LTER

The Network News

In Memory of James T. "Tom" Callahan— Longtime Ecosystem Scientist and Friend of the LTER Network

Dave Coleman, Dac Crossley, James Gosz

Tom Callahan, for many years a leader in the promotion and support of long-term studies, died at his home on Friday, Sept. 10 after a prolonged illness.

Tom was many things: a devoted husband and father, a long-time Program Officer in the National Science Foundation, and certainly a mentor to hundreds of us in ecosystem studies in North America. Tom was born in the mountains of Virginia, where his father worked for a coal mine before taking a more remunerative job at the Savannah River Plant (SRP) in Aiken, South Carolina.

Tom Callahan takes a breather while visiting ruins near the field station: September 1996 OBFS meeting, White Mountains, California. Photo courtesy Bob Parmenter.

Tom attended schools in Aiken, and then the University of South Carolina. He began a Master's degree with Dave Coleman, then switched over to his Ph.D. work, examining the population growth and regulation of the fall webworm, *Hyphantria cunea* Drury. Dave first met Tom when he was an undergraduate at the Savannah River Ecology Laboratory in the summer of 1968, when he signed on with several others in an undergraduate research program funded by the U.S. Atomic Energy Commission. Tom showed early signs of being both a raconteur and polymath, and impressed the faculty in their daily sessions of Introductory Ecology, seminar style, in the sand-hills and wetlands country of the SRP.

In Tom's dissertation work, he carried out much of his population census research by observing the various instars on cherry and persimmon trees along many backroads of the SRP. Dave kidded him about getting a tanned left arm, cruising along in that old Ford Falcon pickup, but Tom's technique demonstrated the very linear and patchy nature of the insect distribution convincingly. He also was interested in what these creatures ate, and their impacts on nutrient cycling, which was published in a short paper he coauthored with Dave Coleman and Carl Monk in *The Canadian Entomologist* in 1969, based in part on some of his undergraduate research studies.

Tom spent most of his time from 1970-72 at UGA, completing course work, and getting active in Earth Day in April 1970. The word ecology did not have much meaning for the public until that first Earth Day—and Tom helped bring it about. Tom finished his degree work in Zoology with Dac Crossley in June 1972, as Dave Coleman had gone to a new job in the IBP Grassland Biome Lab in Fort Collins, Colorado in January of that year. As an ecologist, Tom hit the ground running; he became Ecosystem Studies Program Director at the NSF in August 1972, and never looked back. Tom also was responsible for the IBP funding at NSF and many remember his first IBP coordinating committee meeting held in Alta, Utah, in October, 1972, where he was the bearer of sad tidings. Some budgets were to be cut back significantly in 1973, and Tom got a first-hand impression of how much senior scientists hate to be told they are getting their funding cut.

Many have wondered if that first early experience is what made him so assiduous in his garnering of funds for Ecosystem Studies, especially in the early days of the LTER Program (which began formally in 1980, but was planned from 1977 onward).

In that era of flat funding for NSF (through much of the 1970s and 1980s), Tom found funds to keep his Ecosystem

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The Network News

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Newly Released Satellite Images

from an NSF press release (14 September 1999)

Surveillance satellite images of the Antarctic Dry Valleys were made public recently by President Clinton, who said the National Imagery and Mapping Agency (NIMA) would make the satellite images available to scientists. Vice President Gore has been working for many years to open U.S. intelligence image archives for scientific use. The release of the Dry Valleys images and a previous release of satellite images from the Arctic Ocean are milestones in the process.

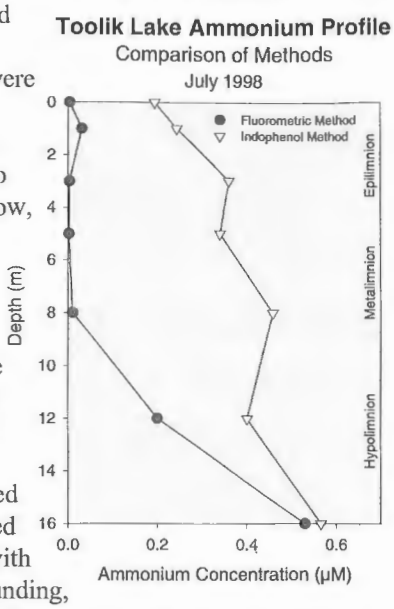
The NIMA image set includes a wide-angle snapshot, taken by surveillance satellites in 1975.

