characteristics, plant-herbivore interactions, secondary succession, long-term fluctuation of *Neuropteroidea*, *Colcoptera*, *Heteroptera*, *Trichoptera*; large-scale spatial distribution of insects, insect populations of agroecosystems, host-parasitoid interactions, food-web organization of ant communities, habitat patchiness and patch dynamics of communities under stress and disturbance.

Available Datasets: Meteorological data from Kecskemét station, groundwater table monitoring data, FLORA Database for the Vascular flora, CoenoDAT Database (floristic and phytosociological data), phytomass dynamics of sand grasslands, ecophysiological characteristics of plant species, insect relative densities in grasslands, data on insects from eight light traps, data on insect dynamics in apple orchards, data on plant-mammal interactions.

Access to site: By car from Kecskemét or Budapest

Housing available: Housing facilities under development on site; at present housing available in Fülöpháza (10 km), Kecskemét (22 km), Bugac (10 km)

Research facilities: The LTER site infrastructure is under development. Indoor research facilities (library, computers, maps, cars, biological reference collections databases) are available at Kiskunság National Park Center in Kecskemét, the Institute of Ecology and Botany, HAS in Vácrátót, ELTE University in Budapest, and JATE University in Szeged.

Information Management: The data and information management system is most developed at the Lake Balaton LTER site, but not well developed at the KISKUN and SIKFÖKUT sites. The home pages of the LTER sites and the developing Hungarian network now being created.

Cross-site Research: Inside the country there are established links between SIKFÖKUT LTER site and the REJTEK Forest Research Project. The KISKUN LTER Site carries out cross-site grassland studies with the US LTER at the Sevilleta (New Mexico) and the Shortgrass Steppe (Colorado) sites.

Network Management is in its initial stage. The principal investigators of the sites are in close contact with each other, and a management framework will be developed from the Hungarian Ecological Network.

Application of LTER Research: The results and data from LTER research have wide applicability for the management of national parks, nature conservation, prediction of changes in biodiversity, pest control in forestry and agriculture; assessing the status of the environment in Europe by the European Environment Agency; and for education of graduate and postgraduate students.

Partnerships: LTER in Hungary is supported by universities, the Hungarian Academy of Sciences, the Hungarian Nature Conservation Authorities, and various national parks.

Collaboration among networks is still underdeveloped as the Hungarian LTER Network is still quite new. Close contacts with the US LTER Network and UK ECN Network provide permanent support and fine examples of good research and management practices.

Dryland Ecosystem-management Network (DEN)

The Jewish National Fund (JNF), in cooperation with scientists from the Jacob Blaustein Institute for Desert Research, Ben Gurion University, from the Agricultural Research Organization - Volcani Center in Bet Dagan and from the Soil Research Station - Ruppin Institute, Israel, initiated an ecosystem management program in 1990. The aim of the program was to develop ecosystem management of drylands that were under long-term human exploitation, based on integration of ecological understanding and application. The program concentrates on fostering the development of ecological landscape management for increasing biotic productivity and diversity. The program was called the Savannization Project, depicting the landscape pattern created by management processes. In the project the appearance of the area is changed from a steppe with scattered dwarf shrubs to a savanna-like landscape with patches of trees.

The project focuses on five questions:

1. What are the processes that control the input, retention and leakage of resources from natural and desertified arid and semi-arid ecosystems?
2. What are the effects of the processes of resource flows in natural and desertified ecosystems on bioproductivity and biodiversity?
3. What are the consequences of biological interactions on flows of organisms and resources and landscape dynamics?
4. What are the potential benefits of management in terms of bioproductivity, biodiversity, manipulation of resource flows, and landscape structure?
5. What are the most efficient approaches for sustainable range management in dry lands?

The assumption is that understanding ecological interactions at various levels of organization is required in order to answer these questions. Therefore, the main objective of the project is to investigate population, community, and ecosystem and landscape responses on local and regional scales for a) interactions among organisms, b) variation in water and nutrient availability, c) landscape dynamics, and d) environmental changes induced by management.

The project focuses on ecosystem management for restoration of areas that have undergone desertification resulting from uncontrolled grazing and clear cutting of woody vegetation. There are two methods for ecosystem management of desertified areas: 1) controlled grazing and 2) formation of water-enriched patches that can support relatively high biological productivity and diversity. The Savannization Project studies the effects and effectiveness of both methods.

The Savannization Project is being carried out in two field stations in the Negev: Sayeret Shaked, with 200mm, and Lchavim with 300mm average annual rainfall. Sayeret Shaked has been designated as an ecological park, while Lchavim has been designated as rangeland for sheep production. After six years (1990-1996) of running the Savannization Project, the need emerged for a national perspective

on how dryland ecosystems are being affected by management activities. As a consequence, in 1997 the JNF established the Dryland Ecosystem-management Network (DEN), a national network of sites for research and monitoring short- and long-term effects of drylands management.

Program Description

The Dryland Ecosystem-management Network (DEN) is a long-term program designed to collect, store, analyze and interpret long-term data on the responses of arid and semiarid ecosystems to management. The objectives of the program are to:

- 1) Set up a national network of sites for long-term research and monitoring of ecological functions in natural, desertified and managed dryland landscapes;
- 2) Bring together scientists and managers for developing approaches and methods for ecosystem management;
- 3) Define the relationships among ecosystem functions, management and services;
- 4) Establish strong scientific rationales for ecosystem management;
- 5) Formulate sound policy and decision making for sustainable development of drylands.

Within the DEN framework, studies will be conducted on:

- 1) Ecosystem composition, structure, function and processes;
- 2) Ecosystem history and current state;
- 3) Ecological consequences of ecosystem management;
- 4) Biodiversity, or the relationships among species, ecosystems and landscape diversity.

The core topics in the DEN program are:

- 1) The effects of natural processes and management on the spatial pattern and temporal variation of primary production;
- 2) The effects of natural processes and management on spatial and temporal distribution of populations selected to represent trophic structure and ecosystem engineering function;
- 3) The effects of natural processes and management on the spatial pattern and temporal variation of organic matter;
- 4) The effects of natural processes and management on water and nutrient flows;
- 5) The effects of natural processes and management on patterns and frequency of disturbances; and
- 6) The effects of natural processes and management on spatial and temporal dynamics of functional and taxonomic diversity.

Site Characteristics

Site Name and Location: Sayeret Shaked Park, northern Negev, Israel.

Principal Contact and Institution: Prof. Moshe Shachak, Mitrani Center for Desert Ecology, The Blaustein Institute for Desert Research, Ben Gurion University of the Negev, Sede Boqer Campus, Israel 84990

Latitude 31°17' N, *longitude* 34°37' E, *elevation* - 200 m; *size* - 300 ha

Principal biome/main communities: Semiarid desert; shrub and grass steppes, rocky and loessial watersheds, dry riverbeds, loessial plains.

Research topics: Animals and ecosystem functions; biodiversity and ecosystem function; desertification; disturbances; ecosystem management; effects of livestock grazing; landscape dynamics; nutrient cycling; organic matter dynamics; organisms as ecosystem engineers; plant community dynamics; remote sensing; watershed ecology.

History of site: The Sayeret Shaked site is an ecological park in the northern Negev near the town of Ofakim. Before the establishment of the park in 1987 the area had been under grazing pressure for thousands of years. Since 1987 the area has been managed by the JNF under the Savannization Project.

This is done by harvesting runoff water into enriched human made catchments and by planting trees. Approximately 30 ha of the park have been designated for research and have been fenced to exclude grazing animals. From 1994 the area has been declared as a demonstration site for the International Arid Lands Consortium (IALC). In 1997 the area became part of DEN.

Types of data collected: changes in landscape mosaic; density, biomass and species diversity of annual plants in natural, disturbed and managed areas; dust and organic matter deposition; litter deposition; nitrogen flux; movement of organic matter by surface runoff across the landscape; rainfall; recovery of crusted and shrub patches; runoff water generation and erosion from disturbed and undisturbed areas; seed bank dynamics; snail, ant and termite population dynamics; spectral reflectance; and, variations in annual plant species composition due to grazing.

Site Name and Location: Lehavim, northern Negev, Israel

Latitude: 31°25' N, longitude: 34°48' E, elevation: 300-400m; size: 800 ha

Principal Contact/Institution: Dr. Avi Perevolotsky, Department of Natural Resources, Agricultural Resource Organization-Volcani Center, POB 6, Bet Dagan 50250, Israel

Principal biome/main communities: Semi arid desert; shrub and grass steppes, rocky and loessial watersheds, dry riverbeds, rangeland.

Research topics: Animals and ecosystem functions; biodiversity and ecosystem function; desertification; disturbances; ecosystem management; effect of grazing; landscape dynamics; nutrient cycling; plant community dynamics; primary production dynamics; remote sensing; spatial and temporal distribution of grazing; watershed ecology

History of site: The Lehavim site is a range management research station in the northern Negev, 14 km north of Beer Sheva. Before the establishment of the station in 1980 the area had been under grazing pressure for thousands of years. Since 1980 the area has been managed by the Ministry of Agriculture and JNF. In 1990 it became part of the Savannization Project. In 1980, communal grazing by Bedouin sheep herds on the site was replaced by controlled grazing under moderate stocking rates. This was done by fencing the entire area and allowing only two herders to exclusively use the area. Since 1980 the station serves as a site for demonstrating appropriate range and livestock management. In 1992 a network of 50 (10 x 10 m) exclosures was established on the predominant habitats of the station allowing monitoring of grazing impact and removal. In 1997 the area was announced as part of DEN.

Types of data collected: changes in landscape mosaic; density, biomass and species diversity of annual plants in grazed and ungrazed areas; effects of different stocking rates on plant communities; soil fertilization; herd movements; organic matter and soil flows by surface runoff across the landscape; primary production dynamics; rainfall and soil moisture dynamics; runoff water generation and erosion; seed bank dynamics; spectral reflectance; and variations in annual plant species composition due to grazing.

Information Management

All data are stored on hard disks and on zip diskettes, accessible through a local network with several Mac and PC computers.

Cross-site Research

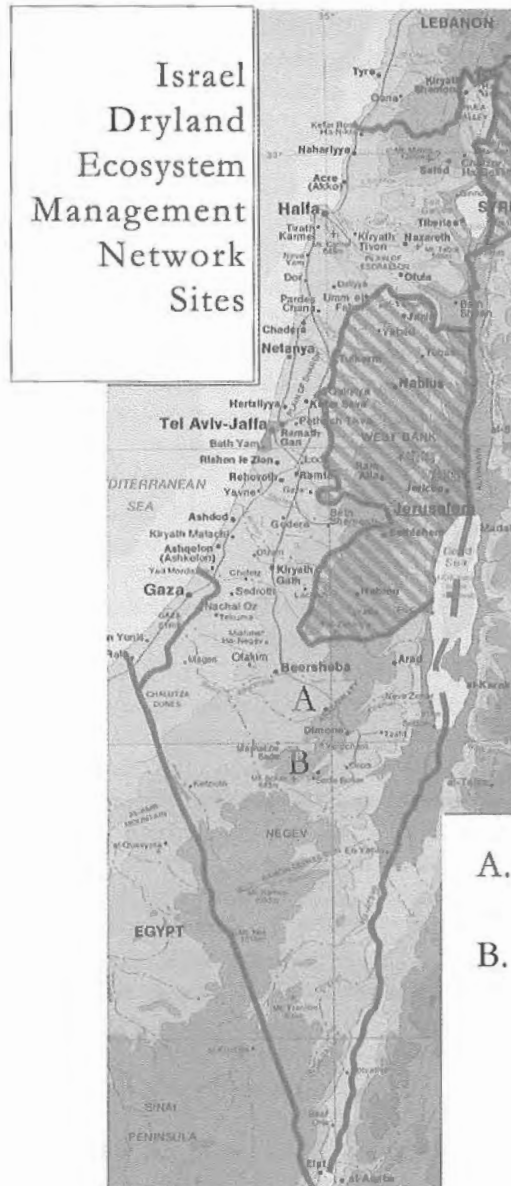
Cross-site research between the Sayeret Shaked and Lehavim sites is aimed at understanding changes in ecological processes in a dry shrub/grassland along a rainfall gradient. Specific questions are asked about the relations between patchiness of shrubs and diversity of annual plants, and the similarity and differences in the effect of grazing and landscape management on productivity and diversity.

Network Management

A committee of six members, four researchers and two managers, meets bimonthly to discuss the research and its implementation.

Application of DEN Research

The Network serves students, scientists and managers by demonstrating ecosystem structure and function and practical methods for sustainable ecosystem management for conservation and restoration.



A. Lehavim

B. Sayeret Shaked Park



The Korean Long Term Ecological Research Network

Eun-Shik Kim (Kookmin University), Bom-Chul Kim (Kangwon National University), Dowon Lee (Seoul National University), and Jeong Soo Oh (Forestry Research Institute)

Over the last 40 years, Korea's landscapes have been dramatically changed by intensive efforts toward afforestation while people convert from firewood to fossil fuel sources. Land area has been largely revegetated and the condition of vegetation is improving over time. Meanwhile, Korea has experienced degradation of the natural environment caused by intensive developmental activities and subsequent pollution. These activities include industrialization, urbanization, the construction of roads and golf courses, fossil fuel consumption, discharge of wastes to water systems, agriculture, mineral extraction, land-clearing, and water control.

As evidence of environmental degradation emerges slowly over decades, most of the people do not sense the symptoms with any precision. Hence extensive collection and careful analyses of relevant data over long time periods is required for better understanding and management of biotic components and the environment of Korea. Although some scientists have realized the importance of studying long-term phenomena in ecology, major advancement in long-term ecological research has not yet been made in Korea.

Recently the Forestry Research Institute (FRI) included Long Term Ecological Research (LTER) as a major project in forestry research, and three sites were officially designated for long-term ecological research. The first LTER site in Korea is Kwangnong Experimental Forest, which represents the oldest natural forest in Korea. Some parts of the forest have been protected for more than 500 years. The other two are the forests of Mt. Kyebangsan and Mt. Keumsan. Although LTER is in its early stages in Korea, promotion and encouragement of the ecologists' activities will help to ensure the sound development of the Korean LTER network in the future.

Description of program, objectives, and core areas

Much effort has been made to establish the LTER program and coordinate research at official and potential sites in Korea. Meanwhile, in order to facilitate communication, coordination, and cooperation among the scientists in ecology and related disciplines, the Korea LTER Committee (KLC) was established in 1997.

The objective of most of the research is to investigate the dynamics of structure and function of ecosystems related to the changes of environment, which is ultimately related to monitoring biodiversity and global change.

All the LTER sites have common themes or core research topics, which must be investigated and

compared with each other. The core areas include primary production, population dynamics, nutrient cycling, impacts of environmental stress and disturbances, and environmental changes.

Site Characteristics

Three official sites (Kwangnung Experimental Forest, Mt. Kyebangsang Forest, and Mt. Keumsan Forest), which are managed by the Forestry Research Institute, as well as three potential sites (Lake Soyang, Mt. Jumbongsan, and Mt. Hallasan) are introduced here. Mt. Chirisan, Mt. Soraksan, Mt. Namsan, and the Demilitarized Zone (DMZ) have been proposed as potential sites. In addition to these sites, other intensively investigated sites monitored by the Ministry of Environment in the national nature and environment census program could also be strong candidates for LTER sites in Korea. The locations of the sites are illustrated in the map of the Korean LTER Network.

Site name/location: Kwangnung Experimental Forest/Kyonggido Province, Korea

Latitude 37° 48' N, longitude 127° 11' E, elevation 300 - 537m, size 500ha

Principal contact/Institute: Dr. Jeong Soo Oh, Director of Forest Ecology/Forestry Research Institute, 207, Chongnyangni 2-dong, Tongdaemun-gu, Seoul 130-012, Korea

Principal biome/main communities: Mixed-hardwood temperate forest/*Quercus*, *Carpinus*, *Prunus*

Research topics: Forest-stand dynamics; water cycling; nutrient cycling; change of biodiversity and microclimate

History of site/type of data collected: Mausoleum (King Sejo, the 7th King of Chosun Dynasty) designated as Experimental Forest in 1913. Kwangnung Arboretum and Forest Museum were established in 1987. Comprehensive introduction to the Experimental Forest was published by the Forestry Research Institute. Hydrological data have been collected for twenty years. Ground survey on biodiversity has been conducted since 1994. The long-term ecological research site was established in 1996.

Site name/location: Mt. Kyebangsang Forest/Kangwondo Province, Korea

Latitude: 37°, 44'N, longitude: 128°, 29'E, elevation: 900-1577m, size: 440 ha

Principal contact/Institute: Dr. Jeong Soo Oh, director of Forest Ecology/Forestry Research Institute, 207, Chongnyangni 2-dong, Tongdaemun-gu, Seoul 130-012, Korea

Principal biome/main communities: Mixed - hardwood temperate forest (*Quercus*, *Betula*, *Kalopanax*, *Tilia*, *Acer*, *Abies*)

Research topics: Forest stand dynamics; air pollution; changes in biodiversity; climate change and monitoring

History of site/type of data collected: The site was designated as Reserve Forest for research in 1991. Ground survey on biodiversity was conducted in 1995. The long-term ecological research site was established in 1996.

