NETWORK NEWS

Newsletter of the U.S. Long-Term Ecological Research Network Fall 1995/Winter 1996, Issue 18

INSTITUTE OF NORTHERN FORESTRY TO CLOSE

Last month, the director of the U.S. Forest Service Pacific Northwest (PNW) Experiment Station announced that the Institute of Northern Forestry (INF) in Fairbanks, Alaska will be permanently closed as a result of Forest Service budget cuts in FY '96. All permanent employees at the Institute received letters on September 7 stating that their positions were abolished. The Forest Service estimates that it will take from four to six months to completely close the Institute and building.

The closure announcement came as a surprise to LTER investigators at INF: they had believed that the December 1995 Memorandum of Understanding between the Forest Service (FS) and NSF pledging cooperation in the LTER Program would insure that the FS research being carried out as part of the Bonanza Creek Experimental Forest LTER would be continued. The Bonanza Creek site is one of five LTER sites located in FS Experimental Forests (others are Hubbard Brook, Coweeta, Luquillo and H.J. Andrews). The INF has been an active partner with the University of Alaska in the Bonanza Creek LTER program (BNZ) and Les Viereck, Principal Plant Ecologist at INF, has served as BNZ co-principal investigator for the past six years.

The INF was first established on the campus of the University of Alaska Fairbanks (UAF) in 1963. At the peak of its operation in the early 1980s, there were 13 scientists and an equal number of supporting staff. The Institute has been the principal federal research laboratory in the United States devoted to research in the Northern Boreal Forest. Since the mid-1980s, INF has seen a continued decline in its budget and a continued erosion of scientists and programs. There are presently six scientists, three permanent technicians, several seasonal technicians, and a support staff of three at the Institute.

Scientists at INF have been active in the BNZ program since it was established in 1987. In addition to several research projects, Institute personnel have been responsible for the management and operation of the two research areas associated with the BNZ; Bonanza Creek Experimental Forest and Caribou-Poker Creek Research Watershed. They have also maintained the associated climate and vegetation monitoring. Three scientists and three technicians presently devote a large share of their time to the program.

At press time, Hermann Gucinski, PNW Program Manager for the Ecosystems Processes Program, was working on a Memorandum of Agreement between PNW and UAF to establish a Forest Research Cooperative Unit on the Fairbanks campus. This unit would contain two FS scientists and would preserve the FS commitment to the LTER program, provide for some continuity in the FS role in the program, and support continued operation of the two LTER research sites.

◆ *Les Viereck, Bonanza Creek*

New Bridge at Caribou-Poker Creeks Watershed

Access to the Caribou-Poker Creeks Research Watershed (CPCRW) became easier this summer with the construction of a new bridge across the Chatanika River. Since the establishment of CPCRW, one of the two research sites of the Bonanza Creek LTER program (BNZ) in the Alaska boreal forest, getting researchers into the site had been a major problem. In summer, vehicle access was limited to fording the Chatanika River or by a long and arduous four-wheeler trail over Haystack Mountain. In periods of high water and during break-up and freeze-up, individual researchers' only access across the river was via a 50-meter-long cable strung between a tree on each bank. Researchers rode in a basket, hung beneath the cable on a pulley, and pulled themselves to the other side. In winter, access was by snow machine across the frozen river.

LES VIERECK

Crossing the Chatanika: The new bridge (left) over the Chatanika River replaces a basket-pulley system (next page) used by researchers during break-up, freeze-up, and periods of high water.

All of that changed in July 1995 when, through the efforts of the U.S. Forest Service's Pacific Northwest station and the U.S. Army Cold Regions Research Laboratory (CRREL), a bridge was constructed across the Chatanika

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INSIDE:

CALL *for* PROPOSALS

National Center for Ecological Analysis & Synthesis

The National Center for Ecological Analysis and Synthesis' focus is collaborative, basic and applied resesarch on the structure and dynamics of ecological systems

The National Science Foundation (NSF) established a National Center for Ecological Analysis and Synthesis (NCEAS) at the University of California, Santa Barbara in May 1995 to advance the understanding of ecology by organizing and synthesizing ecological information so that it will be useful to scientists, policymakers and resource managers. Through a cooperative agreement with NSF's Division of Environmental Biology, the new center has been awarded an estimated 10 million dollars over the next five years.

The center will not be a source of new data, but will be involved in the synthesis and analysis of existing data. Its focus is collaborative, basic, and applied research on the structure and dynamics of ecological systems. Sponsored activities include research and training workshops, working groups, and resident fellows. The first two years, the areas of emphasis are Spatiotemporal Dynamics and Ecosystem Management, but proposals of a highly innovative and synthetic nature will also be considered.

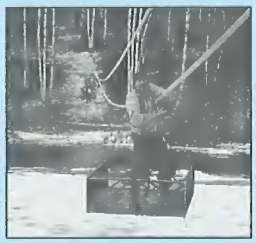
The center will provide facilities and support for individual scientists to produce models, comparative analyses, and synthesis publications. It will also offer short courses on new analytical methodologies and mathematical techniques. Along with encouraging both graduate and undergraduate students to participate in a variety of center functions, NCEAS will support post-doctoral fellows.

The target date for receipt of 1995 proposals is December 31.

◆ *For more information on proposal submission specifications and the review process: 805/893-7670, admin@ceas.ucsb.edu, http://www.ceas.ucsb.edu (web)*

New Edition!—Ecoregions Map

The USDA Forest Service has recently published a fully revised and enlarged edition of Robert G. Bailey's ecoregions map of the United States. The 24" x 36", 1:7,500,000 color map depicts 52 regional ecosystems, from tropical rainforest to arctic tundra to subtropical semi-desert to temperate steppe to mountains with altitudinal zonation. Part of USDA Forest Service Miscellaneous Publication Number 1391, *Description of the Ecoregions of the United States* at is available at no cost from the author at: USDA Forest Service, Ecosystem Management, 3825 East Mulberry Street, Fort Collins, CO 80524. ◆



MARK TACHENY

New Bridge, *continued from page 1*

River. The successful completion of the bridge project is the culmination of 20 years of effort by Dr. Charles Slaughter, for many years the Forest Service scientist in charge of the CPCRW. Dr. Slaughter searched diligently for a "surplus" bridge that could span the 50-meter-wide Chatanika River. Following the Gulf War, a Bailey Bridge used in military operations was located in Europe and shipped by the U.S. Army to Fairbanks, where it was stored at the University of Alaska's Poker Flats Rocket Range adjacent to the watershed. Dr. Slaughter then managed to obtain the necessary $60,000 from PNW's construction fund, primarily for construction of the bridge abutments and access road.

The U.S. Army Cold Regions Research and Engineering Laboratory agreed to take on the responsibility of actually constructing the bridge as part of a realistic training session simulating conditions of an oil field in Siberia. The simulation included a group of "eco-terrorists" who tried to prevent the bridge's construction. For about three weeks in July, as the bridge was being constructed, researchers traveling into CPCRW were scrutinized carefully by the Army units guarding the construction site. The completed bridge will remain the property and responsibility of CRREL, an agency with many long-term research projects in the research watershed.

Ironically, the completion and dedication of the bridge occurred during the same week that PNW administrators were in Fairbanks announcing that the Institute of Northern Forestry would be closed due to recent Forest Service budget cuts. Fortunately, the bridge was completed before this closure and is now available to LTER and other researchers, making access to their research sites much easier on a year-round basis.

◆ *Les Viereck*

LAND USE HISTORY *of* NORTH AMERICA

An Emerging Project of the National Biological Service

The Value of a Land Use History

Efforts to manage the nation's biological resources are hampered by the lack of an historical perspective on conditions prior to European settlement and subsequent changes in the North American landscape. Much of the impact that people have had on the environment can be viewed as a series of unplanned experiments, with particular perturbations generating measurable responses, in the form of contractions in the ranges of some species and expansions in the ranges of others. Within the context of these temporal dynamics, species extinctions and the spread of non-indigenous species may be seen as the extreme cases, where biological elements are lost or introduced. These experiments have been run, and environmental scientists are beginning to assemble the data needed to assess the results. The first task is to develop a clearer understanding of the historic changes in the distributions of plants and animals and their relation to human-induced changes to the landscape. Given this understanding, land managers will be able to review the effects of past perturbations and apply this information when attempting to evaluate the likely outcomes of future land changes.

Much of the data needed to construct such a retrospective view have already been collected; information on landscape change spans the period of human habitation of North America. Impressive regional efforts have been undertaken to synthesize the available information regarding land use change and its impact on ecological systems, but these projects have generally been limited to relatively small areas and short timelines. Large quantities of valuable biological and physical information remain unexplored, warehoused in different locations, and maintained by different organizations.

Consider the abundant information on prehistoric land cover and species distributions accumulated through the creative efforts of paleoecologists. Integration of coarse-resolution data such as these with information derived from original land surveys of the country (e.g., data archived by the Bureau of Land Management), and the U.S. Forest Service's data on the fire history of North America, for example, could make the characterization of historic landscape change quite tractable. When these data are combined with aerial photography from the extensive surveys started in the 1930s, and remotely sensed data from advanced satellite imagery, it will be possible to stitch together a continuous timeline, from prehistoric times to the present. Catalyzing such an effort is the intent of the National Biological Service's Land Use History of North America project (LUHNA).

Launching the Project

LUHNA is an ambitious project, one that will require the collaboration of many different individuals and agencies, both within and outside government. In August 1995, the National Biological Service (NBS) convened a workshop to help define the scope and intent of the LUHNA effort, and to identify a strategy for fostering the multi-disciplinary collaboration that it will require. Representatives from six government agencies, six universities, and three not-for-profit organizations established a framework for building a broader LUHNA effort. While it will serve as the organizer and initial "home base" for the project, NBS cannot possibly carry out such a large project alone, nor fund all the work required. Instead, the Service will provide a forum for discussion, communication and scoping of the project and the initiative for developing the necessary interdisciplinary relationships, and will also approach other organizations for cooperation and/or funding support.

NBS has established an electronic mail account (*luhna@ibis.mib.nbs.gov*) to solicit comment for the LUHNA project. Currently, limited staff are assigned to the project, and messages will be responded to as time allows. In the near future, a bulletin board will be established, permitting an open exchange of ideas among all collaborators and interested parties. The NBS will assemble a directory of individuals and organizations interested in LUHNA, as well as a bibliography of important publications related to the concept.