"The data provide a uniform image over the entire region at a single instant, as context for a wide range of studies on the ecology, hydrology, geology, and glaciology of the region," said an NSF spokesperson. To access the high-resolution declassified images, see:
http://www.nsf.gov/od/opp/antarctic/imageset/satellite/start.htm ◆

Dry Valleys, Antarctica, 1975

New Method Solves Old Problem

In unpolluted environments, ammonium concentrations in lakes and streams are near the detection limit for the standard colorometric method used in hundreds of laboratories. For lack of a better method, we have used this standard method for decades at the Arctic LTER site but results were often variable. While limnologists are good at interpreting just about any patterns, we have been suspicious of this method. Worse, the results of our tracer studies of the fate of ^{15}N-ammonium indicated that measured stream values were likely several times too high. Now, using a new fluorometric procedure (Holmes et al. in press), developed and tested in part with LTER funding, we are able to accurately measure even very low ammonium concentrations, at the 0.02 µM level, and reveal interesting patterns wherever we look. For example, in the ultra-oligotrophic Toolik Lake, we measured the rate of benthic mineralization in the deep water following stratification. Ammonium measurements also allowed us to identify and trace river water as it moved through the epilimnion of the lake. In the nearby Kuparuk River, we have for the first time been able to observe the expected ammonium decline downstream of the phosphorus addition site. This new method also works in the wide range of salinities of the Plum Island Ecosystem LTER site; it will lead to important new insights about ecosystem functioning worldwide. These results illustrate how the long-term nature and flexibility of the LTER projects both helped to identify a need and to solve the analytical problem. The feeling of scientific sense replacing non-sense is intensely satisfying. ◆



Lake Bonney, McMurdo Dry Valleys

Holmes, R. M., A. Aminot, R. Kérouel, B. A. Hooker, and B. J. Peterson. in press. A simple and precise method for measuring ammonium in marine and fresh water. Canadian Journal of Fisheries and Aquatic Sciences.

Laura Huenneke of NMSU will head Jornada Basin LTER Renewal

After 10 years at the helm of the Jornada Basin LTER, William Schlesinger (Duke University, Department of Botany) will step down, and the next LTER proposal will be prepared under the leadership of Laura Huenneke (New Mexico State, Biology).

Laura has a long association with the Jornada Basin LTER site, joining the investigative team in 1988.

While the Jornada Basin investigators are still refining the theme for the renewal proposal, it is clear that a major effort will be directed toward understanding linkages, transfers, and connections within the Jornada Basin.

"This is a logical next step, following a decade of study of plant and patch processes and soil heterogeneity," Schlesinger says. "We need to understand the fate of the materials that are lost from the barren soils in the shrublands." Thus, one goal of the next proposal will be to understand how the Jornada Basin has acted as a source or a sink of atmospheric dust during the vegetation changes of the past century.

At New Mexico State, Laura will be joined by Curtis Monger (Agronomy), Deb Peters (USDA) and Kris Havstad (USDA), and a consortium of outside coinvestigators, including Schlesinger. ◆

Jornada Basin LTER holds its Ninth Annual Science Symposium

H. Curtis Monger, New Mexico State University

The daylong series of research presentations brought more than 100 researchers to the New Mexico State University campus June 24, 1999. Bill Schlesinger opened the morning session with a paper on the relationships between vegetation cover, albedo, and radiant temperatures in arid and semiarid lands of the Chihuahuan desert. As ground cover decreases, radiant land temperature and albedo increase. Satellite imagery detected lower vegetation cover in Mexico, as the result of overgrazing, which showed up as increased temperatures and albedo.

Greg Okin, (California Institute of Technology), described his studies of advanced remote sensing of semiarid grasslands at the Jornada to detect vegetation types, living versus dead vegetation, gravel-sand-clay content, iron oxidation, and land surface disturbance. High spectral resolution from AVIRIS can be used to recognize different ecosystems in the central Jornada Basin.

Al Rango described how the JORNEX project has produced detailed topographic maps of the morphology of mesquite dunes, using remote sensing techniques such as scanning laser and video data. His maps of coppice dunefields have a vertical resolution of 10 cm and a horizon resolution of 1 meter.

Among other papers, Laura Huenneke described patterns of aboveground plant production in the Jornada from 1989 to 1999. Her data revealed three patterns: (1) shrublands and grasslands have similar amounts of aboveground biomass and net primary production(NPP), (2) biomass distribution is more patchy in shrublands than in grasslands, and (3) grasslands have greater temporal variability in NPP than shrubland.