Site name/location: Mt. Keumsan Forest/Kyungsangnamdo Province, Korea

Latitude; 34°, 30'N, longitude: 127° 59'E, elevation: 100-700m, size (ha): 300 ha

Principal contact/Institute: Dr. Jeong Soo Oh, Director of Forest Ecology/Forestry Research Institute, 207, Chongnyangni 2-dong, Tongdaemun-gu, Seoul 130-012, Korea

Principal biome/main communities: Mixed-hardwood temperate forest (*Quercus*, *Carpinus*, *Acer*, *Pinus*)

Research topics: Forest stand dynamics; Change of biodiversity especially in warm temperate forest

History of site/type of data collected: The site was designated as an experimental forest in 1983. Ground survey on biodiversity was conducted in 1994. The long-term ecological research site was established in 1996.

Site name/location: Mt. Jumbongsan Nature Reserve, a part of Mt. Soraksan Biosphere Reserve UNESCO MAB (potential site)/Kangwondo Province, Korea

Latitude 38°00' to 38° 03'N, longitude 128° 26' to 128° 30'E, elevation 900-1424 m, size (ha) 2,049.

Principal contact/Institute: Dr. Dowon Lee/Graduate School of Environmental Studies, Seoul National University, Seoul 151-742, Korea

Principal biome/main communities: Mixed-hardwood temperate forest (*Quercus*, *Kalopanax*, *Fraxinus*, *Carpinus*, *Acer*), montane stream

Research topics: Distribution of vascular plants; soil fauna and nutrients; leaf litter-fall and decomposition; stream invertebrates; avian ecology; integration of ecosystem models and geographic information systems.

History of site/types of data collected: The site has been included as a Biosphere Reserve in UNESCO Man and the Biosphere Program and designated as a Natural Forest Reserve by the Administration of Forestry, Korea in the 1980s. Geology, vascular plants, birds, insects, fishes and amphibians, reptiles, and mammals were partially investigated in 1983. Vascular plants, leaf litter-fall and decomposition, soil and stream invertebrates, and birds have been monitored since September 1994, soil temperature since December 1995 and air temperature, precipitation, wind, leaf-area index and soil respiration since March 1998.

Site name/location: Mt. Hallasan National Park or Mt. Hallasan Nature Reserve (potential site)/Cheju-do Province, Korea

Latitude 33° 19' 15" N to 33° 25' 30"N, longitude 126° 27' 59" E to 126° 37' 38" E; elevation 800-1950 m; size (ha): 15,131.

Principal contact/Institute: Dr. Eun-Shik Kim, Department of Forest Resources, Kookmin University, Seoul 136-702 Korea (or Director, Hallasan National Park Management Office, Cheju City, Cheju-do Province, 690-200 Korea).

Principal Biome/main communities: Mixed hardwood temperate forest and subalpine coniferous forest (*Quercus*, *Pinus*, *Carpinus*, *Abies*)

Research topics: Distribution of vascular plant; forest dynamics and biodiversity; growth decline of Korean fir; climate change and global warming; transboundary transport of air pollutants; impact assessment of human activities and wild deer to ecosystem; restoration of biodiversity; hydrologic modeling

History of site/types of data collected: Mt. Hallasan was designated as Nature Reserve in 1966 and as National Park in 1970. Various studies on climate, geology, soil, vegetation, invertebrates, amphibians, reptiles, birds, and mammals were carried out in 1985 and intermittently thereafter.

Growth data of Korean firs are quantified until recent days and temperature and precipitation data are available in nearby cities. Air pollution and acid precipitation data are also available on the same basis.

Site name/location: Lake Soyang/Kangwon-do Province, Korea (potential site)

Latitude, longitude, elevation, size – dam is at 127° 40'E, 37° 30'N, flood level is 198m, maximum surface area 70km², maximum depth 120m, axial length 60km, watershed 2700km², water capacity 2.9 x 10⁹ m³

Principal contact/Institute: Dr. Bom-Chul Kim/ Department of Environmental Science, Kangwon National University, Chuncheon, 200-701 Korea. bomchkim@cc.kangwon.ac.kr

Principal biome/main communities: warm monomictic circulation, mesotrophic phytoplankton community, no littoral zone, water level fluctuating

Research topics: Productivity and structure of phytoplankton community; zooplankton community structure; distribution of nutrients, input and output of nutrients; ecosystem modeling

History of site/type of data collected: Lake Soyang is the largest reservoir in Korea. A research team at Kangwon National University has been monitoring primary productivity, phytoplankton community, and nutrient distribution. Currently, more zooplankton community, nutrients loading from the watershed, and DOC distribution data are being collected.

Information Management

As the Korean LTER program is in an early stage of development, information is independently managed by principal investigators at each site. In the near future, all the field data will be stored in a computer system and will be accessible for scientific use on the Internet.

Cross-site Research

To establish the comparability of research results among the sites is the most important premise for the success of LTER program. Cross-site research in the core areas will be checked for validity through the standardization of measurement methods and equipment. As the research team from the Forestry Research Institute is conducting the research, cross-site research is established in at least the three sites managed by the Forestry Research Institute. Further cross-site research among sites will be actively discussed in the Third Regional Conference of the East Asia and Pacific Region, which will be held in Korea in 1999.

Network Management

The Korean LTER Committee (KLC) plays a major role in improving the LTER program and activities in Korea. The committee consists of five members—three professors and two governmental officers—and meets quarterly to discuss major activities of research and implementation.

Application of LTER Research

Products of LTER research are useful tools for detecting environmental changes such as regional pollution and global warming and for managing natural resources such as forests, lakes, and rivers. Education programs will be included when more information is collected.

Partnerships

The KLC actively pursues cooperative partnerships with the Korea Science and Engineering Foundation (KOSEF), National Park Authority (NPA), local governments such as the Seoul Metropolitan Government and the Cheju-do Provincial Government, and universities as well as the Forestry Research Institute (FRI) and the Ministry of Environment (MOE). These partnerships facilitate communication and cooperation among the scientists, managers, and policy makers in ecology and related disciplines.

Collaboration among Networks

Collaboration with national networks in the region is made through a biennial Regional Conference. Collaboration among the global networks will be mainly facilitated via the Internet; the address is:

<http://klter.kookmin.ac.kr>.

Principal Contact: Eun-Shik Kim, Ph.D., Associate Professor Dept. of Forest Resources, Kookmin University, Seoul 136-702 Korea, Tel +82-2-910-4814, Fax : +82-2-910-4809, e-mail kimeuns@kmu.kookmin.ac.kr

The Korea LTER Network

A. Kwangnung Experimental Forest

B. Mt. Kyebangsang Forest

C. Mt. Keumsan Forest





THE MEXICAN LONG TERM ECOLOGICAL RESEARCH NETWORK

Gerardo Ceballos, Manuel Maass, Rodrigo Medellín, Miguel Equihua, Rodolfo Dirzo, Andrés García, Marco Lazcano, Lucina Hernández and Felipe Noguera

Long-term studies of ecological processes are relatively scarce despite the fact that many environmental phenomena of concern today (e.g., changes in global temperatures) were documented through the long-term monitoring of key variables. Because ecological processes occur at varying spatial and temporal scales, it has been a formidable challenge to relate the results of short-term and small-scale studies to long-term and larger-scale phenomena (Ehleringer and Field 1993). Unfortunately, long-term studies are infrequent (Tilman 1989), due to the lack of long-term funding and because the systems for evaluating scientific productivity have pushed investigators to emphasize short-term studies that yield rapid results. Long-term studies, however, are essential to distinguish between single events and cyclic patterns or directional trends (Magnuson 1993) and can facilitate the description of natural variability and establish the baseline condition of ecological systems (Franklin et al. 1990; Gosz 1996).

Mexico's participation in the International Long Term Ecological Research Network is important for several reasons. As a result of Mexico's geographic situation and topographic complexity, it supports high levels of species and ecosystem diversity, representing a major fraction of the earth's biota (McNeely et al. 1989). It is imperative that the country understands and protects this heritage because the combination of extensive rural poverty, low technical support and high population growth has led to a rapid land-use transformation in the country. Scientific understanding of the effects of land-use changes on natural ecosystems is necessary for developing practices toward sustainable management and conservation. Additionally, Mexico is affected by ecological processes that operate at continental scales, such as the El Niño–Southern Oscillation, which occur infrequently and can only be understood through collaborative long-term and large-scale efforts. Finally, the proximity of Mexico to a well-established network of long-term studies creates the opportunity for scientific cooperation and development of human resources.

Description of program, objectives, and core areas

In order to implement the proposed Mexican LTER (MEXLTER) we have organized a committee to structure the network. Presently, the committee has completed the proposal and is working with the government to define long-term funding mechanisms.

The fundamental philosophy of the MEXLTER will be to address ecological research at large temporal and spatial scales in a fashion that has not been generally practiced in Mexico. Through the network structure, sites will have similar projects and share standardized data. The MEXLTER program is designed to encompass terrestrial and aquatic ecosystems, including managed ones. National-level studies should allow comparisons within and across biomes. At an international level, it should facilitate comparisons within and across biomes in different geographical areas. Therefore, the network

should have representation of the major biomes within the country, making it desirable to procure replicated sites within biomes.

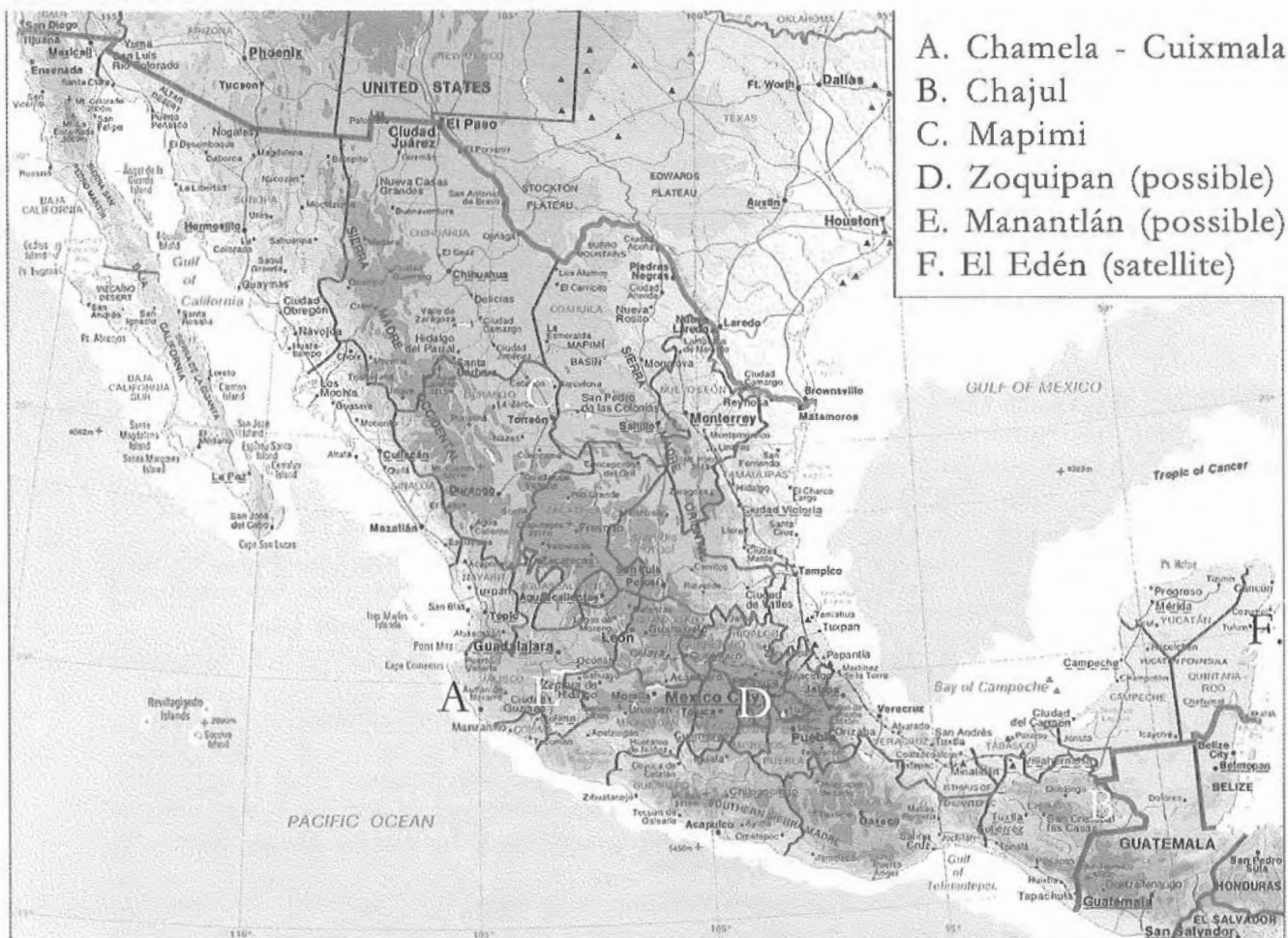
The objectives of the MEXLTER are as follows:

1. Establishing a network of sites to allow Mexican scientists to address in an interdisciplinary way ecological issues on broad spatial and temporal scales. A corollary is to understand the role of biological diversity in ecosystem processes and in the provision of services to the biosphere, including humans.
2. Creating a legacy of well-designed and documented experiments and observations for future generations.

At present we are in the process of formally establishing the MEXLTER, working on an agreement with the National Council of Science and Technology to obtain funding for beginning the Network Office and the initial network of sites. We anticipate that the network will be established this year.

Seven core subjects will define the basic theoretical framework for the research conducted at the

Mexico LTER Sites



sites. These subject areas address the most relevant functional and structural features of ecosystems, and the most pressing environmental issues for human welfare. Within each topic area there will be a background and a hierarchy of three levels of detail which will set the priorities for data acquisition. The core areas are:

- ♦ Patterns and control of ecosystem primary productivity
- ♦ Patterns and control of water, carbon and nutrient dynamics in ecosystems
- ♦ The role of biodiversity in the structure and functioning of ecosystem
- ♦ Patterns and frequency of ecosystem disturbance
- ♦ Effect of climate change on the structure and functioning of ecosystems
- ♦ Interactions at the interface level between managed and natural ecosystems
- ♦ Defining criteria for ecosystem management and conservation

Site Characteristics

Participating sites will be required to fulfill a number of criteria necessary to secure the long-term and large-scale viability of this initiative. All sites will be subject to continuous performance evaluation carried out through independent peer review. The minimum criteria for a site to be eligible for the Mexican LTER are: 1) critical scientific mass; 2) commitment to sharing the resulting data and its long-term management; 3) participation of a higher-level institution and evidence of its commitment; 4) institutional stability or security of site for the future; 5) adequate infrastructure and logistics; and 6) existing knowledge base (availability of long-term data sets).

In order to allow a large number of sites and scientists to be part of the MEXLTER, the organizing committee has decided to have two different types of sites in the network: official sites and satellite sites. Official sites already have the history, the infrastructure, the number of scientists involved in research, and the support of an established research institution. Satellite sites have limited infrastructure, support and research, and an interest in joining an official site in doing research in a particular core area. Such sites may evolve into official network sites in the future.

At present we are in the process of selecting the first sites to be incorporated in the MEXLTER. We have four candidate official sites, a possible official site, and a satellite site. We describe in detail two of the official sites and the satellite site. We also mention the three additional official sites. The distribution of these sites in Mexico is presented in the map (left).

Site Descriptions

Site name/location: Chamela-Cuixmala Biosphere Reserve, Jalisco coast, Western Mexico. Official site.

Latitude, longitude, elevation, size (ha): 19°22'4"-19°35'29"N, 104°56'23"-105°3'36"W, 0-350 meters elevation, 13,141 ha.

Principal contact/institution: Gerardo Ceballos and Andrés García, Fundación Ecológica de Cuixmala, A.C. and Instituto de Ecología, Universidad Nacional Autónoma de México. Felipe Noguera, Estación de Biología Chamela, Instituto de Biología, Universidad Nacional Autónoma de México.

Principal biome/main communities: Tropical dry deciduous forest, tropical semideciduous forest, riparian

LTER vegetation, arroyo forest, xerophilus scrub, mangrove, manzanilla forest, reed beds, palm plantations, dune and aquatic vegetation, and introduced grasslands.

Research topics: Long-term monitoring of environmental variables, long-term monitoring of fauna species populations; effects of seasonality on the biology and ecology of flora and fauna; effects of traditional management on ecosystem properties; conservation biology of endangered species; entomofauna inventories and monitoring.

History of site: The Chamela Biological Field Station was instituted in 1971; the Cuixmala Ecological Foundation was created in 1988; the Chamela-Cuixmala Biosphere Reserve was established in 1993;

the proposal to include the Reserve in the LTER network was made in 1997.

Types of data collected: Flora and fauna inventories since 1971; air temperature, precipitation, insolation and relative humidity since 1977; budgets, pools, and internal fluxes of energy, water and nutrients since 1982; tree species demography since 1984; solar radiation, wind speed and direction since 1986; evaporation since 1987; tree germination and seedling establishment since 1988; monitoring rodent species diversity and abundance since 1988; reproductive patterns and conservation of sea turtles since 1988; population status and conservation of the American crocodile since 1988; activity and movement patterns in the carnivore species community since 1994; monitoring of herpetofauna and insect diversity and abundance since 1995; maps of soils and topography, chemical composition of precipitation, cloud water, population records and biomass of terrestrial and aquatic fauna and flora, stream water, vegetation composition, above- and below-ground biomass, tree growth/mortality, litterfall, litter decomposition, mycorrhizal associations, phenology, streamflow.

