NETWORK NEWS

Newsletter of the U.S. Long-Term Ecological Research Network — Spring/Summer 1996, Issue 19

AN LTER PROFILE

Fifteen years old, the LTER model is showing its worth

Research that is long-term, large-scale, systemwide, across trophic levels, interdisciplinary, experimental, and synthetic is common to all LTER sites. LTER scientists engage in both prescribed research common to all sites and evolving, creative research unique to each site. Now that the LTER way of doing research is some 15 years mature, the LTER Coordinating Committee has taken a look at the numbers (see table below), and the numbers show that the LTER Program has met its promise.

Building a Research Community

The research scope at LTER sites necessitates a team approach with diverse scientific expertise. On average, the sites require 15 investigators from five to six different institutions to accomplish their research programs. Including annual supplements, the National Science Foundation awards LTER sites just under $600,000 per year. Of the 15 investigators funded, those who have earmarked portions of the site's annual budget (a fraction at each site) receive, on average, only $27,000 per year. These resources are used to cover summer stipend support for PIs, direct support of graduate students, or to meet specific field expenses not common to the site's research community.

Efficient Use of Resources

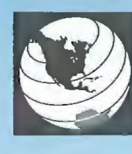
The institutional cost of doing research at LTER sites is modest. The effective overhead rate (the institutional rate adjusted for a university's matching contribution) averages, across all LTER sites, less than 25% of the NSF award. The sites spend 21% of their NSF awards to build research infrastructure to support current and future research. Each year, LTER sites become better equipped and better able to support the LTER research mission. Because they all run field stations, much of the research dollar—56% on average—is spent in the local community surrounding the field station.

Leveraging Science

LTER sites leverage resources to greatly expand their research enterprise. Across the Network, NSF awards, the large pool of scientific expertise, and the research infrastructure provide a powerful base from which to compete for additional research resources, leveraging an average 2.1 dollars from each NSF grant dollar. The scientific expertise is also leveraged in that an LTER site attracts, on average, 25 other research scientists to work at the site and collaborate with LTER scientists—in effect, each LTER scientist attracts two other scientists to the site. This leveraging of dollars, scientific expertise, and field station infrastructure directly supports and enhances education by attracting an average of 17 graduate and 15 undergraduate students each year, meaning that an LTER site supports on average a total of 73 research scientists. As a whole, the LTER community has grown to include nearly 1,400 scientists.

◆ *Bruce P. Hayden, LTER Executive Committee*

INSIDE:



HOW LTER SITES WORK

	AND	ARC	BNZ	CDR	CPR	CWT	HBR	HFR	JRN	KBS	KNZ	LUQ	MCM	NTL	NWT	PAL	SEV	VCR	AVG	per 100K
# of PIs at site	20	16	12	7	13	27	11	10	11	22	8	27	8	15	15	10	14	24	15	2.6
Avg $/PI (x1000)	38	16.6	27	48	10	22	40	56	22	10	40	10	60	19	12	38	10	12	27	4.9
# Institutions	4	9	4	4	3	7	6	6	7	3	9	15	8	4	4	5	4	8	6.1	
Effec. overhead (%)	31	46	37	0	15	26	28	8.5	24	0	27	10	20	11	26	26	8	21	20	20
% $ Infrastructure	30	40	12	30	51	23	10	11	10	20	10	33	8	15	30	23	28	25	21	21.2
% $ Local economy	100	16	80	88	100	25	35	70	70	70	100	8	0	25	100	0	100	30	56	56.3
# Grad students	45	20	19	23	13	19	9	12	10	21	11	19	12	20	12	12	15	40	17	3
# Undergrads	18	8	4	24	15	21	15	25	4	19	13	20	5	15	10	8	27	19	15	2.7
Other $/LTER $	4	2	2	0.7	1.8	2	2.5	3.8	1.1	2	3.2	2.3	0.5	2	2	0.3	3.9	2.1	2.1	212.6
Non-PI scientists	40	8	10	16	34	20	15	57	15	15	30	18	25	15	20	14	88	22	25	4.5

Notes: (1) The table provides averages across all 18 LTER sites as a measure of the attributes of an average site. (2) The table provides a normalized measure of site attributes. This normalization is on a per-$100,000 basis, so that comparisons between LTER and other kinds of science support can be made. (3) McMurdo Dry Valleys and Palmer Station in Antarctica and the Alaskan Tundra site have field stations with finite capacities and limits on the degree to which leveraging of award funds is possible.

Site abbreviations: AND=H.J. Andrews, ARC=Arctic Tundra, BNZ=Bonanza Creek, CDR=Cedar Creek, CPR=Central Plains, CWT=Coweeta, HBR=Hubbard Brook, HFR=Harvard Forest, JRN=Jornada, KBS=Kellogg, KNZ=Konza Prairie, LUQ=Luquillo, MCM=McMurdo, NTL=North Temperate Lakes, NWT=Niwot Ridge, PAL=Palmer Station, SEV=Sevilleta, VCR=Virginia Coast

NSF FURLOUGH EFFECTS & LTER FUNDING OUTLOOK

Right: The pileup of proposals in the mailroom overwhelmed NSF staff the first day back to work after the January furlough.

AP PHOTO/CHARLES TASNADI

It is safe to say that fiscal year 1996 has been an "interesting" year thus far. The budget battle between Congress and the White House shut down parts of the federal government—including the National Science Foundation—for a total of four weeks. The "Blizzard of 1996" followed the second shutdown, immobilizing transportation and closing the government for four more days. Despite these inconveniences, National Science Foundation staff have been working to ameliorate the effects of the furloughs on investigators. Fortunately, all LTER continuing increments for FY96 have been processed, although some delays have resulted from the furloughs.

Nevertheless, as of early April, NSF still does not have its FY96 budget in hand, even though the fiscal year officially began October 1, 1995. The latest (the 12th at press time) continuing resolution provided NSF with funding at the House and Senate conference levels, prorated until April 24, 1996. Yet, because the agency remains under a continuing resolution, we are still unable to develop detailed spending plans for the remainder of this year. The next resolution, which was scheduled to begin April 25, may provide NSF with funding at the House and Senate conference levels through FY96. If and when that happens, it will take about a month for final budget numbers to filter down to the programs.

There is strong support for the LTER Program in the Division of Environmental Biology and the Biological Sciences Directorate. In spite of recent budget reductions in the LTER Program, we are hoping to restore those funds and even to increase the LTER site budgets through supplements and other funding opportunities, such as the Cross-Site Competition held in 1995. We also would like to bring the core funding levels up as soon as possible. It is worth noting, however, that the current federal budget projections do not indicate that NSF will see budget increases in the future. Therefore, finding additional money for LTER will be more and more difficult over time.

Scott Collins, Program Officer, Long-Term Projects
Division of Environmental Biology, NSF

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Current and detailed information on NSF's FY 1997 Budget Request is available through the agency's home page at *http://www.nsf.gov/*

Cynthia A. Veen

Cindy Veen, 41, data manager for the Hubbard Brook, passed away on January 25, 1996 following a long and courageous battle with cancer. Cindy joined the Northeastern Forest Experiment Station, USDA Forest Service in 1988 as the data manager for both the Forest Service Research Work Unit and the Hubbard Brook LTER. In addition to being highly effective at persuading investigators within the HB-LTER to submit data to The Source of the Brook (Hubbard Brook's LTER data management system), Cindy was instrumental in establishing the sample archive system, which includes over 22,000 samples of soil, water, and plant tissue—all bar coded and recorded in a database. She was also very active in the LTER Data Management Committee and developed friendships with many of her colleagues.

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Cindy received degrees from Central Michigan University (BS), Portland State University (MS) and Oregon State University (MS). Prior to joining the Forest Service, she worked as a geophysicist for Mobil. She loved the outdoors, taking every opportunity to hike, bike, kayak, ski and garden. Her sincere concern for both the environment and people was demonstrated by the way she lived her life (a personal goal of zero garbage) and the organizations she supported (Habitat for Humanity). Cindy's cheerfulnesss, positive attitude, and zest for life are missed by her many friends and colleagues.

TWO LTER SCIENTISTS NAMED 1996 PRESIDENTIAL FACULTY FELLOWS

Two LTER scientists have been named by President Clinton as recipients of 1996 Presidential Faculty Fellow Awards. Given annually to 15 young scientists to recognize excellence in scientific research and teaching, as well as the potential for outstanding contributions, the award carries a National Science Foundation grant of $100,000 a year for five years.

◆ **Jim Clark, Coweeta Hydrologic Laboratory LTER.** Jim Clark's research focuses on effects of climate change and disturbance on forest and grassland biomes. The Coweeta Hydrologic Laboratory LTER is one of his principle study sites. He plans to use the award to expand intensive studies along an elevational gradient at Coweeta and extensive analyses of long-term fire effects in the Central Plains and boreal forest. Clark is Associate Professor (Departments of Botany and Geology) and Director of the Center for Quaternary Ecology and Earth Surface Transformations at Duke University, an interdisciplinary graduate program. He teaches Community Ecology, Paleoecology, and Theoretical Ecology.

◆ **George W. Kling, Arctic Tundra LTER.** As Assistant Professor in the Department of Biology at the Univeristy of Michigan, George Kling teaches limnology, oceanography and ecosystems ecology with a special interest in geochemistry. In addition to early work on lake studies with the Arctic Tundra LTER project, his work on the carbon budget of the tundra ecosystem represents a major contribution. One ongoing study involves measuring the partial pressure of CO_2 in water from soils, streams and lakes, tracing the atmospheric transfer of CO_2 from streams with SF6, and using eddy flux to observe the transfer of CO_2 from lakes to the atmosphere. Kling is also carrying out comparative research with LTER colleagues to discover the importance of soil water as a contributor to the supersaturation of CO_2 that occurs in many temperate lakes. He continues his work in the Arctic as leader of the land-water section of the LTER project and his work in Africa as leader of a multinational project on Lake Victoria investigating the causes of the recent changes in productivity. ◆

COURTESY OF JOHN HOBBIE

George Kling

HARVEY CHINN DEPARTS

COURTESY OF HARVEY CHINN

Harvey Chinn, co-developer of the on-line LTER All-Site Bibliography, will be completing his work with LTER in May. His contribution is much appreciated and widely used. The bibiliography project, completed at University of California, Davis under the direction of LTER Research Coordinator Caroline Bledsoe and with the cooperation of the LTER site data managers, was supported by a subcontract to the LTER Network Office grant.

The LTER Bibiography provides a comprehensive compilation of citations on research conducted across the LTER sites, including work completed at a site before it joined the Network. For the initial version, completed in mid-1993, Harvey developed a filter which converted individual site bibliographies into a common format, enabling search functionality and on-line display. The current version contains over 12,000 citations for 19 LTER sites, including the North Inlet site. Harvey recently made the bibliography available in World Wide Web format, and it is now linked through the LTER Network Office home page at *http://lternet.edu/biblio/.*

Harvey reports that the success of this project shows that the integration of site data is not impossibly difficult, and that future efforts to integrate other types of data should probably aim for distributed implementation. In a distributed system, each site's portion of a type of information resides at that site and is maintained by its staff. Mechanisms of such a system would allow users to conduct Network-wide queries of site-based data in a single, integrated operation, with all the returned information presented in the same formatting style, regardless of how it is stored by the local site.