Walt Whitford spoke on his long-term studies of the establishment of *Larrea tridentata* in semiarid grasslands. He tracked the survival of creosote bush seedlings planted in control plots, in irrigated plots, and in irrigated plots with nitrogen. Early in the experiment (1984), many seedlings survived in the control and in the irrigated plots with nitrogen, but by 1986 no seedlings survived, and even the control contained few surviving seedlings. The high mortality rate was attributed to rabbits, other rodents, and damping-off.

Later, Dave Lightfoot spoke of his research of the interactions between rodents, plants and ants, which is conducted at the Sevilleta and Jornada LTER sites and the Mapimi Biosphere Reserve in Mexico. At several sites, more fluff grass is visible inside rodent exclosures because the plants reach greater heights when they are not grazed. This gives rise to more seed-harvester ants because the fluff grass provides them with a food source.

The Symposium closed with a presentation by Ed Fredrickson and Kris Havstad, who reviewed the history of livestock grazing in the Jornada basin, including the impacts of the Pleistocene megafauna, the Spanish introduction of grazing animals, and populations of grazing animals at the Jornada from the late 1800s to present. They pointed out the economic difficulties facing ranchers, who must contend with fluctuations in forage biomass and constant mortgage payments. They described how management practices in the future may include diversifying forage, decreasing forage demand, basing management on ecological principles, and developing economic flexibility. ◆

In Memory of Tom Callahan

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Studies budget growing at 2-3 percent above inflation, which was a major accomplishment. This was also a result of the influence of John Brooks, who was the Division Director for much of that period. Tom and John were very different individuals but they shared a common vision of making the LTER program better and "gently" guiding the scientists to develop broader programs and network the sites into an effort that remains unparalleled in the U.S. John listened to Tom, and vice versa, and this pair was primarily responsible for the LTER growth over much of two decades.

Tom's devotion to his "baby," the LTER, for which he, Frank Golley, Paul Risser, Jerry Franklin, and Wayne Swank were jointly responsible, is by now legendary. His seminal paper in *BioScience* in 1984, setting forth the rationale and long-term goals for this kind of research, is one of the classics of the early LTER era.

Tom attended or supervised literally hundreds of site reviews, mostly of LTER projects. He let the external reviewers handle much of the hour-by-hour reviewing tasks, but was more than ready to administer what he termed a "whup along the side of the head," when the occasion demanded. Those of us who served on panels he convened at NSF headquarters were always impressed at his erudition and grasp of the facts in the many proposals being covered, and more importantly, the science behind the proposals.

Tom was not one to beat around the bush. His comments, offered as a program officer, were always direct and for that reason they were welcome, even when they contained negative criticism. One of Tom's significant contributions to Ecosystem Science was that he provided the institutional memory for Ecosystem Studies at NSF and the patience of Job in training numerous rotators who served as Program Directors for Ecosystem Studies.

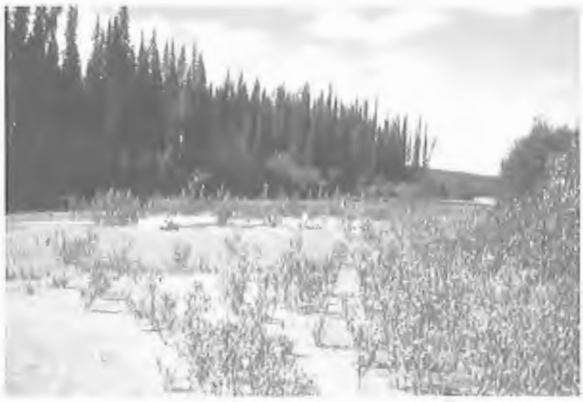
He was one of those rare people who had a truly photographic memory, the ability of recall, and the humor to use this gift wisely and in a mentoring fashion. Tom was that uncommon individual, combining wit, wisdom, and support for literally a generation of ecosystem ecologists, and more importantly, encouraging persons from other levels of resolution, namely population and community ecology, to come under the tent of LTER studies. For all this, he will be remembered as a true colleague and dear friend. We will not see his like again. ◆

Examining the Interactions between Multiple Disturbances and Varying Climates in Alaskan Boreal Forests

John Yarie, F. S. Chapin, III—Bonanza Creek LTER

The boreal forest plays a critical role in determining the rate of global climate change because (1) changes in water and energy exchange could affect regional warming and (2) changes in carbon storage might affect the rate of climatic warming at the global scale.

