LTER NETWORK NEWS

IN THIS ISSUE:

Newsletter of the Long-Term Ecological Research Network — Spring 1991, Issue 9

PALMER STATION

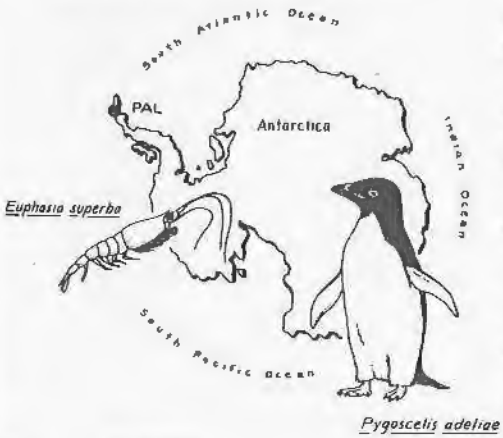
The Antarctic Marine LTER: An Ecosystem Dominated by Ice

by Robin M. Ross & Langdon B. Quetin

ROBIN M. ROSS & LANGDON B. QUETIN

Palmer Station and the surrounding waters have been chosen as the site of the first Antarctic LTER. The smallest of the three U.S. antarctic research stations managed by NSF, the station is located in a protected harbor on an island midway down the Antarctic Peninsula, and more than 600 miles from the tip of South America. LTER research will focus on the pelagic marine ecosystem and the ecological processes which link the extent of annual pack ice to the biological dynamics of different trophic levels. In these polar waters the annual cycle of ice formation and melting affects about 50% of the open sea.

Because pack ice is postulated to be the major physical determinant of temporal/spatial changes in the structure and function of polar biota, interannual cycles and/or trends in the annual extent of pack ice are likely to have significant effects on all levels of the food web, from total annual primary production to breeding success in seabirds. For example, recent studies suggest a connection between the extent of winter sea ice and the winter-over survival or reproductive success of the seabirds and their prey. Both Adélie penguins and antarctic krill, the 35 to 50 mm-long crustacean which is their favored prey, are positively affected when ice cover is most extensive. Conversely, reproductive success in south polar skuas, gull-like migratory seabirds, appears to be connected to the abundance of one age group of the antarctic silverfish, which appears to improve with less extensive ice.



Site Characteristics

The climate is typically maritime Antarctic, with snow and rain common any time of the year. The temperature at Palmer Station is relatively mild, averaging about -10°C in July and 2°C in January. The extent of sea ice is highly variable in the region, with particularly severe ice conditions occurring roughly every seven to 10 years and lasting two to three years within the last two decades. The areal extent of ice can vary by 25% between years.

There are several groups of islands with seabird rookeries between Palmer Station and Palmer Basin, the only deep basin in the area. Species studies under LTER will include the Adélie penguin, which dominates the seabird assemblage, and south polar skuas. During the breeding season, they forage in the upper water column within a 100 km radius of the rookeries, moving southwest into the Basin and west into the open ocean. The summer foraging region and wintering grounds of the seabirds help define the scale of the region to be investigated.

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From the Chair:

1990 LTER All Scientists Meeting

The contrast between the first and second LTER All Scientists meetings makes clear how far we have come as a network and as a research program

by Jerry F. Franklin

This issue of the newsletter recognizes the second LTER All-Scientists Meeting, held in September 1990. Judging from the response I have received since, it was a very successful effort. The ontstanding location in montane Colorado and a good organizational structure certainly helped. We owe the Coordinating Committee planning group, led by John Magnuson, a "well done." And special thanks go to the LTER Network Office staff, who did an outstanding job of facilitating the meeting.

The All Scientists meetings were conceived as a major network-building activity. They provide an opportunity for a large number of scientists from the LTER sites to learn about each others' research and to build the basis for multi-site collaborations. We also made a significant effort at the Colorado meeting to reach out to programs, sites, and scientists outside the LTER Network.

Collaborative Research

With its many and varied working sessions, last fall's meeting was very snccessful at eneouraging collaborative research efforts. There were meetings on technological innovations, such as the use of geolocators and applications of remote imagery, and the potential uses of construction cranes in studies of forest canopies. Common issues, such as the development of on-line data sets and a protocol on data sharing, also received attention.

Multi-site syntheses, observations, experiments and modeling exercises were formulated. Many moved from discussion to action stages. For example, a decision was made to summarize and contrast atmospheric chemistry at all of the LTER sites; and an intersite experiment on macroinverte-brate control of leaf decomposition in streams and a major expansion of the current intersite litter decomposition experiment were planned.

Workshop Products

Products from the workshops are making their way into the literature to reach an even broader community of ecologists. In one case, authors representing eight sites are contributing papers to an upcoming issue of *Ecological Modelling* devoted to LTER modeling efforts. Papers will include considerations of extrapolations from sites to regions, regional predictions, belowground processes, effects of local land use on regional climates, successional modeling across major ecosystem types, and carbon balance models.

The contrast between the first (held in 1984, Lake Itasca, Minnesota) and second LTER All Scientists meetings makes clear how far we have come as a network and as a research program. The Lake Itasca meeting was almost entirely devoted to "getting acquainted." At that time, there were only 11 sites and no network office. Intersite collaboration in research was very limited. There were no multi-site experiments and little in the way of multi-site synthesis and modeling. Some agreements existed regarding data management objectives but there was no Minimum Standard Installation--indeed, there was great resistance to setting any hardware and software standards at all.

We have come a long way in seven years. I look forward to seeing how much more progress we make before our next All-Scientist meeting in 1993! ■