During his three years with LTER, Harvey also developed and maintained a web site for the Information Center for the Environment at UC Davis. He will be seeking Web work on political campaigns for the rest of this election year ◆

COURTESY OF KEN MCGWIRE

New McMurdo Data Manager Hired

The McMurdo Dry Valleys, Antarctica LTER site has announced that Kenneth McGwire, Assistant Research Professor at the Biological Sciences Center, Desert Research Institute, Reno, Nevada since 1994, will assume responsibilities as site Data Manager. Dr. McGwire holds both a master's and a doctoral degree in geography from the University of California Santa Barbara, and has expertise in a broad range of academic and applied issues in physical geography.

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Congressional Reports Available Online

The Committee for the National Institute for the Environment has made over 140 Congressional Research Service (CRS) environmental reports online as part of its National Library for the Environment at *http://www.cnie.org/nle.*

International Checklist of Geological Indicators

The International Union of Geological Sciences, through its Commission on Geological Sciences for Environmental Planning, has developed a checklist of geoindicators of rapid environmental change to be published shortly as part of a monograph outlining the scientific and policy background and including a series of reviews of key geo-indicators. Meanwhile, the checklist itself is available via the Internet at *http://www.gcrio.org/geo/title.html.*

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For more information: Dr. A.R. Berger, Chair, Geoindicators Working Group, 604/480-0840.

USGS FY 97 BUDGET EXPANDS SCIENTIFIC MISSION

The fiscal year 1997 budget request for the U.S. Geological Survey of $746.4 million provides a net increase of $15.9 million over the FY 1996 Conference level approved under the April continuing resolution. Specific components of the increase include $6.8 million to meet the high-priority science needs of Interior land managers, an expanded Cooperative Fish and Wildlife Research Unit System, and increased access to natural resources information; $2 million to cover residual costs for unemployment and workers compensation payments for former employees of the U.S. Bureau of Mines; and $5 million to support the use of classified data by civilian agencies and scientists for environmental applications.

The USGS budget for FY 1997 also includes about $10 million in offsetting decreases and increases. As part of the continuing efforts to implement Phase II of the reinventing government effort, the USGS is eliminating geothermal assessment activities (-$2.2 million), streamlining information dissemination services (-$2.2 million), eliminating low-priority data collection and analysis work on water resources (-$1.1 million), and eliminating federal funding for grants to the Water Resources Research Institutes (-$4.5 million). The savings realized from these program changes would be applied to strengthen the Federal/State Cooperative Program to address national water issues ($4.5 million) and to support four new program directions involving urban hazards ($1 million), drinking water and public health ($1.4 million), a digital national atlas ($1 million), and a framework for geospatial data ($2 million).

The budget reflects an increase over previous years as programs of the former National Biological Service are absorbed within the USGS, as well as part of the mineral information program of the former U.S. Bureau of Mines. The "new" USGS will begin FY97 with 10,700 employees working on projects involving water, earth and natural resources in all 50 states and Puerto Rico.

◆ *For more information: Karen R. King, USGS Public Affairs Office, 703/648-4460*

COLLABORATIVE REMOTE SENSING FIELD CAMPAIGN PLANNED FOR NIWOT RIDGE LTER SITE

In a truly collaborative effort, a large remote sensing and field campaign is scheduled for the Spring 1996 snowmelt season at the Niwot Ridge/Green Lakes Valley LTER site and at nearby Loch Vale Watershed in Rocky Mountain National Park. The objective of the campaign is to provide a comprehensive regional dataset for ongoing research concerning the responses of alpine hydrology and ecology to changing snowpacks. The effort includes contributions from: the NASA AVIRIS Program, the NASA EOS IDS project "Hydrology, Hydrochemical Modeling and Remote Sensing in Seasonally Snow-Covered Alpine Drainage Basins", NOAA's National Snow and Ice Data Center (NSIDC), Analytical Surveys, Inc. (ASI; a commercial photogrammetric surveying and mapping firm located in Colorado Springs, CO), the National Biological Survey (NBS), the National Park Service (NPS), and the USGS Water Resources Division

The remote sensing acquisitions will include a three-flight AVIRIS, Thematic Mapper Simulator (TMS), and high-altitude CIR photography time series of the region in April, May, and June (provided at no cost by NASA), three Landsat TM scenes (provided by NSIDC), and a time series of five to six low-altitude black and white aerial photography (provided by the EOS IDS project). ASI is donating their services to produce a high resolution (10 m) digital elevation model of the Niwot site (NWT), which will be used in subsequent analysis and modeling using the remote sensing data.

The remote sensing data coverage will include the entire alpine region of the Colorado Front Range, including Rocky Mountain National Park. Field surveys supporting the remote sensing data acquisitions will be performed at the Niwot site by NWT, NASA, and EOS personnel, and at the Loch Vale site by NBS, NPS, and USGS personnel. The contributed remote sensing and DEM data alone is valued at ~$125,000.

Immediate uses of the campaign data will include snow water equivalence and snowmelt modeling, and further development of algorithms to retrieve snow surface information from remotely sensed imagery. The snowmelt information will in turn be used as inputs for research on geochemical and biogeochemical controls on the solute content of surface waters. Other potential uses of the data include examination of vegetation/snowpack dynamics and vegetation biomass studies.

◆ *For more information: Don Cline, dCline@LTERnet.edu*

THE LTER NETWORK INFORMATION SYSTEM (NIS)

A network information system (NIS) working group was established at the August 1995 LTER Data Managers Meeting in Snowbird, Utah to design and develop an LTER-wide information system that facilitates cross-site data exchange for inrersite research with the capacity for seamless information and data queries. The primary objectives of the effort are to: increase the utility of the existing network and site information systems; and increase access, query, and retrieval capabilities on intersite data. The multidisciplinary group includes LTER data managers, principal investigators, and members from the research community at large.

The group has begun the process of developing a design document (available via WWW at *http://lternet.edu/is/*) and establishing a preliminary work plan for development and implementation of an LTER Integrated Network Information System. The envisioned system will be a distributed system using advanced client/server network tools, independent of computer platform, ensuring the system is useful into the coming decade. In addition, the group will strive to integrate site-level information systems, not replace them.

The effort will focus on advances in the query and retrieval system that will facilitate: (1) searching for data available anywhere in the LTER Network; (2) combining and analyzing data from different sites; (3) answering standardized information requests; (4) building economical query systems for specific projects; and (5) building analysis and display tools that are intuitive to researchers.

Plans for 1996 include:

- a review of the basic design and implementation strategy,
- establishing participation by intersire and synthesis groups,
- adoption of metadata standards for ecological data, and
- beginning the development of the "distributed" LTER all-site bibliography.

While the mission is to meet the research needs of LTER scientists, the information system will be available to a broader community of scientists.

◆ *For more information: James Brunt, Sevilleta LTER, jBrunt@LTERnet.edu; Rudolf Nottrott, LTER Network Office, rNottrott@LTERnet.edu*

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LTER-NASA STANDARDIZATION WORKSHOP

A workshop will be held at the H.J. Andrews Experimental Forest from May 1-3, 1996 involving LTER scientists and NASA collaborators. The focus of the workshop is standardization of combined field, modeling, and remote sensing methods across the LTER Network for creation of biophysical spatial data layers at the LTER site level, and on comparison of these with data layers created at the global scale by NASA scientists. The workshop will help to kickoff a study partially funded by NASA's Terrestrial Ecology Program in the Office of Mission to Planet Earth, in which 14 LTER sites and NASA's MODIS Land (MODLAND) Science Team are involved. Primary biophysical variables of interest include land cover class (LCC), leaf area index (LAI), and aboveground net primary productivity (NPP). Each site has defined a minimum 100 km^2 area for which these data layers will be developed at a grain size of 25 m. Several methods are proposed for estimating each of the three biosphere variables at all sites, and these will be used to help establish error bounds on the variable estimates. A number of different strategies are proposed for spatially aggregating the fine-grain site maps to a coarse grain (1 km) so that they can be compared to maps of the same three biosphere variables developed by the MODLAND Science Team.

This coordinated, multi-site grain-size aggregation exercise presents the opportunity to grapple with one of the most vexing current problems in ecology, that of the effects on estimates of important biosphere variables of scaling from a fine grain to a coarse grain. Several methods are proposed for addressing this issue, including the calculation of geostatistical and landscape metrics. The intent is to characterize the sites, in terms of the LCC, LAI, and NPP at several spatial scales to elucidate similarities and differences among the multiple sites and biomes and between the MODLAND maps and site maps. The workshop is a crucial step in the future development of LTER and NASA programmatic and science interactions.

◆ *For more information: Warren B. Cohen, 503/750-7322, wCohen@LTERnet.edu*

HARVARD FOREST

Addressing major issues in policy debates and in the understanding of ecosystem process and pattern

The Harvard Forest LTER program has developed an integrated research approach that involves scientists from the biological, physical, and social sciences

By David R. Foster

In pre-European times forest patterns in the New England landscape were broadly controlled by such factors as climate and physiography and were locally determined by soils, aboriginal impacts, and the effects of fire, windstorms, and pathogens. This landscape was transformed by European settlement, with its accompanying broad-scale deforestation, farming, and subsequent abandonment of agriculture and widespread reforestation. In 200 years forest cover dropped to 25 to 40% and then recovered to 65 to 90%. Associated with this landscape transformation were subtle impacts: (1) decimation of native animal populations; (2) widespread alteration of aquatic ecosystems and natural drainage; (3) introduction of pathogens; (4) changes in atmospheric chemistry; and (5) "perforation" of the forest landscape by suburbanization, road construction, and forestry.

COURTESY OF HARVARD FOREST

***Above:** Each summer the Harvard Forest runs an ecological research training program for undergraduates, recent graduates and graduate students. Approximately 30 students, from Maine to Puerto Rico and California to Massachusetts, participate.*

The reforestation of the New England landscape has been heralded as an environmental cause cèlebre in recent book and media coverage, but major ecological questions abound. How does the composition, structure and function of the modern forest landscape compare with that of pre-European times? Does forest response to novel versus natural disturbance and stress differ? What are the legacies of historical land-use in the modern landscape? These questions address major issues in policy debates and in the understanding of ecosystem process and pattern. With a focus on New England terrestrial and aquatic ecosystems, they form the heart of the Harvard Forest LTER Program in Central Massachusetts.

In order to address these questions, the Harvard Forest LTER program has developed an integrated research approach that involves scientists from the biological, physical, and social sciences. Including projects funded by DOE (NIGEC), the Mellon Foundation, NASA, and NSF REU and CRUI programs, this research effort annually involves more than 80 senior scientists and 30 students representing more than 20 institutions. The integrated approach that has been taken in the Harvard Forest LTER (see column at far right) seeks to provide a long-term perspective on the development of the forest landscape; to investigate ongoing processes and relationships through long-term measurement; to study the response to critical stresses and disturbances through experimental manipulations and controlled environment studies; to integrate results across studies, disciplines, and scales; and to apply the resultant understanding to fundamental ecological questions and societally relevant issues. Investigation across spatial scales is an important part of this program because it allows us to place intensive, site-based studies within a broad context, to understand processes that operate across landscapes and physiographic regions, and to identify and address regionally important issues.