In the future, Bonanza Creek Long-Term Ecological Research Program seeks to understand the Alaskan boreal forest as an integrated regional system in which climate, disturbance regime, and ecosystem processes are interactive components. Our overall objective is to document the major controls over these interactions and their ecological and societal consequences. We incorporate disturbance as an integral component of our regional system and study how different disturbances affect population and ecosystem processes and the mechanisms by which these processes interact with climate to determine probability of insect outbreak and fire.



Taiga floodplain, Tanana River, Alaska. Primary succession from bare alluvial surface (left foreground), to open shrub stage (right). Closed-shrub alder with young balsam poplar extends through the closed canopy, (right, mid-distance) to mature white spruce (left background). (Photo by L.A. Viereck)

Climate

Climate research at the Bonanza Creek LTER (BNZ) has focused on describing (1) the regional patterns of climate for Alaska, (2) the patterns of seasonal and interannual variability in climate at BNZ, and (3) the changes in microclimate caused by topography and vegetation succession. We summarized climate data for the entire state and used a krieging routine to produce maps of monthly temperature, precipitation, and climate zones for Alaska. Contours of mean annual temperature show a general northward movement of the 0°C isolines from the 1960s to the 1980s, indicating a warming trend throughout Alaska.

Recent warming has caused the active layer and permafrost surface temperatures to increase by 1-2°C, so that annual temperatures at the ground surface and in the upper active layer exceed the freezing point. Permafrost remains stable at some sites only because of the insulative effects of moss and a thick layer of organic soil, but is thawing at other sites, creating thermokarst.

Environmental monitoring showed that precipitation affects soil moisture in the uplands most strongly in mid-successional deciduous forests. In floodplain stands, soil moisture is controlled by river discharge rates and successional changes in terrace height. Extreme climatic events have had greater impact on stand mortality and structure than have annual fluctuations in climate. These include the record-breaking snowfall of 1990-1991 that reduced tree biomass in conifer stands by as much as 50%, the early snowfall in 1992 that preceded leaf senescence and caused extensive tree mortality in deciduous stands, and the lack of snow during the early winter of 1995-1996 which significantly reduced soil temperatures.

Disturbance Regime

We have used permanent plots to demonstrate the impacts of disturbance on the structure, composition, establishment, and mortality of forests and have used historical records and tree-ring chronologies to extend our observations back in time. These data became the basis of models that were initially largely conceptual and which now operate only at large temporal and spatial scales.

Fire is the major disturbance in central Alaska between the Alaska and the Brooks Ranges. Vegetation distribution and fire scar analysis at BNZ suggest a fire return interval of 70 to 110 years. Maps of lightning strikes are a good predictor of fire frequency, but the area burned is influenced more strongly by climate and vegetation.

Recently burned upland white spruce, part of an experiment by researchers at the BNZ LTER site to contrast the type of initiating disturbance by documenting successional change in resources on sites disturbed by fire and logging in taiga forests of interior Alaska. (Photo by L.A. Viereck)

Insect outbreaks are extensive only in more continental regions of southern Alaska, where climate is relatively warm. Here insects have eliminated spruce forests over broad areas, leading to extensive areas of grasslands. High population levels of spruce budworm were first observed in BNZ in 1989. Repeated defoliation in 1991 and 1992 caused top-kill in trees and mortality in seedlings and saplings. Outbreaks of bark beetles also caused significant mortality in 1993. We are extending these records back in time based on distinctive signatures in tree rings.

The heavy sediment load of the glacier-fed Tanana River supports an aggrading system where silt deposition associated with floods builds terraces of increasing height on the active floodplain.

Population Processes and Successional Dynamics

To test hypotheses about ecosystem controls in forest succession, we monitor a network of 27 sites at BNZ (3 replicates of 3 successional stages in the uplands and 6 on the floodplains—including a recently established time zero stage). These "turning points" in the two successional sequences were selected to document rapid vegetation changes that dramatically alter microclimate and ecosystem processes. We have thus directly observed transitions from one stage to the next in early succession, validating the "space-for-time" assumption that underlies our chronosequence. This design also enables us to contrast vegetation composi-

tion and structure across a floodplain and upland chronosequence. Repeated measurement of permanent plots allows us to document changes in composition and diversity that correlate with the satellite record of vegetation change. Species diversity is closely tied to disturbance regime, with hot spots of insect and bird diversity in early successional floodplain stands and nonvascular diversity increasing in late successional spruce forests.