• Network News •

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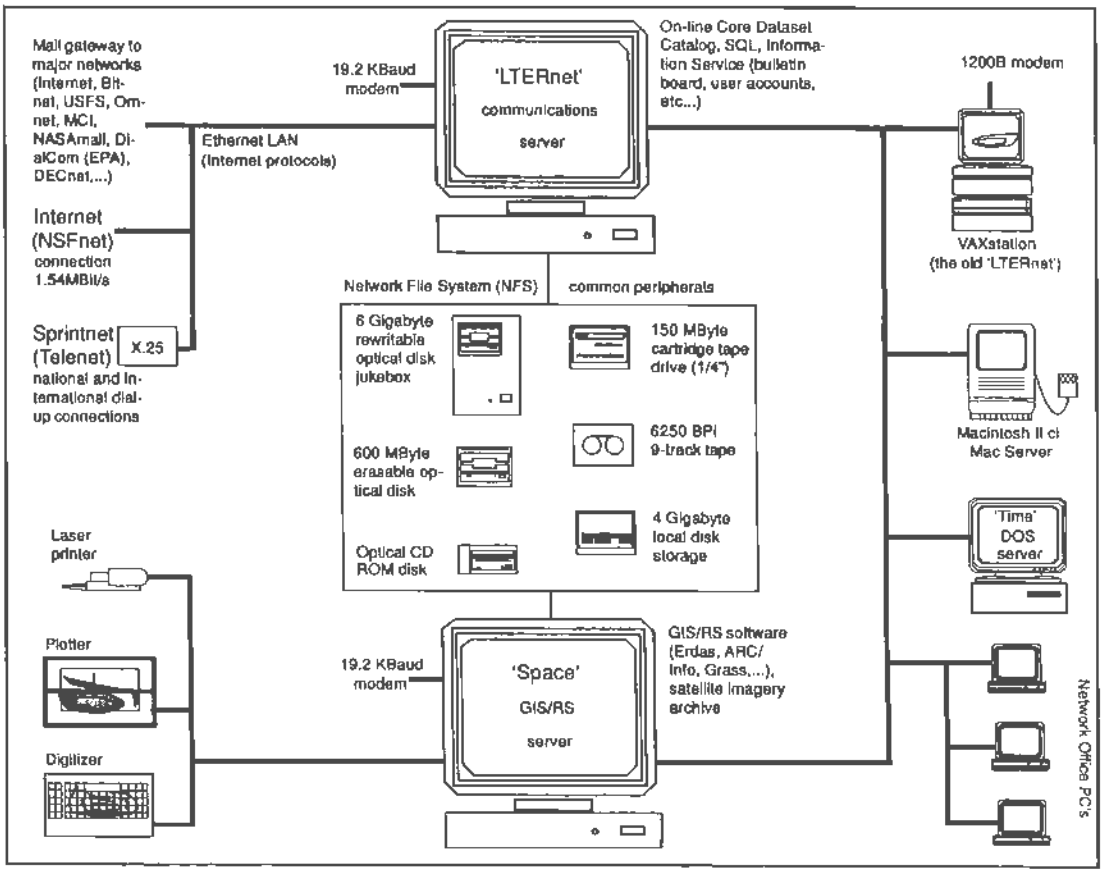
LTERNET Expands



RUDOLF NOTTROTT

by John Vande Castle & Rudolf Nottrott

The Long-Term Ecological Research Network's mail forwarding system has been undergoing a major upgrade with new funding from the National Science Foundation ("Remote Sensing Data Acquisition and Connectivity Initiative for the LTER Network," Franklin, Vande Castle, Nottrott). The current system, "LTERNET.washington.edu", has been running on a relatively small VAXstation-2000 which has continuously been expanded with various mail system interface protocols to allow direct communication to the diverse systems used by LTER. These include the Land-Margin Ecosystem Research Program, U.S. DOE Parknet, NASA, NOAA, EPA, and the USDA Forest Service. Computer services will be expanded from mail forwarding to include an on-line bulletin board, storage, database access, remote file sharing, dial-up access, on-line archival storage.

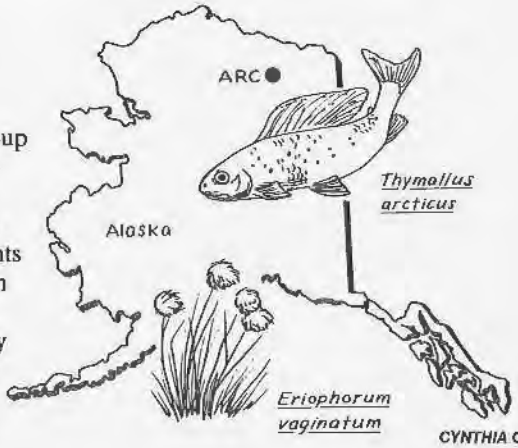
The two systems will share an extensive pool of hardware and software resources in a unified environment along with more than 4 gigabytes (Gb) of hard disk storage. A 6Gb removable, rewritable optical disk jukebox will provide on-line archival storage and backup capability. They will also share two CD-ROM drives, a 600Mb optical disk, 150Mb SUN cartridge tape drive, a Cipher 300-6250 BPI tape drive, and two 19.2kbaud modems.

The complete system will be configured with an X.25 communications link for access to U.S. SPRINTnet services. With this capability, any LTER researcher will be able to access LTERNET, or a local host machine, through a local-dial phone connection. Existing Internet connections will also allow LTER sites direct access via Network File System (NFS) services. Using NFS protocols, file systems at the Network Office can be directly connected to any site's PC, workstation or mainframe.

The existing LTERNET VAX will be renamed and used for VAX network services. Two satellite systems, an 80386 PC running VPIX (DOS) under Unix and a MacIntosh -IIci, will will also be integrated into the network to provide links for DOS and MacIntosh systems. ■

Arctic Tundra LTER

by Bernie Moller & Carolyn Bauman



CYNTHIA CASSELL

The Arctic Tundra LTER conducts its field work on the North Slope of the Brooks Range in Alaska approximately 125 miles south of the Arctic Ocean. Extensive ecosystem research is being conducted on two rivers, 11 lakes and five terrestrial sites. These research sites are now located within an Area of Critical Environmental Concern (ACEC), a designation created recently by the Bureau of Land Management in order to help protect the ongoing long-term research in the Toolik Lake and Kuparuk River areas.

Scaling Up

Two new grants, one through NSF's Division of Polar Programs for freshwater systems and the other for terrestrial research, will enable the Arctic LTER to expand its research program. The expanded program will include a more detailed study of land-water interactions, as well as a "scaled-up" examination of arctic lakes, streams and tundra. This will assist in the development of ecosystem models at both watershed and regional levels.

Nutrient Enrichment Study

In addition to long-term ecosystem monitoring, the Arctic LTER is engaged in extensive research of top-down (predator) and bottom-up (nutrient) controls in aquatic and terrestrial systems. The studies involve manipulations of both predators and nutrients and, in some cases, have been ongoing for more than eight years. Following is a summary of enrichment studies results to date:

• **Lakes.** A study of lake system responses to added nutrients was begun in 1983. Nitrogen (N) and phosphorus (P) were added, first to limnocorrals, then to the treatment side of a lake divided with a plastic curtain. Lakes and limnocorrals responded to added N and P with an immediate increase in algal growth and biomass. Most zooplankton species doubled their abundance after one-year. It took three to four years of enrichment before decomposition of the increased algal biomass began to deplete the bottom water of its late winter oxygen supply. The iron rich sediments of the divided lake tightly bound P and, even though bottom waters approached anoxia, no P was released into the water column. Within the sediments some iron-bound P became available to the benthic algae, which responded with an estimated two- to threefold increase in productivity in 1988.

This year the enrichment will be discontinued and an examination of the dynamics of recovery will begin. In addition, nutrient control will be investigated in another, larger lake type, with a different morphology and community structure.

• **Streams.** The Kuparuk River has been fertilized with P since 1983. The sequence of responses measured indicates that the dissolved phosphate stimulated the growth of epilithic algae, which lead to increased sloughing and export of algal biomass. Bacterial activity and biomass also increased. Only by the third year of treatment did insects show enhanced growth rates and, in some cases, increased densities. As a result of this greater food resource, young-of-the-year and adult grayling grew faster and had better condition factors; only after several years of fertilization did the top predator show response.

