LTER

NETWORK NEWS

IN THIS ISSUE:

Newsletter of the Long-Term Ecological Research Network — *Spring/Summer 1992, Issue 11*

Synthesis in LTER

Synthesis is more than pulling things together: it is also the search for new generalization and new theory

Synthesis is a tradition in the ecological sciences. In LTER we have a greater opportunity to take a broader view than almost any other ecological research program. We have both the challenge and the facilities to cross traditional barriers to more holistic thinking and generalization. We can synthesize across ecosystems so disparate that, owing to differences in the schooling of their scholars, synthesis has been inhibited between forest and grassland ecology, limnetic and lotic aquatic ecology, and aquatic, freshwater, marine and terrestrial ecology. We can synthesize across a wide variety of streams or forests scattered across the continent and beyond. We can evaluate species in a population context, a community context, an ecosystem context, a landscape context, or all of these. The possibilities seem open-ended, and may be limited only by our creativity or resolve to take advantage of a unique opportunity. Synthesis is more than pulling things together: it is also the search for new generalization and new theory.

There are a number of scientific, social and administrative realities of the LTER Program that have created this opportunity. On the science side, we carry out synthesis on data from our own projects, we are asking similar questions in a wide variety of landscapes, we have similar sets of measurements in the same core areas, such as primary production, biogeochemistry, and fluctuations in populations. We have accessible data which, after due acknowledgement to individual scientists, is common property. On the social side, we routinely talk and walk and dine with ecologists different from ourselves; our association causes us to pay attention to a broader array of areas, topics and scientific ideas. On the administrative side, we have a network for communication and planning, a meaningful peer review system to maintain quality, and some common funding to apply new technologies.

At the winter 1992 Coordinating Committee meeting at Trout Lake, Wisconsin in a session we co-chaired, site representatives reviewed recent explorations in synthesis and considered future activities. We were interested in learning what features of LTER or our recent efforts have contributed to or detracted from synthesis, and what new ideas might emerge. Current synthesis efforts include work in the areas of:

- ***Process Studies.*** Synthesis across LTER projects includes the processes of decomposition, biogeochemistry of soils, and terrestrial net primary production.
- ***Climate Forcing.*** Climate change is a reasonable forcing function for testing the reality of

See Page 2

JERRY F. FRANKLIN

South shore of Trout Lake, near the University of Wisconsin's research station in north central Wisconsin. Location of the North Temperate Lakes LTER site.

Synthesis, from Page 1

any of our models; the computing time required for analyses of global circulation models at a spatial scale meaningful to ecologists suggests that LTER may need close ties to global circulation modeling groups, and may need to develop special projects to generate site-specific climate data.

■ ***Analyses of Temporal and Spatial Data.*** LTER's rich data sets allow us to be creative in developing new ideas and new questions from comparisons such as the use of variability to characterize ecosystems.

■ ***Scaling up to Continental and Global Levels.*** Large spatial data bases on climate and soils are being placed in geographic information systems (GIS) and combined with models to evaluate regional responses to climatic variation.

Examples were presented of models that run at continental and global scales. These process models of ecosystem productivity can be used to simulate primary production; they can be linked with GIS and their predictions checked against remote sensing of vegetation properties such as NDVI. They can be run at several different scales using vegetation type, soils, temperature, precipitation, and cloud data, and can predict how processes of present-day ecosystems will respond to global change. Models and GIS sufficient to synthesize our knowledge over regional and continental scales are already in place across the LTER Network.

Ideas for potential future activities emerged from working groups, including: the influence of animals on ecosystem processes using stable nitrogen isotopes, belowground processes and soil health, hydrological responses to climate variations such as El Niño, biological diversity of microbial communities in soils of terrestrial, freshwater and marine ecosystems, the relation between biological diversity and ecosystem processes in a gradient from desert to grasslands, and trend analysis of ice cover and physical limnology of northern hemisphere lakes.

Clearly we have made progress in synthesis in the LTER Program since former NSF Division of Biotic Systems and Resources Director John Brooks challenged us in 1988 to take advantage of our unique resources for synthesis. Research opportunities exist in the commonalties of the sites' common data, common processes, common forcing functions, common questions, common tools (approaches and methods), and common funding. These shared features could lead to some of the most uncommon advances to ecological science in the next decade. ■

STEPHANIE MARTIN

Elongated Schindler Patalis zooplankton sampler at Sparkling Lake, one of seven primary LTER lakes. ***From left:*** *John Hobbie (in cap), Tim Kratz/North Temperate Lakes (kneeling), and John Magnuson.*

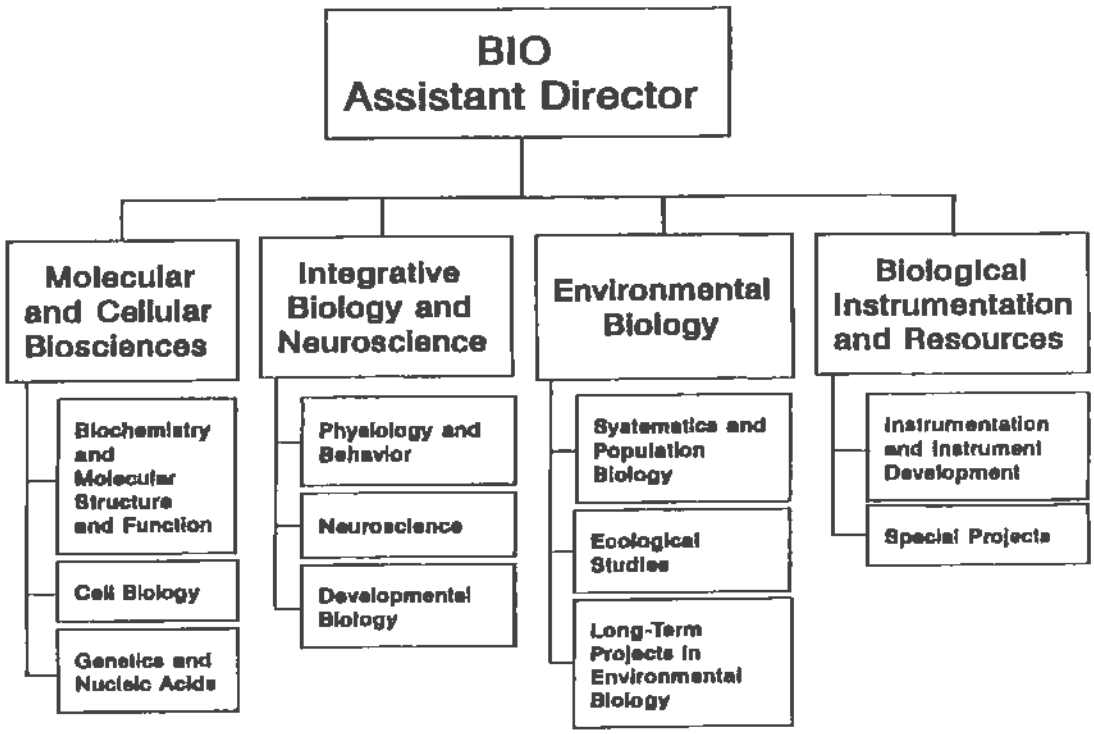
John E. Hobbie, *Arctic Tundra*
John J. Magnuson, *North Temperate Lakes*

LTER Research Coordinator Continues & Expands Activities

Dr. Caroline Bledsoe, LTER Network Research Coordinator, has changed her base of operations from the National Science Foundation (NSF) in Washington, D.C. to the University of California at Davis. She will continue to aid communication between NSF and the LTER Network by attending both individual and combined agency and LTER meetings, and by working with the LTER Network Office staff on Network-wide projects such as the upcoming 10-year evaluation of the LTER Program. She will continue to help develop linkages between the LTER Network and other research networks.