Site name/location: Chajul Tropical Biology Station. Located in the state of Chiapas, Mexico, in the Montes Azules Biosphere Reserve. Official site.

Principal contact/institution: Dr. Rodrigo A. Medellín, Instituto de Ecología, Universidad Nacional Autónoma de México.

Latitude, longitude, elevation, size: 16° 07" N, 90° 56" W; 120 m asl. The Montes Azules Biosphere Reserve covers 331,200 hectares.

Main biome/communities: Tropical rainforest, mesophilous forest, riparian forest, riverine and lake ecosystems.

Research topics: Successional processes, ecosystem productivity and nutrient cycles, effects of human activities on mammal community and population ecology, seed dispersal, plant-animal interactions.

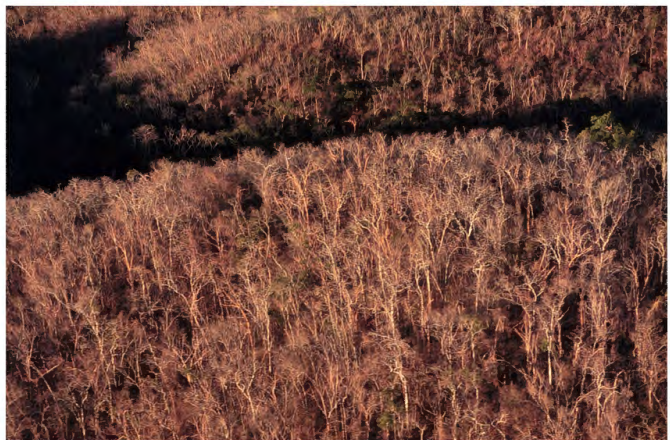
History of site: The Chajul Tropical Biology Station was built by the federal government in 1986 and abandoned two years later. In 1990 the National Autonomous University of Mexico (Institute of Ecology) and Conservation International established a partnership to co-manage the Station. The Montes Azules Biosphere Reserve is part of the largest remaining tropical rainforest tract in Mexico and Middle America. It is inhabited by the Lacandon Indians in the north of the reserve. Its vast mahogany content was actively exploited from the 19th century through the 1960s. Today it faces deforestation threats in its northern and western limits.

Types of data collected: Plant and animal inventories, primary productivity as related to soil nutrient contents and successional stages, small mammal density, demography, and diversity, seed dispersal by vertebrates along a disturbance gradient, insect herbivory, ant-plant interactions, butterfly ecology.

Site name/location: Mapimí biosphere reserve, located in the Mapimí Bolson area, in the vertex formed by the Mexican states of Chihuahua, Coahuila and Durango, Mexico. Official site.

Principal contact/institution: Miguel Equihua, Instituto de Ecología A.C., Xalapa.

Lucina Hernández, Reserva de la Biosfera de Mapimí, Instituto de Ecología, A.C., Centro Regional Durango . Luis Carlos Fierro, Instituto de Ecología, A.C., Centro Regional Durango .



Dry forests in the Chamela-Cuixmala Biosphere Reserve (Photo G. Ceballos).

Latitude, longitude, elevation, size (ha): 26°11' -27°00' N, 103°23' 104°07' W, 1100-1680 m, 172,000 ha.

Principal biome/main communities: Chihuahuan desert, desert shrubland (*Prosopis glandulosa*, *Larrea tridentata*, *Fouquieria splendens*), desert grassland (*Hilaria mutica*), salt shrublands (*Atriplex canescens*, *Atriplex acanthocarpa*)

Research topics: Biological inventories (vertebrates, plant, and invertebrates), ecological monitoring of weather, monitoring of subterranean and superficial hydrology, vegetation monitoring of ecological process, comparative ecological researches with African and North American deserts, studies of endangered species, population ecological studies. Studies of human systems (archeological, historical, demographic patterns, and traditional use of land studies). Studies of rangelands.

History of site: Mapimí was the first Biosphere Reserve in Latin America, it was created in 1978.

Types of data collected: Flora and fauna inventories since 1976, ecological monitoring of climate since 1976, underground and surface hydrology since 1982, resource maps of geology, land use, soils, topography and vegetation since 1988, comparative investigations of ecological processes since 1981, studies of endangered species since 1976, studies of wildlife population dynamics since 1976, archeological and sociological studies since 1985, rangeland management studies since 1976.

Principal contact/institution: Miguel Equihua, Instituto de Ecología A.C., Xalapa.

Site name/location: Zoquiapan experimental station, located in the state of Mexico, in central Mexico. Possible official site.

Principal contact/institution: Armando Equihua, Colegio de Posgraduados, Universidad Autónoma de Chapingo.

Site name/location: Reserva de la biósfera de Manantlán, located in the states of Jalisco and Colima in western Mexico. Possible official site.



Monitoring reptiles and amphibians has provided important information about the dry forests of the Chamela-Cuixmala Biosphere Reserve (Photo: G. Ceballos).

Principal contact/institution: Eduardo Santana, Universidad de Guadalajara, Jalisco, Mexico.

Site name/location: Reserva Ecológica El Edén, 36 Km. W of Cancún, Yucatán Península, Municipality of Lázaro Cárdenas, Quintana Roo, Mexico. Satellite site.

Principal contact/Institution: Arturo Gómez-Pompa, Department of Botany and Plant Sciences, University of California, Riverside, CA.

Latitude, longitude, elevation, size (ha): 21° 12' 36" N; 87° 11' 37" W; 5-10m; 1,492 ha.

Principal biome/main communities: Semi-deciduous tropical forest; savannas; wetlands; secondary growth; caverns; sink holes.

Research topics: Long-term monitoring of biological diversity; population dynamics (amphibians, reptiles); integration of ecosystems, species distribution, land tenure, development patterns and geographic information systems; vegetation

history of the Yalahau Region; ancient Maya settlement and use of wetlands; restoration ecology; regeneration processes caused by natural and human induced perturbations (hurricanes, droughts, forest fires); Chemical diversity.

History of site: Acquired and established as a private reserve in 1990 by Arturo Gomez-Pompa and Marco A. Lazcano-Barrero; La Savanna Research Station established in 1993

Marco A. Lazcano-Barrero; La Savanna Research Station established in 1993

Types of data collected: Population records and biomass of terrestrial and aquatic flora and fauna; maps of vegetation, disturbance history since 1976; two sets of aerial photography since 1980; climatological data since 1998.

Information Management

Maintaining the integrity of long-term databases requires the establishment of secure data storage, backup systems, standardization of reporting procedures and protocols for documenting how data were collected. Each participating site will designate an information manager who will be responsible for the establishment and maintenance of databases for that site. Information managers will work together to assure compatibility and accessibility of data among sites. The MEXLTER network will promote the calibration of analytical techniques being used at each of the sites to assure adequate quality control and comparability. The necessity for standardized data collection and documentation within and across sites in the network requires that participants from each site be trained in information management, the acquisition and use of remotely sensed data, and the collection and analysis of climatic data.

Several standards will be followed to insure the successful development and implementation of the MEXLTER network. The complexity of present-day environmental processes and problems, and the philosophy of the MEXLTER network to conduct ecological research on these issues, requires that all participating sites use similar state-of-the art conceptual and technical tools such as networking, data base management, geographic information systems, and modeling.

Cross-site Research

One of the reasons for establishing a network of research sites is to encourage the development of large-scale and comparative studies. The establishment of such studies will require frequent communication among potential collaborators in order to define possible joint studies. In order to facilitate such communication, the network will organize meetings of all the scientists involved in the long-term research at the participating sites. Meetings will be held every other year during the development of the project and will be designed to maximize interchange of ideas during the formative phase of each research project. Additional goals of the meetings will include the introduction of participating scientists to the concepts of long-term research networks and the importance of key aspects such as data management and the use of remotely sensed data.

Network Management

The implementation of the LTER network in Mexico will require a coordinating mechanism that provides support for the establishment and funding of the research sites. The achievement of the common goals of the network will require centralization of certain processes such as training, network communication, and planning of meetings. In addition, by centralizing other elements such as the acquisition of equipment and software, we anticipate improving efficiency and reducing cost. The basic structure for the coordination and operation of the network consists of an Executive Committee, an Advisory Board, a Network Coordinator and a coordinator for each site. Management of the LTER network will be by an Executive Group with representatives from each of the participating sites.

Partnerships

The MEXLTER will work cooperatively with the National Council of Science and Technology, the National Commission on Biodiversity, and the Ministry of Environment, Natural Resources and Fisheries (SEMARNAP). Other partnerships will be developed with other governmental and academic institutions and NGOs.

Collaboration among Networks between the MEXLTER and regional networks will be made through regular conferences. The MEXLTER is actively involved with both the North American and Latin American regional networks. Global collaborations will be made via the Internet and specific meetings.

Poland

LONG TERM ECOLOGICAL RESEARCH IN POLAND

*Tadeusz Prus and Kajetan Perzanowski, International Centre of Ecology,
Polish Academy of Sciences, Dziekanów Leżny*

Initial contacts between ILTER and Poland took place in 1996 when two Polish representatives were invited to attend an ILTER meeting in Central America. Their experience has provided grounds for a nation-wide discussion about the conditions for and the benefits to Polish scientific institutions joining the ILTER network.

Prior to the meeting, an initial inquiry for potential participants of the country network gathered together 10 institutions including units of the Polish Academy of Sciences (PAS), various research institutes, and a university. That meeting provided the basis for the first country report describing the background of ecological research in Poland and potential LTER sites. The second stage in mutual contacts involved a visit by Dr. James Gosz and Dr. John Vande Castle to Poland in June 1997 which provided them with first-hand knowledge on selected sites including the Bieszczady Mountains, Solina Dam Reservoir, Kampinos Forest, and Bialowieza Forest. All four sites were regarded as excellent potential LTER sites and Bialowieza, with its extraordinary long, meticulously maintained biological records, already met all standards of an ILTER site. Both guests presented the concept and framework of LTER to PAS authorities and the directors of institutions potentially interested in joining LTER network.

At the ILTER meeting in Taiwan in November 1997, a report on the advances in organization of potential ILTER sites in Poland was presented, including a detailed description of a site in the Bieszczady Mountains where long-term ecological studies have been initiated by the International Centre of Ecology (ICE), Polish Academy of Sciences. The report also included a description of two other sites in the eastern (Bialowieza Forest) and central (Kampinos National Park) areas of Poland.

Since 1996 further efforts have been made to spread the idea of ILTER in Poland and fulfil all formal conditions necessary for Polish sites to be accepted into the ILTER network. Besides the sites described earlier in the 1997 National Report, two aquatic sites in the Masurian Lakeland with long-term ecological data were incorporated. The present list of sites is by no means complete. The Committee of Ecology, of PAS is considering further proposals which will be incorporated into an electronic edition of this book as soon as they are ready.

Description of sites and research opportunities

Site: East Carpathian Mountains (Bieszczady)

Terrestrial communities

The Bieszczady Mountains stretch 2000km² between the Użocka Pass in the east, the Lupkowska Pass in the west, the Polish state border with Slovakia and Ukraine in the south, and the valley of the

San River in the north. The geology is typical of the Carpathian Range, with sandstone and shale being the dominating base rocks.

Elevations vary from about 500 m above sea level in main valleys and 1346 m above sea level at the highest peak (Tarnica). The climate has a strong continental influence from Ukraine and western Russia. Average air temperature is +5.1°C, and annual precipitation is 1200-1300 mm. Snow cover lasts from 110 to 160 days. The area is over 60 percent forested with native beech-fir (*Fagetum-Carpaticum*) as the dominant association. Large areas of former agricultural land remain in various stages of secondary succession. The number of vascular plant species is estimated to be about 700. A rich fauna of 284 vertebrate species includes all large European predators (wolf, brown bear, lynx, wildcat) and a number of herbivorous species such as European bison, red and roe deer, elk, and wild boar.

The highest and best preserved part of Bieszczady is inside the National Park boundary, which in 1992 became a part of the Eastern Carpathians International Biosphere Reserve, with more than 1000 km² in Poland. This is the least populated region in the country, with human density ranging from five to ten people per km².

The long-term series of biological data concerning the structure, composition, and the area of local forests, as well as the numbers, harvest, and natural mortality of the main game species are available

Poland LTER Potential Sites



- A. Mazurian Lakeland
- B. Białowieża
- C. Kampinos
- D. Bieszczady

from the State Forest Administration. Data on plant communities, including occurrence and distributions of rare and protected species, are collected by the scientific unit of the National Park. The Carpathian Branch of International Centre of Ecology, PAS, located in Ustrzyki Dolne, coordinates research projects that cover not only the Polish part of the range, but also adjoining areas of Slovakia and Ukraine, allowing access to biological data from both countries. Collaborating institutions in Slovakia and Ukraine are the Forest Research Institute in Zvolen and the Institute of the Ecology of Carpathians in Lvov.

The Bieszczady Mountains, due to their high biodiversity, offer a great range of possibilities for long-term ecological research varying from natural mountain forest and alpine meadows to human-altered forest and agricultural ecosystems. The central part of the region is a 35-year-old cascade of two dam reservoirs on the San River, with a well-documented history. Intensive and experimental studies of soils, plant communities or animal populations can be conducted in the area commercially managed by State Forests. Observational and low-impact studies can be done within the part protected as the Park.

Especially interesting is the potential for interdisciplinary studies based on historical records of land-use patterns and trends of the local economy, reflected in the present status and condition of local habitats. Such projects are conducted by the Historical-Ethnographic Unit of the ICE PAS in Ustrzyki Dolne.

Plans for the near future include an international Polish-Ukrainian project involving an early warning system of disturbances in terrestrial and aquatic mountain ecosystems based on a wide array of biological indicators.

Aquatic communities (Solina and Myczkowce Dam Reservoirs)

In the Bieszczady Mountain region, the aquatic site consists of two dam reservoirs, Solina and Myczkowce, situated one after another forming a two-threshold cascade. The reservoirs differ in size: at around 2100 ha, Solina is over ten times larger than Myczkowce. It is the largest dam reservoir in Poland. The difference in water level between the two reservoirs is about 60m. Maximum depths are 65m and 12m, respectively. Water volume turnover is twice per year in the larger body and 12 times per month in smaller one.

The littoral zone is affected by a large range of water level changes (up to 10 m) weekly or monthly in Solina and 1-2 m daily in the Myczkowce reservoir. One part of Solina Lake is strongly affected by tourist activity; the other is more natural. The entire system holds almost 20 percent of the total water storage in Poland, and the goals for constructing the cascade in 1968 were power generation, flood control, and tourist and recreational functions. As the outflow of water from the upper reservoir emanates from the level of hypolimnion, the water in lower reservoir is approximately 10°C cooler than in the upper reservoir during the vegetation growth season. Both reservoirs freeze over in winter.

The temperature difference creates an excellent opportunity for research, affording a natural *in situ* experiment in terms of temperature gradients. Another topic of research begun by the International Centre of Ecology is the biodiversity of atypical littoral as influenced by fluvial fauna brought with the two large affluents from the San and Solinka. The site presents an excellent opportunity for large teams of international investigators.

Site: Primeval Deciduous Forest (Bialowieza)

Plant communities

Bialowieza Primeval Forest (Puszcza Bialowieza) today covers some 1300 km² on the Poland/Belarus border. The forest is representative of the boreo-nemoral zone and grows on formations from the Riss glaciation. The short growing season (mean 185 days according to synphenological criteria) together with the long duration of snow cover (mean 92 days a year) favors the occurrence of boreal elements in the flora and fauna. However, the high degree of climatic variability from year to year allows for transi-

tional biogeographic characteristics in the Białowieża Forest. The transitory biogeographical nature of the forest is manifested in the dominance of geophyte-rich, essentially central European, multi-species deciduous forests (*Tilio-Carpinetum* of the *Carpinion betuli* alliance), along with some mixed and coniferous forests (of the *Dicrano-Pinion* and *Vaccinio-Piceion* alliances). The unique regional characteristics of the Białowieża forests are emphasised by the co-occurrence in the landscape of thermophilous oak forests (*Potentillo albae-Quercetum* of the order *Quercetalia pubescentis*) and spruce bog forests (*Sphagno girgensohnii-Piceetum* of the *Vaccinio-Piceion* alliance). Of the greatest significance here are three phenomena resulting from the occurrence of spruce—the universal presence of the species in almost all forest communities, the ease with which it dominates in favorable circumstances in all habitats, and the influence it has on the course of the most important ecological processes.

The transitory biogeographical nature of the forest complex is also clear from the considerable role played in the flora and fauna by species with a boreal-mountainous or boreal range. This is most clear in spruce forest communities, irrespective of the participation of sub-oceanic or central European elements, which dominate in deciduous forest complexes. The best-preserved forest communities with tree stands of primary origin have been protected in the Białowieża National Park since 1921 (47 km²), augmented in 1996 to 105 km².

Masurian
lakeland
site
— aerial
view of
Jorka River
Catchment
(Photo:
Archives of
Institute of
Ecology).



Long-term studies on permanent plots in northeastern Poland (mainly in Białowieża Forest) are supplemented with comparative studies in southern Italy (Promontorio del Gargano) and Russia (southwestern Siberia). These studies include: seasonality of forest communities (since 1952); ecotones between forest communities; the role of tree windfall in forest dynamics; geophytes/hemicryptophyte relationships under the influence of wild boar rooting (1975–1982; since 1991); modification of plant populations in forest and meadow communities; plant demography in vegetation succession (since 1972); vegetation fluctuation, regeneration and succession; phenomena related to secondary succession on abandoned farmland (since 1971); species turnover; the role of dioecious species; return of native species; differentiation and integration of community structure; course of succession; fire impact, and stochastic processes during succession; the role of cryptogamous species in the structure and function of forest communities; invasion of foreign species upon native plant communities (neophytism); and the formation of anthropogenic communities and synanthropic flora in the compact forest complex (synanthropisation of plant cover).