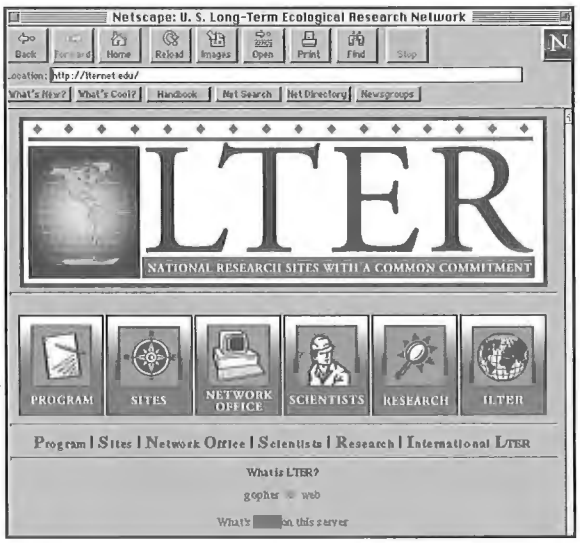
For information on formats, potential contributors are invited to send inquiries to the electronic mail address above. Submissions to both documents will be compiled and distributed electronically to all respondents, unless otherwise requested.

◆ *Thomas D. Sisk, ecologist, and Barry R. Noon, acting chief scientist, National Biological Service, U.S. Department of the Interior, Washington, D.C.*

When the valuable biological and physical information maintained by different organizations is combined with aerial photography and remotely sensed data, it will be possible to stitch together a continuous timeline, from prehistoric times to the present

NIGEC 1996-1997 RFP TO BE ANNOUNCED

The National Institute for Global Environmental Change (NIGEC) will be announcing the annual Request for Proposals on the World Wide Web for FY 1996-97. NIGEC is attempting to answer top-down questions by collection of data and process-oriented studies at the regional level, which will be scaled up to the continental level. To this end, cross-collaboration and integration between different institutions/investigators/programs within a region and between regions is encouraged. The RFP and information on the six regions within NEGEC is available at URL *http://nigec.ucdavis.edu/*. Alternatively, contact Linda Ono, 916/752-7300, *westgec@ucdavis.edu.* ◆



SCREEN CAPTURE, JOE WILMHOFF

The Network Office home page (http://lternet.edu) includes direct links to information on LTER sites, scientists and students, intersite research, and national and international activities

LTERnet to be Featured at New NSF Exhibit Center

In early November 1995, the National Science Foundation is opening a new exhibit center which initially will feature an exhibit on NSF's role in the development and use of the global Internet. The LTER Network, with specific focus on the LTERnet electronic information system, will be featured as an example of a scientific community using the Internet as a major communication tool. The LTER portion of the display will include photographs of LTER sites, a map showing the distribution of the sites, and several computers for visitors to use to explore online information on LTER. ◆

NEW COWEETA SITE MANAGER

Brian D. Kloeppel assumed the position of Site Manager at the Coweeta Hydrologic Laboratory LTER site near Franklin, North Carolina February 27, 1995. Responsibilities of this newly-created position include on-site coordination of 28 principal investigators, communication with the LTER Network Office and other LTER sites to promote the exchange of ideas and research, and assisting site data management personnel to enhance on-site data transfer and electronic communication capabilities.

Brian is also conducting research at Coweeta relating carbon budgets and cycling at local and regional scales. He came to Coweeta after completing studies in forestry at the University of Wisconsin-Madison (B.S. 1989), and graduate work in Tree Physiology at Penn State University (M.S. 1992) and in Forest Ecology at the University of Wisconsin-Madison (Ph.D. 1995, anticipated). ◆

COURTESY OF BRIAN D. KLOEPPEL

RICK INGERSOLL DEPARTS NIWOT RIDGE

The Niwot LTER group reports, sadly, that Rick Ingersoll left the Niwot Ridge/Green Lakes Valley LTER program this summer to join his spouse in Ann Arbor, Michigan. While we will miss Rick, he leaves LTER with an impressive record of accomplishment. During his tenure as Information Manager at Niwot, Rick authored or co-authored a number of network reports, including "The Management of Electronically Collected Data within the LTER Program" and "Proceedings of the 1994 LTER Data Management Workshop," and completed a valuable survey of LTER site online datasets (see table, next page). He also was responsible for single-handedly creating the Niwot Ridge information system. His prowess at this activity is best summarized in the report of the 1995 National Science Foundation-sponsored external site review:

COURTESY OF TIM SEASTEDT

"The review team was sufficiently impressed with the information management efforts at the site that we feel that the group could play a useful role in the development of information networks at the national and international scale outside the LTER Network" (NSF, 6/28/95).

Rick began as a field/laboratory technician at Niwot in November 1988, becoming information manager in January 1990. He is presently working on a manuscript describing the Niwot Ridge LTER information management system, and will still be available online at *ricki@culter.colorado.edu* for consultation with LTER colleagues.

◆ *Tim Seastedt, Niwot Ridge*

LTER SITE ONLINE DATASETS

This table summarizes the current availability, through Gopher or WWW, of documented datasets (i.e., data plus metadata) across the LTER Network. Web access to site information servers is via the "Sites" link (http://lternet.edu/about/sites/menu.htm) from the Network Office home page (http://lternet.edu), and Gopher access via "8. LTER Site Information Servers/" from the main LTER Gopher menu. Sites often have additional, proprietary data available to site researchers, some of which may be available on a per-case basis to others on request. In addition, descriptions or documentation are frequently online for such data. This table is not intended to provide any indication of the quantity or scope of the data available, nor does it reflect spatial or temporal extent.

DATA	SITE(s)
Animals	
aboveground invertebrates	CPR, KNZ
arthropods/nematodes	CPR, KBS, KNZ, NWT
birds	CPR, KNZ
fish	ARC, NTL
mammals	CPR, KNZ, NWT, VCR
Vegetation	
chlorophyll	ARC, NTL, PAL
plant chemistry	ARC, BNZ, HBR, NWT
plant cover/composition	AND, BNZ, CDR, HBR, KBS, KNZ, NWT, SEV, VCR
plant phenology	ARC, CPR, HBR, KNZ
primary production/biomass	AND, ARC, BNZ, CDR, CPR, HBR, KBS, KNZ, NWT, VCR
Biogeochemistry	
atmospheric deposition	AND, ARC, HBR, KBS, KNZ
decomposition	AND, CPR, NWT
fertilization effects	ARC, BNZ, CDR, NWT
litterfall (chemistry)	CPR, HBR, KNZ
snow chemistry	NWT
soil (water) chemistry	ARC, BNZ, HBR, KNZ, NWT
surface water quality	AND, ARC, CWT, HBR, NWT
throughfall/streamflow chemistry	HBR, KNZ
trace gas emissions	ARC, BNZ, CPR, NWT
Environmental Parameters	
meteorology/climatology	AND, ARC, BNZ, CDR, CPR, CWT, HBR, HFR, KBS, KNZ, LUQ, NWT, PAL, SEV, VCR
lake ice duration/meltout	NTL, NWT
snow ablation/melt	AND, NWT
snow physical properties	HBR, NWT
soil moisture/water	AND, KNZ, CPR, HBR, KNZ, NWT
soil temperature	AND, ARC, BNZ, CPR, HBR, KBS, KNZ, NWT
stream channel cross-sections	AND
stream flow/discharge	AND, ARC, CWT, HBR, KNZ, NWT
Miscellaneous	
disturbance effects	ARC, BNZ, CDR, CPR, HBR, KBS, KNZ, NWT
fire history	AND, KNZ
GIS coverage maps	AND, ARC, CPR, KBS, VCR
global positioning systems	VCR
paleoecology	NWT
satellite imagery	KBS, KNZ, VCR

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

COMPILED BY RICK INGERSOL; UPDATED JULY 21, 1995 BY R. INGERSOLL & M. HARTMAN

Methodology

In order to ensure the continued manageability of the LTER Online Datasets Table, general categories of data were used. These categories will subsequently be created, divided or merged, if necessary, to maintain its usefulness and manageability. A few comments regarding the categories are warranted:

- Parenthetical modifiers are optional, e.g., "soil (water) chemistry" includes both "soil chemistry and "soil water chemistry."
- Entries under the "animal" category include species lists, species abundance, individual organism measurements (e.g., weights, sizes).
- Entries for "primary production/ biomass" include proxy measurements such as basal area, diameter, etc.
- Entries for "atmospheric deposition" include precipitation chemistry, as well as wet, bulk, and dry deposition.
- There is overlap for the "disturbance effects" and "fertilization effects" categories, with an entry in the latter being equivalent to an automatic entry in the former.

McMURDO DRY VALLEYS

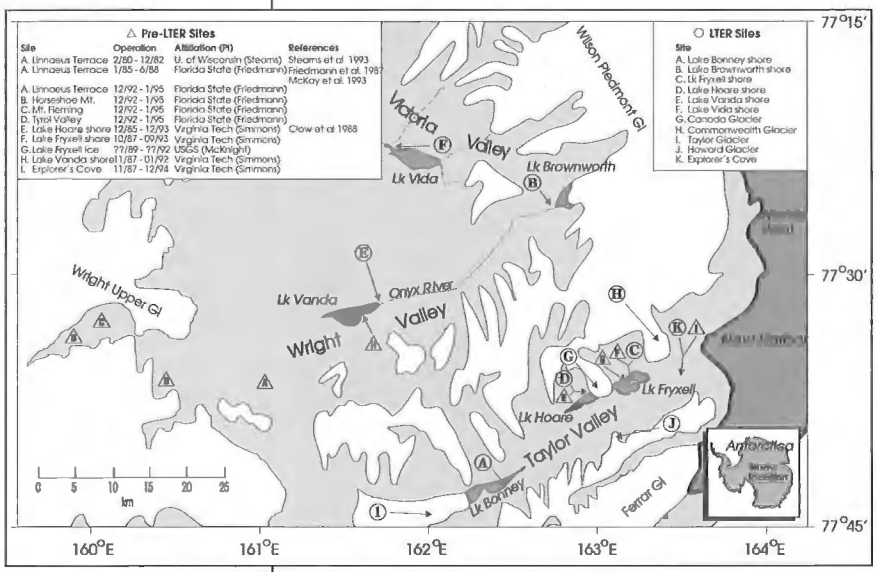
An Overview of 1993-1995 Research Activities

Robert Wharton, Jr.