Dr. Bledsoe is also planning several specific projects for 1992: coordinating with other LTER researchers and data managers on developing an all-site bibliographic reference for LTER; talking with LTER researchers to generate suggestions for a pilot synthesis project; and helping to develop a pilot project across the sites to measure trace gas fluxes and CO_2. The trace gas activities will begin with a workshop, sponsored by the U.S. Man and the Biosphere Program and jointly planned for summer or early fall of 1992 with Arvin Mosier of the USDA Agricultural Research Service in Fort Collins, Colorado. ■

Caroline Bledsoe, Land, Air and Water Resources, University of California-Davis, 916-752-0388 (office), 752-4131 (lab), 916-752-1552 (fax), ***cbledsoe@lternet.washington.edu*** *or* ***csbledsoe@ucdavis.edu.***



NSF Reorganizes Biology Directorate

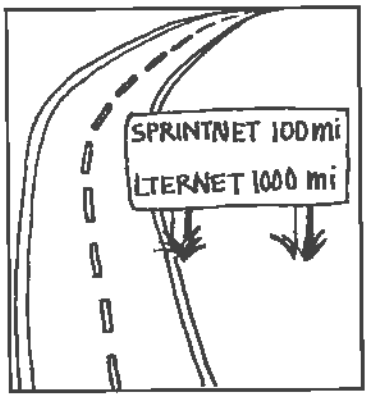
Following an action recommended by its "Task Force Looking to the 21st Century" in October 1991, the National Science Foundation (NSF) has reorganized the Directorate for Biological, Behavioral, and Social Sciences, under which the LTER Program was developed. Two separate directorates, Biological Sciences (BIO) and Social, Behavioral, and Economic Sciences (SBE), have been established. Following is a brief description of the restructuring of the divisions within the BIO Directorate, including the Division of Environmental Biology (DEB) which now contains the LTER Program (excerpted from the NSF *Bulletin, Vol. 19, No. 8*):

Biological Instrumentation and Resources (BIR) includes the Instrumentation and Instrument Development and Special Projects Programs for the former Division of Instrumentation and Resources. These two program names were unchanged. BIR funds most of the major infrastructure within the BIO Directorate.

Environmental Biology (DEB) includes Ecology, Systematic Biology, Population Biology, and Ecosystems Studies of the former Division of Biotic Systems and Resources. Three new program clusters were established: Systematic and Population Biology, Ecological Studies, and Long-Term Projects in Environmental Biology. DEB research advances scientific understanding of the factors governing the interrelationships of environmental biology from individual organisms to complex ecological systems.

Integrative Biology and Neuroscience (IBN) includes the developmental biology and physiological processes programs from the former Cellular Biosciences Division, the Neuroscience and Biological Basis of Behavior programs from the former Behavioral and Neural Sciences Division, and the Physiological Ecology program from the former Biotic Systems and Resources Division. Three new program clusters were established: Physiology and Behavior, Neuroscience, and Developmental Biology. IBN research emphasizes the integration of molecular, subcellular and cellular biology approaches to better understand the development, function and behavior of organisms in both laboratory and natural settings.

Molecular and Cellular Biosciences (MCB). Three new program clusters were established from the former programs of Molecular Biosciences and Cellular Biosciences Divisions: Biochemistry and Molecular Structure and Function, Cell Biology, and Genetics and Nucleic Acids. MCB funding increases fundamental understanding of the chemical, physical, genetic and cellular processes underlying biological phenomena. ■



ADRIENNE WHITENER

LTERnet Access On the Road

The Sprintnet Connection

The LTER Network Support System can be accessed in a variety of ways. Direct access through the national Internet is the most common; high-speed modems and the commercial Sprintnet (formerly Telenet) are other options. Electronic mail forwarding, mail groups (including electronic bulletin boards) and automatic mail replies provide further access.

In 1990, the LTER Connectivity Committee recommended installation at the Network Office of a multi-user computer with sufficient capacity to support user accounts for all LTER researchers, which would be accessible via the Internet, modem and commercial networks. Although Internet connections provide the highest speed and functionality, commercial network access through local phone connection has several advantages. For example, users who are away from their home machines frequently experience difficulty attempting routine tasks like answering electronic mail (e-mail) or reading bulletin boards. Connecting to LTERnet by dialing a local Sprintnet phone number eliminates connectivity and account availabilty problems. Local Sprintnet numbers exist in over 500 locations in the United States, and 150 abroad. Once connected with full Internet access, users may complete their work on the LTERnet computer or further link to more than 500,000 host computers worldwide.

Connecting to LTERnet via Sprintnet

- Obtain a computer account on LTERnet
- Determine your local Sprintnet phone number
- Use the modem and communications software (Procomm, Kermit, etc.) on your computer to dial the local Sprintnet number
- Enter LTERnet's identification number
- Enter your username and password

For further information, send any message to ***Sprint@LTERnet.Washington.edu.***

LTERnet Reaches Out - ESA Long-Term Study Section Added

LTERnet has extended its e-mail forwarding services to members of the Long-Term Study Section (LTSS) of the Ecological Society of America. Over 50 LTSS members have been added to the system, and the list is growing. An electronic-mail distribution group, LTSS, has also been established. For a list of LTSS group members, send any message to *Groups@LTERnet.Washington.edu.*

Searching the Personnel Database

The personnel directory at LTERnet (which now includes LTER, Land-Margin Ecosystem Research, Association of Ecosystem Research Centers, and LTSS personnel) can now be searched by e-mail using all or part of a listed person's name. The result of the search is returned to the requester by automatic e-mail reply. Search requests should be sent to:

PersDir@LTERnet.Washington.edu or
address@LTERnet.Washington.edu.

For information on how to use the search function, send any message to *PersDir@LTERnet.Washington.edu.* In addition, search functions for the on-line LTER Core Dataset Catalog and other information are presently being implemented. ■

For general assistance with LTERnet, send any message to ***Helper@LTERnet.Washington.edu****, or contact Rudolf Nottrott at the Network Office, 206-543-8492,* ***rNottrott@lternet.Washington.edu*** *(Internet) or* ***rNottrott@lternet*** *(Bitnet).*

LTER Data Management Survey Conducted

In January 1992 LTER data managers Rick Ingersoll (Niwot Ridge) and Scott Chapal (North Inlet Marsh) conducted a survey on the management of electronically collected data within the LTER Network. They summarized responses and offered recommendations for the improvement of data collection systems in a report now available from the Network Office. Responses showed that LTER sites rely heavily on such systems for the measurement of many variables, particularly climatological ones. Although variables and methodologies differ among individual sites, the problems they encounter (e.g., power losses, extreme temperature effects, faunal impacts, moisture/condensation effects, equipment/sensor deterioration) are often the same. Survey results suggested the following recommendations:

- Similar evaluations should be conducted annually.
- Interaction among investigators, data managers and technicians should be facilitated and encouraged at both intra- and intersite levels.
- *Standardized Meteorological Measurements for LTER Sites* (1987, LTER Publication No. 3) should be updated and modified using the results of the annual evaluation; an on-line version would be preferred.
- The LTER Network should provide regular feedback to manufacturers of electronic data collection hardware and software to ensure industry responsiveness.
- Network data managers should interact with their counterparts in other scientific organizations to provide a broader base for feedback, and to facilitate the exchange of ideas.

Electronic Discussion Lists

Nutrient Cycling List

An electronic discussion list for nutrient cycling issues has been set up by Dan Binkley (Colorado State University) and Phil Sollins (H.J. Andrews LTER) using the Listserv format (see below). At present the list is being operated as part of Ecolog-L, the distribution list set up by and for the Ecological Society of America (ESA). In future, it may be split off as a separate list, Nutcyc-L. LTER researchers are encouraged to subscribe to Ecolog-L and other Listserv lists, as are other potentially interested faculty, staff and students at the sites. Operating within Ecolog-L, Nutcyc-L is intended as a forum for the following: (1) methods questions, (2) jobs, meetings, RFPs, etc., (3) research opportunities, (4) requests for data for review papers or to test hypotheses, (5) discussion of ideas, problems, etc.

Subscribing & Unsubscribing

To subscribe to a list, simply send the message *SUB listname* to Listserv at the appropriate Listserv site (see below). Unsubscribe at any time by sending *SIGNOFF listname* to the same address. Please note that if your site or its Internet name has changed since you first subscribed, you may have difficulty unsubscribing.

Other Lists Relevant to LTER

Listname	Listserv Site
Ag-Forst (currently inactive)	irlearn.ucd.ie
Ecolog-L (discussion of ecological research issues; information on jobs, meetings, RFPs, etc.)	umdd.umd.edu
GIS-L (geographic information systems)	ubvm.cc.buffalo.edu
Micronet (root-fungus interations)	vm.uoguelph.ca
Nutcyc-L (nutrient cycling issues)	umdd.umd.edu
OTS-L (discussion and research news at Organization for Tropical Studies field stations; general tropical ecology information)	yalevm.ycc.yale.edu

There are several thousand distribution lists worldwide. Those listed above are particularly relevant to LTER. A complete "list of lists" may be obtained by sending ***List Global*** *to any Listserv site (e.g.,* ***listserv@ilearn.ucd.ie****), but the file that comes back is about 200K, which may be too large for your mail system. In this case, you may transfer a copy of the file, available in PUB/Listserv at Lternet via File Transfer Protocol (ftp), to your own computer.*

For more information and a list of current subscribers, send the message ***REVIEW listname*** *to Listserv at the appropriate Listserv site. Or contact Phil Sollins* ***sollins@fsl.orst.edu*** *or* ***sollins@lternet.Washington.edu****.*

Watershed Modeling Workshop

June 17-19, 1992

At a previous workshop, "Modeling Forest-Stream Interactions" (LTER All Scientists Meeting, September 1990, Estes Park, Colorado), participants discussed issues and research questions relating watershed characteristics (soils, slope, vegetation) to hillside and stream biogeochemistry, organic matter processing, and nutrient transport. Modeling the linkages among the interrelated factors clearly requires a quantitative understanding of watershed hydrology. Although several watershed hydrology models are available, few participants were familiar enough with their specific data requirements and application strengths to effectively choose among them for specific research applications.