Animal communities

Since 1959, three times per year (in spring, summer, autumn) small rodents and shrews have been trapped on a small grid and two transects located in an oak-lime-hornbeam forest of the strict reserve of Białowieża National Park. The results show a dependence of rodent population dynamics on the fruiting pattern of the main deciduous trees: oak, hornbeam, and maple. Outbreaks of rodents (followed by deep crashes) occur regularly every six to nine years. Other years are characterized by moderate densities and strongly seasonal population dynamics of rodents. Since 1985, a community of carnivores and raptors that exploit forest rodents has been studied and their predatory impact estimated.

Data on numbers of five species of ungulates (in the form of game inventories and hunting statistics) are available dating from the 19th century. Since 1969, The Mammal Research Institute of the Polish Academy of Sciences has sporadically participated in the inventories and, since 1991, it has conducted annual censuses of ungulates and large predators. Predatory impacts of wolf and lynx and the other factors affecting ungulate population dynamics have been estimated. In co-operation with Białowieża National Park, numbers of wild European bison have been censused annually.



Bieszczady
Mountains
(Carinska
Valley)
Photo:
W. Osakiewicz.

European
bisons of semi-
natural breed
in the
Bialowieza
forest
(Photo:
T. Prus).



Site: Kampinos Forest

The Kampinos National Park is situated in the largest water junction created by valleys of the Vistula, Bug and Narew rivers. It is connected by a system of ecological corridors with natural areas significant to conservation and restoration of rare species of plants and animals. The Park and the valley of the Vistula River, with its unregulated banks, are extremely important biotopes, including old riverbeds, sand dunes, isles, marsh meadows and shrub areas. About 1,100 vascular plant species and more than 200 species of moss, lichens and liverworts have been identified. The species diversity of fauna was estimated as at least 50 percent of Poland's total species (i.e., 16,500 species with only about 3,000 identified).

A precious element of the Park is a mosaic of habitats and the resultant large number of ecotones. A large area of the Kampinos Forest consists of inland dunes, unique in Europe, formed within the pre-valley of the Vistula River. Up to 30 meters high, the dunes give the area an undulated configuration with a variegated landscape.

The forest in the Kampinos National Park covers about 28,000 ha or 80 percent of the total surface area. The most important forest-making species include common pine (72 percent), black alder (13 percent), oak (eight percent), verrucose birch (six percent of the total area). Dominant habitats are temperate forest followed by temperate mixed coniferous forest, temperate mixed forest, humid forest and ash swamp. The average age of tree-stands is about 60 years, and for about 200 years the Kampinos forests have been intensively managed. The Park has a potential to become one of the major centres of specialized tourism in Poland with an international range of influence.

A plan for protection of the Kampinos National Park was established in 1997. The law of nature conservation made it mandatory to prepare protection plans for national and landscape parks, their buffer zones and nature reserves (a novelty in nature conservation in Poland). The Kampinos National Park was selected for the development of the first experimental and exemplary plan of protection in Poland. The essence of the 20-year plan involves protecting, recultivating, restituting and renaturalizing actions for particular types of ecotones and natural landscapes.

The Kampinos forest, and especially the Kampinos National Park, have served as a site for ecological studies for the last 50 years by various scientific institutions: the Institute of Ecology PAS, Warsaw University, the Institute of Forest Research and others. It also has been used for education by secondary schools and universities located in Warsaw.

Site: Masurian Lakeland

A. River Jorka Catchment

The Masurian Lakeland is characterized by severe climatic conditions, an abundance of lakes and swamps and a considerable area of coniferous forests. The climate of this region is more severe than in other regions of Poland. The main hydrographic web of the area is a chain of lakes in the eastern part of the watershed connected by sections of the Jorka River. The lake area (296 km²) constitutes 8.8 percent of the watershed area. In this watershed, small lakes and bogs occur, varying in size and water surface stability. Many of them are periodic. These lakes and swamps retain considerable amounts of nutrients washed out from the watershed. Due to the high nutrient level, this site area is overgrown with hydrophilous vegetation.

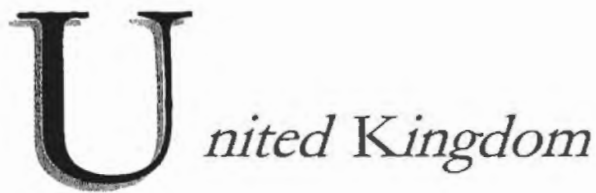
The waters in the Jorka River watershed are both permanent and periodic; swamps bordering lakes and rivers are periodically flooded. The vegetation is highly diversified, represented by groups of benthic and littoral communities, meadows, pastures, forests and synanthropic communities. Within these communities, 20 associations and two communities were found. The structural and functional diversity of the landscape compels research integrating particular elements and processes so as to form a functional entity. One of these processes is cycling and translocation of matter in landscape.

B. Great Masurian Lakes

Lake Sniardwy (the largest lake in Poland—over 11,000 ha) together with Beldany and Mikolajskie and also lakes located on the Krutynia River course (e.g. Lake Mokre) form the south part of the Great Masurian Lakes. The Krutynia River is the longest river in this lakeland. The lakes originated from the last glacial period (i.e., Baltic glaciation), and are characterized by diverse terrain, a high number of void-of-runoff inundations, and considerable moraine ridges.

The landscape is one of the most significant recreational regions in the whole Masurian Lakeland. Tourists number about 80,000 per year (one and a half million person-days). The lakes are also used for fishing: bream inhabit 76 percent of the total lake area, vendace—13 percent, pike and tench—7 percent and perch-pike inhabit 2 percent of total lake area. Some lakes are permanently stocked with vendace and eel fry.

The study focuses mainly on 24 larger lakes. Descriptions of 35 smaller lakes are generalized on the basis of the recognition of their catchment basins. Accelerated eutrophication of the lakes has been estimated by a comparison of annual loading of phosphorus from the external sources, with critical values calculated according to Vollenweider's criteria. Other factors include total catchment to lake-area ratio, lake water residency time, percentage of areas in the basin with no surface outlet, average slope, density of the stream network, and infiltration conditions. Ecological monitoring, trophic state of lakes, water chemistry, macrophytes, phytoplankton, and zooplankton studies have also been performed. Five hundred and seventy six publications on hydrobiology, hydrology, and ornithology have been published.



The UK Environmental Change Network

T. W. Parr, Coordinator of the UK Environmental Change Network, NERC, Institute of Terrestrial Ecology, Merlewood Research Station, Windermere Road, Grange-over-Sands, Cumbria, UK LA11 6JU. (Tel: 01395 32264) (Email T.Parr@ite.ac.uk) (WWW: <http://www.nmw.ac.uk/ecn>)

The UK now has access to a wealth of long-term data sets, which are being increasingly used to quantify the effects of environmental and ecological change. For example, in relation to climate change: since 1971, 31 percent of British birds have been laying their eggs earlier, on average by 8.8 days (Crick et al. 1997) and the active growing season for plants in northern latitudes has advanced by 8 days over the past 11 years (Myneni et al. 1997). In relation to land use change in GB between 1978 and 1990, there was, for example, a 23 percent net loss of hedgerows, a decrease of 30 percent of plant species in arable fields and a 14 percent decrease in plant species in semi-improved grassland (Barr et al. 1993).

These largely sectoral approaches to the detection of environmental change have now been complemented by the establishment of an integrated monitoring network: the Environmental Change Network (ECN). ECN is a multi-agency, multi-disciplinary program of data collection and data management at a national level, which aims to link spatial, temporal, experimental and modeled data in order to detect and interpret environmental change. In conjunction with other UK sectoral monitoring programs, it is designed to identify and quantify environmental changes associated with man's activities, distinguish man-made change from natural variations and trends, and give warning of undesirable effects. The ECN program was established as a response to the concern over forecasts of global environmental change which were being voiced in the late 1980s and the recognition of the scientific and policy value of data collected systematically from networks of monitoring sites (Burt 1994, Tinker 1994).

ECN's program is closely associated with research project, which use both its monitoring data and its sites to study, either by modeling or through field experimentation, the mechanisms and processes of the environmental change. For instance, Rothamsted Experimental Station, with its classic long-term agricultural experiments, and two flagship sites (Moor House and Wytham) established in the UK Natural Environment Research Council's TIGER program (Terrestrial Initiative in Global Environmental Research) are also ECN sites. A priority for ECN is to continue to develop environmental research programs at all ECN sites, and international links promoted through organizations such as ILTER will be particularly important in this process.

Description of Programme, Objectives and Core Areas

ECN was established in 1992 with the following specific objectives:

- ♦ to establish and maintain a selected set of sites within the UK from which to obtain comparable long-term data sets by means of measurement at regular intervals of variables identified as being of major environmental importance;

The U.K. Environmental Change Network

Freshwater Sites

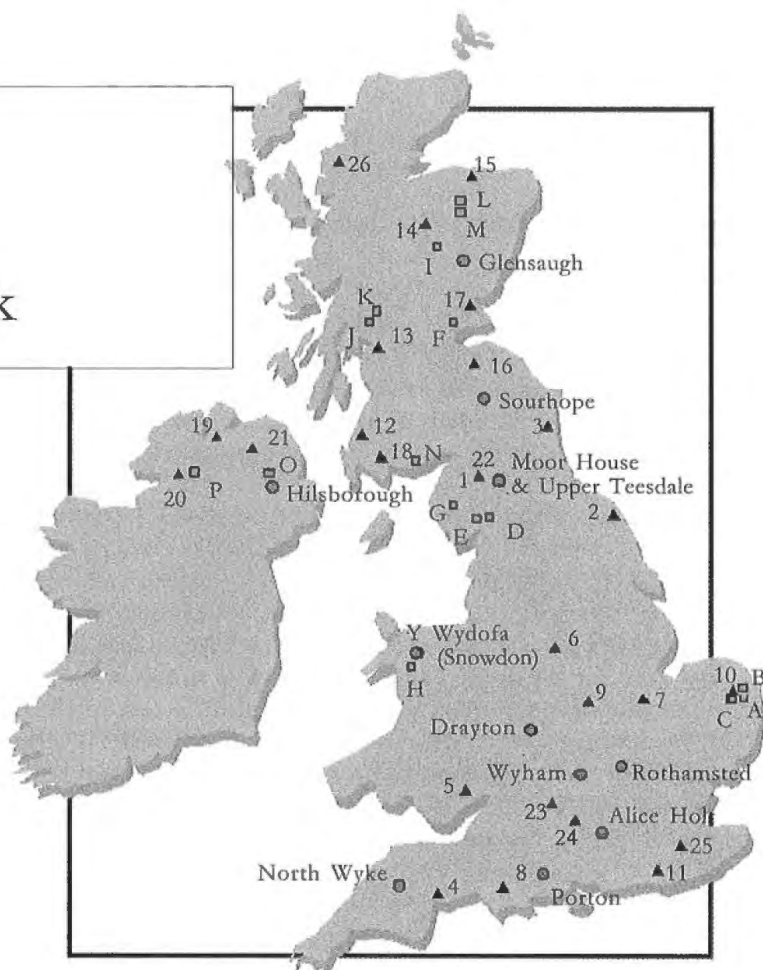
▲ River sites

1. Eden (Cumbria)
2. Esk
3. Coquet
4. Exe
5. Wye
6. Lathkill
7. Cringle Beck
8. Bradgate Brook
10. Bure
11. Old Lodge
12. Stinchar
13. Lower Clyde
14. Allt a'Mharcaidh
15. Spey (Fochabers)
16. Tweed (Galafoot)
17. Eden (Fife)
18. Cree
19. Faughan
20. Garvary
21. Bush
22. Trout Beck (Moor House)
23. Coln
24. Lambourn
25. Eden (Kent)

■ Lake sites

- A Upton Broad
- B Hickling Broak
- C Wroxham Broad
- D Windermere
- E Esthwaite Water
- F Loch Leven
- G Scoat Tarn
- H Llyn Llgi
- I Lochnagar
- J Loch Lomond
- Cailness
- Creinch
- K Loch Katrine
- L Loch Davan
- M Loch Kinord
- N Loch Dee
- O Lough Neagh

● Terrestrial sites (see map)



- ♦ to provide for the integration and analysis of these data sets so as to identify environmental change and improve understanding of the causes of change;
- ♦ to make these long-term data sets available as a basis for research and prediction;
- ♦ to provide, for research purposes, a range of representative sites where there is good instrumentation and reliable environmental information.

By 1997, ECN had established:

- ♦ an expanding network of 53 freshwater and terrestrial sites covering the main environmental gradients in the UK;
- ♦ a program of measurements on some 260 variables which drive or respond to environmental change

in core measurement areas such as climate, atmospheric chemistry, soil water, surface water, soil, flora, fauna, phytoplankton, zooplankton and diatoms; measurements began across the network in 1993 although most sites hold some historical data covering a longer period;

- ♦ standard measurement protocols, quality assessment procedures and data validation procedures to ensure that all data collected are comparable in space and time; ECN has recently published its *Protocols for Standard Measurements at Terrestrial Sites* (Sykes and Lane 1996);

- ♦ links with at least 16 other sectoral monitoring programs or surveys in the UK mainly through the use of common methodologies - this will allow ECN's data to be used in combination with historical data and more spatially extensive data from other monitoring networks within the UK;

- ♦ a central database and data management procedures designed to create seamless transitions from data collection to data dissemination and from data provider to data user;

- ♦ an Internet service to provide direct access to its Oracle summary database and real-time data on climate (<http://www.nmw.ac.uk/ecn/>);

- ♦ a UK focus for international links related to long-term environmental monitoring, e.g., the Global Terrestrial Observing System.

ECN also collaborates closely with research scientists in universities and government research institutes in the UK and with scientist worldwide on projects related to the detection and interpretation of environmental change.

Sites and Measurements

ECN Sites

The UK has many sites with a long history of environmental data collection and repeated surveys. ECN developed criteria for site selection based on choosing sites with known management histories, existing data and a background of environmental research, but also with the overall aim of covering the main range of environmental conditions present in the UK. There are currently 11 terrestrial sites (ranging from small 2 km² intensively managed lowland agricultural establishments to large, 65 km², semi-natural upland areas) and 42 freshwater sites (16 lakes and 26 rivers).

The distribution of sites in the UK is shown in Figure 1. Full details of all sites are available through the ECN Web pages (<http://www.nmw.ac.uk/ecn/>).

The initial contact point for all general inquiries is:

Dr. Terry Parr, Coordinator of the UK Environmental Change Network, NERC, Institute of Terrestrial Ecology, Merlewood Research Station, Windermere Road, Grange-over-Sands, Cumbria, UK LA11 6JU. (Tel: 01395 32264) (Email T.Parr@ite.ac.uk) (WWW: <http://www.nmw.ac.uk/ecn/>)

ECN Measurements

The use of standardized methods of data collection is an important principle in ECN. The program is centered on a series of 'Core Measurements', which are made, wherever possible, at all the sites using standard protocols (Table 1). The measurements relate to variables, which are expected to be important in driving environmental change, and to ecosystem response variables which have been identified as being sensitive or responsive to such change.

Standardized recording began at most terrestrial sites in 1993 and covers 11 sets of measurements on: meteorology, surface water drainage, surface water quality, atmospheric chemistry, precipitation chemistry, soil solution chemistry, soils, vegetation, invertebrates (moths, butterflies, ground predators and tipulids), vertebrates (rabbits, bats, common birds, moorland birds, frogs) and site management. Vegetation maps and aerial photograph coverage are available for each site. Measurements at ECN's freshwater sites began in 1994 and include measurements on water chemistry, water flow, chlorophyll, invertebrates, macrophytes, zooplankton, phytoplankton, and epilithic diatoms.

Whilst as many as possible of the physical measurements in the program are automated, the biological

part of the program relies on more traditional methods of data collection. Recording of animals is directed toward groups believed to be good indicators of environmental change and for which there are already good ecological data that can provide a sound background to interpretation. Animals with wide distributions are be used for inter-site comparisons of possible changes with time; those for which there are already national monitoring schemes, into which results from ECN sites can feed, have also been included. Data on birds, bats, frogs and rabbits are collected. A number of invertebrate groups have been included in the program.

Moths (macrolepidoptera), butterflies and freshwater macro-invertebrates already have national monitoring programs and ECN sites follow the existing methods of these surveys and contribute data to their programs. This allows ECN sites to be placed in a regional and national context.

ECN has recently published its *Protocols for Standard Measurements at Terrestrial Sites* (Sykes & Lane 1996) and a companion volume on ECN's freshwater protocols should be available by 1998.

Table 1. ECN Core Measurements

Terrestrial sites

Meteorology	Automatic weather station: 12 variables summarized hourly, manual back-up
Atmospheric chemistry	NO ₂ passive diffusion tubes (Two-weekly analyses) ammonia (DETR network)
Precipitation chemistry	UK precipitation composition network protocol (14 variables) Weekly analyses
Surface water discharge, chemistry and quality	Continuous discharge measurements; weekly dip samples for major ions; continuous pH, turbidity, temperature, conductivity
Soil solution chemistry	Replicated suction lysimeters at base of a and b horizons Two-weekly samples for major ions
Soil properties	Survey at 1:10 000 or 1:25 000, five-yearly cores for major ions; 20-yearly pits for heavy metals and physical properties
Vegetation	Whole site survey with up to 500 systematic quadrats, related to the National Vegetation Classification (NVC). 50 random grid plots every nine years; plots in each NVC type every three



Loch Lomond, Scotland (Scottish Environment Protection Agency).