The value of this approach is apparent in recent abstracts from the Seventh Annual Harvard Forest Ecology Symposium concerning two very different processes: the effect and legacies of 18th to 19th Century agricultural land-use and the impact of the extreme midsummer drought in 1995. From paleoecological and historical data Janice Fuller, Emily Russell, and David Foster reported that European settlement resulted in the most rapid rates of vegetation change in the last 2,000 years, the development of novel assemblages of tree species, and a decrease in the spatial variation of forest composition across the region, with little indication that the forests were returning to their pre-settlement condition despite more than 100 years of reforestation. Glenn Motzkin and Jason McLachlan used paleoecology, dendroecology, and forest surveys to highlight the long-term impact of land-use on modern stand structure and composition and Kathleen Donohue investigated the demography, architecture and reproductive biology of clonal species to explain the resulting species:land-use patterns.

Land-use legacies also persist in terms of ecosystem process and response to disturbance. Studies reported by Jana Compton indicated that the type of 19th Century land-use was important to modern soil characteristics: formerly plowed and pastured sites have higher nitrification potentials, higher counts of autotrophic bacteria responsible for conversion of nitrate into nitrate, and lower C:N ratios than permanently forested sites. As a consequence of extensive prior land-use the forests are a net sink for carbon, as highlighted by Bill Munger and Steve Wofsy from their eddy flux measurements; Eric Davidson is evaluating the relative contributions of soils and plant biomass to this uptake. One ultimate policy implication of these studies was addressed by John Aber, who suggested that current patterns of nitrate leaching to streams in the northeastern United States may depend more on historical patterns of land-use and disturbance than on current rates of N deposition.

A major value of the LTER program is the ability to detect and evaluate the consequences of unusual events and environmental conditions. In Central New England the summer of 1995 was marked by an extreme mid- to late-summer drought that resulted in the wilting and premature leaf fall of many understory trees and herbs, extreme soil moisture deficits, and some unexpected consequences on forest net ecosystem exchange detected at our Environmental Measurement Station tower. Bill Munger and Steve Wofsy reported that the net uptake of carbon was similar or slightly greater than in previous years, as depressed photosynthesis rates were counteracted by greater declines in ecosystem respiration. Kathy Newkirk, Jerry Melillo, and Eric Davidson documented that soil respiration rates fell precipitously as the drought intensified. Interestingly and atypically, poorly drained sites and trenched sites without roots had the greatest respiration rates, presumably due to higher soil moisture. Oaks studied through the drought by Jeannine Cavender-Bares and Fakhri Bazzaz varied in their response by size class: seedlings had a much greater depression of photosynthetic activity than overstory trees, which were more deeply rooted and able to tap deeper stores of moisture. Apparent species differences in the ability to tolerate the drought suggests that overall species composition, as controlled by land-use and successional status, may have a large influence on overall forest response.

Scaling these observations up Dave Fitzjarrald indicated that positive feedbacks may exist between the vegetation and climate during such a drought period; associated with drought-induced water stress are an increase in bulk canopy resistance to water vapor, decreased evapotranspiration, and a decrease in water vapor in the atmospheric boundary layer. These conditions restrict cloud formation, resulting in increased afternoon temperatures, increased plant stress and a lifting of the condensation layer in the atmosphere and further decrease in cloudiness. As a result of our long-term series of measurements, this change in cloud formation, as well as plant to ecosystem responses to this short-term climatic event, were readily detected.

The annual symposium, along with monthly science meetings, enable the LTER program to synthesize and summarize major findings and to highlight the connections between long-term studies and short-term responses. (Copies of the symposium abstracts are available on request.) We invite other scientists and students to join us in these collaborative efforts.

◆ *For more information: David Foster, 508/724-3302, dFoster@LTERnet.edu*

Harvard Forest LTER Program Design

Research Approaches

1. Reconstruction of ecosystem dynamics using paleoecology, historical ecology, and modeling to evaluate long term trends, to study infrequent processes, and to understand the development of modern conditions.
2. Measurement of modern ecosystem structure, composition, processes, and dynamics on permanent plots, through remote sensing, and through eddy flux measurements of atmosphere-biosphere exchanges to define current conditions and rates.
3. Experimental manipulations of ecosystems to evaluate and compare patterns of response and to collect integrated measurements on multiple processes.
4. Controlled environment studies of plant and population response to specific environmental change.
5. Integration through modeling, comparative studies, monthly meetings, annual symposia, and synthetic products.
6. Application to ecological theory, conservation biology, environmental policy, and forest management.

Spatial Scales of Investigation

1. Plot - 0.1 km
1. Site - 1 km - Harvard Forest
2. Landscape - 10 km - Petersham, MA
3. Sub-region - 100 km - Central Massachusetts
4. Region - 1000 km - New England and adjacent New York

Disturbances, Stresses, and Environmental Processes Investigated

1. Climate change
2. Windstorms and other environmental extremes
3. Fire
4. Native and introduced pathogens
5. Land-use: aboriginal, European, and current
6. Nitrogen deposition and nitrogen saturation

Education Integrated with Research

1. Summer Research Program for Undergraduates and Graduate Students (25-30 students/yr)
2. Informal Education Program through the Fisher Museum (>5,000 visitors/yr)
3. Graduate Programs through diverse institutions at the MS and Ph.D. level (10-20/yr)
4. Bullard Fellowship Program for mid-career Scientists (4-8/yr)
5. Conferences, Symposia, and Workshops (>500 participants/yr)

A major value of the LTER program is the ability to detect and evaluate the consequences of unusual events like the extreme mid- to late-summer drought of 1995 in Central New England

HUBBARD BROOK EXPERIMENTAL FOREST

Probing the complex interactions between biological systems and their physical-chemical environment

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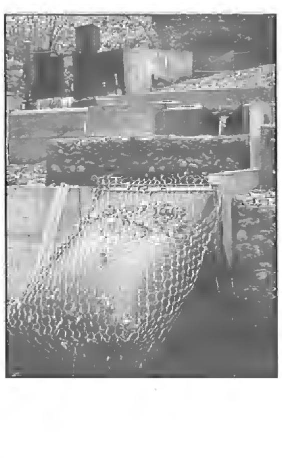
By Timothy J. Fahey

Exploration of the interactions between biogeochemical cycles and anthropogenic disturbances over long time scales has been possible at HBR because of the long-term continuity of the research program

Originally established by the U.S. Forest Service in 1955 as a center for hydrologic research in New England, the Hubbard Brook Experimental Forest became widely known as a site for ecosystem studies, originating the small watershed approach to quantify element cycles and initiating the Hubbard Brook Ecosystem Study (HBES) in 1960. Today, the HBES continues to probe the complex interactions between biological systems and their physical-chemical environment through an integrated suite of long-term monitoring, plot-level and watershed-scale manipulations, and conceptual and quantitative models. Entering the Network in 1987, the Hubbard Brook (HBR) LTER project has contributed greatly toward attaining the overall goal of the HBES: to develop an understanding of ecological processes governing the structure and function of the northern hardwood forest ecosystem and associated aquatic ecosystems in order to provide a scientific basis for their management.

The theme of the ongoing HBR-LTER project is ecosystem response to natural and anthropogenic disturbances. Recognizing that the dynamics of an ecosystem scarcely can be understood in the absence of comprehensive knowledge of the historical and contemporary suite of disturbances to which it is exposed, we have continued to evaluate disturbance effects on biotic communities and on energy flow and element cycles. Most recently, these efforts have been highlighted by our attempts to synthesize current knowledge o the biogeochemistry of macronutrient elements in the HBEF watershed-ecosystems. The cycles of these elements have been altered on a region-wide scale by anthropogenic disturbance, especially land use in the form of forest harvest and air pollution in the form of atmospheric acid deposition. Exploration of the interactions between biogeochemical cycles and these disturbances over long time scales has been possible at HBR because of the long-term continuity of the research program.



TIMOTHY J. FAHEY

Right: Element fluxes in streamwater are quantified for nine experimental watersheds by precise measurements of hydrologic discharge using v-notch weirs and weekly chemical analysis of streamwater samples.

The experimental watersheds at Hubbard Brook are situated on moderate to steep slopes near the upper elevation limit of the hardwood forest in the White Mountains of New Hampshire. Soils are acidic, well-drained spodosols with a thick organic horizon, and soil depth decreases up the hillslope. The HBEF was heavily logged between 1909 and 1917, and although the forest exhibited high rates of biomass accumulation through the late 1970s, in recent years net biomass accumulation has declined almost to zero.

Hubbard Brook Calcium Cycling

The combination of naturally base-poor soils, high deposition of anthropogenically-derived acids and periodically accelerated removal of bases associated with forest harvest would be expected to make the Hubbard Brook ecosystem susceptible to excessive depletion of soil base cations, especially calcium (Federer et al.. 1989). In fact, a quantitative interpretation of our records of precipitation, soil and streamwater chemistry strongly suggests that ecosystem recovery in response to decreases in acid deposition may be delayed significantly (Likens et al. 1996). Reductions in pollution emissions of SO_2 and consequent decreases in deposition of strong acids followed the passage of the Clean Air Act in 1970, but at HBEF these reductions have been accompanied by declining deposition of strong-base cations (CB), especially calcium. Coincident reductions in streamwater concentrations of strong acids and strong bases since 1970 have resulted in a lack of response of pH and ANC of surface waters across the northeastern region.

To evaluate the possible implications of historical and projected changes in atmospheric deposition, Likens et al. (1996) estimated the suite of ecosystem sources and sinks of calcium for the Hubbard Brook forest since 1940. These budgetary calculations suggest that an interval of high net losses of calcium from the soil exchange complex occurred during the peak of acid deposition (1960 and 1970s) when the Hubbard Brook forest was rapidly accumulating biomass (and calcium). Together with the recently reduced

See pages 18-19 for references cited

inputs of CB in bulk deposition, these net losses may be adversely affecting calcium supply to the trees. We have measured marked declines in calcium concentrations in organic soil horizons since 1970, stemwood concentrations have declined steadily since peaking in the 1960s, and on the shallowest soils foliar calcium also appears to be affected. We have observed unusually high mortality of sugar maple in the upper hardwood zone in the Hubbard Brook forest where soil calcium pools are smallest, and foliage Ca concentrations for sugar maple and yellow birch in this zone have been consistently lower by over 50% than lower on the hillslope.

JEFFREY W. HUGHES

Left: A whole-tree harvest experiment on watershed 5 illustrated the mechanisms of reorganization and loss of nutrient capital and heightened concerns about the combined effects of atmospheric acid deposition and forest harvest on ecosystem health in base-poor forests in the Northeast.

Has forest production and health at Hubbard Brook been declining because of limitation by nutrient base cations? We recently implemented a plot-level soil chemical manipulation study on these upper slopes at HBEF to address this question and to further evaluate the base cation cycling patterns and their responses to inputs and losses of base cations. The results of this ongoing study will aid in the design of a watershed-level chemical manipulation that will allow us to take advantage of our small watershed approach and to examine landscape-level variations in ecosystem response to chemical perturbations.