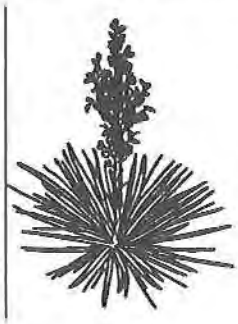
A more technical, hands-on workshop on watershed hydrology modeling is planned for June 17-19, 1992 in Denver, Colorado to review the successes of models which have been used at several study sites, enhance current research, and facilitate further intersite collaborations. Experts on the specific models which have particularly successful track records in ecological applications (PROSPER, PRMS, TOPMODEL) will provide instruction on model concepts, assumptions, data requirements, and hands-on testing. Model applications will be demonstrated using selected data sets and, if time permits, participants will prepare model data files from their own study sites for model applications during the workshop.

The Denver office of the U.S. Geological Survey (USGS) will provide expertise and facilities, and George Leavesley, project directory of the USGS Precipitation-Runoff Modeling Project has arranged with the National Training Center to provide classrooms and computers (Data General workstations). ■

For further information: Hank McKellar, Department of Environmental Health Sciences, University of South Carolina, Columbia, South Carolina 20208, 803-777-6994, ***hMckellar@lternet.Washington.edu.***

Sevilleta LTER - Khoros Group Collaboration

Khoros is an integrated software development environment for information processing and data visualization, which is being used as a foundation to improve productivity and promote software re-use across a variety of application domains. The National Science Foundation partially sponsored its development and has recently funded Jim Gosz (Sevilleta, SEV) and John Rasure (Khoros Group) to extend the application of this technology to a number of other LTER sites to demonstrate its value and versatility. Participating sites are Konza Prairie, North Inlet Marsh, and Virginia Coast Reserve. Donna Koechner (SEV/Khoros Group), a member of the Khoros development team, spent a week at each site during February and March of 1992.



A team of computer engineers and Sevilleta LTER scientists at the University of New Mexico developed the Khoros software system to provide a productive computing environment for biologists. They are using Khoros for near-ground-level image classification, lightning strike data analysis and animation, raster-based GIS, and ecosystem modeling. The Konza group hopes to use Khoros to produce a "fly-by" animation of the prairie by combining imagery and elevation data, and to perform image processing on remotely-sensed data. North Inlet scientists are using Khoros to more easily access SAS statistical software programs and import/export SAS data for 2D and 3D plotting. One of the highlights of the North Inlet training course was the use of the concert program to simultaneously display a video animation of "ibis" counts at the University of New Mexico and at North Inlet. This program allows both sites to control the display of the data and share interpretations.

The goal of the collaboration is to develop a low-cost common software environment for computational biology and collaboration. Positive feedback and constructive criticism from participating sites is being used to improve the capability and design of Khoros. Key to the eventual success of the project will be whether its capabilities help reduce barriers to collaboration. ■

Khoros software is available at no cost and runs on almost all UNIX workstations. For information on obtaining and installing Khoros: Donna Koechner, UNM, Department of Electrical and Computer Engineering, Albuquerque, NM 87131, ***donna@chama.eece.unm.edu.***

Regional Climate Centers

The Regional Climate Centers (RCC) program was initiated by the National Oceanic and Atmospheric Administration to complement the activities of the state climate offices (most states have one) and the two national centers (the National Climatic Data Center, NCDC, in Asheville, North Carolina; and the Climate Analysis Center, CAC, a part of the National Weather Service in Washington, D.C.). Thus, there is now a system of national, regional and state climate centers. The RCCs, administered by the CAC, operate under contract to the federal government, and personnel are employees of their respective state institutions or governments. Many of the individuals associated with the RCC program, including several former state climatologists, have had substantial and invaluable experience with the existing complex U.S. climate service structure.

Over a period of 10 years the present network of six centers serving the United States was funded and developed. Regional centers now exist in the Northeast, Southeast, Midwest, High Plains and the West. In 1990 the last of the six, the Southern RCC, was established. The Caribbean Islands are formally linked with the Southeast RCC, Alaska and the Pacific Islands with the Western during 1992.

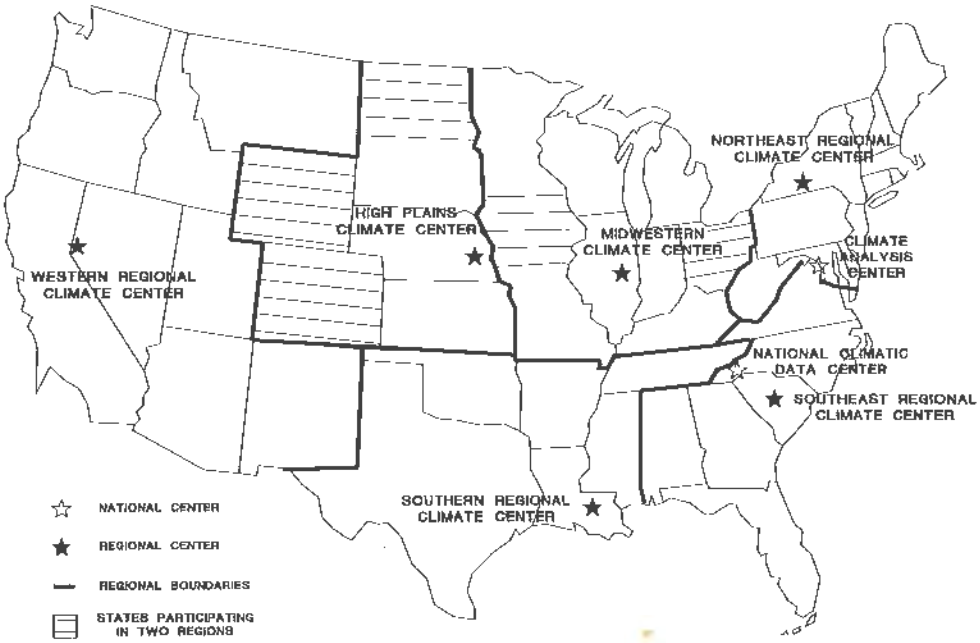
The centers perform four principal functions: (1) maintain regional historical weather and climate databases; (2) disseminate, interpret, summarize, and manipulate climate data and information for the benefit of users in universities, government agencies, and private organizations and individuals; (3) conduct applied and some basic research on regional climate issues; and (4) serve as a focal point for coordination of climate activities among agencies and organizations.

Activities at each RCC are divided into two components: (1) operations and services, and (2) resarch and development. Each center has agreed to provide a set of minimum baseline capabilities, and all computer systems are now linked via the Internet. Differences among the RCCs reflect regional needs; for example, private-sector interests in agriculture and transportation are strong in the Midwest whereas, in the West, natural resource management by federal agencies is a significant factor. A system of review and oversight is being instituted to insure that the RCCs interact effectively with each other, with other climate service entities, and with their constituents. Interactions between the LTER Network and the climate community were recently featured at the April 1992 9th annual PACLIM meeting in Monterey, California.

It is not possible to understand the functioning of natural ecosystems without accounting for the prominent role played by atmospheric and hydrologic interactions, which occur over a range of spatial and temporal scales spanning many orders of magnitude. Although most of the LTER sites have only recently begun atmospheric measurement programs, a considerable body of historical data from the same or nearby sites is available for research purposes. Access to this information can be initiated by contacting the relevant state, regional and/or national climate center.

Additional information on RCCs is contained in a recent issue of the *Bulletin of the American Meteorological Society* (71:527-537), or may be obtained from Kelly Redmond, Regional Climatologist, Western Regional Climate Center Desert Research Institute, P.O. Box 60226, Reno, Nevada 89506, 702-677-3139, krwrcc@nimbus.unr.edu (Internet). ■

NATIONAL AND REGIONAL CLIMATE CENTERS



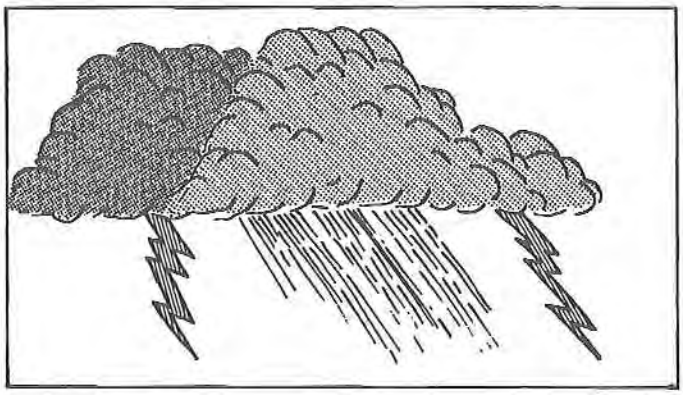
Locations of the national and regional climate centers. Some states participate jointly.