In the LTER continuum of ecosystems, the dry valleys represent "end-member" environments which contain microbially dominated ecosystems

The McMurdo Dry Valleys LTER site is far colder and drier than any of the 17 other established LTER sites. The perennially ice-covered lakes, ephemeral streams, and extensive areas of soil within the valleys are subject to low temperatures, limited precipitation, and salt accumulation. In the LTER continuum of ecosystems, the dry valleys represent "end-member" environments which contain microbially dominated ecosystems. An important aspect of the McMurdo LTER (MCM) research is its potential contribution to general ecological understanding through studies of processes that may be better resolved in these relatively simplified ecosystems. The two key hypotheses addressed are: 1) The structure and function of the Taylor Valley ecosystems are differentially constrained by physical and biological factors, and 2) The structure and function of Taylor Valley ecosystems are modified by material transport.

The McMurdo LTER is addressing these hypotheses and the five LTER core research areas through a program of systematic environmental data collection, long-term experiments, and model development. Research activities encompass several disciplines, including physical, chemical, biological, modeling and information science. During the first six years of the project, MCM is focusing its efforts on Taylor Valley.



Above: The general region of study showing pre-LTER and LTER study sites for the McMurdo Dry Valleys LTER.

The 1993-95 Field Seasons

The McMurdo LTER project has successfully completed two field seasons (October through February) during 1993-94 and 1994-95. During the 1993-94 field season, 18 scientists deployed to McMurdo Station and Taylor Valley to conduct research associated with the LTER project. These scientists initiated core measurement programs to obtain baseline ecologically-relevant data from the atmosphere, glaciers, streams, soils and lakes. During the 1994-95 field season, 26 LTER scientists visited the dry valleys to continue the core measurements and research program.

One of the first objectives of the MCM was to establish a meteorological network that would gather representative weather data year-round from the dry valleys. The McMurdo LTER Automatic Weather Network (LAWN) currently consists of nine stations with two new stations planned for deployment during the 1995-96 field season. Stations are now operational at Explorer's Cove, on the shores of lakes Fryxell, Hoare, Bonney, Brownworth and Vanda, and on the Commonwealth, Howard and Taylor glaciers. The new stations to be deployed are on the shore of Lake Vida and the surface of the Canada Glacier.

Since the McMurdo Dry Valleys lacks significant precipitation, glacier meltwater is the primary source of water to the streams and lakes. In addition to recharging the lakes, this water carries dissolved gases and solutes. A major objective of the LTER glaciological program is to determine the mass balance and meltwater runoff of the glaciers in Taylor Valley that contribute water to the lakes. During the 1993-94 field season, the project established a network of surface-based measurements on the Commonwealth, Canada, and Howard glaciers to determine mass balance and meltwater flow. The following season, LTER scientists measured the major contributions to the surface energy budget of the Canada Glacier in Taylor Valley. Their measurements and modeling of glacier energy fluxes in Taylor Valley are comparable to other regions of the Antarctic. They conclude that the role of sublimation in the mass balance of dry valley glaciers is significant.

Soils in the dry valleys are influenced by a variety of factors including climate, glacial movement, parent material and site characteristics. In Taylor Valley, the oldest soils are found at higher elevations while those at lower elevations were probably deposited during relatively recent glacial activity. During the 1993-94 field season, LTER scientists established an elevational transect on the south shore of Lake Hoare to examine spatial variation in soil properties and nematode abundance. Using observations and samples collected during 1994-95, it appears that the distribution of nematodes in the dry valleys may be governed by pH and concentration of soluble salts.

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Numerous ephemeral streams link the glaciers and lakes within the dry valleys for six to ten weeks during the austral summer. These glacial meltwater streams recharge the dry valley lakes, are important sources of nutrients, and support the growth of moss and microbial mat communities. The McMurdo LTER now has in place an extensive network of gauging stations where stream flow is measured continuously throughout the austral summer. During the first two field seasons, LTER scientists focused efforts on determining the influence of stream channel characteristics on stream flow and annual water budgets for lakes in Taylor Valley. Their results show that there is interannual variation in relative flow, even among streams where stream length and location in the basin are similar. They also found that longer streams have generally higher concentrations of major ions due to greater interaction with the hyporheic zone. In parallel studies, LTER scientists have examined the role of stream gradient, sediment transport, and substrate stability on the distribution of mosses and microbial mats in streams. Results show that the range in abundance of algae and mosses appears to be controlled by gradient and flow conditions.

ANDREW FOUNTAIN

Left: Graduate student Gayle Dana measuring spectral reflectance of Lake Hoare ice cover, Taylor Valley, Antarctica, as part of a remote sensing study to determine spatially-distributed radiative fluxes. (See bottom page 13 for more information.)

Lakes Program

The McMurdo LTER lakes program is focused on understanding the environmental conditions and ecological processes of former and present lakes in the dry valleys. The perennially ice-covered lakes support both phytoplankton and benthic microbial communities. The chemistry of each lake profoundly effects the biota within the lake. The LTER project is collecting major element and nutrient chemistry for lakes Fryxell, Hoare and Bonney in Taylor Valley at least three times per field season. One early result of this effort shows that the depth profiles of K^+, Mg^{2+}, Na^+ and SO_4^{2+} normalized to the conservative ion Cl^- are extremely different among the lakes. Project scientists suggest that these differences cannot be explained by differences in current solute sources or in-lake biogeochemical processes. It appears that the climatological and hydrological histories of each lake need to be closely studied before definitive statements can be made about the overall geochemical evolution of the Taylor Valley lakes.

The LTER lakes project is also investigating phytoplankton nutrient deficiencies. Early results show that the nutrient concentrations are quite different among lakes Fryxell, Hoare, and Bonney (both lobes), as well as vertically within lakes, and suggest that phytoplankton biomass within a lake and levels of productivity between lakes are strongly related to the upward flux of dissolved inorganic nitrogen from deep water pools.

In a study of the benthic cyanobacterial mats in Lake Hoare during the 1994-95 field season, LTER scientists determined photosynthesis versus photon flux curves, the absorption spectra of the mats, and biomass mats from a range of depths. Preliminary results show that the benthic mats are light limited and that there is a decrease in mat biomass with depth in the lake. LTER scientists have developed a mathematical model that simulates the productivity patterns of benthic microbial mats as a function of light intensity.

The McMurdo LTER is an explicitly synthetic effort—a comprehensive, multidisciplinary ecosystem study. Much of the data collected is being incorporated into a geographic information system (GIS) for data management and spatial analysis. LTER scientists have developed a GIS for Taylor Valley which now includes a number of thematic coverages. These include: base map, control points, topography, soils, geomorphology, lakes (with and without bathymetry, drill holes), glaciers (including stake locations), Taylor Valley drainage basin, streams (reach, transects, catchment area), and a coverage of station sites (met, melt holes, stream gauges, stream and soil transects, geodetic control points).

The 1995-1996 Field Season

The McMurdo LTER project is currently conducting its third field season, with 27 scientists scheduled for deployment to the site to continue its program of systematic environmental data collection and long-term experiments. One important new focus for the 1995-96 field season is data collection during the austral winter and spring. In late August 1995, LTER scientists began field activities focused on the changes in lake chemistry and biology during the transition between total winter darkness and the return of light in the spring.

Growing rapidly in size as well as visibility, the project has expanded to include wider student and scientist participation, now involving several undergraduate and graduate students and three postdoctoral positions. This September, MCM welcomed Dr. Valery Galchenko, Russian Academy of Sciences Institute of Microbiology, Moscow, who will be studying biogeochemistry of benthic communities in the lakes. Data Manager Jordan Hastings, currently teaching Computer Science classes at the University of Nevada-Reno, has implemented the Taylor Valley GIS and takes classtime opportunities to introduce the project to student volunteers for hands-on experience. The McMurdo maintains an ftp server which provides public access to datasets collected, and is developing an online Internet presence—the site bibliography was recently added to the LTER All-Site Bibliography at *LTERnet.edu*.

◆ *For more information: Robert A. Wharton, Jr., 702/673-7469, rWharton@LTERnet.edu*

This summer, McMurdo LTER scientists began field activities focused on the changes in lake chemistry and biology during the transition between total winter darkness and the return of light in the spring

PALMER STATION

The impact of sea ice on the structure and function of a pelagic marine ecosystem

By Robin Ross & Langdon Quetin

Observations to date suggest that the western Antarctic Peninsula may be especially sensitive to greenhouse-gas warming

The Palmer LTER (PAL) was established in late 1990 and focuses on the pelagic marine ecosystem west of the Antarctic Peninsula. Although the Palmer LTER is the only fully marine (from coastal to pelagic) site in the LTER Network, it shares with other sites the unifying hypothesis that physical factors control the biology of the system. The general hypothesis for PAL is that the annual advance and retreat of sea ice is a major physical factor governing the structure and function of this ecosystem, and the variability seen at all levels of the food web. A key challenge is to characterize and understand the linkages among the different spatial and temporal scales of the various physical (solar radiation, atmospheric and oceanographic circulation, and sea ice coverage) and biological components (key predators, secondary and primary consumers and microbial loop) of the Antarctic ecosystem.

The PAL study region surrounds Palmer Station (64°40'S, 64°03'W), located in a protected harbor on the southwest side of Anvers Island midway down the Antarctic Peninsula. To structure long-term regional observations, a sampling grid along the west coast of the peninsula (see figure, next page) was created which reflects the scale of atmospheric, oceanic and sea ice interactions with populations in the marine ecosystem. Within the large-scale grid are embedded smaller-scale grids encompassing the foraging ranges of the predators (seabirds) nesting near Palmer Station and where time series data can be obtained throughout the season. The following are routinely sampled within the LTER sampling grids: sea ice, *in situ* bio-optical water properties, temperature and salinity (conductivity), photosynthetic pigments, macro-nutrient concentrations, phytoplankton and bacterioplankton production, secondary production, sedimentation and seabird ecology. Spatial sampling has included annual and seasonal cruises covering most portions of the large scale grid and temporal sampling has included at least weekly observations in the vicinity of Palmer Station.