Potassium Cycling

The importance of landscape-level patterns in explaining whole watershed behavior were particularly evident in our integrative analysis of the cycle of potassium at HBEF (Likens et al. 1994) and its response to large-scale disturbance by forest harvest (Romanowicz et al. 1996). In the upper reaches of the forested watersheds, concentrations of K in streamwater are relatively high (12 µmol/L) and seasonally invariant, whereas lower in the catchment concentrations are lower (4-5 µmol/L) and show a pronounced decline during the growing season. This pattern has been attributed primarily to systematic variation in soil properties across the watersheds. Soils at high elevation are rich in organic matter and hence exchangeable K, and high streamwater K is maintained despite the seasonal vegetation uptake sink. At lower elevations organic matter levels and exchangeable K pools are much lower in mineral soil horizons leading to lower average K concentrations in streams. The seasonal variations at lower elevations appear to result largely from changes in hydrologic flowpaths, with higher concentrations in the late fall, winter and spring when the local water table rises closer to the surface and water migrates laterally through the porous and more K-rich surface horizons (Likens et al. 1994). During the growing season, transpiration lowers the water table and water flows mostly through deeper soil layers.

After clearcutting, K concentrations in streams rise markedly for a few years until vegetation is reestablished; however, K in streams remains elevated (by roughly twofold) for many years thereafter whereas NO_3 concentrations are reduced nearly to zero four years after clearcutting. This unexpected behavior of K appears to be explained in part by increases in soil exchangeable K pools that resulted from accelerated release from detrital pools (dead roots and forest floor). Again, the behavior of K displays a landscape-level pattern that is in accord with the aforementioned soil chemical and hydrologic mechanism of control of streamwater K concentration. For example, in the recovery phase after cutting annual variation in streamwater K is accentuated particularly in the lower part of the watershed where the soils and glacial till are deepest and the shifts in hydrologic flowpaths most prominently affect stream chemistry.

A quantitative interpretation of HBR precipitation, soil and streamwater chemistry records strongly suggests that ecosystem recovery in response to decreases in acid deposition may be delayed significantly

Our greatest challenge in synthesizing macronutrient cycles is the case of nitrogen because of its complex transformations. By integrating the processes and patterns of N cycling over the long period of biogeochemical study at HBEF we hope to contribute to a better fundamental understanding of the behavior of this important nutrient and pollutant (and its interactions with other elements) so that a sound scientific basis for management of N in regional ecosystems can be established. This research continues the tradition of basic and applied biogeochemical studies of the Hubbard Brook Ecosystem Study and the HBR-LTER project.

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SITE ACTIVITIES & PROJECTS

For more information on LTER sites, visit the LTER Network home page at URL http://lternet.edu

◆

RESEARCH TEAM JOINS JORNADA

(Excerpted with permission from Jornada Trails Volume 2, Issue 1, March 1996)

Working together for many years at the U.S. Department of Agriculture's Walnut Gulch research station in southeastern Arizona, the research team of Athol D. Abrahams (SUNY-Buffalo), Tony Parsons (University of Leicester, U.K.) and John Wainwright (King's College, London) have joined the Jornada LTER project. They hope to extend their studies of runoff and sediment transport to a broad area of the desert Southwest.

In recent work published in *Geomorphology*, the team showed that the invasion of desert grasslands by shrubs causes increased erosion from the "interrill" areas, by decreasing resistance to overland flow. This erosion increases the spatial heterogeneity of nutrients in desert soils. Last summer, Athol and his coworkers performed a number of rainfall simulation experiments at the Jornada, in which the runoff waters were collected for measurements of the loss of nitrogen, phosphorus and other soil nutrients from soils in grassland and shrubland habitats.

CENTRAL PLAINS SITE EXPANSION

In the midst of completing their LTER renewal proposal, the Central Plains Experimental Range LTER group reached an agreement with the U.S. Forest Service to expand the LTER site to include not only the Central Plains Experimental Range, where the project has been based, but also the Pawnee National Grasslands. Adding 78,100 ha (193,000 acres) of adjacent land will provide a better representation of the shortgrass steppe and increase the land area available for ecological studies. In a recent analysis (*Ecological Modelling*, Vol. 67 No. 1, 1993), lead investigators Ingrid Burke and Bill Lauenroth suggested that the site within its previous boundaries did not adequately represent areas with fine-textured soils. A name change to reflect the expansion—from Central Plains Experimental Range to Shortgrass Steppe (SGS)—has been implemented at the site level and is under way at the Network level.

The Pawnee National Grasslands includes: a wide variety of soils and soil textures; a broad range of mean annual precipitation; active, relatively large prairie dog towns; riparian communities; a large number of abandoned cultivated fields; two Research Natural Areas that will be protected from grazing; and a direct connection with the major group of land managers who may potentially utilize portions of the information the LTER project develops. The proposed addition increases the realm of inference of the site to 23% of the shortgrass steppe within the Central Great Plains region.

The new site definition will provide the scientists and students who work on the LTER project with some exciting possibilities for future research. A list of high priority research proposed for the next six years includes: (1) the evaluation of keystone species, including prairie dogs and plains prickly pear cactus; (2) population genetics of blue grama, the dominant plant of the shortgrass steppe; (3) atmosphere-biosphere interactions; and (4) detrital food web dynamics. ◆ *Kari Bisbee, Acting Project Manager*

HURRICANE OPAL DAMAGE AT COWEETA

On October 5, 1995, after causing heavy damage along the Gulf of Mexico shoreline, Hurricane Opal moved inland. Damage at the Coweeta LTER site near Franklin, North Carolina consisted of extensive treefalls and road washing due to more than 23 cm of precipitation and heavy winds. Damage was most severe on sites with thin soils and hence poorly rooted trees. Though local utilities were off-line for more than one week in some locations, the main administrative building area at Coweeta and most major research locations experienced no significant damage. However, one plot in the current Rhododendron Removal Project was decimated by extensive treefalls. Since all temperature sensors were still operating underneath the treefalls and access to all streambed wells and two of three sets of soil lysimeters was reestablished, research on the plot will continue. More than two years of extensive baseline measurements on the plot will allow for some unique comparisons between pre- and post-damage conditions. ◆ *Brian D. Kloeppel*

HARVARD FOREST UPGRADES

Harvard Forest now has a full-time data manager (Richard Lent), with responsibility for strategic planning and oversight of all aspects of research information management and support. The site also is now fully connected to Harvard University's computer network in Cambridge via a high-speed leased telephone line. All of our offices and labs in all three HFR buildings have been wired with network cable. Approximately 35 IBM-compatible PC's are now directly connected to Harvard and the Internet. All HFR personnel have Harvard University electronic mail accounts and have switched over to using Eudora e-mail software.

With LTER supplementary grant funds, HFR has significantly upgraded mass storage and data archiving capabilities. New hardware acquisitions include six CD-ROM drives, plus a CD-recordable drive for making our own CDs; 35 Connor tape drives; five internal and one external Bernoulli cartridge drives; six gigabyte-range hard drives; and a Microtek ScanMaker III color scanner. In addition to the new hardware, optical character recognition software now enables scanning and machine-reading of old typescripts stored in the Harvard Forest archives. We are also evaluating neural-network software that translates scanned paper maps into GIS layers. These acquisitions will aid in the conversion of older, archival materials into machine-readable data. ◆ *Richard Lent*

SPATIO-TEMPORAL DYNAMICS OF CANOPY & SOIL MOISTURE

Geoff Henebry and Alan Knapp, Konza Prairie Research Natural Area LTER, have been awarded a National Science Foundation intersite grant for a project that uses Synthetic Aperture Radar (SAR) data from European, Canadian and Japanese orbital platforms to address synoptically the spatiotemporal variation in canopy

(next page, top)

SITE ACTIVITIES & PROJECTS

and soil moisture and their ecological consequences. The SAR imagery is being provided through data grants from NASA and the European Space Agency. These data augment current investigations at Konza and Sevilleta National Wildlife Refuge LTER. Both sites are located within ecotones in which soil moisture is a major determinant of plant productivity and species composition. The primary products will be site-specific time series of soil moisture and canopy change maps. These spatiotemporal data will then be used for several distinct objectives all aimed at improving scene models that link remote sensing and ground truth-level data with ecological processes.

At Konza, the working hypothesis is that temporal shifts of spatial patterns in SAR imagery of prairie landscapes can reveal topoedaphic constraints on soil moisture availability, which translate into constraints on the productivity of the vegetation and which, in turn, are expressed in terms of the structure of a maturing canopy. At Sevilleta, of particular interest are the effects of the El Niño Southern Oscillation as it modulates the amount of annual and seasonal precipitation and thereby available soil moisture, plant production, nutrient cycling, and animal abundance. SAR imagery enables the mapping of soil moisture across the site for parameterization, calibration, and validation of spatially-explicit soil water balance models. Segmentation of SAR image series will facilitate landscape classification of this large and diverse study area. Cross-site objectives include comparative analysis of image series using robust spatial metrics to refine change detection and quantification algorithms and to compare at the landscape level the responsiveness and sensitivity of ecological processes and patterns to climatic fluctuations. ◆ *Geoff Henebry*

HIGH SCHOOL STUDENTS STUDY KONZA PRAIRIE WATER QUALITY

A 1995 NSF supplement to the Konza Prairie LTER funded research by a group of high school students and their teacher to collect and analyze water samples from streams, ponds and groundwater. The goal was to characterize spatial patterns of water quality; previous research has established temporal patterns at select sites on Konza. The student group (Eun Sun, Heather Smith, Pat Weather and Noah Hartford) was assembled by Dru Clark, a science teacher at Manhattan High School. These students previously had been involved in Ms. Clark's EPA-funded project to monitor a nearby stream, and thus had basic training in water sampling and analysis. Through the LTER supplement, they had the opportunity to participate in research at the University level with advanced analytical equipment. Dr. Walter Dodds was the faculty mentor, and Dr. John Blair assisted with chemical analysis. The students left the project with a positive attitude toward science, some research experience, and having contributed to the knowledge base on prairie water quality.

Several longitudinal stream transects were sampled from upland and gallery forest reaches of two separate watersheds. A number of ponds, wells and groundwater springs were also sampled. Several interesting trends emerged that had not been documented previously on Konza. In general, ponds and upland streams had the lowest nutrient content (N and P), and groundwater and lowland streams contained the most nitrate and total N. Wells under agricultural fields had nitrate levels 10 times higher than in prairie wells and springs. A region where groundwater influenced the upland streams was documented with slightly elevated nitrate and soluble reactive phosphorus levels. As streams passed into cultivated areas, the nitrate and total N levels increased several-fold. This occurred despite wide intact riparian buffer zones of gallery forest in the cropland areas. The results will assist in planning future research on water quality. ◆ *Walter Dodds*

LUQUILLO AWARDED TWO MAJOR NASA GRANTS

The University of Puerto Rico (Luquillo LTER site) has recently been awarded two major NASA grants to conduct LTER-related research. The first, "Development of a Center for Tropical Atmospheric Sciences in Puerto Rico," addresses chemical fluxes between the ocean and atmosphere, between the land and atmosphere, and chemical reactions and transport in the troposphere. The 22 collaborators in this three-year project received total funding of $3,360,000 over three years.