Selective browsing by moose and hares modulates the competitive interactions of pioneer species and accelerates the rate of successional change. Herbivores feed preferentially on pioneer willows, leading to the competitive release of mid-successional species such as alder and poplar. The severe negative effects of browsing on growth and reproduction are an important component of this shift in species dominance. Moreover, browsing-induced changes in canopy architecture has cascading effects on nutrient cycling through changes in physical environment, litter chemistry, and the proportion of nutrients returned as feces.

Pattern and Control of Primary Production

We have measured interannual variation in litterfall and tree diameter increment relative to climate in all the major forest successional types, and manipulated the factors thought to control forest production in upland and floodplain successional forests (moisture, microbial energy supply, and N supply). The initial stimulation of microbial respiration and N immobilization following C addition, with resulting changes in tree foliar chemistry, largely disappeared by year three, whereas reduced moisture supply strongly reduced tree transpiration and production, and N addition stimulated N mineralization and production.

Biogeochemical Processes

Experimental treatments (addition of N, sawdust and sugar, moisture reduction) caused significant differences in successional patterns of foliar chemistry between upland and floodplain forests. While both upland and floodplain successional sequences showed similar reductions in foliar N concentration though time, the decline in P concentration was more dramatic in upland stands. Upland vegetation showed clear increases in lignin:nitrogen, lignin:phosphorus, and cellulose:lignin ratios through succession, but successional trends in floodplain stands were less clear. Successional trends in litter chemistry paralleled foliage chemistry.

Alaskan interior forests have rates of fine root production and turnover that are similar to those in temperate forests, despite significantly less aboveground production. This higher proportion of total ecosystem C allocated below ground in boreal forests contributes to large soil C stocks, with most soil respiratory fluxes being derived from the rapid turnover of fine roots rather than from heterotrophic respiration. Approximately three times more N is cycled through fine roots than through aboveground litterfall.

Hydrology and Aquatic Processes

In LTER2 we developed working models of high-latitude cold-dominated watersheds and aquatic ecosystems that summarize existing knowledge and provide structure for future work. Much of interior Alaska is in the zone of discontinuous permafrost, in which south-facing slopes are generally permafrost-free, and cold north-facing slopes and poorly drained valley bottoms are generally underlain by permafrost. Permafrost is a major "ecological adjective" modifying hydrology, thermal regimes, chemical fluxes from uplands to streams, and biotic processes in streams. Therefore, permafrost occupies a central role in our models and has been the focus of our recent research, comparing the hydrology, biogeochemistry, and benthic ecology of permafrost-dominated and permafrost-free watersheds at Caribou-Poker Creeks Research Watershed (CPCRW).

Using GPS technology, two BNZ researchers establish concrete benchmarks to obtain precise position fixes for a field location. Coupled with GIS technology, GPS can greatly facilitate mapping and research efforts as LTER Network scientists focus on broader-scale spatial phenomena, and accurate knowledge of their position on the earth's surface becomes critical. (Photo by William K. Michener)

Extension of LTER Results to the Regional Scale

We have parameterized the models LINKAGES, FORCYTE-10, and CENTURY based partially on data collected in the BNZ LTER project. The CENTURY model effectively simulated the observed results of C and N fertilization, providing a basis for modeling biogeochemical cycling at BNZ. Sensitivity analyses with these models highlighted the importance of: (1) root dynamics in C-budget models; (2) the effect of the vegetation canopy (specifically trees and moss) on soil temperature regime; (3) the difficulty of extrapolating processes from intensive sites to the North American boreal forest; and (4) the importance of precipitation in predicting future forest productivity in global change analysis. In addition we have worked with the EROS data center to develop maps of climatic and ecosystem parameters that will be essential for modeling in LTER3.

We have supported a variety of studies to evaluate the utility of airborne and satellite remote sensing data for extrapolating our understanding of ecosystem processes from BNZ over broader spatial and temporal scales. The GIS programs developed in LTER2 were initially applied to small-scale experiments that manipulated spruce and alder densities, where exact locations and sizes of trees were known. Three data sets at different scales were prepared to test for bias in detecting vegetation change at scales ranging from plot photographs to 30-meter satellite imagery of Bonanza Creek to 1-km AVHRR imagery of Alaska. These data sets demonstrate the significance of bias and correct satellite-based estimates of vegetation change. Satellite images are also being used to test for differences in spectral leaf area index associated with soil type and topography.