Table 1. ECN core measurements Terrestrial sites *con't.*

	years. In addition: linear features, permanent grass, cereals, woodland plots. Annual monitoring of sub-sample of plots.
Vertebrates	Annual census of birds, rabbits, deer, bats, frogs
Invertebrates	Moths daily; butterflies two-weekly; spittle bug nymph density and adult colour morphs; ground predators two-weekly
Soil organisms	Tipulid larvae extracted April and September
Site management	Records of management activities at the site
Freshwater sites	
Surface water	Dip samples analyzed for major ions—monthly for rivers, four times per year for lakes. Continuous pH, temperature, conductivity, turbidity recording. Temperature and dissolved oxygen profiles for lakes.
Surface water flow	stage and discharge at river sites
Chlorophyll	Monthly for rivers, four times per year for lakes
Invertebrates	Twice-yearly at river sites, annually at lake sites for species presence, abundance and deformities
Macrophytes	Recording annually in rivers, every two years in lakes for species presence and distribution
Zooplankton	Sampling at lake sites four times per year for presence and distribution
Phytoplankton	Sampling at lake sites four times per year for presence and distribution
Epilithic diatoms	Yearly at river and lake sites. Samples archived for future analysis for presence and distribution.

Quality Assurance procedures

Quality assurance is an essential part of any long-term program, especially when comparisons in space and time and the ability to distinguish signal from noise or real-effects from measurement artifacts will be crucial to its success. ECN's quality control is based on its standard measurement protocols which were developed and agreed at the outset by ECN's Statistical and Technical Advisory Group. ECN is also implementing a series of quality assessment procedures to provide quantitative data on the accuracy of measurements. These data will be stored in the database to provide information on, for instance, observer and sampling effects in the biological measurements and variations in chemical analyses on water samples at different laboratories.

Standard data recording forms and transfer formats have been produced for each of the core measurements and for the associated quality information to facilitate handling at the ECN Central Coordination Unit (CCU). An overall data handling Protocol describes the general principles to be used for the transfer of data (Sykes and Lane 1996).

Information Management

One of ECN's key objectives is to make long-term datasets available for research and prediction. The management of large quantities of incoming data from different sources for a wide variety of measurements requires a comprehensive strategy; ECN has adopted an integrated approach to data management which aims for seamless transitions from data collection to data dissemination and from data provider to data user.

At the heart of ECN is a central database, which integrates all data and meta-data collected under the program. Full details of the database structure are given in (Lane 1997). Data from all network sites are sent by e-mail to the ECN Central Coordinating Unit at ITE Merlewood, where the database



Chalk grassland at Porton Down, England (Defence Evaluation and Research Agency/MoD).

is maintained under the Oracle relational database management system with links to the geographical information system Arc/Info for spatial data handling. The procedures include specifications for data formats, reporting units and precisions, handling missing data, meta-information and data validation rules.

Data Access Procedures

It is of prime importance to ECN that data collected over the network are made quickly available for research and information purposes. The aim is to have no more than a 6-month lag between data collection and the availability of validated data in the database for measurements sampled throughout the year.

Annual data digests are published in hard-copy format but ECN also provides direct database access to users via the Internet. The ECN database can

currently be accessed at three levels to meet different user requirements:

- ♦ General-purpose database query and retrieval methods are provided primarily for scientific users already familiar with SQL and with the ECN database structures.
- ♦ Users who require guided access to the data without prior training can examine summary data through a tailored interface to the ECN database using the World Wide Web (<http://www.nmw.ac.uk/ecn/>). The interface enables authorized users to build their own database query by selecting any combination of ECN sites, core measurement variables and date ranges for instant generation of tables and graphs. Data may also be downloaded via E-mail in column format for input to local software.
- ♦ ECN also provides access to real-time data via the Web from an automatic weather station (AWS) at the Moor House/Upper Teesdale site in the north Pennines. The AWS generates a summary dataset each hour, which is then transmitted via a modem link to the ECN CCU.

Data licensing Agreements

The current agreement is that summary data are freely available, either from data digests or over the Internet, without the need for a license. Raw data are available under license with charges levied according to the proposed use.

Cross-site Research

ECN's structure and program of standard measurements is specifically designed to encourage cross-site research. This research can be in the form of analyses of data from the ongoing monitoring program or the use of ECN sites for experimental studies designed to test specific hypotheses concerning environmental change. ECN sites have been closely involved in some major UK research programs run by the Natural Environment Research Council, including TIGER (Terrestrial Initiative in Global Environmental Research) the Environmental Diagnostics Programme and the Soil Biodiversity Programme.

Network Management

ECN is a multi-agency initiative, which has attracted financial support from 14 sponsoring organizations with an interest in land-use and the environment. Each organization subscribes to the long-term aim of the network and contributes by funding the monitoring program at one or more

sites or by supporting network co-ordination. Each sponsor has signed a letter of intent, which sets out the arrangements at individual sites, including data ownership.

ECN's 14 sponsors are: Biotechnology and Biological Sciences Research Council; Countryside Council for Wales; Department of Agriculture for Northern Ireland; Department of the Environment Transport and the Regions; Department of the Environment for Northern Ireland; English Nature; Environment Agency; Forestry Commission; Ministry of Defence; Ministry of Agriculture, Fisheries and Food; Natural Environment Research Council; Scottish Environment Protection Agency; Scottish Office, Agriculture, Environment & Fisheries Department; and the Welsh Office.

The organizational structure of ECN consists of a Steering Committee, a Statistical and Technical Advisory Group, a Central Co-ordination Unit and individual site managers. The Steering Committee deals with policy and finance and consists of representatives from each sponsoring organization. The Statistical and Technical Advisory Group deals with technical development and data analysis. Site managers deal with the day-to-day monitoring at ECN sites and meet annually to discuss operational matters and researches opportunities. Finally, the network as a whole is coordinated by the Centre of Ecology and Hydrology from ITE, Merlewood Research Station on behalf of the Natural Environment Research Council (NERC). NERC is one of the UK's six Research Councils and is part-funded by the Government's Office of Science and Technology.

Applications

ECN was set up as a result of recognition of the value of long-term datasets in detecting and interpreting environmental change. In the long-term, ECN's broad range of sponsors will help ensure that its data are fed into a range of applications including policy development, policy implementation, environmental reporting, and fundamental research programs. But ECN is also developing short-term outputs. In research, ECN is:

- ♦ setting standards for measurements which may be used in other research and monitoring programs
- ♦ in 1996 ECN published its *Protocols for Standard Measurements at Terrestrial Sites* (Sykes and Lane 1996), and the freshwater protocols will follow in 1998;
- ♦ providing a range of representative sites where there is good instrumentation and reliable environmental information for related research projects or UK programs such as TIGER (Terrestrial Initiative in Global Environmental Change);
- ♦ providing data for the development or testing of models of environmental change, particularly in relation to the development of models for the early detection of change;

In policy, planning and the public appreciation of science, ECN is:

- ♦ providing regularly updated data on a broad range of environmental attributes of public interest to inform on the ongoing consequences of such events as global climate change;
- ♦ involved in the development of indicators and information for use in national State of the Environment reports;
- ♦ developing data interpretation methods to enable the key features (e.g., long-term trends, seasonal patterns) of the time series data collected to be highlighted (Parr & Hirst, in press);
- ♦ providing real-time climate data from an Automatic Weather Station in the Pennines on the Internet;
- ♦ seeking to develop educational links to promote the use of its data in schools;
- ♦ providing information on its current activities in a bi-annual newsletter: "ECN News".

For industry and commerce, ECN:

- ♦ can provide baseline data on a range of environmental quality indicators so that local environmental assessments can be presented in the context of background trends;
- ♦ is assisting with the development of real-time environmental monitoring sensors and packages by providing test sites and experience in monitoring across a range of disciplines.

Partnerships

ECN is a multi-agency initiative supported by 14 UK sponsoring organizations (see above). It is a broad ranging partnership between Government Departments, Government Agencies, Research Councils, Research Institutes and Universities.

Collaboration among Networks

ECN has links with other networks at three main levels. Firstly within the NERC Institute of Terrestrial Ecology, where ECN forms one level in a hierarchy of terrestrial monitoring initiatives; secondly within the UK, where it is closely linked to other sectoral monitoring networks; and thirdly, internationally, where it provides a focal point for UK contact with similar networks across the globe.

In Great Britain the NERC Institute of Terrestrial Ecology undertakes earth observation and monitoring at a national scale in a hierarchy of inter-linked levels. At the most general level is the ITE Land Cover Map of GB (Barr *et al* 1993) which gives 100 percent coverage based on satellite imagery circa 1990. At the next level comes detailed field recording (Countryside Surveys) in a sample of 1-km squares across GB at intervals of 6 to 10 years (Barr *et al* 1993). At the final level, ECN contributes detailed and continuous data from its network of 53 terrestrial and freshwater sites across the UK.

Whenever possible, ECN has based its protocols on those already used by other sectoral networks operating in the UK. For example, bird monitoring is based on the Breeding Bird Survey used by the British Trust for Ornithology and butterflies are recorded using the methodology of the Butterfly Monitoring Scheme. These sectoral surveys usually use more sites than ECN but lack the same range of measurements. The links between the integrated data provided by ECN with these more spatially extensive datasets is one of the many integrating possibilities, which will be developed in ECN over the next few years.

ECN is an UK focal point for international links connected with long-term integrated monitoring and is becoming increasingly involved in international long-term monitoring initiatives such as the Global Terrestrial Observing System (GTOS). At the European level, ECN is involved in a project in the ENRICH program (European Networking of Research in Global Change)—on “Networking of Long-term Integrated Monitoring in Terrestrial Systems” (NoLIMITS). NoLIMITS is preparatory action aimed at identifying the requirements for integrated site monitoring in Europe and the research and development needed to make it happen. It is headed by a consortium of research organizations including ECN, the Finnish Academy of Science (which administers the International Monitoring Programme) and the Hungarian Academy of Sciences, but will work with the European Environment Agency, the Centre for Earth Observation and GTOS to ensure that plans are targeted toward the requirements of the main user communities for a continental scale network.

Table 2. UK Schemes linked with the Environmental Change Network

Network or Monitoring Scheme	Organization
Acid Waters Monitoring Network	Department of Environment Transport and the Regions
Air Quality Monitoring networks	Department of Environment Transport and the Regions
Ammonia Monitoring Network	Department of Environment Transport and the Regions
Biological River Quality Surveys	Environment Agencies in England, Scotland, Wales and Northern Ireland
Butterfly Monitoring Scheme	Institute of Terrestrial Ecology
Chemical River Quality surveys	Environment Agencies in England, Scotland, Wales and Northern Ireland
Common Birds Census/Breeding Bird Survey	British Trust for Ornithology

Table 2. UK Schemes linked with the Environmental Change Network *con't.*

Network or Monitoring Scheme	Organization
Countryside Survey 1990/2000	Department of Environment, Transport and the Regions Institute of Terrestrial Ecology
Forest Health Surveys	Forestry Commission
GB Harmonized Water Monitoring Scheme	Department of Environment Transport and the Regions Meteorological Office
Met. Office Weather Stations	
MICRONET	Scottish Office Agriculture Environment and Fisheries Department
National Vegetation Classification	Lancaster University
River Habitat Survey	Environment Agencies in England, Scotland, Wales and Northern Ireland
Rothamsted Insect Surveys	Institute of Arable Crops Research, Rothamsted
Soil Surveys	Soil Survey Land Research Institute/ Macaulay Land Use Research Institute/ Department of Agriculture for Northern Ireland
SOMNET	Soil Organic Carbon Monitoring Network (Global Change and Terrestrial Ecosystems)

United States

Status of the U.S. Long Term Ecological Research Network

Robert B. Waide, Executive Director LTER Network Office

The network of sites dedicated to long-term ecological research in the United States has grown steadily since it was formed in 1980. In addition to adding individual sites, the focus of the network has shifted from a concentration on individual site research to a broader synthetic viewpoint. As funding for the program has increased, expectations of results have shifted to include not only individual researcher, single-site products but also cross-site, network-wide, and international collaborative studies. The goal of these latter studies is to search out general ecological principles that apply to many ecosystems at many different scales. Comparative and synthetic approaches have become the norm in the U.S. LTER Network.

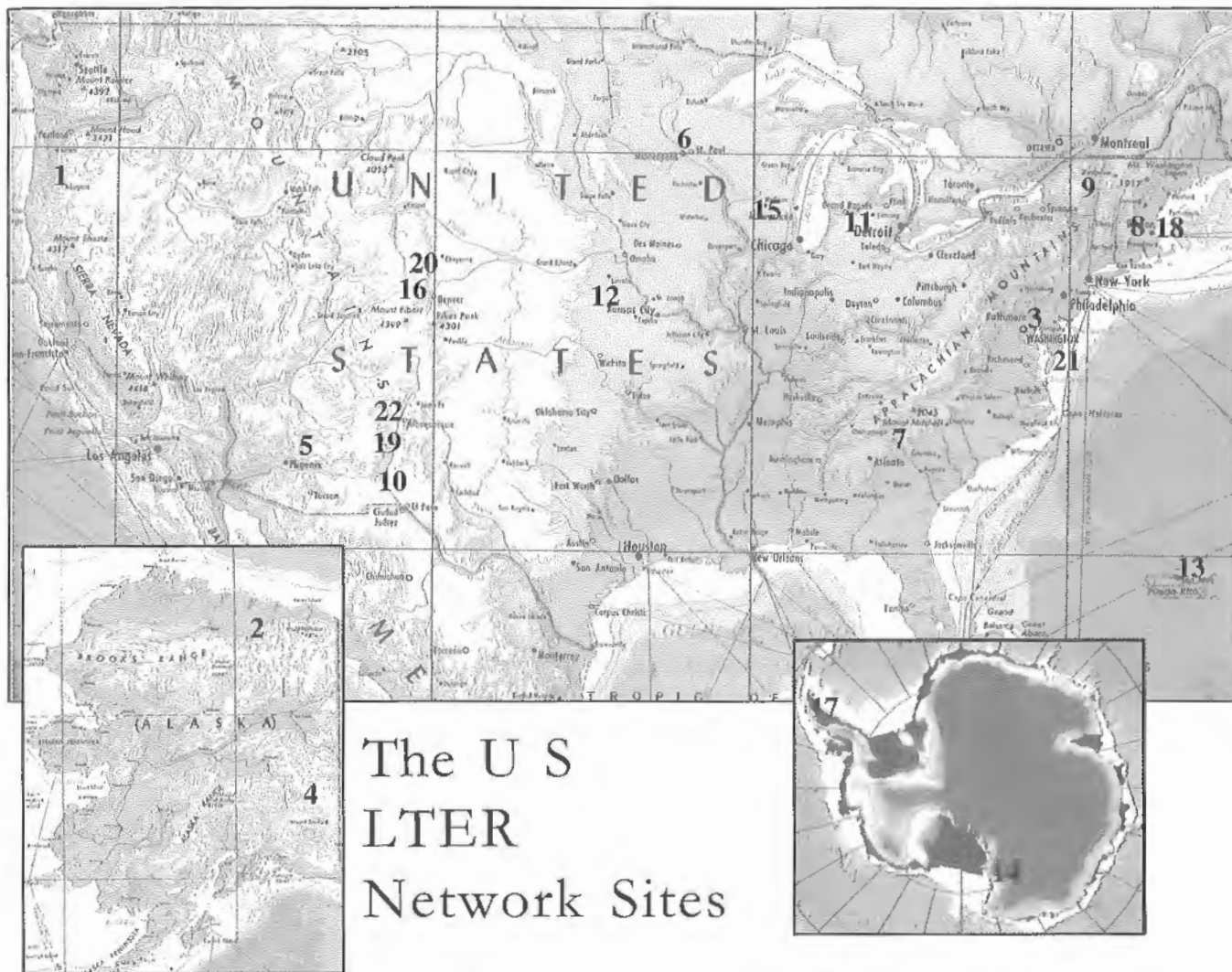
History of the Network

The concept of long-term ecological research sites dedicated to collaborative research was developed during a series of three workshops sponsored by the National Science Foundation (NSF) from 1977 to 1979. At these workshops, the philosophy of collaborative research was developed and a centralized working hypothesis approach to collaboration proposed. Five core areas of research were defined to orient long-term ecological research projects toward question/hypothesis formulation and resolution. The five core research areas common to all LTER sites are:

- ♦ Pattern and control of primary production
- ♦ Spatial and temporal distribution of populations selected to represent trophic structure
- ♦ Pattern and control of organic matter accumulation in surface layers and sediments
- ♦ Patterns of inorganic inputs and movements of nutrients through soils, groundwater and surface waters
- ♦ Patterns and frequency of site disturbances

In 1979, NSF announced a call for proposals for pilot projects in long-term ecological research with goals of 1) initiating the collection of comparative data at a network of sites representing major biotic regions of North America, and 2) evaluating the scientific, technical and managerial problems associated with such long-term comparative research. The first request for LTER proposals resulted in the selection and funding of an initial set of six sites:

H.J. Andrews Experimental Forest, Oregon
Coweeta Hydrologic Laboratory, North Carolina
Konza Prairie Research Natural Area, Kansas
Niwot Ridge/Green Lakes Valley, Colorado
North Inlet Marsh, South Carolina



The U S LTER Network Sites

1. H.J. Andrews Experimental Forest
2. Arctic Tundra
3. Baltimore Ecosystem Study
4. Bonanza Creek Experimental Forest
5. Central Arizona-Phoenix Urban LTER
6. Cedar Creek Natural History Area
7. Coweeta Hydrologic Laboratory
8. Harvard Forest
9. Hubbard Brook Experimental Forest
10. Jornada Experimental Range
11. Kellogg Biological Station
12. Konza Prairie Natural Research Area
13. Luquillo Experimental Forest
14. McMurdo Dry Valleys
15. North Temperate Lakes
16. Niwot Ridge-Green Lakes Valley
17. Palmer Station
18. Plum Island Sound
19. Sevilleta National Wildlife Refuge
20. Shortgrass Steppe
21. Virginia Coast Reserve
22. Network Office

North Temperate Lakes, Wisconsin
 Competitions in 1980 and 1987 added 10 additional sites:
 Arctic Tundra, northern slope of Alaska
 Bonanza Creek Experimental Forest, Alaska
 Cedar Creek Natural History Area, Minnesota
 Central Plains Experimental Range (now called Shortgrass Steppe), Colorado
 Hubbard Brook Experimental Forest, New Hampshire
 Illinois Rivers, Illinois
 Jornada Basin, New Mexico
 W.K. Kellogg Biological Station, Michigan
 Okefenokee, Georgia
 Virginia Coast Reserve, Virginia

In 1988, two sites withdrew (Illinois Rivers and Okefenokee) and three new sites were added:
 Harvard Forest, Massachusetts
 Luquillo Experimental Forest, Puerto Rico
 Sevilleta National Wildlife Refuge, New Mexico

Competitions in 1990 and 1992 through the divisions of Polar Programs and Environmental Biology for sites in Antarctica resulted in the addition of two more sites by 1993:

Palmer Station, Antarctica
 McMurdo Dry Valleys, Antarctica

The withdrawal of one site in 1993 (North Inlet), the addition of the two new urban sites in 1997 (Baltimore and Central Arizona-Phoenix), and the transfer of a Land-Margin Ecosystem Research site (Plum Island Sound) to the LTER Network in 1998 resulted in the current total of 21 sites (Figure 1).