During the last 50 years, more than 30% of Puerto Rico's land area has been released from agricultural uses and is undergoing secondary forest succession. Repeated aerial photography obtained during that period allows the identification of land areas that have undergone this secondary succession for different lengths of time. Within these "chronosequences," under the second grant ("Land Management in the Tropics and its Effects on the Global Environment," $3,800,000 over five years) 13 UPR investigators are (1) identifying successional changes and comparing the outcomes of different land-management strategies; (2) examining physical, chemical, and microbial changes in soils, and effects of those changes on stream quality; and (3) measuring the release of greenhouse gasses through succession. ◆ *Doug Schaefer*

◆

LUQUILLO RESEARCHERS AWARDED SMALL BUSINESS INNOVATION GRANT

Charles Hall (Luquillo Experimental Forest LTER) and Marshall Taylor received a grant for $70,000 from the National Science Foundation's division of Small Business Innovation to develop their spatial models in an object-oriented context to make them much more flexible and user friendly. The proposal was based to a significant extent on earlier work Hall and Taylor had done on watershed modeling in Luquillo, and they will be including Puerto Rico examples as part of model developments under the grant.

STUDENT INTERSITE COMPARISON

Streamflow Hydrology at Five LTER Sites

Hydrology is a critical component of all ecosystems. Water moving through hillslopes and stream channels links terrestrial and aquatic ecosystems, drives nutrient cycling processes, and governs geomorphic and fluvial disturbance processes. Streamflow monitoring is a component of research at 11 of the 18 LTER research sites, and four sites have climate and streamflow records spanning more than 30 years. This article describes preliminary results—supported by a 1995 LTER Network Office graduate student travel award—from an ongoing comparative study of streamflow hydrology at four LTER sites: H.J. Andrews (AND), Coweeta (CWT), Hubbard Brook (HBR), and Luquillo (LUQ), as well as Caspar Creek (CC), a U.S. Forest Service Research Forest in California's Coast Range (see table at right). These sites were selected because they have contrasting hydrologic characteristics and well-documented long-term streamflow and climate records. It is hoped that approaches developed in this study will be extended to examine other sites' long-term streamflow records.

Streamflow patterns from undisturbed watersheds differ markedly among these five sites, reflecting differences in climate and vegetation (see table and figures). At CWT, HBR, and LUQ, precipitation is evenly distributed throughout the year, whereas precipitation at AND and CC occurs predominantly in winter (Figure A) (McKee and Bierlmaier 1987, Swift 1987, Ziemer and Albright 1987, Federer et al. 1990). This distinction produces relatively constant monthly streamflows at CWT and HBR, but much higher winter than summer streamflows at AND and CC (Figure B). AND and HBR also have a seasonal snowpack, whereas CWT only occasionally receives snow, and LUQ and CC lack snow. Melt of the seasonal snowpack contributes to prolonged high spring streamflows at AND and a rapid rise in spring streamflows at HBR compared to CWT and CC (Figure B). Forest canopies at CWT and HBR are dominated by deciduous broadleaf vegetation which transpires throughout the summer months, whereas forest canopies at AND and CC have evergreen coniferous vegetation which may rranspire little during dry summer months. Potential evapotranspiration greatly exceeds precipitation in the summer at AND and CC (Bierlmaier and McKee 1989, Swift et al. 1975), whereas summer soil moisture deficits are smaller at CWT and HBR (Federer 1982).

The availability of these high-quality long-term streamflow data provide the opportuniry to address a number of process-based hypotheses relating hydrology to ecology at long-term ecological research sites. For example, post-disturbance vegetation succession may differ among sites and produce contrasting post-disturbance streamflow patterns. Life history strategies of aquatic organisms and stream community structure may be related to streamflow variability at annual, seasonal, storm, or diurnal time scales. Nutrient fluxes may differ among sites according to the relative importance of rare, large precipitation and streamflow events. A two-year collaborative project is currently under way to further compare streamflow data among these five sites.

◆ *Reed Perkins, H.J. Andrews*

Figure A. Cumulative Annual Precipitation

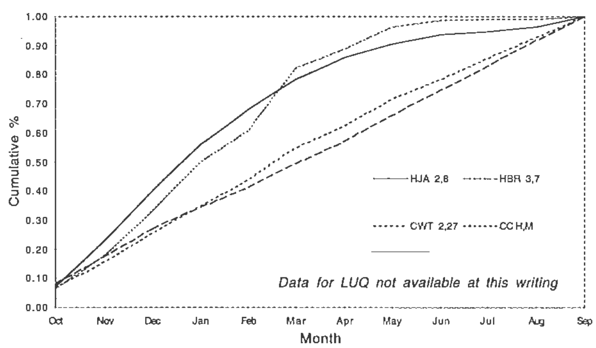
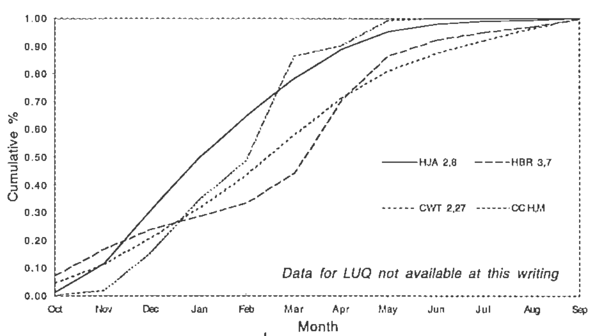


Figure B. Cumulative Annual Runoff



Above: Figure A. Cumulative annual preciptation *of AND, HBR, CWT, and CC.* ***Figure B.*** *Cumulative annual runoff of AND, HBR, CWT, and CC. Percentages represent averaged percentages of runoff produced at two control watersheds at each site.*

Climate and Vegetation Characteristics of Five Long-Term Streamflow Monitoring Sites

Site	*Location*	*Climate*	*Vegetation*
H.J. Andrews	Oregon	winter rain/snow, summer drought	old-growth Douglas-fir forests
Coweeta	North Carolina	winter rain, summer rain	oak hickory forests
Hubbard Brook	New Hampshire	winter snow, summer rain	northern hardwood forests
Caspar Creek	California	winter rain, summer drought	second-growth Douglas-fir, coastal redwood forests
Luquillo	Puerto Rico	`winter rain, summer rain	sub-tropical and lower montane forests

REFERENCES: Streamflow Hydrology at Five LTER Sites

McKee, A. and F. Bierlmaier. 1987. H. J. Andrews Experimental Forest, Oregon. Pages 11-17 in: Greenland, D. (ed). *The Climates of the Long-Term Ecological Research Sites.* Occas. Pap. 44. Institute of Arctic and Alpine Research,University of Colorado: Boulder. 81 pp.

Swift, L.W. 1987. Coweeta Hydrologic Laboratory, North Carolina. Pages 28-33 in: Greenland, D. (ed). The climates of the Long-Term Ecological Research Sites. Occas. Pap. 44. Institute of Arctic and Alpine Research,University of Colorado: Boulder. 81 pp.

Ziemer, R.R. and J.S. Albright. 1987. Subsurface pipeflow dynamics of north-coastal California swale systems. Pages 71-80 in: R. Beschta, T. Blinn, G.E. Grant, F.J. Swanson and G.G. Ice (eds). *Erosion and Sedimentation in the Pacific Rim* (Proceedings of the Corvallis Symposium, August, 1987). International Association of Hydrological Sciences Pub. No. 165.

Federer, C.A., L.D. Flynn, C.W. Martin, J.W. Hornbeck and R.S. Pierce. 1990. *Thirty Years of Hydrometeorological Data at the Hubbard Brook Experimental Forest, Nw Hampshire.* Gen. Tech. Rep. NE-141. USDA Forest Service, Northeastern Forest Experiment Station: Radnor,PA. 44pp.

Bierlmaier, F.A. and McKee, A. 1989. Climatic summaries and documentation for the primary meteorological station, H. J. Andrews Experimental Forest, 1972 to 1984. Gen. Tech. Rep. PNW-242. USDA Forest Service, Pacific Northwest Research Station: Portland, OR. 56 pp.

Swift, L.W., W.T. Swank, J.B. Mankin, T.J. Luxmorre and R.A. Goldstein. 1975. Simulation of evapotranspiration and drainage from mature and clear-cut deciduous forests and young pine plantation. *Water Resources Research* 11(5): 667-673.

Federer, C.A. 1982. Improving forest hydrology research. Pages 653-663 in: Canadian Hydrology Symp. 82, National Research Council of Canada. Fredricton, New Brunswick.

STUDENT INTERSITE COMPARISONS

Fall 1995 Travel Awards

In response to a 1994 request by the LTER Graduate Student Committee, the LTER Executive Committee approved the use of LTER Network Office funds to support student travel to LTER sites for intersite comparison work. Fall 1995 student proposals were reviewed by the Executive Committee and awarded February 1, 1996.

Cross-Site Comparisons of Two Important C_4 Perennial Grasses in North American Grasslands

TAMERA J. MINNICK
Ph.D. candidate, Colorado State University (Ecology)

Bouteloua gracilis and *Bouteloua eriopoda* are two important perennial grasses in North American grassland ecosystems. Both are C_4 perennial bunchgrasses that tolerate high temperature and low moisture regimes, yet their geographic distributions differ remarkably: *Bouteloua gracilis* is distributed throughout the central grasslands of Canada, the United States and Mexico and *B. eriopoda* is limited to the U.S. Southwest and Mexico. The LTER Network is the ideal system for comparing these species, since *B. gracilis* dominates the Central Plains Experimental Range (CPR), *B. eriopoda* dominates the remnant grassland portion of the Jornada, and both are found in abundance at the Sevilleta (SEV). The general objective of my doctoral research is to investigate effects of disturbance, environmental constraints, and competition on the distribution and abundance of these two important North American species. I will combine field experiments with simulation modeling to address site- and regional-level questions across an environmental gradient that includes these three LTER sites. I want to know how these patterns can explain the current and predict the future geographic distributions and abundances of the two species. I am also examining experimentally the role of competition at CPR and SEV to determine the influences of inter- and intraspecific competition, the physical environment and the interactions of these on the distributions and abundances of *B. eripoda* and *B. gracilis.* By using a variety of approaches at different spatial and temporal scales, my goal is to determine relative effects of disturbance, environmental constraints, and competition on the distribution and abundances of these two important North American perennial grasses.

Local Adaptation of Hymenolepis citelli *in Ground Squirrels*

L. DWIGHT FLOYD
Ph.D. candidate, Colorado State University (Zoology)

Ground squirrels (*Spermophilus spp.*) cover a wide range in western North America from the Arctic to northern Mexico. Across their range, the ground squirrels may vary in a number of ways, but particularly with respect to hibernation regimes. These differences may occur between species but also within species along latitudinal and altitudinal gradients. Despite these differences in life history, *Hymenolepis citelli* (a tapeworm) is found in all species of ground squirrel. The purpose of this study is to determine how H. citelli reacts to these differences in their ground squirrel hosts and how the ground squirrels react to different parasite populations. These differences should help to determine the extent of local adaptation in parasite and host populations. Ground squirrels of different species and different ranges will be captured and cross-infected with parasites of complementary geographical regions or species. Hibernation regimes may then be controlled by placing some animals in cold rooms. Host and parasite fitness will then be compared between experimental groups. ◆

CARBON DYNAMICS OF TWO CONIFER ECOSYSTEMS:

Northwest Russia & the Pacific Northwest, USA

For the past two years, scientists from Russia and the H.J. Andrews Forest LTER program have been collaborating on a project that compares the carbon dynamics of two major conifer-dominated regions of the globe. Originally planned at the 1993 LTER All-Scientists Meeting, the project has since involved four joint workshops funded through NSF's Long-Term Studies Program and International Division. The latest, a two-day symposium to report progress held February 4-17, 1996 at Oregon State University, Corvallis, was very productive despite heavy rains and flooding that required a hasty evacuation of the Russian participants from their motel!