LTER Climate Committee Activities

New Climate/Ecosystem Dynamics Bulletin Board Developed

A climate/ecosystem dynamics bulletin board, *CED*, has been developed for the LTER Network by the Climate Committee to exchange interdisciplinary information and ideas, data, bibliographies and literature discussions. In addition, LTER-wide citations for climate and ecosystem publications will be compiled. *CED*, which is posted on LTERnet periodically, will reflect the interests of contributors and users.

Contributions may be sent to David Greenland (H.J. Andrews LTER; *Greenlan@oregon.uoregon.edu*) or to Bruce Hayden (Virginia Coast Reserve LTER; *bph@envsci.evsc.virginia.edu*). Requests to be added to the mail group list should be sent to Daniel Pommert at the Network Office, *dPommert@lternet.Washington.edu*. Back issues may be requested from Bruce Hayden.



LINDA WILKINSON

1885-1991 Storm Data Available

Storm frequency data for the coterminous United States has been transferred to LTER Network computers. The data, which covers the period 1885 through mid-1991, is from monthly storm center counts of storms passing through 2.5 degrees-latitude and 5 degrees-longitude grid cells. Users need to consider the weather results of storm centers in particular geographic positons relative to the LTER site of interest.

For many locations there have been significant changes in the number of storms per year over the last 100 years. Data plots should reveal that there have been real climate changes in the synoptic weather systems that frequent the areas near the sites. These may or not be accompanied by changes in temperature or rainfall.

For details on the data collection process and an application for using the data see: Hayden, B.P. 1981. Secular Variations in Atlantic Coast Extratropical Cyclones. *Monthly Weather Review* 109(1):159-172. Users should credit the Virginia Coast Reserve, and send Bruce Hayden a reprint of any publication that results.

Climate Synthesis Proposal Submitted

David Greenland, Bruce Hayden and Tim Kittel (Central Plains LTER) have submitted a proposal to the National Science Foundation to update and expand the climatic description and synthesis document for LTER. The comparative analysis chapter will be redone and the issue of climate change across LTER sites will be addressed. Four new sections are planned: (1) site descriptions for new LTER sites, (2) climate variability analysis, (3) projected climate changes at LTER sites, and (4) comparative climatology across sites.

LTER El Niño Study Group

The Sevilleta, Jornada, North Inlet, Virginia Coast and North Temperate Lakes sites have formed a study group on El Niño and ecosystem responses at LTER Sites. Future activities may include a workshop, an intersite proposal, and/or a joint publication. Other LTER researchers who have detected an El Niño signal at their sites are encouraged to participate. Initially, the group will communicate via the *CED* bulletin board.

NASA Surface Temperature Data Obtained for LTER Sites

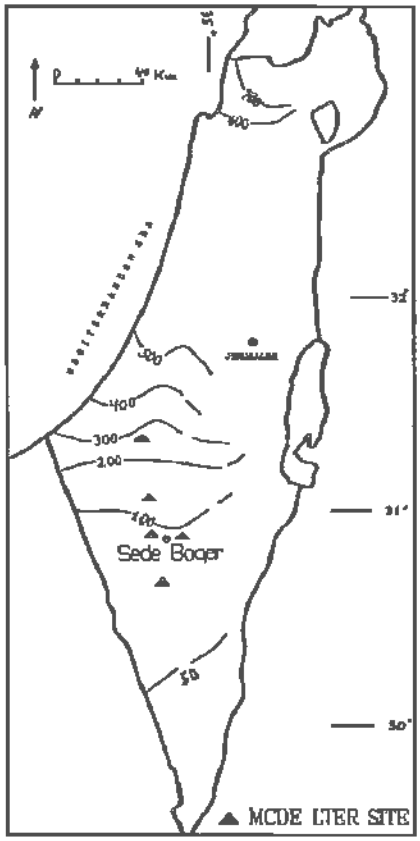
The National Aeronautics and Space Administration (NASA) is now in its 14th year of measuring surface temperatures via satellite. The 13-year dataset (through 1991, which covers the lifespans of all the LTER sites) is currently being obtained for each of the 18 sites. Readouts produced are for average monthly temperatures in 2.5 latitude-by-2.5 longitude grid cells. The readings are said to be correct to within 0.01 C. Following quality checks, these data will be archived in the Network Office. ■

Long-Term Ecological Research in Israel

The Ecology of Global Climate Change in a Desert/Non-Desert Ecotone

Ecologically speaking, the State of Israel is an ecotone: it is a narrow 520 km-long strip of land, with a mean annual precipitation range from 30 mm in the south to 700 mm in the north, i.e., a mean rate of change of 16 mm per 10 km across the ecotone. The rate is 25 mm per 10 km in an 80-km belt in the center of Israel, where the desert meets the non-desert: the transition zone.

Long-term research of global climate change (GCC) ecology within this zone has three merits: (a) The steep gradient generates spatial and temporal patchiness and instability. It is anticipated that the biota there is highly adaptable; hence, it should react clearly and fast to experimental manipulations simulating climate change; (b) Since climatic changes should be most apparent there, the transition zone can serve as a sensitive arena for detecting ecological responses to climate changes elsewhere, and for monitoring the resulting fluctuations in populations' distributional boundaries; (c) Due to their anticipated adaptability, species of the transition zone may constitute biogenetic and ecological resources for rehabilitation of regions damaged by GCC effects. The transition zone may function as a refuge, which should be properly managed in order to be conserved. Prone to desertification exacerbated by GCC, Israel provides an opportunity to explore active measures of arresting the desertification of desert/non-desert transition zones.

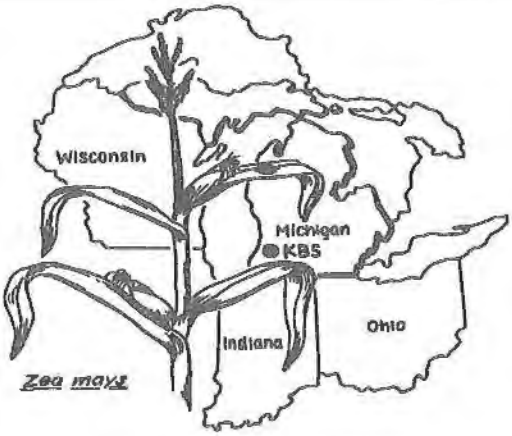


Mitrani Center for Desert Ecology

The Mitrani Center for Desert Ecology (MCDE) of the Blaustein Institute for Desert Research, located within this transition zone, has recently launched a program with the following goals: (a) to predict the reactions of populatious, communities and ecosystems to GCC, (b) to verify the predictions, by developing a long-term ecological monitoring scheme; (c) to investigate means for utilizing biogenetic resources of climatic transition zones for ecosystem restoration and rehabilitation. The five long-term ecological research sites established by the MCDE cover the variation within the ecotone in rainfall (75, 100, 150, 200 mm) and in habitat (loess plain, rocky watershed, sand dune).

Scientists from several research institutes and universities in the United States, Canada, Russia and Israel, are collaborating on projects initiated in 1991: stability of the rock/endolithic-lichen/snail ecosystem under increased rainfall and two alternative scenarios of increased and decreased dew; life history traits of algae-eating snails subjected to increased precipitation; responses of dune annual plant communities to elevated and reduced soil moisture; effect of reduced habitat structure, due to predicted thinning of perennial plants, on spider community structure; application of patch-dynamics ecology for exploring a novel land management practice "savannization," which couples landscape modification with afforestation as an anti-desertification measure; effect of changes in precipitation and temperature on decomposition of litter through their effect on soil microorganisms and microarthropods; and feasibility of using desert Tenebrionid beetles as indicators of GCC. ■

The MCDE research sites are open for collaborative research. For details: U. Safriel, MCDE, the Blaustein Institute for Desert Research, Sede Boqer 84990, Israel.



KELLOGG BIOLOGICAL STATION

By G. Philip Robertson

Much has been written in recent years about the expected long-term sustainability of modern row-crop (e.g., corn-soybean) cropping systems. Concerns about the short- and long-term economic viability of these systems, as well as the environmental costs of chemical-intensive management, is changing the tenor if not yet the substance of basic agricultural field research in the United States. It has become clear to agronomists attempting to address the issue of sustainability that at its heart the issue is an ecological one, and that at present we have a truncated understanding of basic ecological relationships in our most economically important cropping systems.