This year P enrichment of Oksrukuyik Creek will begin. This stream has a number of characteristics (size, discharge volume, riparian and macrophyte development, and stream bed composition) that differ from the Kuparuk and may alter nutrient uptake dynamics and, consequently, responses to enrichment. The expanded enrichment study will provide the opportunity to investigate how various stream types respond to similar experimental treatments.


JOHN E. HOBBIE

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Palmer Station, Antarctic LTER

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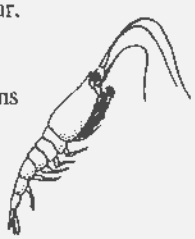
Overall Objectives

The overall objectives of the Antarctic Marine LTER are: (1) to document interannual variability in the development and extent of annual pack ice, and in life-history parameters of primary producers and populations of key species from different trophic levels; (2) to quantify the processes that underlie natural variation in these representative populations; (3) to construct models that link ecosystem processes to physical environmental variables, and that simulate the spatial/temporal relationships between representative populations; and (4) to employ such models to predict and validate the impacts of altered periodicities in the annual extent of pack ice on ecosystem dynamics.

Approach & Methodology

The general approach capitalizes on populations that are easily accessible near Palmer Station during a prolonged breeding season, and that sample the surrounding marine environment. Beginning in October 1991 (austral spring) a suite of critical biological and environmental variables will be monitored continuously on a small spatial scale (adjacent to Palmer Station) representing the seabird summer foraging area, but a long and recurrent temporal scale (every year, the entire breeding season).

Satellite imagery will be used to continuously monitor certain environmental parameters such as sea ice extent and thickness, sea surface temperature, and potentially color (fluorescence) on larger spatial scales and throughout the year. In addition, automatic weather stations at several selected positions in the regions will continuously monitor atmospheric pressure, wind speed and direction, and air temperature. Research at Palmer Station and in the surrounding nearshore waters will focus on the seabirds, the prey of the seabirds, primary production and hydrographic characteristics of the water column.



Processes (reproduction, recruitment) and parameters (food availability) that are sensitive to environmental change and are important in the structure and function of the communities will also be monitored. The inherent interan- nual variability in the extent of pack ice allows researchers to "conduct" natural experiments on the effects of pack ice on the various trophic levels as parameters and processes are monitored during and after seasons of different pack ice cover.

The spatial scale of sampling prey distribution, abundance, and physiological condition, water column properties, primary production estimates, and hydrographic measurements will be extended during two types of research cruise: (1) time-series cruises in the late spring; and (2) process-oriented cruises at critical times in biological cycles. These process-oriented cruises are essential for verification of the models of regional processes, such as primary production, oceanic circulation, and the biological/physical models of prey abundance.

Robin Ross or Langdon Quetin, Marine Science Institute, University of California, Santa Barbara, 98106, 805-893-2096, "rRoss@lternet.washington.edu" or "lQuetin@lternet.washington.edu".

Arctic LTER

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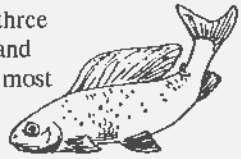
• **Terrestrial.** Plots of tussock tundra were fertilized with N and P beginning in 1980. Air temperature and light intensity were also manipulated on experimeutal plots by placing small greenhouses over the tundra. The greatest responses were seen on the fertilized plots. In the first three years the grasses and sedges responded most rapidly to the fertilization, while deciduous shrubs were able to take advantage of the increased nutrients only when air temperature was also increased. By year nine, the main component of the increased productivity in the fertilized plots was the dramatic increase in the slower-growing deciduous shrubs. Nutrient supply appears to be the primary control over net productivity and eventual composition of the community. Temperature, however, plays a major role in controlling the rate of change in community composition.



In 1989 the study was expanded to include dry heath and wet sedge areas. Results from these studies show that it may take years for ecosystem responses to appear.

Field Database

Communications at the Toolik Lake Station took a great step forward last summer with the addition of a satellite phone system that provides for voice communication as well as a computer link through the University of Alaska. This summer the Arctic LTER database will be available at the Toolik Research Camp, allowing resident scientists to quickly access data.

Contact Bernie Moller, Marine Biological Laboratory Ecosystem Center, Woods Hole, MA 02543, 508-548-3705, or "bMoller@lternet.washington.edu".■

1990 All Scientists Meeting

H · I · G · H · L · I · G · H · T · S

Dr. Mary Clutter, Biological & Behavioral Sciences, NSF: "Politics of Ecology"

Atmospheric Chemistry

by Wayne T. Swank
Coweeta LTER

The Atmospheric Chemistry Workshop brought 25 participants together to discuss LTER Network needs related to atmospheric chemistry measurements and research. Three objectives offered for discussion were: (1) interest in preparing a summary document that characterizes atmospheric chemistry measurements and background data at LTER sites; (2) the need for establishing protocols for different levels of Network monitoring relative to ecological processes; (3) the development of funding and other programs to fill the gaps at sites.

Consensus was reached on the following actions:

• Develop a Network document comprised of (a) an inventory of atmospheric chemistry measured at each site, method of measurement or collection, number of locations for measurement, duration of record, participation in ongoing networks (NADP, NDDN, Mountain Cloud, etc.), and (b) demonstrated illustrations of linkages between atmospheric chemistry and biological/ecological phenomena based on past or current site research (site-specific, summarized examples provided by site investigators), including a list of relevant publications. Wayne Swank will take lead responsibility in collaboration with Bill Munger (Harvard Forest) for compiling and editing the document.

• Organize a workshop to synthesize trends, patterns, similarities and differences in atmospheric chemistry across Network sites. This should include wet, particulate, and gaseous atmospheric constituents.

• Organize several working sessions to develop a document which describes standard methods and protocols for atmospheric chemistry across the Network at several different levels of complexity, similar to the climatic measurement protocols. Emphasis should be placed on those parameters considered to be of greatest ecological importance. This document would be of general ecological interest as noted at the Ecological Society of America meeting in Snowbird, Utah. Recommendations could lead to the development of an NSF Network supplemental proposal for atmospheric chemistry equipment and operation.

• Identify Network leadership to establish linkages with other institutions, organizations, and programs conducting near-ground atmospheric chemistry measurements, and to communicate opportunities to sites for followup.

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Canopy Studies

by Nalini Nadkarni
The Marie Selby Botanical Gardens, Sarasota, Florida

The Canopy Studies workshop was organized to respond to the growing interest of LTER scientists in forest canopy studies, especially in gaining canopy access. The overall goal of the workshop was to initiate discussion on

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Dr. Paul Risser, Sevilleta: "International Network & Global Ecology"

PHOTOGRAPHS BY JERRY F. FRANKLIN

Canopy, cont'd.

both inside- and outside-LTER Network needs for canopy measurements and research. A diverse group of scientists from 11 sites discussed related issues, including:

• Importance of canopy studies - what questions should/can be addressed in the canopy?

• Ongoing LTER (and other) efforts - what questions are currently being addressed?

• Canopy access techniques, including the proposed crane.