Synthesis and Integration

In summary, we have documented significant climatic changes since the initiation of our LTER research, including warmer air and soil temperatures, and drought that is unprecedented in the past 200 years. These trends correlate with increased frequency of thermokarst (melting of ice-rich permafrost), fire, insect outbreaks (southern Alaska), reduced growth and seed production in white spruce, the late-successional dominant tree, and extensive grassland development following large-scale disturbances. These changes suggest directional changes in structure and function of the Alaskan boreal forest. However, within stands, the microclimate, stand structure, productivity, and biogeochemistry have been influenced more strongly by extreme events such as snow breakage and by successional changes in browsing and vegetation than by broad climatic trends. In LTER3 our studies will be broadened to the landscape level, using observations, GIS, and modeling to integrate these two scales

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Proposal-writing Workshop in the Works for LTER Education

Diane Ebert-May and Patricia Sprott are organizing a workshop to assist LTER sites in writing proposals for enhancing education programs at their sites. The workshop, to be held at the Kellogg Biological Station, Michigan State University, Hickory Corners, Michigan 19-21 November 1999, will challenge and provoke representatives from the LTER sites to consider previous experience and future desires for education programs.

The timing of the workshop –two years after the LTER sites received their first Schoolyard LTER Supplements—allows sites an opportunity to bring some experience to the table.

Follow-up

In October 1998, teams of scientists and educators from 13 LTER sites assembled at the Biosphere II conference facility in Arizona to plan and share ideas for further developing their educational programs utilizing LTER resources. Recommendations from the workshop participants included ways to acquire funding required to sustain educational programs at LTER sites.

This workshop is designed to provide support and ideas for developing and writing proposals to programs in the Education and Human Resources (EHR) Directorate of the NSF and to other agencies and/or foundations that support science education programs.

The Workshop

This workshop is intended to assemble teams of two individuals from 13-15 LTER sites to collaborate with each other and with expert science educators who have extensive experience with garnering funding from the NSF and other agencies for science education programs. The goal of the workshop is to formulate ideas and frameworks for competitive proposals. People interested in attending have been encouraged to review existing programs at NSF for ideas.

Teams of interested people from the LTER sites should include the individual who will be the PI on the proposal and a teacher or science educator who will be involved in the project.

The workshop is sponsored by the LTER Network Office, NSF - Division of Environmental Biology, and NSF - Directorate of Education and Human Resources.

For more information about the LTER Education project, please see the Web site: http://www.lternet.edu/oppts/education/ ◆

Second Volume in LTER Synthesis Series Published

Standardized methods and measurements are crucial for ecological research, particularly in long-term ecological studies where the projects are by nature collaborative and where it can be difficult to distinguish signs of environmental change from the effects of differing methodologies. This second volume in the LTER Network Series addresses these issues directly by providing a comprhensive standardized set of protocols for measuring soil properties. The goal of the volume is to facilitate cross-site synthesis and evaluation of ecosystem processes. Chapters cover methods for studying physical and chemical properties of soils, soil biological properties, and soil organisms, and they include work from many leaders in the field. The book is the first broadly based compendium of standardized soil measurement methods and will be an invaluable resource for ecologists, agronomists, and soil scientists throughout the LTER Network, and the greater ecological research community.

Order the latest volume in the LTER Synthesis series from Oxford University Press: 1-800-451-7556 or http://www.oup.com

About the Editors:*G. Philip Robertson is Professor of Crop and Soil Science at the W.K. Kellogg Biological Station, Michigan State Univ; Caroline S. Bledsoe is Professor of Soil Ecology in the Department of Land, Air, and Water Resources at the Univ of Calif, Davis; David C. Coleman is Research Professor of Ecology at the Institute of Ecology, Univ of GA; Phillip Sollins is Professor of Forest Ecology and Soils in the Forest Science Department, Oregon State Univ.* ◆

LTER Graduate Student Report

by Christy Tyler, VCR

The LTER graduate students met twice during the August 1999 ESA Annual Meeting in Spokane, Washington.

The general meeting was attended by 56 students, including 11 Japanese and Korean students and nine students from outside the LTER Network.