Research underway as part of the LTER program at W.K. Kellogg Biological Station (KBS) is geared toward addressing basic questions related to ecological interactions in modern row-crop farming systems. Efforts are also aimed understanding the impact of these systems on the larger environment.

Past Research Efforts

Agricultural productivity integrates the interactions of three major functional groups in cropped communities: microbes that regulate nutrient availability, insects and other consumers (including pathogens) that regulate net primary productivity (NPP) loss to herbivory and disease, and non-crop plant competitors that affect crop access to resources. LTER research at KBS generally focuses on interactions among these three groups and on the effects of these interactions on NPP (especially crop productivity) and biogeochemical fluxes.

To address these foci we have assembled a group of over 20 senior investigators representing both the agronomic and ecological sciences. Much of our effort is focused on a 120-ha field site divided into 1-ha treatment plots, which correspond to eight different cropping systems and plant communities. These include conventionally farmed corn-soybean rotations, organic-based corn-soybean-wheat rotations, perennial (alfalfa and Poplar) systems, and unmanaged old-field communities. We also examine watershed-level processes in the nearby Augusta Creek watershed. In 1991-92 the following new projects were initiated by KBS LTER scientists.

Differential Responses to Soil Resource Heterogeneity

If different annual and perennial plant species respond differentially to patchy distributions of soil resources, then knowledge of these differences may allow us to better predict plant success in cropped and other early successional communities. In this project Kay Gross and Kurt Pregitzer, with primary support from the National Science Foundation (NSF) Ecology Program, are comparing *in situ* soil spatial heterogeneity to the abilities of successional dominants to respond to this heterogeneity. Species-specific responses are being evaluated in greenhouse minirhizotron experiments in which root responses to artificial nutrient patches are evaluated. Preliminary experiments suggest that perennial species respond more quickly to patches of enhanced nutrients than annuals, but that annuals can rapidly exploit a large soil volume.

Lacewing fly on horseweed, important refugia for insect predators during field cropping.

Trace Gas Fluxes

There is at present a massive imbalance in the global nitrogen trace gas budget: only about 60 percent of global nitrous oxide sources are identified, which leaves a net atmospheric flux of about 6 Tg N per year from unknown sources. Agricultural contributions to the missing flux may be underestimated: conventional sampling programs can miss many of the highly dynamic flux events in

(next page)

disturbed soils, and much of the effect of agriculture may be expressed at uncropped sites in the downstream portion of the watershed. With primary support from the U.S. Department of Energy, LTER researchers Phil Robertson, Keith Paustian, and Mike Klug are using automated sampling chambers to provide fine temporal resolution of *in situ* fluxes from a variety of cropping systems on the main LTER site. With partial funding from the Mellon Foundation, Lars Hedin is also examining water-borne fluxes along hydrologic flow paths in an adjacent mixed-agriculture watershed.

Belowground Carbon Flow

To better understand the influence of contemporaneous (same-season) carbon inputs on soil-plant carbon cycling, William Horwath, Eldor Paul, and Kurt Pregitzer have dual-labeled a set of Poplars ^{14}C and ^{15}N to track carbon and nitrogen into various plant components (sugars, starch, proteins, lipids, and lignocellulose residues in particular), and then to soil microorganisms and soil organic matter. Root exudates and turnover may have strong immediate effects on soil microbial biomass, which may in turn affect seasonal community-wide nutrient retention. This work is funded by the National Science Foundation.

Landscape-Level Coccinellid Movement

Insect populations in cropping systems can be very sensitive to disturbances associated with crop management; this is especially true for predaceous populations that might in general be beneficial to the crop. Local landscape heterogeneity may affect survival and recolonization rates by these predators by providing temporary refugia, overwintering sites, or other critical habitats. In this project, Stuart Gage and Karim Maredia, with NSF and U.S. Department of Agriculture (USDA) support, are addressing questions related to landscape structure, organization, and disturbance frequency as predictors of Coccinellidae species dynamics in row crop systems.

Spatially-Explicit Modeling

Biogeochemical models of nitrogen and carbon fluxes in cropping systems generally ignore small-scale spatial variability, though much of this variability is imposed by planting patterns associated with the crop itself. To improve the efficiency of existing models and to evaluate the importance of crop spacing for nutrient turnover and retention, Keith Paustian and Phil Robertson use N_{15}-tagged crop litter to track the cross-row variability of important N-cycle processes in three major tillage systems. Primary funding is from the USDA National Research Initiative Comptetitive Grants Program. ■

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*Sandy Halstead examines three-year-old hybrid poplar (**Populus** sp.) for diameter growth. Short-rotation popular are grown as one of eight main cropping systems at Kellogg Biological Station.*

KONZA PRAIRIE

By Alan K. Knapp & John M. Briggs

The tallgrass prairie was once the second largest biome in the contiguous United States. Today there are only small remnants. The Konza Prairie Research Natural Area, a 3,400-ha tract of native tallgrass prairie 10 km south of Manhattan, Kansas was purchased in 1971 by The Nature Conservancy and is managed by the Division of Biology, Kansas State University, for the purpose of long-term ecological research. Konza Prairie is representative of the Flint Hills in eastern Kansas, with relatively steep slopes and distinctive limestone benches. Soils on hillsides and uplands are typically shallow and rocky while lowlands usually have deeper, more permeable soils. The Konza Prairie was part of the first cohort of LTER sites selected in 1981, and is now in its 11th year of funding.

Development of the LTER Program

During the initial LTER funding cycle (LTER I), Konza Prairie scientists developed a research protocol emphasizing comparative studies on the effects of annual spring fire in tallgrass prairie watersheds. Comparisons were made primarily with unburned watersheds. In LTER II, we expanded these research efforts to include various fire frequencies (i.e., annual, two-year, four-year and unburned watersheds). Furthermore, we increased our sampling efforts and implemented additional experiments to examine belowground net primary production and the interactions of soil biota with root dynamics. Throughout these two funding cycles, data collected was usually limited to upland (shallow soils) and lowland (deeper soils) sites. During LTER II, our research program was significantly enhanced by collaborative research with the NASA-FIFE program (FIFE=First ISLSCP Field Experiment; ISLSCP=International Satellite Land Surface Climatology Project). Techniques relevant to scaling ecological phenomena and remotely-sensed data to levels compatible with climate models continue to be developed as a result of this collaboration.

DON W. KAUFMAN

The effect of fire in tallgrass prairie is strongly affected by topography and the activities of herbivores. Grazing to the right of the fenceline reduced the severity of the fire. To the left of the fenceline is ungrazed prairie. The prominent white bands indicate areas of shallow, rocky soils with low productivity.

Present LTER Research

Ongoing LTER research on Konza Prairie represents the most significant expansion of our long-term ecological research effort to date. With the re-introduction of native ungulates (American Bison) to the prairie, we are examining their impacts on the tallgrass prairie ecosystem. Specifically, our objective is to understand how grazing influences biotic processes and patterns imposed by fire frequency over the landscape mosaic. To accomplish this goal, we have assembled a multidisciplinary team of over 20 scientists from Kansas State University, Ottawa University, University of Colorado, University of Oklahoma, University of Kansas, University of West Florida, Utah State University and several government agencies. *(next page)*

In addition to our core LTER effort, several other NSF-sponsored research projects continue to contribute to our knowledge of the tallgrass prairie ecosystem. For example, David Hartnett is examining in greater detail the effects of grazing by bison on individual plant populations and community structure. A conservation biology research project by Alan Knapp, Tim Seastedt and Clarence Turner focuses on the mechanisms of persistence of tallgrass prairie forbs within a "sea of grass," and Charles Rice is leading a group of scientists in studying patterns of trace gas flux across the prairie landscape.

A cooperative agreement among the U.S. Geological Survey (USGS), USDA Soil Conservation Service, University of Kansas and Kansas State University has led to a study of the dynamics of groundwater-surface water interactions. To accomplish this, USGS has installed observation wells on one of our gauged watersheds that will allow us to characterize groundwater from different stratigraphic horizons by its chemical signature. These groundwater wells coupled with an extensive geomorphic analysis of the watershed will improve our understanding of chemical and biological processes operating at Konza Prairie.

Use of Recent Technologies

Using technologies that have only recently been made available to ecologists, Konza LTER researchers have completed a geographic information systems (GIS) analysis of the expansion of woody vegetation on Konza Prairie. Historical aerial photos have been geometrically corrected using global positioning systems (GPS) and GIS technology. Detailed analysis of the woody vegetation on Konza Prairie indicated that this vegetation type has expanded by over 54 percent from 1939 to present. This expansion is probably related to a combination of changes in land-use pattern and a reduction in fire frequency. We are also using remote sensing technology as a tool to quantitatively estimate the heterogeneity of vegetation patterns across the tallgrass prairie landscape.