Consensus was reached on these issues in the following areas:

• Canopy studies make up an important part of understanding long-term phenomena in ecosystems. A dearth of quantitative data exists because of the difficulty of access and the lack of a strong statistical basis for rigorous sampling and analyses. Important areas include: (1) development of sampling protocol and analyses; (2) staging within-canopy micrometeorological studies, including measurement of gaseous, dry and wet deposition; (3) documenting diversity and behavior of canopy biota; (4) measuring tree architecture; and (5) validating canopy structure from remote sensing data.

• Specific canopy studies being carried out (or planned/desired for the future) by scientists present included: (1) photosynthesis studies; (2) vertical stratification of animals, including their distribution and behavior; (3) validating canopy structure from remote sensing data; (4) canopy structure and light extinction in the "air column" of the canopy; (5) analyzing the role of epiphytes in forest nutrient cycles; and (6) mapping tree structure with surveying and computer graphics techniques.

• To date, access to the canopy has been accomplished with a variety of techniques; for example, free-climbing, single-rope techniques, which are relatively inexpensive and safe, but do not provide access to the outer branches or upper crowns of most trees.

The possibility of installing large construction cranes in forests was discussed extensively. This tool could substantially increase canopy studies, including the ability to: (1) lift heavy instrumentation to the canopy, such as IRGAs, for process-oriented research; (2) reside for long periods of time in the canopy for long-term observations of animal behavior and certain phenological phenomena; (3) provide total access to the trees and the three-dimentional volume of the whole forest; (4) provide access for those individuals who may not otherwise be physically able to get into the canopy; and (5) provide good "publicity" for fund-raising for forest canopy and other research.

However, cranes are extremely expensive ($1.2 million to install and operate one machine), somewhat destructive to the immediate area of installation, and require considerable infrastructure to maintain. The example of the Smithsonian crane will be investigated to evaluate feasibility, costs, and benefits.

The workshop provided valuable contacts for future collaboration and highlighted the diverse interests, geographical locations, forest ecosystem types, and research questions that relate to the canopy. Further communication among participants and other LTER and outside researchers was encouraged.

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Dr. William Schlesinger, Jornada LTER: "Soil Warming Experiments"

Climate Committee

by Phyllis Adams
Bonanza Creek LTER
& David Greenland
Niwot Ridge LTER

Following a review of past activities of the LTER Climate Committee, which is a standing committee of the LTER Coordinating group formed at the last All Scientists Meeting in 1984, the following accomplishments were noted:

• Established protocols for site climate monitoring

• Created a site climate description book

• Held a workshop on Climate Variability and Ecosystem Response

• Published a monograph

The monograph, *Climate Variability and Ecosystem Response*, published in 1990 in cooperation with the USDA Forest Service Southeastern Experiment Station, has already been widely distributed. The final summary chapter will be submitted for publication, possibly in the bulletin of the American Ecological Society.

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1990 All Scientists Meeting, continued

Dr. David Tilman, Cedar Creek LTER: "Climate Variability & Controls of Biodiversity Patterns"

Climate, cont'd.

Traditionally, the Climate Committee has undertaken only one or two major projects at a time with one or two people assigned responsibility. After discussing several suggestions, the following activities were agreed upon:

- **Update Climate Description Document** - This would include adding new sites and updating the site comparison chapter. David Greenland will take the lead on the description and comparison, and Tim Kittel (Central Plains LTER) on the time series analysis. A proposal will be submitted to the National Science Foundation.
- **Potential Climate Change at LTER Sites** - A document will be produced by Bruce Hayden (in association with a forthcoming project with the National Park Service) to provide sites with information on projected and historically based suggestions of the range of climate changes which sites might reasonably expect to experience. The study would be based both on GCM output data and the historical record.
- **Data Managers** - The LTER Data Managers have proposed to create a prototype on-line intersite climatological database which could be accessed via electronic mail over the Internet. They requested support from the Committee in implementing such a project. The group agreed to aid the effort, and modelers were encouraged to suggest what variables to include and how to standardize these data.
- **Provide sites with information** on projected and historically based suggestions of the range of climate changes which sites might reasonably expect to experience. This will be accomplished using the LTERNET group mailing list or by posting items of interest on the LTER electronic Bulletin Board. Topics to be circulated include: a bibliography of climate ecosystem interactions (from Bruce Hayden), questions about equipment problems, the latest global climate change information, and items of general interest.

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Decomposition

by Stephen C. Hart
H.J. Andrews LTER

The Decomposition workshop organized by Mark Harmon (H.J. Andrews) centered around the intersite fine litter decomposition experiment currently being installed in the field at 21 sites (17 LTER and four others). The study, which was designed at a workshop held in Woods Hole in 1989, will involve annual sampling over a 10-year period, except for tropical sites where faster decomposition will require a three-month interval.

Nine standard litters (six leaf, three "fine" root) are being placed at each site; these species vary in nitrogen and lignin content. The concept of using "wildcard" species to check the results has been incorporated into the design, and identical wooden dowels are being placed in the soil at each site to discern site effects on woody debris decomposition.

The discussion then turned to the development of a proposal to be sent to the National Science Foundation Ecosystems panel. Participants were particularly concerned about receiving credit for their contributions. This issue was resolved in the decision to have three to four investigators submit the proposal with one key participant per site identified as part of the research team.

Funding will be sought to run the experiment, cover the costs of sample processing and chemical analysis, and hold a workshop marking the first five years. Participants agreed in principle that each site would provide support to harvest the samples and provide background data, and that the only costs to be recovered would be for chemical analysis and data management.

A proposal draft was scheduled to be sent out to all participants by mid-November, and a final draft by December. A small workshop involving the modeling aspects of the proposal was held at Wood's Hole in November.

Another group concern was data sharing and authorship. To meet these concerns, the following guidelines were developed:

Sevilleta LTER site poster display

Decomposition, cont'd.

• Each site will receive its own site data and has priority on this data for one year after the receipt from the central data bank at Oregon State University, Corvallis.

• Small groups of sites will be free to publish smaller syntheses; i.e., the tropical sites, which will have completed work prior to the others.

• Team synthesis papers using all the data were planned to summarize findings at one, five, and 10 years.

Also considered was the possible addition of six to seven new sites with support from the group. Sites with interest in this area were encouraged to develop their own studies.

Finally, the need to decide what climate indices to use for characterizing sites was discussed. It was clear that mean annual values would not distinguish seasonally distinct climates. A related concern was the degree to which MET station would be located near each of the four replicate litterbag sites and, if not, how to "correct" for the other locations.

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GIS / Modeling

by Mark MacKenzie
North Temperate Lakes LTER

The Geographic Information System (GIS)/Modeling working session was attended by approximately 90 scientists with a wide variety of backgrounds and interests. Objectives of the session were:

• to stimulate a discussion on what is "modeling" as the term relates to GIS and ecology;

• to discuss the importance of scale and how GIS can address the scale issue;

• to discuss methods for linking ecological models with GIS;

• to discuss regional digital databases and how to access them; and

• to provide a forum for current research on GIS and modeling.

The interactions between process modelers and those skilled in GIS are expected to lead to further exchanges and collaborative research, particularly as these researchers continue to address regional to global issues.