Right: *Participants of the February 1996 Workshop at Oregon State University, Corvallis (left to right, lower to upper rows): Janice Harmon, Kira Kobak, Maria Fiorella, Olga Krankina, Marina Botch, Victor Soloviev, Oleg Chertov, Peter Homann, Yevgenii Kuznetsov, Warren Cohen, Steve Garman, Yuri Koukouev, Alexander Lioubimov, Mark Harmon, Rudolf Triefeld, Anatoli Greskin. Other attendees included Art McKee and David Greenland.*

The overall objective of the collaboration has been to compare the carbon dynamics of the St. Petersburg, Russia area (specifically Leningrad Oblast) to western Oregon and Washington. Both regions are dominated by coniferous vegetation, and the forests are a major economic resource. They differ, however, in terms of climate, potential productivity, and land-use history. Comparison at the regional scale requires a large cast of characters: thus far, the project has involved 20 scientists from the H.J. Andrews Experimental Forest, Oregon State University, and the U.S. Forest Service Pacific Northwest Research Station; the St. Petersburg Forestry Academy, the State Hydrologic Institute, the Komarov Botanical Institute, and the Northwestern Forest Inventory Office (all based in St. Petersburg), as well as the All-Russia Forest Inventory Department of the Russian Federal Forest Service, based in Moscow.

At the first three workshops, held alternately in St. Petersburg and Corvallis in 1994 and 1995, participants developed a general workplan, a detailed Russian workplan, coordinated data gathering and analysis efforts, and the 1996 workshop. Frequent communication has been key to keeping the effort on track and has lead to a healthy convergence of approaches. Initially, the U.S. team was strongly centered on the integration of simulation modeling and remotely sensed data to determine changes in vegetation condition in a GIS framework, while the Russians took advantage of an abundance of high quality, spatially explicit inventories for forest, wetland, and soil resources. As the project develops, however, U.S. participants are revisiting archival inventory data and Russian participants are applying GIS and remote sensing technologies.

This transition of approaches was most evident in the February workshop, which included working sessions where papers were outlined, data crunched, simulations run, and satellite imagery of the St. Petersburg area was analyzed. The paper abstracts will be published by the LTER Network Office, and participants are developing a book to compare the dynamics of several carbon pools. These comparisons have already shown that: (1) Carbon stores in St. Petersburg-area forests have increased over the last 30 years, whereas those in the Pacific Northwest (PNW) have decreased over the same period. (2) Carbon distribution in the two regions differs, with roughly a 50:50 mix in live and detrital/soil stores in the PNW versus 70, 15, and 15% stored respectively in peat, live vegetation and detritus/soil pools in the St. Petersburg region. (3) Forest products are minor carbon stores in both regions, with approximately 20% of the carbon harvested over the last 100 years still residing as forest products or waste. The proportion of waste to products is quite different, however, with buildings storing 70% in the PNW and industrial manufacturing waste storing 75% in the St. Petersburg area (showing there is more than one way to skin a log!). Other interesting features will no doubt emerge as the project continues.

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CLIMATE CHANGE 1995 IPCC SECOND ASSESSMENT REPORT

An overview of the complete reports of the Intergovernmental Panel on Climate Change (IPCC) to be published this spring by Cambridge University Press was presented at the AAAS meeting in Baltimore, MD in February 1996. Of special interest to ecologists will be the results of Working Group II: Scientific Analyses of Impacts, Adaptations, and Mitigation of Climate Change. Working Group I directly analyzed greenhouse gases, climate and climate change.

The Working Group II report includes chapters on forests, rangelands, deserts, the cryosphere, mountain regions, hydrology and freshwater ecology, non-coastal wetlands, coastal zones and small islands, and oceans; as well as on land degradation and desertification, human settlement, agriculture, forest products, water resources management, human population health, and more. Working Group III treats economic and social dimensions.

The major points presented on the climate system and greenhouse gases were that greenhouse gases continue to increase, anthropogenic aerosols negatively influence radiative forcing and counter greenhouse warming in some places, climate has warmed in the last century, the influence of humans on the climate appears to be discernible, climate change is expected to continue, and there are many uncertainties.

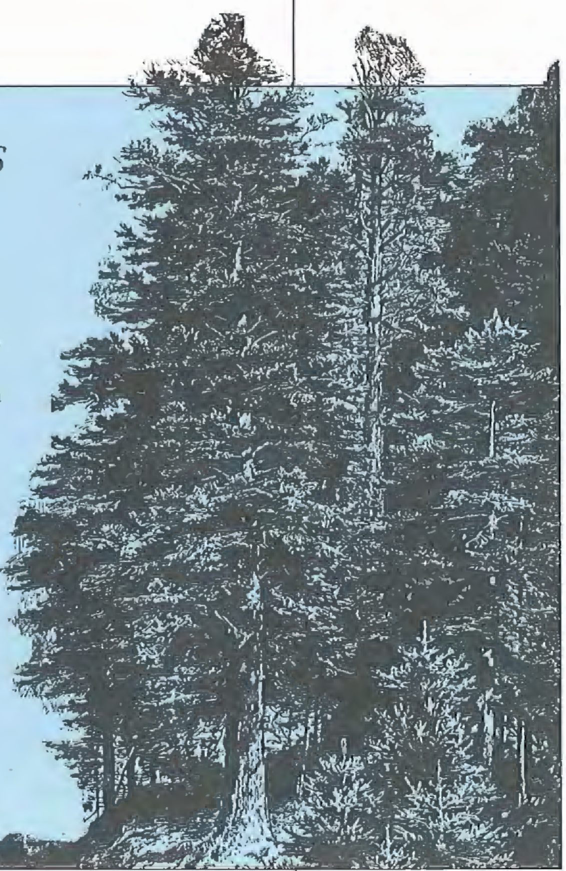
Among the uncertainties: Future unexpected, large and rapid climate system changes (as have occurred in the past) are, by their nature difficult to predict. This implies that future climate changes may also involve "surprises." In particular, these arise from the non-linear nature of the climate system. When rapidly forced, non-linear systems are especially subject to unexpected behavior. Progress can be made by investigating non-linear processes and sub-components of the climatic system. Examples of such non-linear behavior include rapid circulation changes in the North Atlantic and feedbacks associated with terrestrial ecosystem changes.

Summaries of the IPCC Second Assessment are available on the UNEP web site at

http://www.unep.ch/ipcc/ipcc95.html

◆ John J. Magnuson, North Temperate Lakes LTER

INTERNATIONAL CANOPY NETWORK ANNOUNCES JOINT BIODIVERSITY PROJECT with HARVARD UNIVERSITY & MADAGASCAR



The International Canopy Network (ICAN) is pleased has undertaken a joint project with Harvard University and the Ranomafana National Park of Madagascar to explore and begin documenting the biodiversity of the forest canopy in Madagascar. The ultimate goal of this project is to establish canopy biodiversity monitoring stations in at least two locations on the island.

The first phase of the project will begin with an April, 1996 expedition to explore the canopy in a variety of sites the first such exploration to date. Joel Clement (ICAN), Gary Alpert (Harvard), and resident biologists will use single rope canopy access techniques to sample arthropods, epiphytes, and collect natural history observations in sites ranging from Ranomafana in the south to the Masoala Peninsula in the north. Additional funding will be sought to follow up on this exploration and establish monitoring stations.

◆

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INTERNATIONAL LTER (ILTER) INTERACTIONS

U.S. LTER & LMER Scientists Visit Iberian Sites

Right: Charles Buchanan, Jr., Fundação Luso-Americana (FLAD), addresses U.S. and Iberian scientists at a joint meeting in Lisbon prior to their departure for site visits. From left: Charles Simenstad, Matos Fernandes, Francisco Andrade and Buchanan.

COURTESY OF FLAD

A team of U.S. scientists representing the LTER and Land-Margin Ecosystem Research (LMER) programs traveled to Portugal and Spain March 9-16, 1996 to visit possible sites for a long-term ecological research network for those countries and discuss the potential for future interaction. The visit was jointly funded by the U.S. National Science Foundation's International Programs division, the Fundação Luso-Americana (FLAD) in Portugal, and the University of Seville in Spain. The U.S. representatives were: James Brunt (Sevilleta, LTER Data Managers Committee Chair), Paul Bolstad (Coweeta), Bob Christian (Virginia Coast), James Gosz (U.S. LTER and ILTER) Bruce Hayden (Virginia Coast), Alan Knapp (Konza Prairie), Johanes Knops (Cedar Creek), Manuel Molles (Sevilleta), and Charles Simenstad (LMER).

The group divided into two teams to visit several coastal/estuarine sites and terrestrial/montane sites in both Portugal and Spain. The LTER research model was well accepted as an important complement to the traditional form of science practised in both countries. Once Iberian sites are identified, with joint funding from the same institutions appropriate U.S. LTER sites will host Spanish and Portugese scientists to identify training needs and possible collaborative projects. Further developments in the interaction will be reported in future issues of the *Network News* ◆

Right: Professors Garcia-Novo (left) and Fonseca (foreground) discussing cork oak ecosystems with Manuel Molles (Sevilleta LTER) and Johannes Knops (Cedar Creek LTER) in Portugal.

JAMES R. GOSZ

COURTESY OF FLAD

Above: ILTER Chair James Gosz addresses representatives of the Fundação Luso-Americana (FLAD) in Portugal.

JAMES R. GOSZ

Above: Lunchtime for the U.S., Portugese and Spanish scientists on the dune ecosystems of coastal Spain.

CHARLES A. SIMENSTAD

Above: Regional botanist describes coastal bluff/dune vegetation communities south of Sines, Portugal to the ILTER coastal contingent.

INTERNATIONAL LTER (ILTER) INTERACTIONS

Central Europeans Visit NSF & LTER Sites

Following the NSF International Programs-supported visit of a team of seven U.S. LTER representatives to Central Europe in June 1995, a group of 11 scientists from Poland and the Czech and Slovak republics visited the United States in September 1995. First stop was at NSF for an overview of the U.S. LTER Program and International Programs (INT) opportunities for research exchanges. While each participating country develops core support for their own research programs, INT will fund efforts that facilitate interaction and communication. Proposals from other countries are submitted to their counterpart funding agencies, and U.S. companion proposals either to a regular program (for direct research support plus travel from INT) or to INT for travel funds. U.S. scientists who already receive NSF funding may be eligible for travel and collaboration supplements.

JAMES R. GOSZ

Left: U.S. scientists discussing the 150 year-old spruce and beech forest in the Sumava National Park in the southern Czech Republic. The forest naturally regenerated following the only logging ever performed in this forest (~1800-1850).