Intersite Research Efforts

Konza LTER scientists have been or are currently involved with the cross-site research efforts underway withinthe LTER Network. Some of these projects include the intersite litter decomposition study, a comparative analysis of methane flux in small-order streams, the intersite climate database, seasonal responses of stream periphyton to nutrient enrichment, cross-biome modeling efforts, and studies of ecosystem properties across environmental gradients. ■

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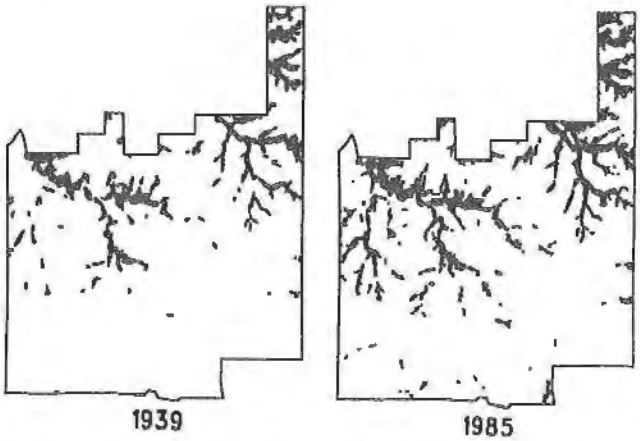
JACE FAHNESTOCK

American Bison. Bison were re-introduced to Konza Prairie in the fall of 1987. Currently there are more than 100 individuals.



CHRISTY KNIGHT

Extent of woody vegetation cover on Konza Prairie in 1939 and 1985. Using GIS technology, we estimate a 54-percent increase.

SMITHSONIAN ENVIRONMENTAL RESEARCH CENTER

By David L. Correll

For the last 10,000 years sea level has been rising and gradually flooding the Atlantic Coastal Plain of North America. As the river valleys of the Susquehanna, Potomac, James, and a series of smaller rivers were flooded, a very large coastal plain estuary was formed: Chesapeake Bay. The watersheds of the smaller tributaries to this estuarine system, including the Rhode River estuary, lie completely within the coastal plain geological province. Rhode River watershed soils consist of about a thousand meters of sedimentary layers laid down over the eastern portion of the Piedmont geological province at times of high sea levels. On the Rhode River watershed, however, an impervious layer, the Marlboro Clay, occurs near current sea level, isolating shallow, perched aquifers from the deeper layers. Thus, both the surface and groundwater draining each subwatershed of the Rhode River can be readily sampled, measured, and related back to source areas. In 1965 the Smithsonian Institution made the decision to begin a long-term study of this Rhode River watershed/estuary environmental system.

Site Characteristics

The Rhode River watershed is comprised of 3,300 ha of uplands on the western shore of Chesapeake Bay on the inner coastal plain. It was the home of Piscataway Indians for several thousand years prior to European settlement about 1650. The colonists quickly cleared most of the existing hardwood deciduous forest and established tobacco plantations. The soils are fine, sandy loams and are easily erodible. Mean watershed slopes are about 5 percent. Thus, erosion rates have been very high for over three centuries. Several cycles of forest clearing for agriculture, followed by abandonment to secondary succession are characteristic of the region. A few small relicts of undisturbed forest remain, including a 6-ha subwatershed, but most of the mature forest dates to agricultural lands abandoned in the early 1800s. The soils are very rich in both phosphorus and nitrogen and secondary forest succession is usually very rapid. The watershed is within the tulip poplar association of the eastern deciduous forest biome. Currently, about 35 percent of the watershed is agricultural, mostly in corn production.

DAVID L. CORRELL

Aerial view, Smithsonian Environmental Research Center tidal marsh CO_2 enrichment site.

The Rhode River estuary joins Chesapeake Bay in its mesohaline reach and, typical of the Bay, is a low-energy, soft-bottom system. It has a surface area of about 550 ha of open water and a mean depth of 2 meters. About 25 ha of tidal marshes occur near the tidal headwaters. Mean tidal amplitude is about 30 cm but extreme tides due to winds and pressure differentials between the Bay and the continental shelf range up to 3 meters. A combination of sea-level rise and regional subsidence results in an increase in mean tidal elevations of about 4 mm per year. Due to seasonal variations in freshwater discharges from the land the salinity at the head of the Rhode River varies from 0 ppt in the spring to

(next page)

DAVID L. CORRELL

Tidal marsh CO_2 enrichment experiment.

about 10 ppt in a normal fall. At the juncture of the Rhode River and Chesapeake Bay this corresponds to about 5 ppt to 15 to 20 ppt.

The Research Program

The research program for 20 years has had the goal of understanding how human use of the air, land, and water effects the ecology of the region. Long-term studies of populations, communities, ecosystems, and the overall landscape attempt to establish a better grasp of cause and effect. The research involves both descriptive observations and manipulative experiments. For example, the chambers in the illustrations are used to maintain a continuous elevated carbon dioxide concentration in tidal marsh communities over a period of years. This simulation of carbon dioxide concentrations anticipated in the next century allows measurements of physiological and ecological effects at the community level with only minimal experimental artifacts. The plant communities quickly and dramatically increased their photosynthesis and water-use efficiency and decreased their respiration rates. After four years the plants have not begun to acclimate to this increase in carbon dioxide concentration. Larger chambers are now in use in forest floor communities to examine effects of elevated carbon dioxide on woody species such as *Lindera benzoin.*

Regional studies use the Rhode River system as a basis for comparisons. For example, a study of the overall Chesapeake Bay watershed seeks to understand the relative importance of geology, land-use patterns, and variations in weather on discharges of nutrients and suspended sediments. Ten coastal plain subwatersheds on the inner, mid-, and outer coastal plain of Delaware and Maryland and 10 subwatersheds on the inner and outer piedmont of Maryland and Pennsylvania are being compared with nine long-term Rhode River study subwatersheds. Future work will include subwatersheds in the great valley, ridge and valley, and appalachian plateau geological formations of Pennsylvania and New York. Topographic and land-use data for these subwatersheds are entered into ARC/INFO as a data base for landscape-level simulation models of nutrient dynamics. Another regional/continental scale long-term comparative study concerns woodland neotropical migratory bird populations. It focuses on the effects on these species of forest habitat fragmentation in both their mid-Atlantic breeding grounds and their wintering grounds.

The Center has either purchased or helped protect from development about 2,000 ha of the Rhode River watershed and is attempting to protect another 1,000 ha. Facilities at the Center include about 20,000 square feet of office and laboratory space, a Smithsonian branch library, a computer center and local-area computer network, a fleet of vehicles and small boats, a student dormitory, and limited housing for visiting scientists. We have a competitive internship program for undergraduates and a fellowship program for graduate students and postdoctoral fellows. ■

For further information: David L. Correll, Smithsonian Environmental Research Center, P.O. Box 28, Edgewater, Maryland 21037-0028.

Recent Publications

(Submitted and in-press citations not included)

Abrams, M.D., and D.J. Gibson. 1991. Effects of fire exclusion on tallgrass prairie and gallery forest communities in eastern Kansas. Pages 3-10 *in* S.C. Nodvin and T.A. Waldrop (eds). *Fire and the Environment: Ecological and Cultural Perspectives.* Proceedings of an International Symposium, Knoxville, Tennessee, March 20-24, 1990. USDA Forest Service, Southeastern Forest Experiment Station.

Autry, A.R. and J.W. Fitzgerald. 1991. Determination of kinetic parameters for sulfur processing potentials: verification of the constant specific activity approach. *Soil Biol. Biochem.* 23:1003-1004.

Autry, A.R. and J.W. Fitzgerald. 1991. Organosulfur formation in forest soils: site comparison of kinetic parameters. *Soil Biol. Biochem.* 23:689-693.

Bazzaz, F.A. and E.D. Fajer. 1992. Plant life in a CO^2-rich world. *Scientific American* 266:68-77.

Benfield, E.F., J.R. Webster, S.W. Golladay, G.T. Peters and B.M. Stout. 1991. Effects of forest disturbance on leaf breakdown in southern Appalachian streams. *Verh. Internat. Verein. Limnol.* 24:1678-1690.

Bentivenga, S.P. and B.A.D. Hetrick 1991. *Glomus Mortonii sp. Nov.*, a previously undescribed species in the Glomaceae isolated from the tallgrass prairie in Kansas. *Mycotoxon* 42:9-15.

Brillhart, D.B., and D.W. Kaufman. 1991. Influence of illumination and surface structure on space use by deer mice (*Peromyscus maniculatus*). *Journal of Mammalogy* 72:764-768.

Chapin III, F.S., R.L. Jeffries, J.F. Reynolds, G.R. Shaver and J. Svoboda. 1991. *Arctic Ecosystems in a Changing Climate.* Academic Press, Inc., San Diego, CA. 470 pp.