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Dr. Philip Bacon, Natural Environment Research Council, U.K.; Rudolf Nottrott, LTER Network Data Manager; Dr. Boris Vinogradov, Academy of Sciences, U.S.S.R.

Hydrology & Biogeochemical Modeling

by Gordon Grant
H.J. Andrews LTER

Nel Caine (Niwot Ridge) and Gordon Grant chaired a workshop on hydrology and biogeochemical cycling that attracted over 50 participants from 15 LTER sites, the U.S. Geological Survey, the National Park Service, and several other institutions. Objectives included sharing information about the direction and scope of current work in this area among the various sites and related activities in other agencies, and exploring opportunities for future intersite work. It was suggested that understanding hydrological and biogeochemical processes is one of the major themes linking all LTER sites.

Hydrologic features and flowpaths at LTER sites span a considerable range of types and spatial and temporal scales. Major hydrologic landforms represented include lakes, marshes, estuaries, ephemeral washes, intermittent streams, perennial channels, and small rivers. Sites vary in terms of the relative proportion of flow following surface or subsurface pathways, and the sequence of flowpaths within a site.

While in most sites flowpaths are gravitationally driven and thus unidirectional, some coastal sites (i.e., North Inlet) have bidirectional fluxes driven by tidal fluctuations. Different sequences of flowpaths provide different opportunities for interaction among water, vegetation and soils which is then reflected in the water chemistry.

Spatial and temporal scales of interest vary widely between sites, ranging from plot scale studies of storm response and diurnal variations in soil moisture to landscape-level studies of trends in lake chemistry or rainfall-runoff relationships extending over decades.

Common themes that emerged from a "roll call" of related research activities by site were:

• an interest in characterizing flow pathways, particularly exchanges between different landforms;

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Dr. Patricia Werner, Biotic Systems & Resources, NSF: "Biodiversity & Ecosystem Function"

1990 All Scientists Meeting, continued

Hydrology, cont'd.

• controls on movement and transformation of elements (water, sediment, nutrients, organics), particularly the degree of coupling between hydrologic and biogeochemical phenomena;

• the role of disturbance in modifying flow paths and fluxes; and

• the importance of viewing flow phenomena within a broader landscape context.

The importance of the LTER Network within the larger physical and biogeochemical science community was emphasized in a presentation by George Leavesley, a U.S. Geological Survey hydrologist involved with the Survey's Water, Energy, and Biogeochemical Budgets (WEBB) program. This program, part of the Survey's in-house global change initiative, is designed to fund process-level studies relevant to climate change.

Two LTER sites (North Temperate Lakes and Luquillo) were among the five WEBB sites chosen in FY '91; Coweeta, Andrews, Konza and Bonanza will be among those considered for FY '92 funding. The WEBB program demonstrates the growing recognition that LTER sites are key areas for interagency, interdisciplinary research into the biological and physical implications of global change.

Topics proposed for future activities included: an examination of the relative importance and degree of interaction between land-use and climate-imposed changes in hydrologic regimes; an intersite comparison of streamflow generation processes, particularly the interaction between groundwater and surface water. The importance of linked biogeochemical and hydrologic studies, particularly those using isotopes and tracers, was also emphasized.

An ad-hoc working group is currently investigating holding a workshop which would develop alternative conceptions of flow generation and pathways in several different sites. This might lead to an actual modeling exercise to compare the response of different sites to scenarios of changing climate and land use, an approach which would fit in well with the work of Leavesley and his colleagues to develop a common hydrologic modeling framework.

Future activities might include symposia co-sponsored by groups such as the ESA, linkage of computer networks, and increasing visibility of the Network as a forum for interdisciplinary work.

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Modeling Forest-Stream Interactions

by H. McKellar
North Inlet Marsh LTER

The 25 participants in the Modeling Forest-Stream Interactions workshop outlined four main zones of a forested watershed which must be conceptually and quantitatively linked with respect to hydrology and biogeochemistry in order to effectively model the dynamics of forest-stream interactions. These are:

• the watershed vegetation,

• the upland soils and groundwater,

• the interface zones between uplands and streams--i.e. riparian and hyporheic zones--and

• the stream channel.

All agreed that the hydrologic coupling of these zones represents an important, yet difficult, component of any modeling effort. A considerable number of models currently exist for simulating aspects of watershed hydrology; however, none of these was considered entirely adequate for addressing the specific time, space, and process dimensions of forest-stream interactions. Therefore, combining the most appropriate components of existing models was discussed as a possible approach. A specific example mentioned was the combination of PROSPER (with its rigorous treatment of evapotranspiration) with PRMS (with its variable time-step capability for simulating processes over the hydrographic time scale). A particularly useful document by van der Heijde et al.* for evaluating and comparing the strengths of existing hydrology models was noted.

Also addressed were approaches to interpreting nutrient chemistry and solute transport in evaluating the major biotic and geochemical transformations from hillside to stream. Although empirical relationships may suggest the relative importance of specific processes of nutrient and organic matter processing at different soil depths and lateral positions along the hillside, emphasis was placed on *direct measurement* of specific processes (i.e., nitrogen fixation, denitrification, nitrification, decomposition, etc.) for deriving rate parameters in forest-stream interaction models.

The hydrology and biogeochemistry of the riparian and hyporheic zones was discussed as especially complex and less well understood at present, although several sites are providing new information which could be incorporated into developing models.

The roles of riparian vegetation in transmitting light and exporting woody

continued, page 11

Dr. Caroline Bledsoe, NSF; Dr. James Gosz, Sevilleta LTER; Zhao Shidong, Chinese Ecological Research Network (CERN)

Dr. James Schindler, Biotic Systems & Resources, NSF; Dr. Clive Jorgensen, U.S. Department of Energy, Ecological Research Division; Dr. Diane Wickland, National Aeronautics & Space Administration

Forest-Stream, cont'd.

material was discussed as a key component of forest-stream interactions, determining hydrologic and biotic characteristics of the stream ecosystem.

Participants agreed that individual investigator collaborations were well served and that sufficient interest exists for convening additional working groups at future LTER meetings.

van der Heijde et al. 1988. Groundwater modeling: an overview and status report. GWMI 88-10, The Groundwater Modeling Institute, Butler University, Indianapolis, Indiana 46208.

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Species Invasion

by John J. Magnuson
& Ann S. McLain
North Temperate Lakes LTER

John Magnuson chaired a meeting of 18 scientists interested in aspects of species invasion (10 LTER, Savannah River Ecology Laboratory, Idaho National Environmental Research Park, and the NERC in Great Britain). Participants' specific interests ranged from the natural process of invasion as a part of succession to the invasion of established systems by non-native species. Still others were interested in the intentional introduction of new species as part of a management strategy.

The group's main objective was to determine how action in the context of the LTER Network could enhance efforts to answer the classic questions of invasion theory--what makes a good invader, what makes a system invasible, how does the system resond to invasion.