ROBIN ROSS/LANGDON QUETIN

Below: *Capturing tagged Adélie penguin chicks from a rookery near Palmer Station to obtain fledging weights before they go to sea.*

Climatology

Several factors make the Palmer LTER study region ideally sited for investigations of the response of polar ecosystems to global change: a historical climate record, a strong response to climate change, a persistent pattern of sea ice and temperature anomalies, and a northern area intermittently covered and a southern area consistently covered every winter by sea ice. Although by standards in the northern hemisphere the climate record in the Antarctic is relatively short, scattered expedition records for the region west of the Antarctic Peninsula start in the early 1900s and predate the consistent, quality-controlled records of the British Antarctic Survey from the mid-1940s. There is a statistically significant warming trend in this region over the past 45 years which is larger than elsewhere in the Antarctic. Winter temperatures show the strongest warming trend, with a 5.5°C increase in June (winter) temperatures over the 48-year record. Within the long-term record, air temperature at Faraday, a former British station only 40 km from Palmer, and the Southern Oscillation Index (SOI) show significant coherence. Combined with the anticorrelation between temperature and sea-ice coverage, this supports the possibility for a coherence between LTER ice extent and SOI. Since the El Niño/Southern Oscillation phenomenon is a large-scale source of climate variability, understanding this linkage is of considerable importance for the global connections of the Palmer LTER to the Southern Hemisphere. While there are complex linkages between cyclonic activity, air temperature and sea ice which have yet to be elucidated, observations to date suggest that the western Antarctic Peninsula may be an area which is especially sensitive to greenhouse-gas warming.

In the Palmer LTER region, both air temperature and sea-ice extent show persistent anomalies which appear as consecutive high ice/low temperature years followed by consecutive low ice/high temperature years. These anomalies appear to impact the survival rates, distributions and life histories of a number of dominant species in the pelagic marine ecosystem. High interannual variability in these physical factors provides a study site where "natural" experiments will test the sensitivity of ecological processes to climate variability and change.

Highlights from Recent Research

The interaction between the Adélie penguin and its primary prey, Antarctic krill, provides an example of research across variable space/time scales associated with the Palmer LTER. During the past three summers, we have conducted investigations (making use of both ship and shore based observations) during a critical period of chick rearing of the relationship between prey availability and penguin at-sea foraging behavior, and the reproductive ecology of the Adélies nesting in the nearby rookeries. During this critical period, prey biomass has varied by more than an order of magnitude, with parallel changes in foraging duration and adult behavior necessary to feed the chick(s). Two interactive possibilities exist to explain this variability in krill availability, variability in recruitment leading to decreases in the stock, and/or shifts in population distributions linked to changes in atmospheric and oceanic circulation. Factors that affect the population dynamics and distribution of krill populations on the mesoscale and over its seven-year life span affect prey availability on small time (critical period during chick rearing) and space (foraging range) scales for the Adélies. Prey availability in turn impacts reproductive success in the Adélies that season. Krill recruitment success has been highly variable in the Palmer LTER region, and is strongly correlated with the timing and magnitude of winter ice, a physical factor operating on regional scales.

Primary production and phytoplankton standing stock also vary on several time and space scales. Temporal observations in the nearshore Palmer grid over the production season and spatial observations in the larger regional grid during a restricted period show strong seasonal and interannual variability. The two seasons following winters with high ice coverage developed overall phytoplankton biomass during bloom periods five times greater than two other seasons, on both the fine- and regional scale grids. On/offshore gradients were present in all years, and there is evidence that this gradient is modulated alongshore by latitudinal variability and the annual advance and retreat of sea ice.

Results from the first four field seasons support the hypothesis that interannual variability in physical factors such as sea ice impact all levels of the ecosystem and that this provides the Palmer LTER with the means to investigate the impact of these physical factors on the structure and function of the pelagic marine ecosystem.

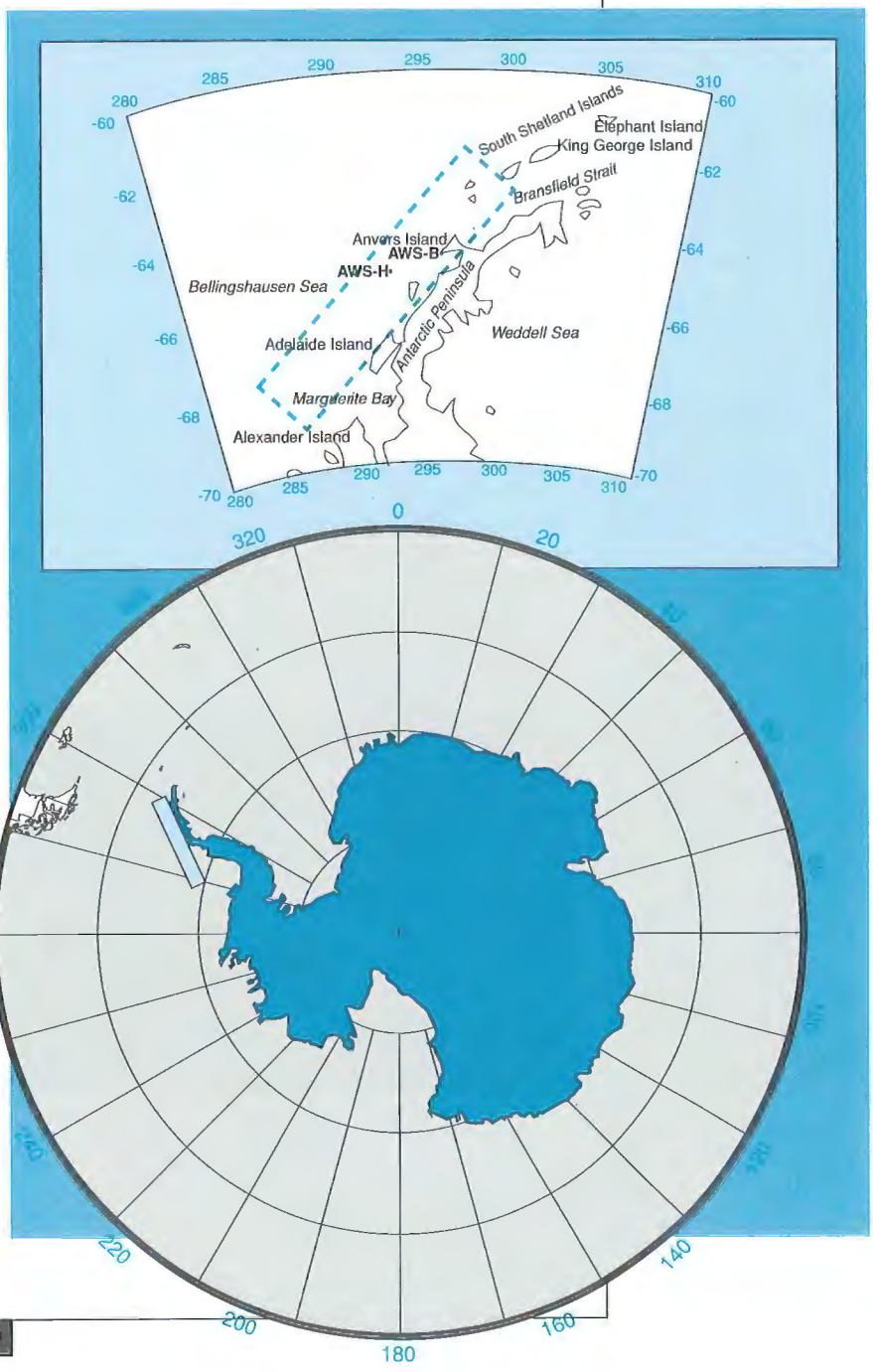
◆ *For more information see the PAL web site at* http://www.icess.ucsb.edu/lter *or contact members of the Palmer LTER:*

Karen Baker, *karen@icess.ucsb.edu*
Bill Fraser, *ubiwf@trex.oscs.montana.edu*
Eileen Hofmann, *hofmann@kuroshio.ccpo.odu.edu*
Dave Karl, *dkarl@iniki.soest.hawaii.edu*
John Klinck, *klinck@kuroshio.ccpo.odu.edu*
Langdon Quetin, *langdon@icess.ucsb.edu*
Robin Ross, *robin@icess.ucsb.edu*
Ray Smith, *ray @icess.ucsb.edu*
Wayne Trivelpiece, *ubiwt@msu.oscs.montana.edu*
Maria Vernet, *mvernet@ucsd.edu*

TIM NEWBERGER

Left: Trawling for Antarctic krill in the fine-scale grid near Palmer Station from a zodiac.

Below: Palmer LTER study region shown outlined west of the Antarctic Peninsula and south of the tip of South America. Detail shows large-scale Peninsula grid (dotted lines). Automatic weather station (AWS) locations are AWS-B, Bonaparte Point near Palmer Station on Anvers Island, and AWS-H, Hugo Island.



HARVARD BULLARD FELLOWSHIPS IN FOREST RESEARCH

Each year, Harvard University awards a limited number of Bullard Fellowships to individuals in biological, social, physical and political sciences to promote advanced study, research or integration of subjects pertaining to forested ecosystems. The fellowships, which include stipends up to $30,000, are intended to provide individuals in mid-career with an opportunity to utilize the resources and to interact with personnel in any department within Harvard University. In recent years, Bullard Fellows have been associated with the Harvard Forest, Department of Organismic and Evolutionary Biology and the Kennedy School of Government, and have worked in areas of ecology, forest management, policy and conservation.