Coleman, D.C and B.D. Fry. 1991. *Carbon Isotope Techniques.* Academic Press, Inc., San Diego, CA. 274 pp.

D'Angelo, D.J., J.R. Webster and E.F. Benfield. 1991. Mechanisms of stream phophorus retention: an experimental study. *Journal of the North American Benthological Society* 10:225-237.

Dyer, M.I., C.L. Turner, and T.R. Seastedt. 1991. Influence of mowing and fertilization on biomass, productivity and spectral reflectance in *Bromus inermis* plots. *Ecological Applications* 1:443-452.

Fay, P.A. and D.C. Hartnett. 1991. Constraints on the growth and allocation patterns of *Silphium integrifolium* (*Asteraceae*) caused by cynipid gall wasps. *Oecologia* 88:243-250.

Foster, D.R. and E. Boose. 1992. Technology development in the LTER Network - Current status of GIS, remote sensing, Internet connectivity, archival storage and global positioning systems. LTER Publication No. 12, Seattle, Washington.

Franklin, Jerry F., F.J. Swanson, M.E. Harmon, D.A. Perry, T. A. Spies, V.H. Dale, A. McKee, W.K. Ferrell, J.E. Means, S.V. Gregory, J.D. Lattin, T.D. Schowalter, and D. Larsen. 1991. Effects of global climatic change on forests. Northwestern North America. *Northwest Environmental Journal* 7:233-254.

Fry, Brian. 1991. Stable isotope diagrams of freshwater food webs. *Ecology* 72:2293-2297.

Giblin, A.E., K.J. Nadelhoffer, G.R. Shaver, J.A. Laundre, and A.J. McKerrow. 1991. Biogeochemical diversity along a riverside toposequence in arctic Alaska. *Ecological Monographs* 61(4):415-435.

Glenn, S.M., and S.L. Collins. 1992. Effects of scale and distrubance on rates of immigration and extinction of species in prairie. *Oikos.* 63:273-280.

Haines, B.L. 1991. Identification and quantification of sulfur gases emitted from soils, leaf litter and live plant parts. *Agriculture, Ecosystems and Environment* 34:473-477.

Haines, B.L. 1991. Identification and quantification of sulfur gases emitted from soils, leaf litter, and live plant parts. Page 510 *in* D.A. Crossley, D. Coleman, P. Hendrix, W. Cheng, D. Wright, M. Beare and E. Edwards (eds.). *Modern Techniques in Soil Ecology.* Elsevier, NY, NY.

Hetrick, B.A.D. and G.W.T. Wilson. 1991. Effects of mycorrhizal fungus species and metalazyl application on microbial suppression of mycorrhizal symbiosis. *Mycologia* 83:97-102.

James, S.W. 1991. Soil, nitrogen, phosphorus, and organic matter processing by earthworms in tallgrass prairie. *Ecology* 72:2101-2109.

Johnsen, K.H., B.C. Bongarten and L.R. Boring. 1991. Effects of nitrate on in vivo nitrate reductase activity of seedlings from three open-pollinated families of *Robinia pseudoacacia*. *Tree Physiology* 8:381-389.

Recent Publications, *continued*

Knapp, A.K., and J.B. Yavitt. 1992. Evaluation of the closed-chamber method for estimating methane emissions from aquatic plants. *Tellus* 44B, 63-71.

Kim, J. and S.B. Verma. 1991. Modeling canopy stomatal consuctance in a temperate grassland ecosystem. *Agricultural and Forest Meteorology* 55:149-166.

Martinez, N.D. 1991. Artifacts or attributes? Effects of resolution on the Little Rock Lake food web. *Ecological Monographs* 61(4):367-392.

Montagnini, F., B.L. Haines and W.T. Swank. 1991. Soil-solution chemistry in black locust, pine/mixed-bardwoods and oak/hickory forest stands in the southern Appalachians. *Forest Ecology and Management* 40:199-208.

Merrill, G.L. 1991. Bryophytes of Konza Prairie Research Natural Area, Kansas. *The Bryologist* 94:383-391.

Merrill, G.L. 1991. New records for Kansas mosses, III. *Evansia* 8:25-31.

Nassar, R., R. Stewart, and C.M. Tate. 1991. Stochastic analysis of the dynamics of nitrogen concentration in a stream ecosystem. *Ecological Modelling* 56:33-45.

Perlmutter, D.G. and J.L. Meyer. 1991. The impact of a stream-dwelling harpacticoid copepod upon detritally associated bacteria. *Ecology* 72:2170-2180.

Pielke, R.A., G.A. Dalu, J.S. Snook, T.J. Lee and T.G.F. Kittell. 1991. Nonlinear Influence of mesoscale land use on weather and climate. *Journal of Climate* 4:1053-1069.

Potter, C.R., H.L. Ragsdale and W.T. Swank. 1991. Atmospheric depositon and foliar leacbing in a regenerating Southern Appalachian forest canopy. *Journal of Ecology* 79:97-115.

Prezelin, B.B., and H.E. Glover. 1991. *J. Plankton Res.* 13:45.

Qualls, R.G. and B.L. Haines. 1991. Geochemistry of dissolved organic nutrients in water percolating through a forest ecosystem. *Soil Science Society of America Journal* 53:1112-1123.

Qualls, R.G., B.L. Haines and W.T. Swank. 1991. Fluxes of dissolved organic nutrients and humic substances in a deciduous forest. *Ecology* 72:254-266.

Schlesinger, W.H. 1991. *Biogeochemistry, An Analysis of Global Change.* Academic Press, Inc. San Diego, CA. 443 pp.

Segal, M, J.H. Cramer, R.A. Pielke, J.R. Garrat and P. Hildebrand. 1991. Observational evaluation of the snow breeze. *Monthly Weather Review* 119(2):412-424.

Smith, R.C., B.B. Prezelin, K.S. Baker, R.R. Bidigare, N.P. Boucher, T. Coley, D. Karentz, S. MacIntyre, H.A. Matlick, D. Menzies, M. Ondrusek, Z. Wan, K.J. Waters. 1992. Ozone depletion: ultraviolet radiation and phytoplankton biology in Antarctic waters. *Science* 255:893-1040.

Swank, W.T. and J.M. Vose. 1990/91. Watershed-scale responses to ozone events in a *Pinus strobus L.* plantation. *Water, Air, and Soil Pollution* 54:119-133.

Taylor, G.E., Jr., B.M. Ross-Todd, E. Allen, P. Conklin, R. Edmonds, E. Joranger, E. Miller, L. Ragsdale, J. Shepard, D. Silsbee and W. Swank. 1992 Patterns of tropospheric ozone in forested landscapes of the integrated forest study. Pages 50-71 *in* D.W. Johnson and S.E. Lindgerg (eds.). *Atmospheric Deposition and Forest Nutrient Cycling: A Synthesis of the Integrated Forest Study.* Springer-Verlag, New York, NY. 707 pp.

Thorp, J.H., and A.P. Covich (eds.). 1991. *Ecology and Classification of North American Freshwater Invertebrates.* Academic Press, Inc., San Diego, CA. 991 pp.

Vose, J.M. and W.T. Swank. 1991. A soil temperature model for closed canopied forest stands. Research Paper SE-28. USDA Forest Service, Southeastern Forest Experiment Station, Asheville, NC. 11 pp.

Vose, J.M. and W.T. Swank. 1992. Water balances. Pages 27-49 in D.W. Johnson and S.E. Lindberg (eds.). *Atmospheric Deposition and Forest Nutrient Cycling: A Synthesis of the Integrated Forest Study.* Springer-Verlag, New York, NY. 707 pp.

Walbridge, M.R., C.J. Richardson and W.T. Swank. 1991. Vertical distribution of biological and geochemical phosphorus subcycles in two southern Appalachian forest soils. *Biogeochemistry* 13:61-85.

Wallace, J.B., T.F. Cuffney, B.S. Goldowitz, K.Chung and G.J. Lugthart. 1991. Long-term studies of the influence of invertebrate manipulation and drought on particulate organic matter export from headwater streams. *Verh. Internat. Verein. Limnol.* 24:1676-1680.

Wallace, J.B., T.F. Cuffney, J.R. Webster, G.J. Lugthart, K. Chung and B.S. Goldowitz. 1991. Export of fine organic particles from headwater streams: effects of season, extreme discharges, and invertebrate manipulation. *Limnology and Oceanography* 36:670-682.

(*next page*)

Publications of Interest

Improved Global Data for Land Applications. 1992. 87 pages. IGBP Report No. 20. The outcome of a project of the Land Cover Working Group of the IGBP Data and Information System. Outlines a proposal to produce a global data set at a spatial resolution of 1 km derived from the Advanced Very High Resolution Radiometer primarily for land applications. Available from the IGBP Secretariat, The Royal Swedish Academy of Sciences, Box 50005, S-10405 Stockholm, Sweden.