These possible contributions of conducting intersite comparisons across a variety of biomes were identified:

- more general principles might be revealed, particularly through investigations of disturbance in invasion and the role of scale in the match between invader and community;
- greater understanding of the response of the ecosystem to invasion--since the removal of species is in many ways similar to the addition, extirpations as well as invasions should be examined; and
- greater understanding of invasion at the landscape level through consideration of corridors/ linkages both facilitating invasion and changing in response to it.

The issue of genetically engineered organisms, one that may focus increased attention on invasion studies in the future, was also raised.

The group agreed that an important goal would be to produce guidelines as a basis for decision-making about new/introduced invading species. Specific actions were also agreed upon:

- Each LTER site will be asked to prepare a list of invading and extirpated species. This effort will estimate the magnitude of the problem, identify possible areas of cooperative study, focus attention on the issue of non-native species, and encourage sites to develop policy concerning them. A committee was formed to work on this project.
- A syposium on invasion will be planned for the August 1992 Ecological Society of America (ESA) meeting in Hawaii. As a warm-up for that event, a committee was formed to organize a contributed paper group for the 1991 ESA meeting in San Antonio.
- Jon Evans may organize a workshop on succession as an area of interface between ecosystem and population studies.

It was also suggested that a bulletin board for the invasion group be established, though no action on this was taken.

• • • •

continued, page 12

Dr. Timothy Kratz, North Temperate Lakes LTER and Dr. Robin Ross, Palmer Station (Antarctic) LTER

1990 All Scientists Meeting

Remote Sensing/Geographic Information System (GIS) demonstration

Stream Processes

by Judy Meyer
Coweeta LTER

Judy Meyer organized a workshop attended by approximately 40 scientists to discuss "burning" questions in stream ecology and whether the LTER Network offered a series of sites to use in answering these questions.

Four action items arose from these discussions and from smaller working groups formed during the workshop:

- Develop a catalog listing basic attributes of streams at each site. This would serve the needs of individual researchers, stimulate and facilitate intersite research, and encourage outside researchers to use LTER sites. A small working group met and developed a short questionnaire that will be sent to sites with streams. Judy Meyer and Stuart Findlay will compile these data and make copies available to interested researchers.
- Judy Meyer (with help from Cliff Dahm, program chairman) will organize a session at the May 1991 National Association of Biological Science (NABS) meeting that will allow each site 20 minutes to describe its stream program. This session will serve to inform not only the sites, but also the larger scientific community about opportunities for research at LTER sites. A half-day workshop for LTER scientists at the meeting will also be planned to discuss intersite projects and comparisons.
- A group organized by Cliff Dahm discussed new methodologies for investigating the role of interfaces in controlling stream processes. This topic will be pursued further at the proposed workshop.
- A subset of the group met to plan an intersite experiment to determine if there are latitudinal gradients in macroinvertebrate control of leaf decomposition in streams. Most aspects of the experiment were planned and, when an appropriate method for excluding macroinvertebrates is developed, a proposal to address the question will be prepared.

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New Remote-Sensing/GIS Lab

Virginia Coast LTER, the National Park Service, and the University of Virginia exchange high-resolution aerial photography for detailed biological and ground-truth data in a unique collaboration

by John H. Porter

A tentative agreement has been reached with the National Park Service (NPS) to create a Cooperative Park Science Unit which will focus on the barrier islands of the National Seashore at the University of Virginia. The Unit will link remote sensing and geographic information system (GIS) technology with landscape and ecosystem modeling.

The agreement is a culmination of an ongoing relationship of NPS, the Virginia Coast Reserve (VCR) LTER and the University's Department of Environmental Sciences, which extends back to the early 1970's when LTER researchers Robert Dolan and Bruce Hayden performed pioneering photogrammetric studies of coastal parks.

Current NPS projects at the University of Virginia complement the remote-sensing activities of VCR in creating GIS data layers for barrier island systems. The NPS Barrier Island Remote Sensing and GIS Project is funded by the Southeast Regional Office of the Park Service. Its objectives are: (1) to create winter and summer remote-sensing profiles of Atlantic and North Gulf Coast barrier islands; (2) to develop extremely high resolution (~2 m) vegetation profiles of barrier islands; (3) to develop a digitized GIS database consisting of Fish and Wildlife Service ecological inventory maps, Minerals Management Service ecological atlas (this includes socioeconomic areas, soils, hurricane inundation zones, biological resources and oil reserve information), seagrass maps, results of previous vegetation inventories, U.S. Geological Service 1:100,000 digital line graphs (DLGs) of park areas and new 1:24,000 DLG coverages; (4) to incorporate GIS elements into an inlet sediment transport model for 18 major inlets within Park Service jurisdiction; (5) to use remote sensing and GIS systems to parametrize spatially explicit ecosystem models and to display model output statistics.

To accomplish these goals, an aggressive campaign of aerial image acquisition spanning two coastal LTER sites (VCR and North Inlet) is underway.

Oil Spill Support System

A second NPS-sponsored project, the Oil Spill Decision Support System, involves collaboration between the NPS and the Environmental Sciences and Systems Engineering departments at the University. Students participating in the Capstone program are creating the system which uses GIS elements in support of a decision response system. In addition to GIS-derived data the system incorporates information on historical spills, cleanup techniques, bioremediation techniques, resource availability and socio-economic impacts. A test is planned near the North Gulf Coast islands in August 1991.

These activities dovetail with the research on transitions and steady-states at the VCR site. Current remote-sensing and GIS projects include the development of long-term chronosequences of shorelines, marsh boundaries and vegetation zones, the characterization of current landscape patterns and the formulation of spatially explicit sediment transport and vegetation models.

The high-resolution aerial photography database provided by NPS has proved extremely useful in establishing up-to-date vegetation maps of the LTER site. Despite the high altitude at which the aircraft flies, photographs clearly show footpaths used by LTER researchers and thus provide an excellent baseline for establishing vegetation cover changes in conjunction with past and future images. LTER modeling activities are facilitated by access to the remotely-sensed data and to the other GIS data layers being compiled by NPS projects.

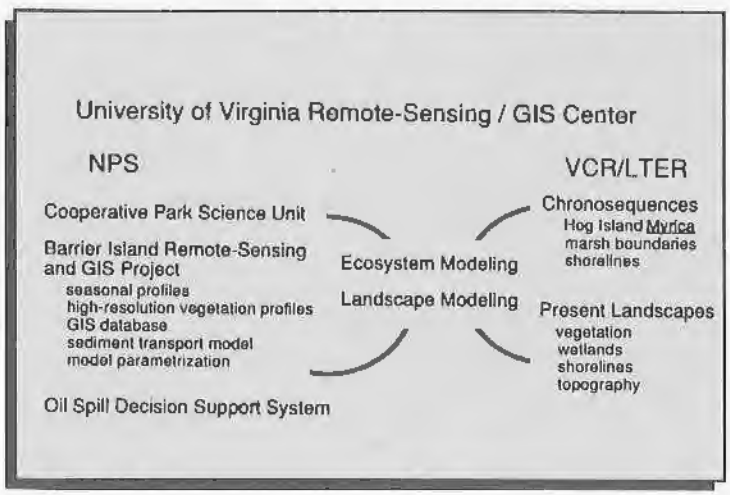
The NPS projects benefit from the detailed VCR field site biological and ground-truth information, which aids in the development of detailed classification criteria for islands within the National Park system.