Diane Ebert-May spoke briefly about the upcoming LTER Education proposal-writing workshop, post-doc opportunities in teacher education through LTER, and about education in general at the Network level. Diane's presentation helped all of us to start looking beyond our specific research question to the bigger picture of science and education, and to remind us of the social responsibilities that come with being a scientist. (Learn more about Diane Ebert-May and her work at the Lyman-Briggs School at Michigan State University at http://www.msu.edu/~lbs/animated.html)

Bob Waide spoke about the history of the LTER program and described the funding, governing, and coordinating of the Network, offering a good introduction to the far-reaching aspects of LTER (ILTER, and Schoolyard LTER) as well as a practical introduction to the governing of such a diverse research endeavor. The presentation was especially valuable for the many students who may not be aware that "LTER" is more than just their particular site.

The LTER Student Exchange trip to Japan was among the many interesting presentations. (see article page 11)

Also, participants made many good suggestions regarding the format of LTER Graduate Student Meetings. In the future, look for posters on each of the sites, science talks from student representatives, and greater opportunities for interactions.

ESA '99 was also the site of the first meeting of the LTER Graduate Student Committee. Co-chairs Christy Tyler (VCR) and Greg Hoch (KNZ) led the meeting of representatives from each site. In addition to the changes to ESA get-togethers, making cross-site research more accessible for students, improving communication between students, and planning for the Y2K LTER All Scientist's Meeting (August, Snowbird, Utah) were also discussed.

Getting Ready for Y2K

Registration for the ASM will be handled through the general ESA registration process. Each LTER site will have funding for travel, including students. Students must

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Graduate Student Report

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discuss their plans to attend the meeting with the PI at their LTER site. The funding does not include the ESA meeting. Christy Tyler is assembling a tentative number of students who plan to attend. She also needs volunteers to help organize the meeting. Laura Broughton (KBS) has volunteered for general organization and social events. If you are interested in helping, please contact her.

Please review the agenda. If you are interested in helping out with any of these, please volunteer! Check the Web site for more detailed information and updates. These session topics were compiled from LTER student suggestions. Further comments are encouraged. A final summary must be submitted by winter break. Please forward your comments and suggestions to Christy Tyler. In addition to posters, workshops and sessions, many other student-focused activities are planned. Lunch groups will form around discussions on various topics in ecology, led by a PI appropriate for each subject. Suggestions for topics and PIs are welcomed. Other ideas include hikes and field trips in the surrounding mountains, as well as booths for each site displaying general information. ◆

Proposed Student Seminars and Workshops for the LTER Y2K All-Scientist's Meeting Wednesday, 2 August through Friday, 4 August, 2000

A. *Seminars* (Wednesday and Thursday, 4:30 - 5:30pm)

1. Statistics (Karen Wilson)
2. Remote Sensing (Erica Hoffa, Jennifer Edmonds)
3. GIS (need a volunteer)

B. *Symposia* (to be held concurrently with other sessions)

1. Cross-site research and collaborative research (Stephanie Madson)
2. Incorporating LTER data into teaching programs and using long-term data (Greg Hoch)
3. Career Workshop (Erica Hoffa)
4. Social Diversity in Ecological Sciences (Rob Daoust)
5. The integration of social and biological sciences (Jennifer Edmonds)

C. PI lunches (TBA) (Christy Tyler, Laura Broughton)

D. Field Trips (TBA) (Christy Tyler, Laura Broughton)

E. Pre-Meeting Web-based activities (TBA) (Greg Hoch)

KDI Grant Funded

The LTER Network Office, the National Center for Ecological Analysis and Synthesis, and the San Diego Supercomputer Center have successfully collaborated in a proposal to the Knowledge and Distributed Intelligence program of the National Science Foundation.

The successful proposal, which was titled "A Knowledge Network for Biocomplexity: Building and Evaluating a Metadata-based Framework for Integrating Heterogeneous Scientific Data", received an Outstanding ranking and was featured in the NSF press release about the competition (http://www.nsf.gov/cgi-bin/getpub?pr9950).

The goal of the project is to enable scientists from a wide range of disciplines to address biocomplexity questions by providing for discovery, retrieval, interpretation, integration, and analysis of heterogeneous and distributed information about biodiversity and the earth's ecosystems.

The participants in the KDI grant (LTER, NCEAS, and SDSC) have joined forces with University of Kansas Natural History Museum and Biodiversity Research Center in the Partnership for Biodiversity Informatics.