A National Center for Integrating Ecological Research. 1991. A report to the National Science Foundation on the results of a 1989 workshop on ecological syntheses organized by the Association of Ecosystem Research Centers. Available from John E. Hobbie, Co-Director, The Ecosystems Center, Marine Biological Laboratory, Woods Hole, MA 02543.

Biotropica. Special Issue: Ecosystem, Plant, and Animal Responses to Hurricanes in the Caribbean. 1991. 521 pages. Volume 23 Number Four, Part A. Brings together, for the first time, a collection of case studies that document the damage to natural ecosystems and the initial recovery process frm three recent hurricanes in the Caribbean, in particular, Hurricane Hugo (1989). Editors and numerous authors are from two LTER sites, the Luquillo Experimental Forest and North Inlet Marsh. Available from the Association for Tropical Biology, Inc., Department of Ecology, Evolution and Organismal Biology, Tulane University, New Orleans, LA 70118.

Global Change and Terrestrial Ecosystems, The Operational Plan. 1992. 95 pages. IGBP Global Change Report No. 21. Details of the strategic research plan and operational plan for the International Geosphere-Biosphere Programme (IGBP) core project on Global Change and Terrestrial Ecosystems (GCTE), a synthesis of four international workshops held during 1991. Available from the IGBP Secretariat, The Royal Swedish Academy of Sciences, Box 50005, S-10405 Stockholm, Sweden.

Global Environmental Change: Human and Policy Dimensions. Quarterly journal published in cooperation with the United Nations University. Butterworth-Heinemann Limited, Reed International Books, 88 Kingsway, London WC2 8AB, United Kingdom. (*next page*)

Recent Publications, *continued*

Wallace, J.B., A.D. Huryn and G.J. Lugthart. 1991. Colonization of a headwater stream during three years of seasonal insecticidal applications. *Hydrobiologia* 211:65-76.

Webster, J.R., D.J. D'Angelo and G.T. Peters. 1991. Nitrate and phosphate uptake in streams at Coweeta Hydrologic Laboratory. *Verh. Internat. Verein. Limnol.* 24:1681-1686.

Webster, J.R., S.W. Golladay, E.F. Benfield, J.L. Meyer, W.T. Swank and J.B. Wallace. 1992. Catchment-disturbance and stream respouse: an overview of stream research at Coweeta Hydrologic Laboratory. Pages 232-253 *in* P.J. Boon, P. Calow and G.E. Petts (eds.). *River Conservation and Management.* John Wiley & Sons, Ltd., Chichester, U.K.

Zimmerman, J.L. 1992. Density-independent factors affecting the avian diversity of the tallgrass prairie community. *Wilson Bulletin* 104:85-94.

Publications of Interest

Integrating Ecological Research. 1991. A report to the National Science Foundation on the results of a 1989 workshop on ecological syntheses organized by the Association of Ecosystem Research Centers. John E. Hobbie, Co-Director, The Ecosystems Center, Marine Biological Laboratory, Woods Hole, MA 02543.

Report of the Institute of Terrestrial Ecology. 1991. 95 pages. Research objectives and priorities, resources, and strategies of the ITE, which is part of the Terrestrial and Freshwater Sciences Directorate of the Natural Environment Research Council, the main U.K. organization responsible for research and training in the environmental sciences. A complete list of ITE titles and publications can be obtained directly from HMSO Publications Centre, P.O. Box 276, London SW8 5DT, United Kingdom.

Soil-Warming Experiments in Global Change Research. 1991. 27 pages. The report of a workshop held in Woods Hole, Massachusetts, September 27-28, 1991. Recommends initiation of a long-term, multi-site soil-warming experiment to understand the response of soils to global climate change. Available from W.H. Schlesinger, Duke University, Department of Botany, Durham, NC 27706, 919-684-2453, "dcalic@dukemvs.bitnet" or "wSchlesinger@lternet.washington.edu" (Internet).

Two Long-Term Instrumental Climatic Data Bases of the People's Republic of China. 1991. 198 pages. ORNL/CDIAC-47, NDP-039. Compiled in accordance with a joint research agreement signed by the U.S. Department of Energy and the Institute of Atmospheric Physics, Chinese Academy of Sciences. Prepared by D.P. Kaiser, Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, TN. Available from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. ■

Network News

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CALENDAR

June - August 1992

JUN	*1*	***NSF Program Deadline: Geosciences.*** U.S. Antarctic Research, Division of Earth Sciences: Continental Dynamics (Leonard Johnson, 202-357-7721, ljohnson@nsf.gov); Geology and Paleontology (John Maccini, 357-7866, jmaccini@nsf.gov); Geophysics (Michael Mayhew, 357-7355, mmayhew@nsf.gov); Instrumentation and Facilities (Daniel Weill, 357-7807, dweill@nsf.gov); Tectonics Program (Thomas Wright 357-7355, twright@nsf.gov); Research on Terrestrial and Limnetic Ecosystems in Antarctica (Polly Penhale, Polar Programs, 357-7894, ppenhale@nsf.gov). Hydrologic Sciences (James Hays, Earth Sciences, 357-7958, jhays@nsf.gov). ***NSF Target Date: Biological Sciences.*** Animal Developmental Mechanisms (Judith Plesset, 202-357-7989); Animal Systems Physiology (Barbara Zain, 357-7975); Biochemistry (Marcia Steinberg, 357-7945); Biophysics (Arthur Kowalsky, Molecular and Cellular Biosciences, 357-7777); Cell Biology (Eve Barak, 357-7474); Endocrinology (Elvira Doman, 357-7975); Functional and Physiological Ecology (Donald Jackson, 357-7975); Genetics (DeLill Nasser, 357-9687); Integrative Plant Biology (Ernest Uribe, 357-7975); Plant and Microbial Developmental Mechanisms (Tom Brady, 357-7989).
	15	***NSF Target Date: Division of Environmental Biology.*** Ecology (Laurel Fox/Joann Roskoski, 202-357-9734); Ecosystem Studies (James Reynolds/James Callahan, 357-9596); Population Biology and Physiological Ecology (Grace Wyngaard/Theodore Garland, 357-9728); Systematic Biology (Terry Yates/James Estes/James Rodman, 357-9588).
	17-19	***LTER Workshop: Watershed Modeling.*** Denver, Colorado. Hank McKellar, North Inlet Marsh LTER, 803-777-6994, 777-3391 (FAX), or hMckellar@lternet.Washington.edu (Internet).
	18-20	***LTER Meeting: Executive Committee.*** Washington, D.C. Includes a visit to the Smithsonian Environmental Research Center, Edgewater, MD.
JUL	*1*	***NSF Target Date: Social, Behavioral, and Economic Sciences.*** Archaeology (John Yellen, Behavioral and Cognitive Sciences, 202-357-7804); Cultural Anthropology (Stuart Plattner, Behavioral and Cognitive Sciences, 357-7804); Physical Anthropology (Mark Weiss, Behavioral and Cognitive Sciences, 357-7804). ***NSF Target Date: Atmospheric Sciences.*** Research proposals that require National Center for Atmospheric Research or University-based national facilities for April 1, 1993 through October 1, 1993 (357-9695). ***NSFNET Program.*** Connections to NSFNET (Daniel VanBelleghem, Networking and Communications Research and Infrastructure, 357-9717 or *dvanbell@nsf.gov*). ***NSF Program Deadline: Computer and Information Science and Engineering.*** Research on Scientific Databases (Maria Zemankova, 357-9570).
	15	***NSF Target Date: Biological Sciences.*** Animal Behavior (Fred Stollnitz, 202-357-7949) ***NSF Program Deadlines: Social, Behavioral, and Economic Sciences.*** U.S.-Taiwan Cooperative Science Program (William Chang, International Programs, 202-653-5343).
	31-	***LTER Meetings: Executive and Coordinating Committees.*** Fairbanks, Alaska. *Sponsor:* Bonanza Creek LTER
AUG	*6*	site. Additional field trip to Toolik Lake and Prudhoe Bay (Arctic Tundra LTER site).
	1	***NSF Program Deadline: Education and Human Resources.*** Informal Science Education (Robert Russell 202-357-7076); Teacher Enhancement/Preparation (Mary Bahns 357-7431/Miriam Leiva 357-7069).
	3	***NSF Program Deadline:*** CISE Instrumentation (Caroline Wardle, 202-357-7349 or *cwardle@nsf.gov*).
	8-9	***LTER Meeting: Data Managers.*** Honolulu, Hawaii. In conjunction with AIBS/ESA meetings. Rudolf Nottrott, 206-543-8492, *rNottrott@lternet* (Bitnet) or *rNottrott@lternet.Washington.edu* (Internet).
	9-13	***77th Annual Meeting: AIBS/Ecological Society of America.*** Honolulu, Hawaii, 202-628-1500.

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