Fellowships are available for periods ranging from four months to one year, and can begin at any time in the year. Applications from international scientists, women and minorities are encouraged. The annual deadline for applications is February 1. ◆ *For more information: Committee on the Charles Bullard Fund for Forest Research, Harvard University, Harvard Forest, Petersham, MA 01366 USA*

SITE ACTIVITIES & PROJECTS

BIODIVERSITY WORKSHOP TO BE HELD AT CEDAR CREEK

A workshop to be held in conjunction with the October 20-22, 1995 LTER Coordinating Committee meeting at the Cedar Creek site in Michigan will address the issue of whether there is a unique role for a network of sites like the LTER Network in the field of biodiversity. Organizer Bob Waide, co-principal investigator at Luquillo Experimental Forest LTER, Puerto Rico, has asked each LTER site to send a representative to the meeting who will also participate in the workshop. Following the keynote speaker (not confirmed at press time), site representatives will be asked to provide a brief description of ongoing site biodiversity research. More detailed case studies will be presented for several sites, and working groups will attempt to develop possible cross-site experiments and proposals. ◆

For more information: Bob Waide, 809/767-0371 or 0338, bWaide@LTERnet.edu

EXPERIMENTAL TREATMENT AT COWEETA RIPARIAN SITE

On August 29, 1995, the long-awaited removal of the heavy rhododendron subcanopy was conducted on a riparian site at the Coweeta LTER site in North Carolina. This experiment will be used to assess the functional role that *Rhododendron maximum L.* plays on the hydrological, nutrient, and light components of riparian sites in the Southern Appalachians. The area occupied by rhododendron in this region continues to increase over time and is expected to play a large role as a link between terrestrial and aquatic ecosystems. The removal treatment was preceded with more than two years of baseline data collection in both control and treatment plots and will be followed by at least two years of post-treatment data collection. ◆

JUDY L. MEYER

***Above:** A rhododendron-shaded site on Coweeta Creek.*

McMURDO DRY VALLEYS BEGINS SOLA PROJECT

Working in the Antarctic environment poses numerous challenges, but also provides unique opportunities. One critical opportunity for the McMurdo LTER (MCM) is organizing and providing access to the site's Data and Information (D&I) resources across an international community of 50-plus project scientists, colleagues and students working at one of the most remote field stations on Earth. There is a high level of public interest in Antarctic projects in general and the anomalous, exotic Dry Valleys area in particular.

The MCM grant proposal was written with the intention that, to the largest extent possible, the project's D&I resources would be integrated and displayed interactively via a Geographic Information System (GIS) operating across the global Internet. In ways which could barely have been imagined five years ago when the proposal was in preparation, both D&I management and GIS technologies have advanced to make this goal feasible.

In August 1995, the MCM was awarded joint support by the NSF Database Activities Programs and Office of Polar Programs to formally begin the development of its GIS-based D&I management system. The overall project is referred to as SOLA (Science On-Line Antarctica). The first phase, requirements analysis, will proceed during fall and winter 1995-96 with assistance from the National Center for Geographic Information and Analysis, and will culminate in a planning review workshop in April 1996. This invitational workshop, to be held at the Biosphere 2 facility in Tucson, Arizona, is co-sponsored by the LTER Climate and Synthesis committees, with participation of the LTER Data Managers. The goals of the workshop are to solicit comments and suggestions from the entire LTER community on McMurdo's SOLA prototype efforts, and to provide the community with an opportunity to be involved in the ongoing SOLA development process, which also may hold promise for the LTER Network as a whole. ◆

For more information: Evangeline Elston, SOLA Project Coordinator, 702/674-7700, eelston@maxey.dri.edu

McMURDO ENVIRONMENTAL MANAGEMENTWORKSHOP

A workshop entitled "Environmental Management of the McMurdo Dry Valleys" was held in Santa Fe, New Mexico, during March 14-17, 1995. Warwick Vincent of Laval University, Quebec City, Canada served as chair of the workshop, which was attended by 35 participants from around the world including the United States, New Zealand, Canada, Australia, Japan, United Kingdom, Germany, Italy and South America. The major objectives were to develop: (1 an ecosystem-based approach to managing the conduct of scientific activities in the

top next column

SITE ACTIVITIES & PROJECTS

McMurdo Dry Valleys, (2 a code of environmental conduct for scientists working in the field, (3 recommendations for an environmental monitoring program—including suitable indicators—that can address project specific and cumulative impacts, and (4 recommendations for management plans for regions within the dry valleys.

Key questions addressed included: ◆ Given that the Environmental Protocol affirms the importance of environmental protection of Antarctica as well as the value of the area for conducting scientific research, what are the interrelationships and possible conflicts between these two objectives? ◆ What are the critical parameters to be monitored to assess the impact of human activities of the long range transport of contaminants? ◆ What other research methodologies could be used to minimize human impact (e.g., remote sensing, remotely operated instrumentation)?

In addition, John Calkins of ESRI gave a demonstration on "The McMurdo GIS," and participants visited the Sevilleta National Wildlife Refuge LTER site. A workshop report will be available. ◆

For more information: McMurdo LTER Project Office, 702/673-7425, juliem@maxey.dri.edu

McMURDO CO-SPONSORS 1995 ASLO MEETING

The 1995 Annual Meeting of the American Society of Limnology & Oceanography (ASLO) was held June 11-15, 1995 at the University of Nevada-Reno. The meeting was co-sponsored by the Desert Research Institute (DRI), the University of Nevada-Reno Center for Environmental Science and Engineering and the Division of Continuing Education, and the University of California-Davis Tahoe Research Group. Co-conveners were McMurdo LTER Principal Investigator Robert A. Wharton, Jr., DRI, and David Garrison, Institute of Marine Sciences, University of California-Santa Cruz.

The diverse group of marine and freshwater scientists in attendance addressed a theme of extreme environments. Plenary sessions included: "Cold Water Limnology: Insights from the Arctic and Antarctic" (Warwick Vincent, Laval University), "Water and Life on Mars" (Chris McKay, NASA-Ames Research Center), and "The Freshwater Imperative"(John Magnuson, North Temperate Lakes LTER). LTER Data Managers Jordan Hastings (McMurdo) and Karen Baker (Palmer Station) co-presented two pre-conference workshops which focused on geographic information system technologies and their application to freshwater and marine ecosystem studies. Special sessions covered a broad range of topics dealing with limnology and oceanography, and several papers on research at LTER sites were presented. ◆

For a list of abstracts: McMurdo LTER Project Office, 702/673-7425, juliem@maxey.dri.edu

STEPHANIE MARTIN

At Left: Robert Christian (left, East Carolina University) and Linda Blum (right, University of Virginia), describe Virginia Coast Reserve marsh/upland studies on a May 1995 LTER Coordinating Committee field trip to the site.

MARSH / UPLAND GROUNDWATER MONITORING OF AGRICULTURAL INPUTS

On the Eastern Shore of Virginia, upland agricultural areas are linked to adjacent wetland areas by the flux of groundwater nutrients. As such, there is great potential for groundwater discharge to alter nutrient cycling, trophic structure, and secondary production in this environment. In this study, groundwater was monitored at a series of nested wells installed in the center and perimeter of an agricultural field which borders a tidal creek and is adjacent to a salt marsh. Nitrate concentrations are higher on the creek side of the field than on the marsh side (mean NO_3^- = 373 υM/L and <2 υM/L, respectively). Ammonium concentrations are greater on the marsh side of the field than on the creek side (mean NH_4^+ = 23 υM/L and 2 υM/L, respectively). Concentrations of nitrate generally decrease and ammonium concentrations increase in the direction of ground water flow. The observed nitrate concentrations can be as high as 700 υM/L and suggest possible contamination from human activity.

Del^{15} nitrate analyses suggest no simple relationship between isotopic composition and concentrations of ammonium and nitrate. The $\delta^{15}N$ ammonium values of selected samples suggest that ammonium is formed by mineralization of organic nitrogen. The $\delta^{15}N$ values of selected samples suggest that nitrate is derived from soil or fertilizer sources, and is modified by denitrification. The marsh/upland ecotone is a sharp ecosystem N-economy transition which, at the Virginia Coast Reserve, is not yet overwhelmed by heavy agricultural input.

◆ *Steve Macko & R.J. Tapper, Graduate Student*

LUQUILLO - NRCS SOIL SURVEY

A ceremony acknowledging the publication of the Order 1 Soil Survey was held at the Natural Resources Conservation Service (NRCS) office, Hato Rey, Puerto Rico, June 22, 1995. Members of the field team and Jess Zimmerman (Luquillo LTER) were present. NCRS Soil scientists who worked on the collaborative project included Bruce Dubee (Richmond, Virginia), Warren Lynn and Henry Mount (Lincoln, Nebraska), Roy Vick (Hato Rey).

Field work for the Luquillo LTER Grid survey was completed from February 17-27, 1993. Seventeen soils were sampled for characterization data. The report includes a digital map and analysis of the laboratory data, as well as near-surface properties (boulder and stone cover and leaf litter cover from 64 cells). ◆ *For survey copies: Henry R. Mount, NRCS, Federal Building, Room 152, 100 Centennial Mall North, Lincoln, NE 68508-3866*

SOIL REFERENCE & INFORMATION CENTRE

The International Soil Reference and Information Center in Wageningen, The Netherlands, collects and disseminates scientific knowledge about soils, has a permanent display of over 120 soil monoliths, and maintains a collection of 5,000 soil maps and 15,000 color slides available to researchers by arrangement. ◆ *For more information: ISRIC, 31-8370-24460 (FAX), ISRIC@rcl.wau.nl*

NSF Graduate Research Traineeship

COARSE WOODY DEBRIS IN LENTIC SYSTEMS

Timothy E. Essington

BS 1991-University of Michigan, Biology
MS 1995-University of Minnesota, Fisheries

James F. Kitchell, Advisor

Although the role of coarse woody debris in lotic systems has been well studied, the role of coarse woody debris in lentic systems is not as well understood. As in streams, coarse woody debris in lakes may provide fish refuge from avian and fish predators, causing fish to preferentially utilize areas with coarse woody debris. This may be particularly true during nesting, when adults and offspring are susceptible to predation. Additionally, the presence of a structurally complex environment may alter the feeding habits of some fishes, particularly benthic-oriented feeders which may consume invertebrate colonizers of coarse woody debris. I will examine how coarse woody debris affects the reproductive success and habitat utilization of largemouth bass and the feeding habits of bluegill sunfish in two north temperate lakes. ◆

LTER GRADUATE STUDENT COMMITTEE

As of August first, I stepped down as chair of the LTER Graduate Student Committee to allow our two newly elected co-chairs a chance to release some creative energy. Janet Fischer (North Temperate Lakes) and Reed Perkins (H.J. Andrews), have been very active in the GSC since its creation at the 1993 LTER All Scientists Meeting, and I look forward to seeing what contributions they will make as co-chairs.