The visitors provided an overview of research in their respective countries, noting that the short-term nature of funding makes it difficult to develop the comprehensive, integrated long-term efforts. While sites may be well-characterized, more advanced technologies (GIS, remote sensing, modern weather stations) are needed for comparability. The group was divided into three focus groups for U.S. LTER site visits:

- *Biogeochemistry and forest ecology*—Hubbard Brook and Coweeta LTER sites. Chris Johnson (Hubbard Brook/Syracuse University) and Steve Macko (Virginia Coast/University of Virginia), leaders
- *Hydrobiology in lakes and streams*—North Temperate Lakes and Coweeta LTER sites. Fred Benfield (Coweeta/Virginia Polytech Institute), leader
- *Montane and alpine systems*—Sevilleta and Niwot Ridge LTER sites. James Gosz (Sevilleta/University of New Mexico), leader

JAMES R. GOSZ

Left: Czech and U.S. scientists "in" the residual snow field in the alpine region of the Krkonossky Narodni Park in the northern Czech Republic.

The Czech scientists met near the end of the tour to plan for an LTER effort. They formed a committee, elected a chair (Vera Straskrabova, Director, Institute of Hydrobiology, Czech Academy of Sciences), and identified six sites: Krivoklatsko (Krivoklat area), Krkonose (Giant Mountains), Palava hills, Sumava (Bohemian Forest Mountains), Trebonsko (Trebon area), and Vltava watershed reservoirs. The U.S. LTER Network Office agreed to help identify funding for training assistance in connectivity and data information management, and to help develop and initially host a Czech WWW home page ◆

Publications of Interest

Ecosystem Geography. Bailey, R.G. 1996. Springer-Verlag: New York, NY. 204 pp. 1-800/777-4643.

Final Report of the Ecological Society of America Committee on the Future of Long-Term Ecological Data (FLED). Volumes I and II. K.L. Gross (chair) and several Committee members are LTER-affiliated. Volume I is available in printed form from Brian Kellet, Ecological Society of America, 2010 Massachusetts Avenue NW, Washington, D.C. 20036. Volume II is accessible from ESA's web site at *http://www.sdsc.edu/1/SDSC/Research/Comp_Bio/ESA/FLED/rep_vol2.htm.*

International Partnerships in Large Science Projects. 1995. OTA-BP-ETI-150. 132 pages. Suggestions from the now-defunct Office of Technology Assessment on internationalizing big science projects. Available from the U.S. Government Printing Office, 202/512-1800, 202/512-2250 (fax).

Sonoran Desert Plants: An Ecological Atlas. Turner, R.M., J.E. Bowers and T.L. Burgess. 1995. 504 pages. Available from the University of Arizona Press, Tucson. 1-800/425-3797.

NEW FROM THE NETWORK OFFICE!

Guidelines for Measurements of Woody Debris in Forest Ecosystems. Mark Harmon and Jay Sexton. April 1996. Publication No. 20. LTER Network Office. University of Washington, Seattle.

PUBLICATIONS

Benning, T.L. and T.R. Seastedt. 1996. Landscape-level interactions between topedaphic features and nitrogen limitation in tallgrass prairie. *Landscape Ecology* 10: 337-348.

Briggs, J.M. and A.K. Knapp. 1995. Interannual variability in primary production in tallgrass prairie: climate, soil moisture, topographic position and fire as determinants of aboveground biomass. *American Journal of Botany* 82:1024-1030.

Brillhart, D.E., G.A. Kaufman and D.W. Kaufman. 1995. Small-mammal use of experimental patches of tallgrass prairie: influence of topographic position and fire history. Pages 59-65 in: D.C. Hartnett (ed). Proceedings of the 14th North America Prairie Conference.

Clark, J.S., B.J. Stocks and P.J.H. Richard. 1996. Climate implications of biomass burning since the 19thC in eastern N. America. *Global Change Biology.* (In press)

Clark, B.K., D.W. Kaufman, G.K. Kaufman and S.K. Gurtz. 1995. Population ecology of Elliot's short-tail shrew and least shrew in ungrazed tallgrass prairie. Pages 87-92 in: D.C. Hartnett (ed). Proceedings of the 14th North America Prairie Conference.

Clinton, B.D. and J.M. Vose. (In press.) Effects of *Rhododendron maximum L.* on *Acer rubrum L.* seedling establishment. *Castanea.*

Clinton, B.D., K.J. Elliott and W.T. Swank. (In press.) Response of planted eastern white pine (*Pinus strobus L.*) to mechanical release, competition, and drought in the southern Appalachians. *South. Jour. of Appl. For.*

Clinton, B.D., J.M. Vose, and W.T. Swank. (In press.) Shifts in aboveground and forest floor carbon and nitrogen pools after felling and burning in the southern Appalachians. *Forest Science.*

Coleman, D.C. and D.A. Crossley, Jr. 1996. *Fundamentals of Soil Ecology.* Academic Press: San Diego. xv +205 pp.

Collins, S.L. and S.M. Glenn. 1995. Grassland ecosystem and landscape dynamics. Pages 128-156 in: A. Joern and K.K. Keeler (eds). *The Changing Prairie.* Oxford University Press: Oxford, U.K.

Coxwell, C.C. and C.E. Bock. 1995. Spatial variation in diurnal surface temperatures and the distribution and abundance of an alpine grasshopper. *Oecologia* 104: 433-439.

de Soyza, A.G., A.C. Franco, R.A. Virginia, J.F. Reynolds and W.G. Whitford. 1996. Effects of plant size on photosynthesis and water relations in the desert shrub *Prosopis glandulosa* (Fabaceae). *American Journal of Botany* 83:99-105.

Dodds, W.K. and G.M. Henebry. 1995. Simulation of responses of communiry structure to species interactions driven by phenorypic change. *Ecological Modelling* 79:85-94.

Dyer, M.I., A.M. Moon, M.R. Brown and D.A. Crossley, Jr. 1995. Grasshopper crop and midgut extract effects on plants: an example of reward feedback. *Proceedings of the National Academy of Sciences* 92: 5475-5478.

Elias, S.A. 1996. Ice Age History of National Parks in the Rocky Mountains. Smithsonian Institution Press: Washington, D.C. 170 pp.

Evans, E.W. and T.R. Seastedt. 1995. The relations of phytophagous invertebrates and rangeland plants. Pages 580-634 in: D.J. Bedunah and R.E. Sosebee (eds). *Wildland Plants: Physiological Ecology and Development Morphology.* Society for Range Mgmt.: Denver,CO.

Federer, C.A., J.W. Hornbeck, L.M. Tritton, C.W. Martin, R.S. Pierce and C.T. Smith. 1989. Long-term depletion of calcium and other nutrients in eastern U.S. forests. *Environ. Manage.* 13:593-601.

Fetcher, N., B.L. Haines, R.A. Cordero, D.J. Lodge, L.R. Walker, D.S. Fernandez and W.T. Lawrence. (In press.) Responses of tropical plants to mineral nutrients on a landslide in Puerto Rico. *Journal of Ecology.*

Fredrickson, E.L., R.E. Estell, K.M. Havstad, W.L. Shupe, and L.W. Murray. 1995. Potential toxicity and feed value of onions for sheep. *Livestock Production Science* 42:45-54.

Gibson, D.J. and E.G. Towne. 1995. Dynamics of big bluestem (*Andropogon gerardii*) in ungrazed tallgrass prairie. Pages 9-15 in: D.C. Hartnett (ed). Proceedings of the 14th North America Prairie Conference.

Groffman, P.M. and C.L. Turner. 1995. Plant productivity and nitrogen gas fluxes in tallgrass prairie. *Landscape Ecology* 10:255-266.

Hamerlynck, E.P. and A.K. Knapp. 1995. Environmental and physiological factors influencing the distribution of oaks near the edge of their range. Pages 17-20 in: D.C. Hartnett (ed). Proceedings of the 14th North America Prairie Conference.

Hartnett, D.C. and K.H. Keeler. 1995. Population Processes. Pages 82-99: A. Joern and K. Keeler (eds). *The Changing Prairie.* Oxford University Press: Oxford, UK.

Henebry, G.M. 1995. Spatial model error analysis using autocorrelation indices. *Ecological Modelling* 82:75-91.

Henebry, G.M. and H. Su. 1995. Observing spatial structure in the Flint Hills using AVHRR biweekly composites of maximum NDVI. Pages 143-151 in: D.C. Hartnett (ed). Proceedings of the 14th North America Prairie Conference.

Hoover, C.M. and D.A. Crossley, Jr. 1995. Leaf litter decomposition and microarthropod abundance along an altitudinal gradient. Pages 287-292 in H.P. Collins, G.P. Robertson and M.J. Klug (eds). *The Significance and Regulation of Biodiversity.* Kluwer Academic Publishers: The Netherlands.

Huenneke, L.F. and I.R. Noble. 1995. Arid and semi-arid lands. Pages 349-354 in: V.H. Heywood (ed). *Global Diversity Assessment.* Cambridge University Press.

Humphries, H.C., D.P. Coffin and W.K. Lauenroth. 1996. An individual-based model of alpine plant distributions. *Ecological Modelling* 84: 99-126.

Inouye, R.S. and D. Tilman. 1995. Convergence and divergence of old-field vegetation after 11 years of nitrogen addition. *Ecology* 76:1872-1887.

Johnson, S.R. 1995. Gas exchange and reproduction of *Spiranthes vernalis* (Orchidaceae) in a Kansas tallgrass prairie. Pages 21-24 in: D.C. Hartnett (ed). Proceedings of the 14th North America Prairie Conference.

Johnson, S.R. 1995. Nests of *Hibana gracilis* are reused by *Phidippus clarus* in wetlands of northeastern Kansas. *The Journal of Arachnology* 23:44-45.

PUBLICATIONS

Johnson, S.R. 1995. Wind induced leaf binding by prairie cordgrass onto common milkweed in northeastern Kansas. *The Prairie Naturalist* 26:301-305.

Johnson, S.R. 1995. Spider communities in the canopies of annually burned and long-term unburned *Spartina pectinata* wetlands. *Environmental Entomology* 24:832-834.

Johnson, S.R. and A. Knapp.1995. The role of fire in *Spartina pectinata* wetlands dominated tallgrass prairie wetlands. Pages 92-101: S.I. Cerulean and R.T. Engstroms (eds). *Fire in Wetlands:a Management Perspective.* Proceedings,Tall Timbers Fire Ecology Conference, No. 19. Tall Timbers Research Station:Tallahassee, FL.

Kareiva, P. 1996. Diversity and sustainability on the prairie. *Nature* 379:673-674.

Kaufman, D.W. and S.H. Bixler. 1995. Prairie voles impact plants in tallgrass prairie. Pages 117-121 in: D.C. Hartnett (ed). Proceedings of the 14th North America Prairie Conference.

Kaufman, G.K., D.W. Kaufman, D.E. Brillhart and E.J. Finck. 1995. Effect of topography on the distribution of small mammals on the Konza Prairie Research Natural Area, Kansas. Pp. 97-102: D.C. Hartnett (ed). Proceedings of the 14th North America Prairie Conf.

Likens, G.E., C.T. Driscoll and D.C. Buso. 1996. Long-term effects of acid rain: response and recovery of a forest ecosystem. *Science.* (In press).

Likens, G.E., C.T. Driscoll, D.C. Buso, T.G. Siccama, C.E. Johnson, G.M. Lovett, D.F. Ryan, T.J. Fahey and W.A. Reiners. 1994. The biogeochemistry of potassium at Hubbard Brook. *Biogeochemistry* 25:61-125.

Lipson, D.A., T.K. Raab, and R.K. Monson. 1996. Delta-acetylornithine as a major nitrogen storage compound in *Bistorta bistortoides. Phytochemistry* 41(1): 29-30.