At the same time that the Network was expanding its scope, the National Science Foundation initiated efforts to broaden participation in LTER research. The purpose of these efforts included a desire to involve additional investigators at satellite research sites, an interest in attracting scientists working at landscape and regional scales, and a need to apply results from LTER research to the solution of societal problems. Trial efforts to expand the studies conducted at individual sites were implemented at the Coveeta and North Temperate Lake sites by inviting the participation of social scientists and by expanding the geographical scale of the research. More recently, this trend has been carried further by the inclusion of the two new urban sites in the LTER Network.

Description of program and objectives

The U.S. LTER Network comprises sites chosen competitively on the basis of research excellence, quality and duration of existing data sets, and strength of the commitment to long-term research and site security. The 21 sites that constitute the network at present represent a wide variety of research emphases and approaches. Over 1000 scientists and students are involved in long-term research projects throughout the network of sites. As part of their commitment to the LTER program, each site conducts a series of measurements and experiments directed towards the understanding of the five core areas as well as studies addressing ecological issues specific to the site. The most common scientific approaches include observation, experimentation, comparative analysis, retrospective study, and modeling, although emphases differ among sites.

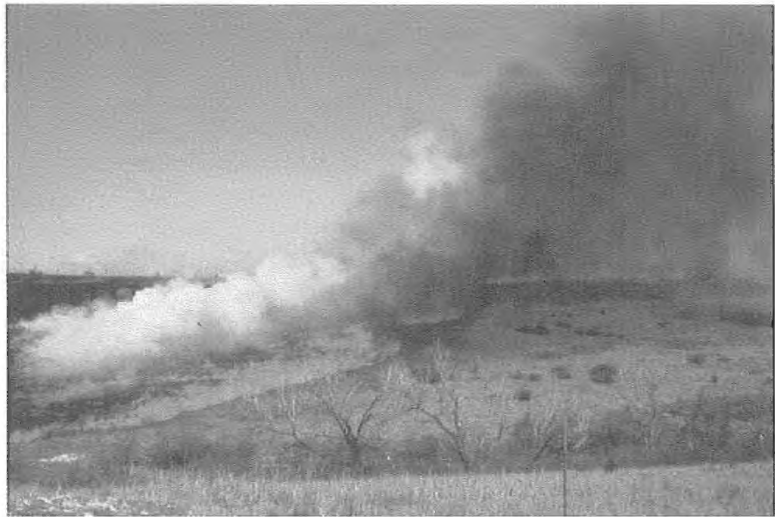
The mission of the LTER Network as it is now understood is to conduct and nurture ecological research by:

- ♦ Understanding general ecological phenomena that occur over longer temporal and spatial scales;
- ♦ Creating a legacy of well-designed and documented long-term experiments and observations for the

use of future generations;

- ♦ Conducting major synthetic and theoretical efforts; and
- ♦ Providing information for the identification and solution of societal problems.

The LTER Network comprises a broad array of ecosystems ranging from tropical rain forest in Puerto Rico to polar desert oases at McMurdo Station, Antarctica (see table). Collectively, the sites in the LTER Network provide opportunities to contrast marine, coastal, and continental regions, the full range of climatic gradients existing in North America, and aquatic and terrestrial habitats in a range of ecosystem types. All sites are sufficiently large to incorporate moderate to large landscape mosaics, and most sites include human-manipulated as well as natural ecosystems. The majority of sites embody considerable within-site variability in habitats and ecosystem processes and attempt to characterize this variability in the context of broad regional gradients covering hundreds of kilometers.



Prescribed fires at the Konza tallgrass prairie LTER site, a fire-derived and fire-maintained ecosystem (Photo: Alan Knapp).

Information Management

The development of comparable data sets within the LTER Network has been facilitated by an active group of information management professionals representing the sites. Approaches have ranged from standardization of equipment and methodology for commonly collected data (such as climate measurements) to efforts to develop tools to access and analyze jointly data sets existing in a distributed environment. The LTER Network Information System (NIS) sets standards in information management sufficient to achieve network-wide data integration. The goal of the NIS is to facilitate seamless data exchange and synthesis within the LTER Network and to make data collected at LTER sites available to scientists worldwide. This goal is accomplished through the use of the latest advance in World Wide Web database interfaces, which provide access to network-wide data sets through a single point of entry.

The development of several interactive database prototypes demonstrates the capabilities of the Network Information System. These prototypes include network-wide databases containing information on climate, personnel, publications, and site characteristics as well as a catalogue of data being collected at LTER sites. Development of these prototypes will facilitate the interoperability of site databases and provide techniques to extend the information system as future data modules and sites are added. In addition, information management staff from the LTER Network Office is actively cooperating with several national agency/interagency efforts to assure interoperability between the LTER Network and the greater scientific community.

Cross-site Initiatives

In 1994, NSF announced a special competition for cross-site comparisons and synthesis at LTER

and non-LTER sites in response to the 10-year review of the LTER Program. Nine awards ranging from \$109,353 to \$200,000 were given for comparative research within the U.S. LTER Network, between LTER and non-LTER sites in the U.S., and with sites in Ireland, Scotland, Costa Rica, Argentina and Russia. In 1995, a second special competition for cross-site comparisons and synthesis was conducted, with thirteen awards ranging from \$150,000 to \$200,000 given. These competitions have stimulated cross-site interactions both within the LTER Network and between the Network and other sites. At present, eleven different cross-site studies, ranging from a study of the relationship between net primary productivity and biodiversity to the development of standard soil methodologies for use at LTER sites, have involved the majority of sites in the Network. In addition, each individual site has developed its own collaborative studies with other research programs within and outside of the LTER Network.

Management of the Network

The U.S. LTER Network is lead by a Coordinating Committee comprising representatives of all 21 sites. This group meets twice a year to plan LTER activities under the guidance of a chairman (presently Dr. James R. Gosz), who is selected by a vote of the Coordinating Committee. The Executive Committee, with six members selected by the Coordinating Committee, meets four times a year and is empowered to act on behalf of the LTER Network in routine matters. Representatives of the National Science Foundation are invited to these meetings to discuss LTER program development and direction.

Seven standing committees help to coordinate specific LTER activities: collection and synthesis of climate data, education, publications, information management, graduate student participation, research synthesis, and technology development. The members of these committees are drawn from the LTER



Log decomposition study at H.J. Andrews LTER site in Oregon. The 200-year-long study is now a hub for wood decomposition studies in both the US and abroad (Photo: Jerry Franklin).

community at large. The activities of the standing committees include the development of network-wide policies and initiatives, preparation of proposals for funding to support these initiatives, and interactions with private and public institutions as well as other segments of the U.S. scientific community.

In 1983, NSF established the LTER Network Office at Oregon State University under the direction of the LTER Coordinating Committee Chair and the LTER Coordinating and Executive Committees. The goals of the Network Office are:

- ♦ to facilitate communication among the LTER sites and between the LTER Program and other scientific communities
- ♦ to support the planning and conduct of collaborative research efforts, including provision of some technical support services

- ♦ to facilitate intersite scientific activities
- ♦ to provide a focal point and collective representation of the LTER Network in its external relationships
- ♦ to develop linkages with other relevant long-term research programs, site networks, and science and technology centers.

In 1989, the coordination grant was moved to the University of Washington, in the College of Forest Resources. In 1996, NSF announced an open competition for the LTER Network Office cooperative agreement. The University of New Mexico was awarded the cooperative agreement, and the Network Office moved there in 1997. Current staff includes an Executive Director, two Associate Directors for Information Management and Technology Development, and specialists in the fields of publishing, network management, computer programming, and office management. Responsibilities of the Network Office include facilitating cross site research synthesis, coordinating the acquisition of satellite imagery for all sites, developing and maintaining network-wide databases, preparing publications describing site and network accomplishments, maintaining the LTER site on the World Wide Web, organizing All-Scientists, Coordinating Committee, and Executive Committee meetings, and leading in the development of the International LTER program.

Application of LTER Research

Education

A primary goal of the LTER Network is to provide a wide range of educational opportunities for students at participating institutions. Many undergraduate and graduate students are supported directly from LTER awards each year and others use LTER facilities and equipment in support of their research programs. Most LTER sites participate in NSF's Research Experience for Undergraduates program, which provides opportunities for students at both LTER and non-LTER institutions to work with LTER scientists. In addition, the LTER Network, through its association with other networks worldwide, provides opportunities for the international interchange of students and faculty. Prime examples of this kind of opportunity are the interchanges of students from Asian and U.S LTER sites organized in 1997 and 1998.

The Committee on Education has initiated an intensive effort to integrate science and education using the LTER Network. The goals of the School LTER Program include K-12 teacher enhancement programs at LTER sites, development of data collection and experimentation sites on or near school grounds, development of educational materials for experiential learning, facilitation of the use of the Internet to input and share data at schools, and development of funding for participation of students and educators in LTER programs.

Research

The LTER program has demonstrated high scientific productivity during the 18 years of its existence (Risser 1993). Specific examples of exemplary early findings are described by Franklin et al. (1990). A complete bibliography of LTER research publications is available at <http://www.lternet.edu>. The LTER Network has initiated publication of two series of books, one synthesizing research results at individual sites and the other describing cross-site comparisons of ecological processes.

The LTER Network has made important contributions to the application of ecological research to the resolution of important societal problems. For example, research on forest and stream ecosystems at three LTER sites – H.J. Andrews Experimental Forest in Oregon, Hubbard Brook Experimental Forest in New Hampshire, and Coweeta Hydrologic Laboratory in North Carolina – has been used extensively in the formulation of emerging forest research management policies in the United States (Franklin 1992). Experiments conducted at the Cedar Creek Natural History Area have contributed

to a better understanding of the importance of biodiversity in maintaining ecosystem processes. The availability of long-term records of rodent population dynamics at the Sevilleta National Wildlife Refuge allowed a rapid identification of the vector of hantavirus during a recent outbreak in the Southwest. Archived tissue specimens associated with the field records allowed a retrospective analysis of the distribution of virus in rodent populations. A predictive model associates viral outbreaks with specific weather conditions including El Niño-Southern Oscillation phenomena.

Partnerships

A strong relationship has developed between the LTER Program and the USDA Forest Service. Five LTER sites are located on land managed by the Forest Service, and several other sites benefit from cooperation with Forest Service units. The Forest Service contributes the use of facilities and the participation of scientists in research programs at many LTER sites. In addition, LTER programs on Forest Service land are the beneficiaries of funds allocated directly to cooperating USDA scientists. The LTER Network continues to develop interactions with associated programs such as NASA's Mission to Planet Earth. These interactions have included continued support for state-of-the-art instrumentation including sun photometer deployment and data processing for six LTER sites as well as acting as a contact point for LTER sites with NASA's associated "AERONET" program. Both of these projects have been integrated with planned LTER modeling activities. Interaction with the NASA Oak Ridge Distributed Active Archive Center has enhanced other LTER/NASA collaboration, in particular the LTER Information Management group.

The LTER program has benefited from studies of soil properties at several sites in cooperation with the Soil Conservation Service (SCS). Soil scientists associated with SCS have worked with LTER scientists to develop soil maps and descriptions at several LTER sites.

Personnel from the LTER Network Office are actively cooperating with several national agency/interagency efforts to assure interoperability between the LTER Network and the greater scientific community. Two important efforts this year were the advancement of the NBII metamaker project and the U.S. National Committee for CODATA.

Collaboration among Networks

Since the first exploratory discussions associated with the 1993 All Scientists' meeting in Colorado, efforts by U.S. LTER scientists have led to the adoption or consideration of the U.S. LTER network model in many other countries. Within the last 18 months, NSF funding has enabled U.S. scientists to visit countries where there is demonstrated interest in LTER and has facilitated the development of national (see chapters in this volume) and regional (North American, Latin American, East Asia/Pacific, Central European) networks.

As a result of the international meeting in 1993, an International LTER (ILTER) Network was formed with a mission to facilitate international cooperation among scientists engaged in long-term ecological research. The main objectives are to:

- ♦Promote and enhance understanding of long term ecological phenomena across national and regional boundaries;
- ♦Facilitate interaction among participating scientists across sites and disciplines;
- ♦Promote comparability of observations and experiments, the integration of research and monitoring and encourage data exchange;
- ♦Enhance training and education;
- ♦Contribute to the scientific basis for ecosystem management and improve predictive modeling at larger spatial and temporal scales.

Based on the recommendations of the summit's working groups, directives for the U.S. LTER participation in an International LTER (ILTER) program include the following:

- Assisting in the establishment of networks for long-term ecological research in other countries;
- Creating programs and scientist exchanges between U.S. and foreign LTER sites and networks;
- Developing and operating a communication and data sharing system among an international network of sites.

The U.S. LTER Network Office has played an important role in the development and activities of the ILTER Network. From the 1993 International Summit to the present, the Network Office has provided the catalytic efforts to encourage the development of long term research in developed and developing countries, the stimulus to focus on research-intensive (research platform) sites as a fundamental way to address interdisciplinary and integrative needs to understand complex systems, and the training/leadership required for electronic communication, networking activities and information management. The maturation of the ILTER Network has expanded and progressed to the stage where it is now important for the broader LTER and environmental science community to become actively engaged in developing research efforts that promote scientist to scientist, site to site, and network to network interactions. The Network Office remains the primary mechanism to stimulate these follow-up activities.

Among the primary strengths of the U.S. LTER Network are the quality and diversity of the research done at its individual sites. The 21 sites that make up the Network represent an enormous range of biological diversity and institutional affiliations.

Site Characteristics

H.J. Andrews Experimental Forest, Oregon

Institutional affiliations: Oregon State University; USDA Forest Service, Pacific Northwest Research Station.

Principal biome/main communities: Temperate coniferous forest. Douglas-fir/western hemlock/western red cedar; true fir and mountain hemlock; streams.

Research topics: Successional changes in ecosystems; forest-stream interactions; population dynamics of forest stands; patterns and rates of decomposition; disturbance regimes in forest landscapes; carbon sequestration; disturbance impacts on hydrologic response.

Arctic Tundra, Alaska

Institutional affiliations: The Ecosystem Center, Marine Biological Laboratory; Universities of Alaska, Massachusetts, Minnesota, Cincinnati, and Kansas; Clarkson University.

Principal biome/main communities: Arctic tundra, lakes, streams. Tussock tundra; heath tundra; riverine willows; oligotrophic lakes; headwater streams.

Research topics: Movement of nutrients from land to stream to lake; changes due to

Measuring
ground-
water at
Coweeta
LTER site
in North
Carolina
(Photo:
Brian
Kloeppel).



anthropogenic influences; controls of ecological processes by nutrients and by predation.

Baltimore Ecosystem Study, Maryland

Institutional Affiliations: Institute of Ecosystem Studies; USDA Forest Service; Johns Hopkins University; University of Maryland, Baltimore County and College Park; University of North Carolina; Parks & People Foundation; US Geological Survey; Yale University.

Principal biome/main communities: Eastern deciduous forest biome/suburban-agricultural fringe, urban parks, residential and commercial patches, riparian and stream habitats.