NEW CO-CHAIRS

Janet Fischer (left) and Reed Perkins (right), 1996 LTER Graduate Student Committee Co-Chairs

Since I was inducted as chair in September 1993, the GSC has completed several activities toward accomplishing its three primary goals: ◆ facilitating communication among graduate students and researchers across LTER sites, ◆ creating opportunities for intersite research projects, and ◆ developing a more interdisciplinary graduate education.

Student E-mail Group. An e-mail group which allows anyone to send a notice to LTER students was established and has been used primarily to post announcements of meetings, decisions, and job opportunities pertinent to all students. The list presently includes nearly a hundred names and is always changing. To be added, students may send a message to *students-request@LTERnet.edu* including name, address and work phone.

Web Page. LTER students now have their own World Wide Web page (*http://lternet.edu/about/scientis/students.htm*, part of the Network Office home page) which includes information ranging from a list of students and their projects at different sites to funding opportunities and previous e-mail notices to students. (The same information is available on the LTERnet.edu gopher server.) This is also a great place to find out about the GSC.

ESA Mixer. Alison Magill (H.J. Andrews) organized a student mixer at the 1995 Ecological Society of America meeting to bring students together to share ideas and stimulate some cross-site comparison projects. More than 200 LTER and non-LTER students attended. ESA chair Judy Meyer noted that she would like to see the mixer become an annual event, perhaps with some support from ESA.

Cross-Site Award. In May 1995, the LTER Coordinating Committee passed a unanimous resolution creating an LTER student cross-site award from Network Office funds to encourage students to apply their current studies to other LTER sites. The first competition produced two awards (Bryan Dail, Coweeta and Reed Perkins, H.J. Andrews) but, since the total budget was not depleted, the Executive Committee allowed another competition this month (October 1995). Information about these awards and the new competition is available via the student web page under "Student Opportunities." Awardees are required to write a report describing their work, so watch for some interesting feedback online and in future issues of the *Network News*.

Overall, the Graduate Student Committee is off to a good solid start. Many of the original goals are being met, and LTER students now have additional options to enhance their education. On the students' behalf, I would like to thank the LTER community for giving us this opportunity to play a more active role in the Network. Special thanks to Dr. Caroline Bledsoe for her invaluable advice and support in making the GSC a success. I'm sure you will be hearing more about the GSC and its activities in the coming year.

◆ *Josh Greenberg, 206/543-4512, josh@LTERnet.edu*

NSF RESEARCH TRAINEESHIPS IN LAKE & STREAM ECOLOGY

Three NSF Graduate Research Traineeships have been awarded for the first of five years of a new program supporting an integrated approach to the study of lake and stream ecology (see left and right column sidebars for abstracts of two). The specific objective of the program, an outgrowth of NSF's Freshwater Imperative effort, is to develop scientists who can work across environmental gradients and circumvent the intellectual barriers that traditionally have existed between lake and stream or river studies. The traineeships are sponsored jointly by the Center for Streamside Studies, University of Washington, Seattle, and the Center for Limnology, University of Wisconsin-Madison. Students will receive degrees from either institution, spending at least six months at the other university.

For more information:

Washington ◆ Rick Edwards, Center for Streamside Studies, 206/543-3507, *ricke@pisces.fish.washington.edu*

Wisconsin ◆ Charlotte S. Stein, Center for Limnology, 608/263-3264, *stein@engr.wisc.edu*

STUDENT PILOT PROJECTS

Two Awards Announced for Intersite Comparisons

COMPARISON OF HYDROLOGIC PATTERNS AND PROCESSES ACROSS FOUR LANDSCAPES

Reed Perkins—H.J. Andrews Experimental Forest LTER

Patterns of streamflow hydrology are an important research theme at 11 LTER sites. To date, however, no cross-site comparative hydrologic analyses have been done. Because streamflow is regulated by climatic variation and terrestrial processes, such analyses would provide a natural link between existing cross-site studies on climate and stream ecology. Small (<200 ha) control watersheds, originally intended for comparison of paired basins within a site, provide a logical basis for analysis of hydrologic processes underlying streamflow patterns across the LTER Network. This study will provide a preliminary and descriptive comparison of the hydrologic processes and runoff patterns occurring at each site. It is also intended to develop hypotheses about links between differences in the relative importance of hydrologic processes across sites and differences in runoff patterns.

This fall, I will collect necessary streamflow, climate, and physiographic data at the Coweeta, Hubbard Brook, and Luquillo LTER sites and at Caspar Creek, a U.S. Forest Service research forest in northern California. Cooperators include Lloyd Swift and Wayne Swank at Coweeta, Wayne Martin and Jim Hornbeck at Hubbard Brook, Doug Schaefer at Luquillo, and Bob Ziemer at Caspar Creek.

Specific research objectives include: ◆ characterize basic components of each site's annual and monthly water budgets; ◆ describe dominant hydrologic processes and flowpaths operating; ◆ catalog status and availability of hydrologic datasets; ◆ describe hydrologic research objectives being pursued.

Products of the work will include an article to be published in the spring/summer 1996 *LTER Network News* and a working document which will be used to stimulate further intersite communication among hydrology researchers. ◆

INFLUENCES ON PRECIPITATION-BORNE SULFATE RETENTION AT TWO WATERSHEDS

Bryan Dail—Coweeta Hydrologic Laboratory LTER

Precipitation-borne sulfate is a major source of sulfur to ecosystems. As such, it is readily available to plant and microorganism populations. At the Coweeta LTER site, we have been investigating the fate of this form of sulfur input into headwater watershed soils and sediment, measuring two major sulfur immobilization processes: ◆ primarily non-biological adsorption of sulfate directly to soil and sediment, and ◆ biologically-mediated incorporation of sulfate into organic matter. Both processes have been linked to soil organic matter content, intrinsic sulfur content, and activity of the soil or sediment microbial community.

By enlarging our study to include watersheds of different physical as well as biological features, we hope to better explain these influences on retention of S in ecosystems. The Rio Salado drainage at the Sevilleta LTER offers many such contrasting features, including (1 high native sulfate due to a gypsum formation, (2 a potential for higher primary productivity, and (3 a flash flood regimen

RIO SALADO, SEVILLETA / D. BRYAN DAIL

that scours the stream basin during late summer monsoon rains. In addition, the flash floods deliver organic matter to the parafluvial soils and support blooms of microbial activity, a phenomenon measured in initial visits to the Sevilleta. In continuing work with cooperators Robert Parmenter and Doug Moore in the Rio Salado, with support from the Pilot Project grant and both sites, we will be using selective agents to "knock out" several microbial communities in microcosm experiments to determine their relative importance in immobilizing sulfate. ◆

NASA GLOBAL CHANGE FELLOWSHIP AT McMURDO LTER

Glaciers are the primary source of water in the dry valleys of Antarctica, influencing numerous processes important to the lake, stream, and soil ecosystems. As part of the McMurdo Dry Valleys LTER (MCM) and a NASA Global Change Fellowship, and under the guidance of Drs. Robert Wharton, Jr. and Andrew Fountain, I am studying the seasonal and interannual trends of melting activity in dry valley glaciers of Antarctica by addressing these four questions: ◆ What is the annual mass balance of the glaciers? ◆ What are the important processes controlling mass gain/loss? ◆ What is the energy balance of the glaciers? How is water routed on/in the glaciers? ◆ How will changes in climate affect glacial melt patterns? I am also using satellite data to answer some of these questions, and am participating in a joint NASA-LTER Network project to measure atmospheric properties at six LTER sites using automated sun photometers. During the 1994-95 field season, I collected sun photometer data in Taylor Valley, Antarctica (see photo, top page 7). At a June 1995 joint workshop held at the Network Office in Seattle, I learned more about processing and applications of such data. Participants will continue to collect data during 1995-96 and plan to meet with NASA next spring to implement incorporation of these data into LTER research activities.

◆ *Gayle L. Dana, 702/674-7538, gdana@maxey.dri.edu*

NSF Graduate Research Traineeship

SCALE-DEPENDENT LANDSCAPE EFFECTS ON DOC CONCENTRATIONS IN NORTH TEMPERATE LAKES

Sarah Gergel

BS-1992, University of Florida-Gainesville, Wildlife Ecology
MS-expected 1996, University of Wisconsin-Madison, Zoology

Monica Turner, Advisor

The objective of this study is to attempt to quantify the interactions between pattern in the landscapes (e.g., relative abundance and spatial arrangements of various land-cover and land-use classes) surrounding north temperate lakes to address the question: At what scale(s) do landscape attributes exert a detectable influence on lakes? The dependent variables to be addressed initially include dissolved organic carbon, silica, calcium and alkalinity—signals that might be expected to show a strong land influence. The initial study will focus on the northern lake district in Wisconsin. ◆

SOLUTE DYNAMICS IN STREAMS

A Productive Intersite Workshop

While the rest of the country was sweltering in the summer heat wave, 26 stream researchers gathered for three days (July 16-18) in the cool Southern Appalachians at Coweeta Hydrologic Laboratory for a NSF-sponsored workshop entitled "Transport and Cycling of Biologically Important Solutes in Streams: A Cross-Biome Comparison." Planning for the workshop began at the 1993 LTER All Scientists Meeting when a group discussing cycling of nitrogen in streams and another discussing stream channel hydraulics and solute dynamics coalesced to plan a comparative study of solute dynamics in streams. Donna D'Angelo and Judy Meyer, Coweeta LTER (CWT), joined with Bruce Peterson, Arctic Tundra, ARC), to lead the workshop and plan the study. Beth O'Grady (CWT) organized logistics.

JACK WEBSTER

Right: Stream solute workshop participants, Coweeta Hydrologic Laboratory, July 1995.

The workshop revealed that we have some exciting ideas about factors controlling nitrogen dynamics in streams—and it introduced powerful new tools for rigorously testing them

Four features contributed to the success of the workshop:

- using models to analyze existing data prior to the workshop;
- hands-on experience with the models during the workshop;
- the availability of user-friendly versions of the models to take home and use at individual sites; and
- demonstrations of conservative tracer and stable isotope field experiments and analytical methods.