Lugo, A.E. and C. Lowe (eds). 1996. *Tropical Forests: Management and Ecology.* Springer-Verlag: New York, NY.

Naiman, R., J.J. Magnuson, D. McKnight, J. Stanford and J. Karr. 1995. Freshwater ecosystems and their management: A national initiative. *Science,* 27 October 1995.

Reichman, O.J. 1995. The influence of crowding and pocket gopher disturbance on growth and reproduction of a biennial, *Tragopogon dubius.* Pages 123-127 in: D.C. Hartnett (ed). Proceedings of the 14th North America Prairie Conference.

Reynolds, B.C. and D.A. Crossley, Jr. 1995. Use of a canopy walkway for collecting arthropods and assessing leaf area removed. *Selbyana* 16: 21-23.

Romanowicz, R.B., C.T. Driscoll, T.J. Fahey, C.E. Johnson, G.E. Likens and T.G. Sicama. 1996. Changes in potassium pools and fluxes in a northern hardwood forest following a whole-tree harvest. *Soil Sci. Soc. Amer. Journal.* (In press)

Ross, R.M., E.E. Hofmann and L.B. Quetin (eds). 1996. *Foundations for Ecosystem Research in the Western Antarctic Peninsula Region.* American Geophysical Union: Antarctic Research Series. (In press)

Schlesinger, W.H., J.A. Raikes, A.E. Hartley and A.F. Cross. 19965. On the spatial pattern of soil nutrients in desert ecosystems. *Ecology* 77:364-374.

Schowalter, T.D. 1995. Canopy arthropod communities in relation to forest age and alternative harvest practices in western Oregon. *For. Ecol. and Mgmt.* 78:115-125.

Schowalter, T.D. 1995. Canopy invertebrate community response to disturbance and consequences of herbivory in temperate and tropical forests. *Selbyana* 16:41-48.

Seastedt, T.R. 1995. Soil systems and nutrient cycles of the North American Prairie. Pages 157-174 in: A. Joern and K.K. Keeler (eds). *The Changing Prairie.* Oxford University Press: Oxford, U.K.

Sheets, K.R. and J.M.H. Hendrickx. 1995. Noninvasive soil water content measurement using electromagnetic induction. *Water Resources Research* 31:2401-2409.

Shelton, A.L. and R.S. Inouye. 1995. Effect of browsing by deer on the growth and reproductive success of *Lactuca canadensis* (Asteraceae). *American Midland Naturalist* 134:332-339.

Sipe, T.W. and Bazzaz, F.A. 1994. Gap partitioning among maples (Acer) in Central New England: Shoot architecture and photosynthesis. *Ecology* 75:2318-2332.

Sipe, T.W. and Bazzaz, F.A. 1995. Gap partitioning among maples (Acer) in Central New England: Survival and growth. *Ecology* 76:1587-1602.

Smith, R.C., K.S. Baker, W.R. Fraser, E.E. Hofmann, D.M. Karl, J.M. Klinck, B.B. Prezelin, L.B. Quetin, R.M. Ross, W.Z. Trivelpiece and M. Vernet. 1995. The Palmer LTER: A Long-Term Ecological Research program at Palmer Station, Antarctica. *Oceanography* 8(3):77-86.

Thomas, P.M., K.F. Golly, R.A. Virginia and J.W. Zyskind. 1995. Cloning of nod gene regions from mesquite rhizobia and bradyrhizobia and nucleotide sequence of the NodD gene from mesquite rhizobia. *Applied and Environmental Microbiology* 61:3422-3429.

Tilman, D. 1996. Biodiversity: population versus ecosystem stability. *Ecology* 77:350-363.

Tilman, D., D. Wedin and J. Knops. 1996. Productivity and sustainability influenced by biodiversity in grassland ecosystems. *Nature* 379:718-720.

Toetz, D. 1995. Water chemistry and periphyton in an alpine wetland. *Hydrobiologia* 312: 93-105.

Whitford, W.G., G.S. Forbes and G.I. Kerley. 1995. Diversity, spatial variability and functional roles of invertebrates in desert grassland ecosystems. Pages 152-195 in: M. McClaran and T.R. Van Devender (eds). *The Desert Grassland.* University of Arizona Press: Tucson.

Williams, M.W., A D. Yang, A. F. Liu, A J. Turk and A.J. Melack. 1995. Controls on the major ion chemistry of the Urumqi River, Tian Shan, PR China. *Journal of Hydrology* 172: 209-229.

Yavitt, J.B. and A.K. Knapp. 1995. Wetlands may change tallgrass prairie from a sink to a source for atmospheric methane. Pages 137-141: D.C. Hartnett (ed). Proceedings of the 14th North America Prairie Conference.

Zimmerman, J.K., E.M. Everham III, R.B. Waide, D.J. Lodge, C.M. Taylor and N.V.L. Brokaw. 1994. Responses of tree species to hurricane winds in subtropical wet forest in Puerto Rico: implications of tropical tree life histories. *Journal of Ecology* 82:911-922.

Zimmerman, J.K., W.M. Pulliam, D.J. Lodge, V. Quilones, N. Fetcher, R.B. Waide, S. Guzman-Grajales, J.A. Parrotta, C.E. Asbury and L.R. Walker. 1995. Nitrogen immobilization by decomposing woody debris and the recovery of tropical wet forest from hurricane damage. *Oikos* 72:316-322.

Publications About LTER

CEDAR CREEK

Two papers reporting results of the Cedar Creek LTER biodiversity experiment (see Tilman et al. 1996 and Tilman 1996 at left) captured international, national and local media attention. The *Nature* paper was featured by British Broadcasting Corporation (BBC) World Service Radio and BBC Science Magazine and was translated into 15 languages and broadcast worldwide. National and local coverage included:

"Biodiversity is root of environmental growth." T. Meersman, [Minneapolis] *Star Tribune,* February 22, 1996, pg. B3.

" Ecosystem's productivity rises with diversity of its species." C.K. Yoon. *The New York Times,* March 5, 1996, pg. B8.

"The importance of biodiversity." B.F. Vento, House of Represenatives. Congressional Record Vol. 142 No. 3, March 13, 1996.

"Biodiversity is a boon to ecosystems, not species."A.S. Moffat. *Science* 271:1497.

U.S. LTER - LMER

During a visit of U.S. LTER and LMER scientists to Spain and Portugal, the LTER model and program received coverage in two Portugese papers, *Correio da manhã* (March 12, pg. 8) and *Diário de Notícias* (March 12, 1996, pg. 17).

PALMER STATION

Palmer's Bill Fraser participated in a week-long interactive K-12 science curriculum project ("Blue Ice: Focus on Antarctica") in conjunction with the "24 hours in Cyberspace" Internet project in February 1996. See Blue Ice's web page for some of the results: *http://www.usinternet.com/onlineclass/BI/blueice.html*

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Next U.S. LTER Coordinating Committee Meeting:

October 3-6, 1996 Harvard Forest

LTER

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CALENDAR

May 1996 ◆ November 1996

MAY 1-3 LTER-NASA MODLAND Workshop. H.J. Andrews Forest (Warren Cohen, H.J. Andrews LTER, 503/750-7322, *wCohen@LTERnet.edu*).

MAY 1 NSF Program Deadline: Biological Instrumentation & Resources. Multi-User Biological Equipment and Instrumentation Resources, Instrument Development for Biological Research (Karl A. Koehler, 703/306-1472 *kkoehler@nsf.gov)*

MAY 7 NSF-EPA Program Deadline. Joint Competition in Environmental Research (NSF: James Edwards, BIO, 703/306-1400, *jledward@nsf.gov*; EPA: Robert Menzer, 202/260-5779, *nabzer.robert@dpamail.epa.gov)*

MAY 30 - JUN 1 ILTER Connectivity Station. Puerto Rico (Rudolf Nottrott, LTER Network Office, 206/543-8492, *rNottrott@LTERnet.edu)*

JUN 1 NSF Program Deadline: Biological Instrumentation & Resources. Instrument Development for Biological Research (Karl A. Koehler, 703/306-1472 *kkoehler@nsf.gov)*

JUN 1 NSF Proposal Deadline: Education & Human Resources. Informal Science Education. (Hyman Field, 703/306-1616, *hfield@nsf.gov*)

JUN 15 NSF Target Date: Biological Sciences. Division of Environmental Biology, LTREB (Scott Collins, 703/306-1483, *sCollins@nsf.gov*). Systematic & Population Biology (James Rodman, 703/306-1481, *jrodman@nsf.gov;* B. Jane Harrington, 703/306-1481, *bharring@nsf.gov.* Ecological Studies (Michael Auerbach, 703/306-1479, *mauerbac@nsf.gov*; Taber D. Allison, 703/306-1479, *tallison@nsf.gov*)

JUL 15 NSF Program Deadline: Biological Sciences. Division of Environmental Biology, Long-Term Projects (Scott Collins, 703/306-1483, *sCollins@nsf.gov*). Research Collections in Systematics and Ecology (Scott Collins, 703/306-1483, *sCollins@nsf.gov*)

AUG 15 NSF Preliminary Proposal Deadline: Education & Human Resources. Informal Science Education. (Hyman Field, 703/306-1616, *hfield@nsf.gov*)

SEP 15 NSF Program Deadline: Biological Sciences. REU site proposals (James H. Brown, 703/306-1470, *jhbrown@nsf.gov*)

SEP 29 NSF Program Deadline: Biological Sciences, Special Competitions. Basic Research In Conservation and Restoration Biology (James H. Brown, 703/306-1470, *jhbrown@nsf.gov*)

OCT 1 NSF Program Deadline. Management of Technological Innovation (MOTI). (M. Christina Gabriel, Engineering, *cgabriel@nsf.gov*; Marietta Baba, Social Behavioral and Economic Sciences, *mbaba@nsf.gov*)

OCT 3-6 LTER Meetings: Executive and Coordinating Committees. Harvard Forest LTER, Petersham, MA. Field trip to Hubbard Brook LTER, NH. (Adrienne Whitener, Network Office, 206/543-4853, *aWhitener@LTERnet.edu*)

OCT 11 NSF Target Date: Biological Sciences, Special Competitions. Doctoral Dissertation Improvement Grants (James H. Brown, 703/306-1470, *jhbrown@nsf.gov*)

NOV 1 NSF Preproposal Deadline: Biological Instrumentation & Resources, Special Projects. Postdoctoral Research Fellowships in Biosciences Related to the Environment (James H. Brown, 703/306-1470, *jhbrown@nsf.gov)*

NOV 11 NSF Target Date: Biological Sciences. Division of Environmental Biology, Biotic Surveys and Inventories (Scott Collins, 703/306-1483 sCollins@nsf.gov)

NOV 11-16 International LTER (ILTER) Regional Meeting. Panama and Costa Rica. (Jerry Franklin, 206/543-4853, *jFranklin@LTERnet.edu*; Rudolf Nottrott, 206/543-8492, *rNottrott@LTERnet.edu)*

NOV 15 NSF Proposal Deadline: Education & Human Resources. Informal Science Education. (Hyman Field, 703/306-1616, *hfield@nsf.gov*)

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For more information on funding opportunities: NSF Science & Technology Information System (STIS), stis@nsf.gov, *703/306-0214, or* http://www.nsf.gov

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