Research topics: Patch dynamics of built, social, biological, and hydrological components of the metropolitan area; feedbacks between social, economic, and ecological components of an urban ecosystem; effect of infrastructure and development on fluxes of nutrients, energy, and water in upland, stream, and coastal regions of metropolitan Baltimore.

Bonanza Creek Experimental Forest, Fairbanks, Alaska

Institutional affiliations: University of Alaska; Institute of Northern Forestry, USDA Forest Service, Pacific Northwest Research Station.

Principal biome/main communities: Taiga. Areas of boreal forest including permafrost-free uplands and permafrost-dominated north slopes and lowlands; floodplain seres.

Research topics: Successional processes associated with wildfire and floodplains; facilitative and competitive interactions among plant species throughout succession; plant-mediated changes in resource and energy availability for decomposers; herbivorous control of plant species composition; hydrologic regime and stream ecology.

Cedar Creek Natural History Area, Minnesota

Institutional affiliations: University of Minnesota.

Principal biome/main communities: Eastern deciduous forest and tallgrass prairie. Old fields; oak savanna and forest, conifer bog; lakes; pine forest; wetland marsh and carr.

Research topics: Successional dynamics; primary productivity and disturbance patterns; nutrient budgets and cycles; climatic variation and the wetland/upland boundary; plant-herbivore dynamics; fire.

Central Arizona-Phoenix, Arizona

Institutional affiliations: Arizona State University; Maricopa Community Colleges.

Principal biome/main communities: Sonoran Desertscrub. Urban parks, residential, interior remnant desert patches, commercial/industrial urban fringe, regulated river and floodplain (dry), canals; effluent-dominated river.

Research topics: Interactions of ecological and socioeconomic systems in an urban environment; influence of pattern of development (land use change) on ecological pattern and process; movement of nutrients through highly manipulated, urban flowpaths; interactions of introduced and native species in urban environment; millenium- and century-scale geomorphic change in landforms and interaction with engineering works.

Coweeta Hydrologic Laboratory, Otto, North Carolina

Institutional affiliations: University of Georgia; USDA Forest Service, Southeastern Forest Experiment Station; Virginia Polytechnic Institute and State University; Duke University, University of Minnesota, Mars Hill College; University of Wisconsin-Madison; and Portland State University.

Principal biome/main communities: Eastern deciduous forest. Hardwood forests and white pine plantations.

Research topics: Long-term dynamics of forest ecosystems including forest disturbance and stress along an environmental gradient; stream ecosystems along an environmental gradient; and the riparian zone as a regulator of terrestrial-aquatic linkages; the cumulative effects of land-use practices on water quality; interdisciplinary, inter-institutional implementation of ecosystem management on national

forests; interrelationships of forest litter on stream productivity, decomposition, and trophic levels; impacts of atmospheric deposition on forest ecosystems; physiological studies of forest carbon balance and competition; and biodiversity. All of the above within a context of past and current land use patterns in the southern Appalachian region.

Harvard Forest, Massachusetts

Institutional affiliations: Harvard University; Universities of New Hampshire and Massachusetts; The Ecosystem Center, Marine Biological Laboratory.

Principal biome/main communities: Eastern deciduous forest. Hardwood-white-pine-hemlock forest; spruce swamp forest; conifer plantations.

Research topics: Long-term climate change, disturbance history and vegetation dynamics; comparison of community, population, and plant architectural responses to human and natural disturbance; forest-atmosphere trace gas fluxes; organic matter accumulation, decomposition and mineralization; element cycling, fine root dynamics and forest microbiology.

Hubbard Brook Experimental Forest, New Hampshire

Institutional affiliations: Yale, Cornell, and Syracuse Universities; Institute of Ecosystem Studies; USDA Forest Service, Northeastern Forest Experiment Station.

Principal biome/main communities: Eastern deciduous forest. Northern hardwood forests in various developmental stages, spruce-fir forests; streams and lakes.

Research topics: Vegetation structure and production; dynamics of detritus in terrestrial and aquatic ecosystems; atmosphere-terrestrial-aquatic ecosystem linkages; heterotroph population dynamics; effects of human activities on ecosystems.

Jornada Experimental Range, New Mexico

Institutional affiliations: Duke University, NC; New Mexico State University; USDA ARS Jornada Experimental Range; NOAA, Research Triangle Park, NC; University of New Mexico; Dartmouth College, NH; SUNY Buffalo, NY; University of Leicester, UK; Kings College, London, UK;

Principal biome/main communities: Hot desert. Playa, piedmont, and swale; bajada, basin, mountain and swale shrubland; mesquite dunes.

Research topics: Desertification; factors affecting primary production; animal-induced soil disturbances; direct and indirect consumer effects; vertebrate and invertebrate population dynamics; grazing effects on ecosystem structure and function; biodiversity and ecosystem function; small mammal effects on soil and vegetation heterogeneity; soil microbial processes; surface hydrology; trace gas emissions from soils; eolian processes

W.K. Kellogg Biological Station, Hickory Corners, Michigan

Institutional affiliations: Michigan State University, Michigan Agricultural Experiment Station

Principal biome/main communities: Row-crop agriculture. Conventional and organic-based corn-soybean-wheat cultivation; perennial biomass cultivation; native successional communities; old-growth forest; wetlands, and stream-watershed interface.

Research topics: Ecological interactions underlying the productivity and environmental impact of production-level cropping systems; patterns, causes, and consequences of microbial, plant, and insect diversity in agricultural landscapes; gene transfer, community dynamics, biogeochemical fluxes; land/water/atmosphere interactions; human social dimensions of row-crop agriculture and its management.

Konza Prairie Research Natural Area, Manhattan, Kansas

Institutional affiliations: Kansas State University.

Principal biome/main communities: Tallgrass prairie. Tallgrass prairie; gallery forest; prairie stream.

Research topics: Effects of fire, grazing and climatic variability on ecological patterns and processes in tallgrass prairie ecosystems, use of remotely sensed data and geographic information systems to evaluate

grassland structure and dynamics.

Luquillo Experimental Forest, Puerto Rico

Institutional affiliations: Institute for Tropical Ecosystem Studies, University of Puerto Rico; International Institute of Tropical Forestry, USDA Forest Service.

Principal biome/main communities: Tropical rainforest. Tabonuco forest; palo Colorado forest; palm brake; dwarf forest and montane streams.

Research topics: Patterns of and ecosystem response to different patterns of disturbance; land-stream interactions; effect of management on ecosystem properties; integration of ecosystem models and geographic information systems

McMurdo Dry Valleys, Antarctica

Institutional affiliations: Desert Research Institute, Reno, Nevada; U.S. Geological Survey, Boulder, Colorado.

Principal biome/main communities: Polar desert oases.

Research topics: Microbial ecosystem dynamics in arid soils, ephemeral streams, and closed basin lakes; resource and environmental controls on terrestrial, stream and lake ecosystems; material transport between aquatic and terrestrial ecosystems; ecosystem response to greater hydrologic flux driven by warming climate.

Niwot Ridge-Green Lakes Valley, Colorado

Institutional affiliations: National Center for Atmospheric Research, Denver University, University of Colorado at Denver, Institute of Arctic and Alpine Research, University of Colorado.

Principal biome/main communities: Alpine tundra and subalpine forest interface. Fellfield; meadow; herbaceous and shrub tundras; cliffs and talus; glacial lakes; streams and wetlands.

Research topics: Causes and consequences of biotic diversity. Patterns and controls of nutrient cycling; trace gas dynamics, plant primary productivity and species composition; geomorphology, and paleoecology.

North Temperate Lakes, Wisconsin

Institutional affiliations: Center for Limnology, University of Wisconsin-Madison, Wisconsin.

Principal biome/main communities: North temperate lakes in glacial landscapes; watersheds are urban and agricultural at Madison and forested at Trout Lake. Oligotrophic, dystrophic and eutrophic lakes and connected streams and wetlands.

Research topics: Dynamics of lakes in a landscape and regional context; physical, chemical and biological limnology, hydrology and geochemistry; producer and consumer ecology; ecology of invasions; ecosystem variability; climate forcing; social sciences.

Palmer Station, Antarctica

Institutional affiliations: University of California at Santa Barbara; University of California at San Diego; University of Hawaii; Montana State University; Old Dominion University

Principal biome/main communities: Polar marine. Coastal and open ocean pelagic communities; seabird nesting areas.

Research topics: Marine ecology of the Southern Ocean focused within the Western Antarctic Peninsula area, including: physical forcing (atmospheric, oceanic and sea ice) of the ecosystem with emphasis on the ecological consequences of sea-ice variability; biological processes with emphasis on microbial, primary production and the life-history parameters of secondary producers (krill) and apex predators (penguins); physical/optical/chemical/biological modeling that links ecosystem processes to environmental variables.

Plum Island Sound, Massachusetts

Institutional affiliations: Woods Hole

Principal biome/main communities: Coastal estuary

Research topics: Linkages between land and coastal waters involving organic carbon and organic nitrogen

inputs to estuarine ecosystems from watersheds with various land covers and uses.

Sevilleta National Wildlife Refuge, New Mexico

Institutional affiliations: University of New Mexico; U.S. Fish and Wildlife Service.

Principal biome/main communities: Multiple-intersection of montane mixed-conifer forest/meadow, riparian Rio Grande cottonwood forest, interior chaparral, Great Plains grasslands, Colorado Plateau shrub-steppe, Chihuahuan Desert, juniper savanna, pinyon-juniper woodlands.

Research topics: Landscape and organism population dynamics in a biome tension zone; semiarid watershed ecology; climate change; biospheric/atmospheric interactions; paleobotany/archaeology; microbial role in gas flux; and control of landscape heterogeneity; scale effects on spatial and temporal variability

Shortgrass Steppe, Colorado

Institutional affiliations: Colorado State University; USDA Forest Service; USDA Agricultural Research Service.

Principal biome/main communities: Shortgrass steppe; upland steppe; floodplain; shrubland; saltmeadow.

Research topics: Soil water; above- and belowground net primary production; plant population and community dynamics; prairie dog and other small mammal biology; effects of livestock grazing; soil organic matter accumulation and losses, soil nutrient dynamics; trace gas fluxes; interactions of land use and mesoscale climate; ecosystem recovery from cultivation.

Virginia Coast Reserve, Virginia

Institutional affiliations: University of Virginia.

Principal biome/main communities: Coastal barrier islands. Sandy intertidal; open beach; shrubthicket; mature pine forest; salt marsh; estuary.

Research topics: Holocene barrier island geology; salt marsh ecology, geology, and hydrology; ecology/evolution of insular vertebrates; primary/secondary succession; life form modeling of succession.

A community garden
in an abandoned lot
in Baltimore,
Maryland (USA).
Researchers at the
Baltimore Ecosystem
Study Urban LTER
will inform residents
of the research
processes and results
(Photo: J. Morgan
Grove)





The IELD Network

The participation of Uruguay in the ILTER Program is recent. A first planning meeting was held at Montevideo in December 1997, during which a broad panel of researchers from different institutions discussed the implementation of the Uruguayan component of ILTER. Two working groups were established: the Information Management Group and the Research Group, both composed of representatives of different institutions involved in long-term ecological research. This report summarizes the results of the discussion and the status of the program, including the description of the proposed sites.

Description of program, objectives, and core areas

The IELDU (Investigaciones Ecológicas de Larga Duración - Uruguay) has advanced in the planning process through the definition of the general objectives and core areas.

The core areas for research across sites are:

- ♦ Pattern and control of primary production;
- ♦ Spatial and temporal distribution of populations selected to represent trophic structure;
- ♦ Pattern and control of organic matter accumulation in surface layers and sediments;
- ♦ Patterns of inorganic inputs and movements of nutrients through soils, groundwater and surface waters;
- ♦ Patterns and frequency of site disturbance; and
- ♦ Biodiversity

The criteria for site selection were :

- ♦ biome representation
- ♦ inter-institutional relationships
- ♦ ecosystem services
- ♦ ecosystem monitoring value

Additionally, the existence of protected areas, the possibility to include coastal areas, and the presence of research teams were also considered.

Site Characteristics

Organization: The IELD Program in Uruguay has defined provisionally a system of contiguous sites (Coastal Lagoon System), covering the coastal lagoons and associated coastal area and islands. As a multi-institutional initiative, each individual site is regulated by a different institution, leaving the general coordination to the IELD Program.

Principal contact/Institution: Dr. Carlos M. Martínez, Marine and Atmospheric Sciences Program, Faculty of Sciences, University of the Republic. E-mail: cmml@heavy.fisica.edu.uy.

Latitude, longitude, elevation, size: 33°30'-35° S and 53°28'-54°52' W; 10-200m, approximately 400000 ha

General description/ principal biome and main communities: Oceanic coast and islands, Sand dunes, Coastal Lagoons, Wetlands, Thorn shrubs, Coastal forest, Hilly forest, Flooding forest, Ombú forest,

Deciduous forest, Grassland, Palm brake, Plantation (forestry and rice), Range management.

Legal situation: Biosphere Reserve "Bañados del Este"; including Lagoons National Park, Potrerillo Biological Station, Reserve and Protected Areas of San Miguel and Santa Teresa, Islas Costeras National Park, Natural Monument of Dunas and Atlantic Coast, Cabo Polonio and Aguas Dulces Forest Reserves, Fauna Refuge of Laguna de Castillos.

Research topics: definition of ecosystems with value for ecological monitoring; land-stream interactions; long-term monitoring of main ecosystems; biodiversity and ecosystem function; patterns of land cover changes; bird migration monitoring; lagoon biogeochemistry; long-term monitoring of interface natural-productive systems; forest hydrology and management; distribution of animal populations.

History of site/type of data: Ombú forest dynamics; other natural forests, litterfall production, entomological fauna, fungi; forestry systems, mycorrhizal associations; forestry management; fauna monitoring; sea lion population dynamics (Ministry of Livestock, Agriculture and Fisheries, since 1942 and Faculty of Sciences); fish population dynamics and fishing management (National Institute of Fisheries - PROBIDES, 1985); vegetation composition (Botanical Garden of Montevideo, 1986); primary production in coastal lagoons (Faculty of Sciences, 1988); organic pollution in Laguna de Rocha (Faculty of Sciences, 1991); productivity of flooded forests (Faculty of Sciences, 1992); maps of geology, geomorphology, soils, vegetation, aerial photography (PROBIDES, 1993); structure and function of coastal forest, vegetation cover changes, above and below-ground biomass, nutrient cycling (Faculty of Sciences - PROBIDES, 1997).

Infrastructure:

PROBIDES Regional Station (2 laboratories, accommodations, computer facilities); Puerto de los Botes Station, (Faculty of Sciences) 1 laboratory, sampling equipment to measure limnological variables.

Inter-institutional relationships:

PROBIDES, University of the Republic, Governmental Environmental Secretary, National Institute of Fisheries, MAB-UNESCO Program, Municipal GovernmentS; Ministry of Livestock, Agriculture and Fisheries, Botanical Garden of Montevideo, Ministry of Transport and Public Works.

Uruguay LTER

- A. Wetlands
- B. Laguna Negra
- C. Laguna de Castillos



Proposed sites

1) *Site name/location:* José Ignacio, Garzón and Rocha Wetlands

Infrastructure: PROBIDES Regional Station (2 laboratories, accommodation, computer facilities); Puerto de los Botes Station, (Faculty of Sciences) 1 laboratory, sampling equipment to measure limnological variables.

2) *Site name/location:* Laguna Negra

Infrastructure: PROBIDES Regional Station, Biological Station of Potrerillo, San Miguel and Santa Teresa National Parks

3) *Site name/location:* Laguna de Castillos

Infrastructure: Laguna de Castillos Natural Refuge, Forestry Reserve, and two Base Stations (Ministry of Livestock, Agriculture and Fisheries).

Information Management

A Working Group on Information Management and Interconnectivity is in charge of the communications between research teams, the preparation of databases and the technical assistance. Two WWW mirror sites are under operation (<http://glaucus1.fcien.edu.uy/pcmmya/ieldu> and <http://www.fisica.edu.uy/pcmmya/ieldu>).

Cross-site Research

The proposed sites are establishing common research plans for some specific objectives. Including vegetation cover change, biogeochemistry and ecosystem response to climatic fluctuations, including climate change.

Network Management

The Steering Committee of the IELDU Program is located at the Faculty of Sciences. The addresses for each Working Group are: Comité IELDU - Research Working Group, Contact: Alice Altesor, Unidad de Ecología Funcional, Facultad de Ciencias, Iguá S/N, Montevideo, Uruguay. E-mail: aaltesor@genetica.edu.uy Fax: (+5982) 5258617, Comité IELDU - Information Management Group Contact: Carlos M. Martínez, Programa de Ciencias del Mar y de la Atmósfera, Facultad de Ciencias, Iguá S/N, Montevideo, Uruguay. E-mail: cmml@heavy.fisica.edu.uy Fax: (+5982) 5258617

Application of LTER Research

The IELDU Program objectives are devoted to the establishment of the scientific basis for Natural Resources Management. From this, the structure of the initiative prioritizes the interinstitutional work, in order to integrate the work of scientists, technicians and decisions makers. A second important application is to promote and develop educational activities at different levels, particularly the Masters Degree Program in Environmental Sciences of the Faculty of Sciences.

Partnerships

To date, several institutions participate in the planning process: Faculty of Sciences, through different laboratories; Secretary of Environment; PROBIDES; National Institute of Fisheries; MAB-UNESCO Program; Municipal Governments; Ministry of Livestock, Agriculture and Fisheries; Botanical Garden of Montevideo; Ministry of Transport and Public Works; and Antarctic Institute of Uruguay.