Workshop participants included graduate and undergraduate students, technicians, post-docs, and principal investigators from 10 stream sites: H.J. Andrews, Arctic, Bonanza Creek, Coweeta, Hubbard Brook, Kellogg, Konza Prairie and Luquillo LTER sites, as well as Walker Branch and Sycamore Creek research sites. The first day, participants compared physical, chemical and biological features of the streams they had been studying. Jack Webster and Jen Tank, CWT, led an afternoon field trip to Hugh White Creek, where the group conducted a conservative tracer addition experiment to learn the field techniques involved and how to analyze the resultant data using a program developed by Donna D'Angelo and Les Howard to estimate hydraulic parameters. A copy of that user-friendly program was given to all participants.

Use of stable isotopes to assess nitrogen cycling and transport was the theme of the second day. Bruce Peterson discussed insights gained from use of stable isotope additions in the Kuparuk River, Alaska. Using a model developed by Bruce and David Jones, participants made predictions on the expected distribution of ^{15}N added to the stream based on our current understanding of inputs, exports, and cycling of nitrogen in the ecosystem. This is an extremely powerful tool that permits development of testable hypotheses on factors controlling nitrogen cycling in streams. Participants learned how to use the model and will now be able to parameterize it with local data at their home sites.

Before the workshop, Will Wolheim (ARC) used data supplied by four sites to develop predictions of isotope distribution. Since at one of these sites, Hugh White Creek, Bob Hall (CWT) had run a pilot $^{15}NH_4$ addition the month before, participants were able to compare the predicted isotope distribution to what was observed. Using a sample analysis completed in just two days at the Woods Hole stable isotope facility, they found they had predicted labeling of the consumers fairly well, but had underestimated the size of some of the nitrogen pools with long turnover times. This pilot experiment was a compelling demonstration of the model's usefulness in showing which components of the stream are most in need of further research. Despite several power failures, participants were also able to analyze some ^{15}N samples in real time with the assistance of Brian Fry and three Europa Scientific staff, who brought one of their mass specs to the workshop.

The final day, participants learned new stream mapping methods and planned an intersite comparison of nitrogen retention and cycling in streams. Responsibilities for proposal development were assigned, and a timetable was established. Overall, the workshop revealed that we have some exciting ideas about factors controlling nitrogen dynamics in streams. Now we have the tools to rigorously test them.

◆ *For more information: Judy L. Meyer, 706/542-3363, jMeyer@LTERnet.edu*

LTER CLIMATE COMMITTEE

David Greenland—Chair

The LTER Climate Committee welcomes several new members this fall. Johannes Knops will be representing the Cedar Creek site. Vince Gutschick will be taking over from Wes Jarrell at Jornada. Doug Gooding will be representing Konza Prairie, while Dale Robertson—an original founding member of the Climate Committee—returns to represent the North Temperate Lakes site.

Work is progressing on the Analysis and Synthesis Project through which data are being collected from all the sites for analysis and synthesis. Tim Kittel is working on a project which integrates nicely, the Vegetation/Ecosystem Modeling and Analysis Project (VEMAP). As part of VEMAP, Tim has produced a useful data set which provides monthly and daily average values of temperature, precipitation, and windspeed on a 0.5 degree latitude/longitude grid for the coterminous United States. The data are for the most recent 30-year climatic normal averaging period. There is another set of corresponding data for 2x CO_2 scenarios from three different GCMs. These digital data, and details of their accessibility, will be incorporated in our final report of the Analysis and Synthesis Project. The data are particularly useful for LTER regionalization studies.

DAVID GREENLAND

Left: Two of the original six LTER Meteorological Committee members, Art McKee (H.J. Andrews, left) and Lloyd Swift (Coweeta, right) at Coweeta Hydrologic Laboratory, fall 1994. Coweeta was the site of the first meeting, held February 22-24, 1982.

LTER sites wishing to access these data before the final report comes out should contact Tim Kittel (*Tim_Kittel@qgate.ucar.edu*) at NCAR. A second part of this project will produce corresponding data from transient model runs. In addition, the Climate Committee will be helping Jordan Hastings (McMurdo Dry Valleys) to organize a workshop in spring 1996 whose aim is to initiate work on producing a prototype GIS-based data and information system. ◆

PHENOLOGY WORKSHOP HELD IN GERMANY

A Phenological Study Group was founded in 1993 at the 13th Congress of the International Society of Biometeorology (ISB) in Calgary, Alberta, Canada. The four goals of the group are:

- To promote a global dialogue among phenologists, by compiling information on phenological research and data sets, and making this list available in electronic and printed form
- To use this global forum to encourage establishment and expansion of phenological networks for data exchange for international cooperation
- To explore methods of using phenology to stimulate public interest, especially among pupils and students
- To encourage research that correlates phenological trends with climatic trends, especially in the context of global change monitoring

At a May 1995 workshop in Germany, the Study Group was further developed, along with initial action plans for four working sub-groups: Network, Data Processing and Linkage, Modeling, and Education. The general focus of the main group is the use of phenological observations on wild and domesticated species as well as ecosystems (e.g., "green wave") for the benefit of international programs addressing the impact of environmental change. Of particular interest is climate change and its monitoring. The ultimate goal is to create a global phenological observation system (International Phenological Network, IPN) with special attention to site locations within Biosphere Reserves, National Parks, and other natural preservation regions across all nations. Information from climate stations nearest the phenological observers will be incorporated into the IPN database.

Plans are under way for a second workshop, which will concentrate on defining the role of phenology in global change studies, and developing a plan for the U.S. component of the International Phenological Network.

◆ *For more information: Mark D. Schwartz, 414/229-3740, mds@csd.uwm.edu*

A second workshop will concentrate on defining the role of phenology in global change studies, and developing a plan for the U.S. component of an international phenological network

1995 ILTER Meeting in Hungary

Representatives of the developing International LTER (ILTER) Network met in Budapest, Hungary August 26, 1995 to assess progress toward initial goals of identification, promotion and linkage of LTER efforts around the world, and toward developing a program and infrastructure to facilitate communication and distributed database management among LTER sites internationally. Among the countries or regions represented were Australia, Canada, China, Hungary, United Kingdom, United States, Russia, South Africa and Taiwan.

In discussions of network mission and structure, participants decided to keep the coordinating body small and relatively unstructured, and to change its name from the ILTER Steering Committee to the "ILTER Network Committee." Jim Gosz was elected chair, replacing past chair Jerry Franklin, and Hen-biau King (Taiwan) was elected vice-chair. The remainder of the meeting was devoted to country reports on the status of long-term ecological research, discussion of funding sources, and the development of a future meetings schedule. A report of the meeting is in preparation. ◆

Future ILTER Network Committee Meetings:

Latin America-1996
Taiwan-1997
China-1998
Africa-1999
United States-2000

INTERNATIONAL LTER INTERACTIONS

AUSTRALIA

Two representatives of the U.S. LTER Network (Rudolf Nottrott, Data and Information Manager, and John Vande Castle, Network Manager) visited the Environmental Resources Information Network (ERIN) in Canberra February 10-4, 1995 and the Forestry Depattment of Tasmania, Hobart, February 15-17. They met with representatives of governmental, academic and private research organizations to discuss the potential for collaborative work and, more specifically, the possible establishment of electronic communication facilities for researchers focused on long-term ecological research. Although informal links exist, and scientists cooperate on a one-to-one basis (often via the Internet), there is no established electronic network which includes the primary functions proposed by ILTER. Australian scientists expressed interest in ILTER and the idea of enhancing communication on a network scale. A draft letter of understanding between ILTER and ERIN has recently been exchanged to formalize an effort to utilize the existing ERIN server as a central contact and link to other Australian sites or nodes via the common ILTER WWW home page. ◆

COSTA RICA

In March 1995, Susan Stafford (H.J. Andrews) and an NSF Biological Instrumentation and Resources Division (BIR) review team visited the Organization of Tropical Studies (OTS) in San Jose, Costa Rica and its field stations at La Selva, Las Cruces and Palo Verde to assess facilities secured primarily through BIR funding. Reviewers discussed current and long-range research plans at each of the sites and assessed electronic connectivity capabilities. In 1993 Costa Rica was connected to the Internet and CRNet, a digital backbone linking major institutions in the country, was created. Long-range priorities include improving e-mail connections and accessibility across the network of sites, developing a local-area network (LAN), and establishing a gopher server and WWW home page.

Following the NSF site visit, U.S. LTER Data Manager Rudolf Nottrott (Network Office) met with personnel at each of the field stations to evaluate what opportunities may exist for joint activities on data management tools and protocols, GIS, remote sensing, and simulation modeling, as well as the potential for ILTER participation. ◆

UPDATE: COLLABORATIONS WITH MEXICO

Two joint U.S.-Mexico research projects focusing on long-term ecological studies, either about to be launched or in the proposal evaluation stage, present important steps on the road toward extending LTER Network research to sites in Mexico.

As noted in the last issue of *Network News*, an NSF-supported U.S.- Mexico workshop to promote joint research in ecology was held in October 1994 at the Mapimí Biosphere Reserve Research Station in central Mexico. Participants discussed potential common research interests in ecological responses to climate dynamics and land-use changes along the environmental gradient of the Chihuahuan Desert, stretching southward from central New Mexico to central Mexico (including the Jornada and Sevilleta LTER sites). The U.S. group was led by Jim Gosz, then-director of NSF's Division of Environmental Biology (DEB), the Mexican group by Carlos Montaña, Instituto de Ecología, Xalapa, Veracruz. The Mapimí Biosphere Reserve is managed by the Instituto and spans contiguous areas of the states of Durango, Coahuila and Chihuahua.

EMILY B. RUDIN

Mexican ecologist Jorge Lopez-Portillo displays beetle to Laura Huenneke (Jornada) at Mapimí.

In June 1995, Sevilleta's David Lightfoot and co-PIs James Brown and James Brunt submitted a collaborative proposal to DEB's Long-Term Studies Program for a cross-site study of the effects of indigenous small mammals on the species composition and structure of plant communities in grassland and shrubland ecosystems within the Chihuahuan Desert. Jorge Lopez-Portillo submitted a parallel proposal to CONACyT (NSF's counterpart in Mexico) under the bilateral agreement between NSF and CONACyT. The project has been recommended for a three-year award to the Univetsity of New Mexico, and is expected to begin in October 1995.