RS & GIS Laboratory

Remote-sensing and GIS research activities of the NPS and VCR are conducted in the Remote-Sensing and GIS Laboratory of the Department of Environmental Sciences. The laboratory consists of a network of five Sun workstations and a 386-PC which support a variety of GIS and remote-sensing software packages.

Funds to establish the laboratory were provided by the University, the National Park Service and the National Science Foundation.

Contact John Porter or Sam Patterson, Department of Environmental Science, University of Virginia, Clark Hall, Charlottesville, VA 22903, (804) 924-8999, "jPorter@lternet.washington.edu" (Internet). ■



New Publications

*Note: this list does not include submitted and in-*press publications.

Autry, A.R., Fitzgerald, J.W. and Caldwell, P.R. 1990. Sulfur fractions and retention mechanisms in forest soils. Can. J. For. Res. 20:337-342.

Autry, A.R. and Fitzgerald, J.W. 1990. Sulfonate-S a major form of forest soil organic sulfur. Biol. Fertil. Soil. 10:50-56.

Bildstein, K.L. and Brisbin, Jr. I.L. 1990. Lands for long-term research in convervation biology. Conservation Biology 4:301-308.

Clark, B.K., and D.W. Kaufman. 1990. Prevalence of botfly (*Cuterebra sp.*) parasites in populations of small mammals in eastern Kansas. The American Midland Naturalist, 124:22-30.

Clark, B.K., and D.W. Kanfman. 1990. Short-term responses of small mammals to experimental fire in tallgrass prairie. Canadian Journal of Zoology, 68:2450-2454.

Collins, S.L. 1990. Introduction: Fire as a natural disturbance in tallgrass prairie ecosystems. Pp. 3-7 in *Fire in North America Tallgrass Prairies* (S.L. Collins and L.L. Wallace, eds.). University of Oklahoma Press, Norman.

Collins, S.L. and D.J. Gibson. 1990. Effects of fire on plant community structure in tallgrass prairie. Pp. 81-98 in *Fire in North America Tallgrass Prairies* (S.L. Collins and L.L. Wallace, eds.). University of Oklahoma Press, Norman.

Collins, S.L. and S.M. Glenn. 1990. A hierarchical analysis of species' abundance patterns in grassland vegetation. American Naturalist 135:633-648.

Collins, S.L. and L.L. Wallace. 1990. Fire in North America tallgrass prairie. University of Oklahoma Press, Norman. 175pp.

Fahnestock, J.T., and A.K. Knapp. 1990. Response of *Andropogon gerardii* to simulated acid rain. Transactions of the Kansas Academy of Science, 93:85-90.

Gibson, D.J., C.C. Freeman, and L.C. Hulbert. 1990. Effects of small mammal and invertebrate herbivory on plant species richness and abundance in tallgrass prairie. Oecologia, 84:169-175.

Gibson, D.J., D.C. Hartnett, and G. Smith-Merrill. 1990. Fire temperature heterogeneity in contrasting fire-prone habitats: Kansas tallgrass prairie and Florida sandhills. Bull. Torre, Bot. Club, 117:349-356.

Grace, J. and D. Tilman, Eds. 1990. Perspectives on Plant Competition. Academic Press, New York.

Gleeson, S. and D. Tilman. 1990. Allocation and the transient dynamics of competition during succession on poor soils. Ecology 71:1144-1155.

Glenn, S.M., and S.L. Collins. 1990. Patch structure in tallgrass prairies: dynamics of satellite species. Oikos, 57:229-236.

Hale, D.D. and Fitzgerald, J.W. 1990. Generation of sulphate from cysteine in forest soil and litter. Soil Biol. Biochem. 22:427-429.

Hartnett, D.C. 1990. Size-dependent allocation to seed and vegetative reproduction in four clonal composites. Oecologia 84:254-259.

Hetrick, B.A.D., G.W.T. Wilson, and C.E. Owensby. 1990. Influence of mycorrhizal fungi and fertilization on big bluestem seedling biomass in tallgrass prairie soil. Journal of Range Management, 43:286-290.

Hetrick, B.A.D., G.W.T. Wilson, and T.C. Todd. 1990. Differential responses of C3 and C 4 grasses to mycorrhizal symbiosis, phosphorus fertilization, and soil microorganisms. Canadian Journal of Botany 68:461-467.

Kling, G.W., G.W. Kipphut and M.C. Miller. 1990. Arctic lakes and streams as gas conduits to the atmosphere: implications for tundra carbon budgets. Science 251:298-301.

Knapp, A.K., and J.T. Fahnestock. 1990. Influence of plant size on the carbon and water relations of *Cucurbita foetidissima*. Functional Ecology 4:789-797.

Kaufman, D.W., and G.A. Kaufman. 1990. Influence of plant litter on patch use by foraging *Peromyscus maniculatus* and *Reithrodontomys megalotis*. The American Midland Naturalist, 124:195-198.

Kaufman, D.W., and G.A. Kaufman. 1990. House mice (*Mus musculus*) in natural and disturbed habitats in Kansas. Journal of Mammalogy, 71:428-432.

Kaufman, D.W., E.J. Finck, and G.A. Kaufman. 1990. Small mammals and grassland fires. Pp. 46-80 in Fire in North American Tallgrass Prairies (S.L. Collins, and L.L. Wallace, eds.), University of Oklahoma Press, Norman.

Lattin, J.D. 1990. Arthropod diversity in Northwest old-growth forests. Wings: Essays on Invertebrate Conservation 15:7-10.

McKane, R.B., D.F. Grigal, and M. Russelle. 1990. Spatiotemporal differences in 15N uptake and the organization of an old-field plant community. Ecology 71:1126-1132.

Milne, B.T. 1991. Lessons from applying fractal models to landscape patterns. Pp. 199-235 in *Quantitative Methods in Landscape Ecology*. M.G. Turner and R.H. Gardner, eds. Springer-Verlag, New York. (Sevilleta LTER Publication No. 5.)

New Publications

LTER To Be Featured in *Ecological Modelling*

Dr. Philip Bacon, who attended the All Scientists Meeting as a representative of the proposed United Kingdom Environmental Change Network of sites (ECN), is directing publication in *Ecological Modelling* of a special collection of LTER papers which will explore the theme of local models of simple processes made reasonable on a wide scale by parameterization to local driving variables via GIS/database techniques.

LTER authors are currently preparing articles on the following topics:

- extrapolating from sites to regions, decades to centuries;
- regional predictions;
- belowground processes, modeling and spatial auto-correlation of parameters;
- atmosphere/ecosystem interactions affected by local land use;
- succession modeling across sites and ecosystems; and
- a carbon balance model for diverse sites.