As the initiative is in progress, it is expected that other institutions and research teams will be considered in the near future.

Collaboration among networks

A special collaborative effort with the Latin-American and the established research networks related with Global Change and ecological research ILTER network will be developed. In particular, inter-site research between Brazil and Uruguay is under consideration.



The Venezuelan Long Term Ecological Research Network

Wilfredo Franco

Chair of the Venezuelan LTER Network Coordinating Committee

Venezuela is a South American country of nearly one million square kilometers and a population of 22 million people. The country is divided in three quite different regions: a) the coastal and mountain region, which comprises one third of the surface but supports 90 percent of the population; b) the flat alluvial region of the Orinoco Llanos, which comprises about 20 percent of the country; and c) the Guayana-Amazonas region, which is the southern half of the country and is still very sparsely populated. This territorial and economical distribution determines a wide demand for long-term ecological research, which varies from the study of the environmental impact of the industrial and urban development in the North to the inventory of the still quite unknown biological diversity in the southern half of the country.

The Venezuelan government, through the National Council for Scientific and Technological Research (CONICIT) and encouraged by the success of the US LTER Network, decided in 1996 to establish and support the Venezuelan Long Term Ecological Research (LTER) Network in cooperation with scientific institutions throughout the country.

In December 1996, CONICIT created the Commission for the LTER Network, which carried on a review process of 14 potential sites, of which nine were selected using the following criteria:

- Scientific background and commitment to long-term ecological research and cooperation
- Existing capabilities in facilities and personal
- Biogeographical setting
- Current and potential long-term ecological research

The Venezuelan LTER Network was established 29 September 1997, in a special program celebrated at the Venezuelan Botanical Garden in Caracas. Present were: Dr. Walter Jaffe and Dr. Claudio Bifano, CONICIT authorities; Dr. James Gosz, chairman of the Coordinating Committee of the International Long Term Ecological Research Network; Dr. Robert Waide, executive director of the US-LTER Network Office; and Dr. Wilfredo Franco, coordinator of the Venezuelan LTER Commission.

The representatives from each Venezuelan LTER Network site met at a workshop at CONICIT on 30 September to initiate their collaborative activities. A second workshop was conducted in March 1998 in Merida with the support of CONICIT, FUNDACITE-MERIDA (Regional Science Foundation) and the Universidad de Los Andes. It addressed important decisions regarding network organization, including proposals to develop a Network Office and a project for the strengthening of all the stations and their connectivity. The current Network organization has a Coordinating

Committee comprised of two scientists from each station and headed by a Chair, an Executive Committee comprised of the Chair and three Regional Coordinators, and an Advisory Council of independent scientists.

Program, Objectives, and Core Areas

At the current level of the network development, each station is carrying on its own research program. Efforts must be made to promote a common research program and to initiate interactions among stations. At the second national workshop in March 1998, the main objectives of the Network were defined as: 1) to study long-term ecological changes in some key biomes of the country; 2) to understand ecological processes in selected ecosystems; 3) to provide ecological information relevant to sustainable development; 4) to contribute to regional and global ecological monitoring initiatives. Similarly, the following common core areas were established: a) primary productivity and biogeochemical cycles; b) evaluation of biological diversity; c) population dynamics; d) Environmental impact of human activities; e) alternatives to improve productivity through ecosystem management; and f) global change.

The Venezuelan LTER Sites

Center for Highland Ecology (CETA)

This research center was established in 1989 by a non-government organization (NGO) and it is supported by the local government, the Regional Council for Research, and eight other organizations. It is located at El Cobre, at 2000 m altitude (8° 03' N; 72° 02' W) in the west part of the Venezuelan Andean mountain range in the State of Tachira. The research activities focus on the climate, soils, biodiversity and ecological features of the cloud montane forest, and other vegetation types of the region. Work is also done on the land-use pattern of the highlands and its environmental impact. The researchers collect data mainly on species composition, climate, soils, and on the results of experimentation in order to improve agricultural productivity.

Contact person: Dr. Norberto Rebolledo. E-mail: nrebolle@neblina.reacciun.ve Address : CETA, El Cobre-Estado Tachira, Venezuela. Telefax : (—58-77) 97069.

Bocono Center for Ecological Studies

This research center was created in 1980 by the University of Los Andes and by CONICIT. It is settled in the central part of the Venezuelan Andes in the state of Trujillo at 1500 m altitude (9° 15' N; 7° 15' W). Its main research program focuses on soil and water resources and land-use patterns of the Bocono river. The center, which belongs to the University of Los Andes and is supported by the local government, has as a main goal to contribute to the sustainable development of the Bocono river region. The researchers collect data mainly on hydrological parameters, climate, soil, vegetation and land use in the Bocono river region.

Contact person: Dr. George Bone. Centro de Ecologia Bocono. Bocono-Estado Trujillo, Venezuela. Fax : (—58) 72. 521142. Tel. 72.521531.

Caparo Experimental Station

This research station has been operated by the Faculty of Forest and Environmental Sciences of the University of Los Andes since 1970 in cooperation with the Ministry for Environment and Renewable Natural Resources (MARNR). It is located in the western Llanos of the Orinoco river in the state of Barinas at 100m altitude (7° 25' N; 71° 07' W). It is located in the Caparo forest reserve (170,000 ha) and the main research programs focus on the biodiversity and ecological features of the forest and on the development of suitable silvicultural practices. Additional studies are conducted on agroforestry research and forestry plantations. The reserve contains mainly a seasonal evergreen forest under long-term forest management for timber production, but it is under high social pressure caused by agricultural settlers. The station is used for research and teaching purposes. The researchers

collect data mainly on species composition, tree growth and phenology in natural forest and forestry plantation, plant-animal relationships, agroforestry experimentation, soil-water-plant relationships, remote sensing and others areas.

Contact person: Director INDEFOR, Forestal-ULA, Mérida-Venezuela. Telefax : (—58-74) 401580, Tel. (—58-74) 401581. E-mail : <indefor@forest.ula.ve>

La Iguana Agroecological Research Station

This station has been operated by the University Simon Rodriguez since 1979. It is located in the middle of the country on the seasonally dry central Llanos of the Orinoco river in the state of Guárico at 100m altitude 8° 25' N; 65° 25' W). The main research topics are ecology of the tropical grassland savanna and the improvement of its productivity for cattle ranching, and nutrition experimentation of bovine under dry savanna conditions.

Contact person: Ing. Pablo Herrera, Estacion La Iguana. Universidad Simon Rodriguez, Apdo. Postal 47-925. Caracas C.D. 1041-A. Venezuela.

Ing. Carlos Bravo, Sector La Represa, 3a. Transv. Edificio USR. Valle de la Pascua, Estado Guárico-Venezuela. C.P. 2307. Telefax : 035-416419

El Merey Center for Forestry Research

The eastern plains of the country on very poor grassland and sandy soils, the Venezuelan government and some private companies have established an extended *Pinus caribaea* plantation, which covers nearly 500,000 ha. This station aims to develop the necessary ecological and silvicultural background for both the conservation of the savanna and the riparian forest and the management of the forestry plantation. It is located in the State of Monagas at 50 m altitude (8° 35' N; 62° 50' W). It belongs to the government forestry company CVG-PROFORCA. The researchers collect data mainly on genetics, growth, phenology, pathology and silvicultural management of *Pinus caribaea* var. *hondurensis*. Similarly, they collect information about climate, soils and natural vegetation (savanna and riparian forest).

Contact person: Ing. Pedro Altuve<proforca@telcel.net.ve>. Telefax : (—58.87)91694, (—58.86)613403, 233971.

EDIMAR: Margarita's Marine Research Station— La Salle Foundation

This is a well-equipped research station, which carries on advanced oceanographic projects in cooperation with national, United States, and European institutions. The station is located on Margarita Island at sea level (10°54'N; 64°07'W) at the confluence of the Caribbean Sea and the Atlantic Ocean. The station belongs to the La Salle Foundation; an outstanding NGO dedicated to education and research. The main projects focus on fisheries resources evaluation, oceanography, marine biology, aquaculture and food-quality control. The station has an important museum dedicated to marine biology.

The station is the coordinator of the Cariaco project (NSF-CONICIT), which is interested in examining the budget of total CO₂ upwelled with deep, nutrient-rich water relative to annual export of organic carbon from surface waters. It has also par-



The tropical rain forest in the Amazonas state: Land use conflicts and biodiversity are two of the top priorities for research (Photo: Wilfredo Franco).

ticipated in the CARICOMP project (COMAR/UNESCO) since 1990, which attempts to determine the variations in the productivity of coastal marine ecosystems such as mangroves, sea-grass beds and coral reefs. The oceanography department has developed a data base (SIOCDE) that keeps the oceanographic and meteorological information obtained at the station since it was founded. For many years the Fisheries Department has collected data of artisanal fisheries not included in official statistics. The station has three vessels available for research: one small boat (10 m) a polyvalent ship (16 m) and an oceanographic research vessel (24.5 m).

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Parupa Scientific Station

Southeastern Venezuela, Canaima National Park and headwaters of the Caroní river.

Parupa Scientific Station, managed by Autoridad Gran Sabana of the Corporation of the Venezuelan Guayana (CVG), addresses research topics in coordination with local, national, and international institutions. Research projects are submitted to BioGuayana, a joint program between UNEG (a local university) and FUNDACITI-Guayana (a foundation that promotes science and technology within the Guayana region).

Research includes restoration ecology, atmosphere-biosphere interactions, fire ecology, community dynamics along environmental gradients, changes due to anthropogenic influences, disturbance regimes associated with fire events and indigenous uses of the Gran Sabana, effects of tourism on sensitive landscapes, reproductive biology, selection of autochthonous species for restoration in the Canaima National Park, biodiversity and species inventories for ecology and conservation, and alternative uses and sustainability for indigenous inhabitants.

This site is located in the headwaters of the Caroní River, 600 km south of Ciudad Guayana at the confluence of the Caroní and Orinoco river in one of the oldest and most impressive landscapes of the world. The region, known as "Gran Sabana," has an elevational range of 400 to 2,800 m. The equatorial climate produces a mean temperature of about 20°C near the station (5°40'30" N; 61°32'35" W), with

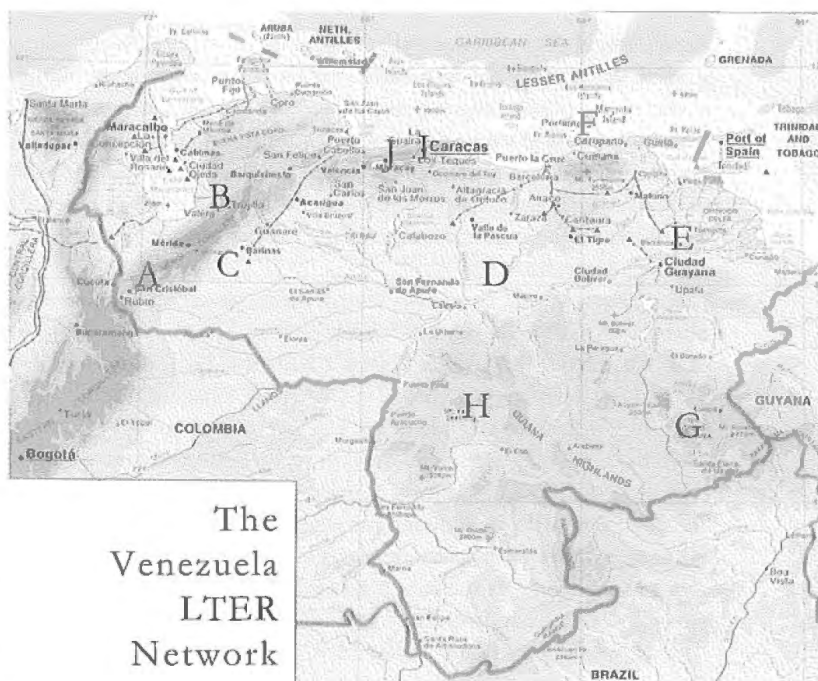
a year-round variation of 3°C. However, the elevation for the entire region range causes differences in temperature. Annual precipitation varies from 1,500 to 4,000 mm. There is a relatively dry period from January to March and a rainy period from May to November. The principal communities are treeless savannas with a mosaic of forest patches and gallery forest, montane forest, shrublands and broad leaved meadows. The magnificent table mountains (tepui) surround the area.

The mountainous tropical rain forest (between 800 and 1400 m altitude) below the tepuis has been partially transformed to savanna in the last thousand years by fire initiated by indigenous people for shifting cultivation, hunting, and other traditional activities. Therefore, the station's main program is devoted to study the biodiversity and the environmental impact of human activities. The station is near the road



Urban ecology in the capital city: Caracas, IBE-Arboretum Station (Photo: Carlos Uzcátegui).

- A. CETA
- B. Bocono
- C. Caparo
- D. La Iguana
- E. El Meroy
- F. EDIMAR
- G. Parupa
- H. Amazonas
- I. Arboretum
- (in Caracas)
- J. Rancho Grande



connecting Venezuela to Brasil (Puerto Ordaz-Boa Vista-Manaos) in the Amazonia. They collect data on human impact, climate, soils and vegetation. A good site description can be found in Berry

et. al 1995. *Flora of the Venezuelan Guayana*. Vol. I. Timber Press, Portland.

Contact person : Ing. Gabriel Picón <gpicon@canaima.uneg.edu.ve>. Address : CVG-Autoridad Gran Sabana. Estacion Cientifica Parupa. Centro Comercial Altavista, Torre A, Piso 8. Puerto Ordaz, Estado Bolivar-Venezuela. Fax : (—58.86) 612574, 661879, 226639.

Amazonas Experimental Station

This station is located in Puerto Ayacucho, the capital city of the Venezuelan Amazonas state at 200 m altitude (5°40' N; 67° 37' W). Its main research program pays special attention to three research topics: a) development of sustainable Amazonian agriculture; b) conservation and development of the biological diversity with agricultural potential; and c) biology and ecology of the fish biodiversity in the Orinoco and other major rivers of the region. Similarly, researchers at the station conduct studies of forest biodiversity (90 percent of the state is covered by various types of rain forest) and on the indigenous experience and technologies using the Amazonas biodiversity. The station belongs to the governmental Fund for Agricultural Research (FONAIAP). The station has one of the biggest collection of river fishes in the country.

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Arboretum— IBE Experimental Station

This station belongs to the Central University of Venezuela. It is an urban station located in Caracas and it is associated with the Experimental Biology Institute (IBE) where more than 50 researchers work on diverse areas of biology. An important part of the research is devoted to ecology and related areas, i.e., ecophysiology, evolution, taxonomy, reproductive biology and animal-plant interactions. Also, the behavior of different animals such as birds, ants and mosquitoes are studied.

Particularly, the structure and significance of mixed bird flocks visiting continuously monitored bird feeders is studied. We plan to develop models of the urban ecology of the city of Caracas. This secondary forest represents a relict of the original vegetation and fauna of the Caracas valley, and we are planning to compare its biodiversity with other areas at varying distances from this urban center. One of the main purposes of these studies is to understand how the vicinity of the urban activity disturbs the forest structure, and eventually to develop means of recovering the original structure and diversity of this and other similar forests. This experimental station is the oldest of the national web and is rapidly growing: well supported with long-term research and a well-developed infrastructure.

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"Dr. Alberto Fernandez-Yepes", Rancho Grande site

This research center was created in 1966 by the Faculty of Agronomy of the Universidad Central de Venezuela. It is located in Rancho Grande in the Henri Pittier national Park, at approximately 1100m above sea level (10° 21'08"N; 67°41'02"), in the middle of the road between Maracay and the town of Ocumare de la Costa, Aragua State (approximately 15km from Maracay). We define it as a research center for the study of the history, dynamics and evolution of the tropical mountains ecosystem and the factors that affect it. The main objective is to obtain the necessary information to enable us to teach environmental education to other people, thus preserving this area and its resources for future generations. For more than 30 years of continuous research activities, the biological station has produced a great number of information that has reflected in more than 300 publications. At this moment there are about 25 different projects ranging from inventory and monitoring of natural resources, waste management and monitoring of agriculture in protected areas. Furthermore, the biological station has the important roll of being a center for education on this type of ecosystem for more than 35 national and international institutions, as well as hosting various meetings on conservation and environmental education.

The Next Steps

The recently initiated Venezuelan LTER Network is now working on the following initiatives:

1. Reinforcement plan for each station: to improve the capabilities of the stations through the cooperation between CONICIT and the station holder institutions;
2. Connection program between the stations. All the stations should be interconnected via the Internet for access to information and data;
3. Creation of databases for each station, including a directory of researchers and projects;
4. Discussion of the concepts, structure and functioning of the LTER Network according to the needs of the country; and
5. Creation of the Network Office.

In June 1998, Venezuela hosted the 4th Latin American LTER Conference, with the objective of discussing the concepts, structure and function, of the national LTER networks in accordance with regional and country particularities. Additionally, the meeting initiated the development of a Latin American LTER Pilot Project. The meeting included extensive discussions of data management needs and resources in the region. This Conference was an integrated effort of CONICIT, the National Science Foundation and the US-LTER Network Office, the CNPq (Brazil), the Humboldt Institute for Biodiversity (Colombia) and other Latin-American Institutions.

Principal Contact of the Network

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