Lightfoot and his co-investigators aim to determine experimentally how small mammals affect Chihuahuan Desert ecosystems, and how these influences are, in turn, affected by short-and long-term climate change, both locally and regionally across the Desert. This project will extend to the Mapimí site research now under way at the Sevilleta and Jornada sites, and will provide a training opportunity for both U.S. and Mexican students. Significantly, the NSF grant will enable a real-time satellite communications link to be established at Mapimí, thereby connecting the site to LTERnet and allowing centralized integration of data management for the project.

Another collaborative project with Mexico, submitted to NSF's International Programs in May and still pending, proposes a joint workshop on international ecology and biodiversity. The U.S. organizer and co-organizer is Gerardo Ceballos of the Centro de Ecología at the Universidad Nacional Autónoma de Mexico. The workshop would bring U.S. and Mexican ecologists from a variety of sub-fields and institutions together for meetings at Puerto Vallarta, Mexico and the Sevilleta.

◆ *Emily B. Rudin, program manager for the Americas at the NSF, is on assignment at the University of New Mexico, where she is special projects officer for research administration and visiting scholar at the Latin American Institute. For more information: rudin@sevilleta.unm.edu*

INTERNATIONAL LTER INTERACTIONS

HUNGARY

In an exchange initiated in 1993, ten U.S. LTER scientists met in Vácrátót, Hungary March 26-28, 1995 as guests of the developing Hungarian LTER network The meeting was supported by a grant from NSF, International Programs Division, awarded to Diana Freckman, (McMurdo), Debra Coffin (Central Plains) and Edit Kovács-Láng (Hungarian Academy of Sciences). LTER sites represented were Virginia Coast, Sevilleta, H.J. Andrews, Luquillo, North Temperate Lakes, Konza Prairie and W.K. Kellogg.

Participants discussed graduate student and scientist exchanges and research collaborations, electronic networking and database development, and opportunities presented by participating in the ILTER Network. They developed a conceptual framework and strategic six-year research plan, and a number of collaborative proposals, which were submitted to NSF and the Hungarian Academy, and considered additional sources of funding for long-term ecological research. Products of the meeting included: an executive summary, an action plan for the Hungarian network, a plan to link with LTERnet and make Hungarian LTER information available on the Internet, a plan to submit articles to the U.S. LTER and Ecological Society of America newsletters, and the production of a book summarizing Hungary's LTER site history, research and datasets, condensed from a proposal written by scientists from the Kiskunsagi site. ◆

IBERIA

LTER Chair Jim Gosz presented an invited paper on the U.S. LTER Program at the Conferencia Internacional de la UNESCO sobre Reservas de Biosfera in Sevilla, Spain March 20-25, 1995. Four-hundred participants from many countries presented papers and posters on Biosphere Reserves. Dr. Gosz presented the rationale for the LTER Program and the developing ILTER effort. From contacts developed at the conference, he visited several research sites in Spain and Portugal and met with scientists and administrators in Lisbon (Luso-Americano Development Foundation, FLAD). There he presented a seminar and lead a workshop on the U.S. LTER Program and ILTER that was attended by 20 individuals from academia, government, and the U.S. Embassy. Additional presentations at the University of Lisbon and the National Board for Scientific and Technological Research (Junta Nacional de Investigaçao e Tecnologica, JNICT) led to discussions of appropriate Portugese sites for ILTER participation, and the formulation of plans for a site visit exchange.

Subsequently, funding was received from NSF International Programs for a team of LTER scientists to visit sites in Spain, Portugal and Morocco in the spring of 1996, followed by a visit of scientists from the Iberian Peninsula to U.S. LTER sites and the potential development of collaborative research projects. ◆

POLAND, CZECH & SLOVAK REPUBLICS, RUMANIA

During the March 1995 UNESCO conference in Spain, LTER Chair James Gosz met with individuals from the Czech and Slovak republics. With Jim Edwards, Assistant Director, NSF Biology Directorate, he developed plans for a scientific visit to Prague and three potential ILTER research areas. As a result, a team of seven U.S. scientists traveled to Prague in June 1995, with funding from NSF International Programs through the LTER Network Office, to interact with scientists from Poland and the Czech and Slovak republics at Krkonose/Karkonosze Bilateral Reserve, and at Krivoklat and Trebon Basin reserves.

The U.S. team, primarily from LTER sites with comparable habitats, represented the disciplines of botany and plant ecology, animal ecology, biogeochemistry, and information management. A reciprocal visit to NSF and a set of LTER sites (North Temperate Lakes, Hubbard Brook, Coweeta, Niwot, Sevilleta) in September is expected to lead to the development of collaborative research projects and scientific exchange on the model of the ongoing and successful interactions with Hungary.

Dr. Gosz also met with the head of the Faculty of Biology, University of Bucharest, to discuss the possibility of developing an exchange between Rumania and the U.S. LTER Program. A meeting in Rumania is tentatively planned for December 1995 to introduce the ILTER model to Rumanian scientists and administrators. ◆

SOUTHEAST ASIA

In April 1995, Jim Gosz, Jerry Franklin (retiring LTER Chair and ILTER Steering Committee Chair), John Vande Castle (LTER Network Manager), and Rudolf Nottrott (LTER Data Manager) attended the ILTER Southeast Asia organizational meetings in Taipei, Taiwan, which were designed to develop linkages between the U.S. LTER Program and existing or planned LTER-like sites in Southeast Asia.

Representatives from Taiwan, Mongolia, Japan, Korea, Indonesia and Australia participated. Other interested countries unable to attend included Malaysia, the Peoples' Republic of China, and the Philippines. Current LTER-like activity described ranged from the PRC, with numerous sites already undertaking research, to Taiwan with five sites to Korea and Mongolia, who are interested in initiating LTER research. Projects of interest range from classical ecosystem dynamics to human impact research to individual systematic studies. Many researchers—particularly those from Indonesia, Japan, and Mongolia—focus on biodiversity studies. ◆

JAMES R. GOSZ

Above: Stream gauging station, Taiwan long-term research site.

ILTER Training Course

A training course for ILTER information specialists from Taiwan, China and Malaysia was held at the U.S. LTER Network Office March 14-24, 1995 at the University of Washington, Seattle. The two-week course, organized and taught by Rudolf Nottrott, U.S. LTER Data Manager, introduced the six participants to the fundamentals of developing World Wide Web home pages and regional information servers on the global Internet.

Upon returning to their home countries and institutions, participants continued work on the content of their information servers and added site maps and descriptions, and personnel and other information, for a demonstration at a networking workshop on April 13, 1995 as part of the Southeast Asia Regional ILTER meeting in Taipei, Taiwan. The ILTER information server at the Network Office will host regional servers until the necessary infrastructure has been developed at the regional level. ◆

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Upcoming U.S. LTER Coordinating Committee Meetings:

April 1996—Konza Prairie LTER site, Kansas

October 1996—Harvard Forest LTER site, Massachusetts

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CALENDAR

November 1995 ◆ April 1996

NOV 1 NSF Program Deadline: Biological Sciences. Joint NSF/Alfred P. Sloan Foundation Postdoctoral Research Fellowships in Molecular Evolution (Carter Kimsey, 703/306-1469). Computer and Information Science and Engineering. New Technologies (Richard Hirsh, 306-1970, *rhirsh@nsf.gov*); Postdoctoral Research Associateships in CISE Experimental Science—Cross-Disciplinary Activities (Tse-Yun Feng, 306-1981, *tfeng@nsf.gov*). Education and Human Resources. Presidential Faculty Fellows (Sonia Ortega, 306-1697). Social, Behavioral and Economic Sciences. Cooperative Science with Argentina, Brazil, Chile, Mexico and Venezuela and International Research Fellow Program (306-1706); International Dissertation Enhancement Awards and Visits to Japan (306-1701, *intjapan@nsf.gov)*

NOV 1 NSF Target Date: Social, Behavioral and Economic Sciences. Cooperative Research Programs with the Americas (703/306-1706).

NOV 3 NSF Program Deadline: Biological Sciences. Postdoctoral Research Fellowships in Biosciences Related to the Environment (Carter Kimsey, 703/306-1469).

NOV 6 NSF Program Deadline: Education and Human Resources. Graduate and Minority Research Fellowships (Susan Duby, 703/306-1694).

NOV 6 U.S. Information Agency. Exchanges, Collaborative Research and Outreach (Sue Borja, 202/619-5289, *affiliat@usia.gov*).

NOV 13 NSF Program Deadline: Biological Sciences. Biotic Surveys and Inventories (M. Lane, 703/306-1483).

NOV 14 NSF Program Deadline: Education and Human Resources. Instrumentation and Laboratory Improvement (703/306-1666).

NOV 15 NSF Program Deadline: Education and Human Resources. Visiting Professorships for Women (Margrete Klein, 703/306-1607). Social, Behavioral and Economic Sciences. U.S.-Israel Binational Science Foundation (BSF) (306-1707).

NOV 15 NSF Target Date: Informal Science Education. General Projects (306-1616).

DEC 1 NSF Program Deadline: Metabolic Biochemistry. Biochemistry and Molecular Structure and Function (Robert Uffen, 306-1443, *ruffen@nsf.gov*); Developmental Mechanisms (Karen Bennett, 306-1417, *kbennett@nsf.gov*).

DEC 15 NSF Program Deadline: Global Change Research Program. Ecological Rates of Change Activity and Water and Energy Atmospheric, Vegetative and Earth Interactions (WEAVE) (Cliff Dahm, 703/306-0367, *cdahm@nsf.gov*).

DEC 31 Target Date: National Center for Ecological Analysis and Synthesis. Spatiotemporal Dynamics and Ecosystem Management. (805/893-7670, *admin@ceas.ucsb.edu, http://www.ceas.ucsb.edu*).

JAN 16 NSF Program Deadline. Grant Opportunities for Academic Liaisons Within Industry (Soni Ortega, 703/306-1469, *gselzer@nsf.gov*).

FEB 1 Application Deadline: Harvard Bullard Fellowships in Forest Research. (Charles Bullard Fund for Forest Research, Harvard University, Harvard Forest, Petersham, MA 01366)

APR tba LTER Executive and Coordinating Committee Meetings. Konza Prairie LTER site, Kansas (Network Office, *Office@LTERnet.edu)*

APR 28-30 Pre-Planning Workshop, Biosphere 2, Oracle, AZ. Science On-Line Antarctica (SOLA) (Evangeline Elston, 702/674-7700, *eelston@maxey.dri.edu*)

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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 *(World Wide Web).*

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