LTER Network Highlighted in *Conservation Biology*

An article in the September 1990 issue of *Conservation Biology* by Keith Bildstein (North Inlet Marsh) and I. Lehr Brisbin, Jr. highlights the LTER Network. "Lands for Long-Term Research in Conservation Biology" describes LTER in conjunction with the U.S. Department of Energy's National Environmental Research Parks (NERPs) as appropriate places to develop long-term studies on a large scale. They recommend that conservation biologists explore the possibility of using LTER, NERP and other similarly available sites in their research programs, and include a directory of sites and contacts. (*See citation page 14.*)

1990 Arctic LTER Weather Data Summary Now Available

The 1990 Arctic LTER Weather Data Summary is now available. The report contains summaries for daily air, lake and soil temperature, wind speed and direction, vapor pressure and solar radiation. Summaries have also been completed for the years 1988 and 1989.

Presently, a series of papers related to arctic lakes and streams research is being prepared for publication as a special volume in *Hydrobiologia*.

For additional information, contact Bernie Moller, 508-548-3705, or "bMoller@lternet.washington.edu" (Internet).

Publications, continued

Ramundo, R.A. and T.R. Seastedt. 1990. Site-specific underestimation of wetfall NH4+ using NADP data. Atmospheric Environment 24:3093-3095.

Schaeffer, D.J., T.R. Seastedt, D.J. Gibson, D.C. Hartnett, B.A.D. Hetrick, S.W. James, D.W. Kaufman, A.P. Schwab, E.E. Herricks, E.W. Novak. 1990. Field bioassessment for selecting test systems to evaluate military training lands in tallgrass prairie. Ecosystem Health. Environmental Management, 14:81-93.

Seastedt, T.R. and R.A. Ramundo. 1990. The influence of fire on belowground processes of tallgrass prairies. Pp. 99-117 in *Fire in North American Tallgrass Prairie* (S.L. Collins and L.L. Wallace, eds.), Univ. of OK Press, Norman.

Su, Haiping, E.T. Kanemasu, M.D. Ransom, S. Yang. 1990. Separability of soils in a tallgrass prairie using SPOT and DEM Data. Remote Sensing of the Environment, 32:10-17.

Tate, C.M. 1990. Patterns and controls of nitrogen in tallgrass prairie streams. Ecology, 71:2007-2018.

Tilman, D. 1990. Mechanisms of plant competition for nutrients: the elements of a predictive theory of competition. In J. Grace and D. Tilman, eds., *Perspectives on Plant Competition*. Academic Press, New York.

Tilman, D. 1990. Constraints and tradeoffs: toward a predictive theory of competition and succession. Oikos 58:3-15.

Wedin, D. and D. Tilman. 1991. Species effects on nitrogen cycling: a test with perennial grasses. Oecologia 84:433-441.

Zak, D.R., D.F. Grigal, S. Gleeson and D. Tilman. 1990. Carbon and nitrogen cycling during secondary succession: constraints on plant and microbial biomass. Biogeochemistry 11:111-129. ■

CALENDAR

Spring - Fall 1991

APR	20-23	**LTER Meetings: Executive and Coordinating committees.** Seattle, WA. Optional field trip to Olympic Peninsula (April 23). Representatives of the Land-Margin Ecosystem Research (LMER) Program, NSF and several agency programs (NOAA, DOE, USFS, USGS, EPA) have been invited to participate.
	29-MAY 2	**8th Thematic Conference: Geologic Remote Sensing.** Denver, Colorado. Environmental Research Institute of Michigan, Ann Arbor, 313-994-1200, ext. 3234, or 313-994-5123 (FAX).
MAY	1	**NSF Program deadlines: Biological, Behavioral, and Social Sciences.** Ethics and Values Studies in Science, Technology and Society, Vivian Weil, 202-357-9894; Instrumentation and Instrument Development, Robley Light, 202-357-7652. **NSF Program deadline: Scientific, Technological and International Affairs.** U.S.-France, -Latin America, -Argentina, -Brazil, -Mexico, -Venezuela cooperative research. 202-357-7571. **NSF Target date: Computer and Information Science and Engineering.** Networking and Communications Research. Anbrey Bush, 202-357-9717. **NSF Target date: Geosciences.** Biological Oceanography, Chemical Oceanography, Marine Geology and Geophysics, Physical Oceanography. Michael Reeve, Ocean Sciences, 202-3547-7924.
	6-8	**Workshop: Improving Natural Resource Management Through Monitoring.** Oregon State University, LaSells Stewart Center. Keynote address: Paul Risser, Sevilleta LTER/University of New Mexico, Albuquerque. Toni Gwin, Conference Coordinator, 503-737-2329.
JUN	18-22	**Society for Conservation Biology, annual meeting.** University of Wisconsin, Madison. Stanley Temple, 608-263-6827.
	18-22	**Xerces Society.** University of Wisconsin, Madison. Melody Allen, 503-222-2788.
JUL	14-27	**Coupled Climate System Modeling, workshop.** University of Wisconsin, Madison. David Houghton, Meterology, Meterology and Space Building, University of Wisconsin, 1225 W Dayton Street, Madison, 53706.
AUG	4-8	**American Institute of Biological Sciences (AIBS), 42nd annual meeting.** San Antonio, Texas. "Education: the Future of Biology. Meetings Department, 202-628-1500 or 1-800-992-2427.
	18-25	**Environmental Biogeochemistry, 10th international symposium.** San Francisco, California. "Global Change and the Biogeochemistry of Tadiative Trace Gases." Ronald Oremland, 415-329-4482 (phone) or 415-329-4463 (FAX).
SEP	1-6	**International Union of Biological Sciences (IUBS) symposium.** Biological Diversity & Global Change. Amsterdam, Netherlands. H.M. van Emden, General Assembly, 31-20-222902 (phone).
	3-4	**Ecology of Regulated Streams, 5th International Symposium.** Flathead Lake Biological Station, Montana. Ecosystem approaches to the science and management of regulated rivers. 406-982-3301.
	8-12	**American Fisheries Society, annual meeting.** "Habitat: A Place for Fish, A Place for Fishing, A Place for Fisheries." San Antonio, Texas. Donald J. Orth, Program Chair, 703-231-5919.
	10-13	**Applied Climatology, 7th conference.** Salt Lake City, Utah. Thomas R. Karl, National Climate Data Center, Federal Building, Asheville, NC 28801.
OCT	14-21	**Environmental Education, conference.** Toronto, Ontario. Charles Hopkins, 613-598-4330.
	21-14	**Constructed Wetlands, International symposium.** Wetlands Research Laboratory and Institute for Coastal and Estuarine Research at University of West Florida, co-sponsors. Pensacola Hilton, Pensacola, Florida. Karl Rodabangh, 904-474-2156.
NOV	10-14	**Estuarine Research Federation, 11th international conference.** San Francisco, California. Jerome Williams, 301-266-5489.
	25-28	**Methods of Research on Soil Structure/Soil Biota Inter-relationships.** Wageningen, The Netherlands. L. Hotke-Staal, 31-8370-90111 (phone) or 31-8370-18552 (FAX).

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