The University of Kansas also is the recipient of a KDI grant that focuses on museum collections. One exciting result of the work at Kansas is the release of the web version of the Species Analyst by Dave Vieglais. This software allows anyone to access records from 12 museum collections with more being available in the near future. Taxa available are birds, mammals, butterflies and plants, largely in North America. You can try this out at http://chipotle.nhm.ukans.edu/nabin/ For more information on the KDI project, contact Bob Waide or James Brunt. ◆

NPACI Update

As reported in the last Network Newsletter, the LTER Network has developed a series of collaborations with the National Partnership for Advanced Computational Infrastructure (NPACI), a program of the San Diego Supercomputer Center (SDSC). These collaborations include efforts to develop versions of biological-scale process models that can take advantage of the computational power available at SDSC as well as more general attempts to apply technologies being developed at NPACI to specific LTER problems.

A workshop on biological-scale process modeling was held in San Diego in December 1998. Participants from 16 LTER sites discussed how supercomputer applications could be of use to them and their research programs. A report of this workshop can be found at http://www.sdsc.edu/sdsc-lter/.

A number of follow-up experiments were proposed. The most advanced of these include efforts to create parallel versions of models being developed at the SGS and KBS LTER sites. The Short Grass Steppe models include the Regional Atmospheric Modeling System (RAMS) and the CENTURY model, while the Kellogg model describes regional maize production. A second workshop focusing specifically on these models will be held in San Diego, 9-10 November 1999.

> "We are searching for applications for technology that would allow data collected at remote field locations to be transmitted to SDSC via satellite uplink, analyzed and displayed graphically, and transmitted in real-time to interested investigators. We invite LTER scientists to suggest possible applications for this technology."

The goal of collaboration with SDSC is to produce model versions whose use is no longer limited by computational resources.

Funding from the NPACI program is being used to develop a joint project between the LTER Network Office and the University of Kansas. The object of this project is to link information on land use history from LTER sites with climate change predictions from the RAMS model and biodiversity information accessed through software developed at the University of Kansas. The goal is to tease apart the direct effect of land-use change on biodiversity from any indirect effects acting through regional climate change. Lixin Lu, a post-doctoral associate working with the Network Office, is providing the RAMS-CENTURY modeling output for this project.

Tony Fountain, the LTER liaison with SDSC, has been working to develop opportunities for LTER scientists to use mass data storage and visualization capabilities being developed under the NPACI program. A new initiative will take advantage of high-speed network connections and wireless technology to develop prototype systems of data collection and analysis from field sites. For example, we are searching for applications for technology that would allow data collected at remote field locations to be transmitted to San Diego via satellite uplink, analyzed and displayed graphically, and transmitted in real-time to interested investigators. We invite LTER scientists to suggest possible applications for this technology. ◆

Introducing Project FIRST* Through Field Stations

*Faculty Institutes for Reforming Science Teaching Through Field Stations

Project FIRST is designed to develop and sustain a model for faculty professional development that will increase the quality of undergraduate science teaching and learning for all students, and especially those preparing for careers as elementary and secondary school teachers, who may take only two or three natural science courses.

"Faculty who teach undergraduate biology should learn how to use strategies that promote learning science through inquiry, so these future teachers can in turn pass on experience and knowledge to future generations," says Diane Ebert-May, past president of ESA's education committee and chair of the LTER Education Committee. Together with Janet Hodder, Academic Coordinator at the University of Oregon's Institute of Marine Biology, Diane has developed a program utilizing field stations and marine laboratories (FSML) to enhance biology education.

Project FIRST will prepare faculty associated with field stations to utilize inquiry-based, active learning approaches for reforming undergraduate biology courses and curriculum. "Field stations are inherently conducive to the process of education," says Terry Detling, leader of the Hancock Biological Station FIRST team. "Students have an *a priori* expectation that field stations involve investigation of the natural environment, asking questions for which there are no established answers, and learning."

Diane Ebert-May has been a leader in the reform of undergraduate biology education throughout her research and university faculty career. "While holding responsibility for educating our citizens in the biological sciences," Diane says, "most scientists and graduate students are unaware of instructional strategies about teaching for learning." Most university faculty are rewarded to conduct research and publishing rather than develop comparable excellence in teaching science to undergraduates.

Field stations are places where students can go to have real "hands-on/minds-on activities," say Kathy Williams, associate professor of biology, San Diego State University, and *FIRST* team leader there. "They can make observations, develop hypotheses to explain their observations, then design ways to test those hypotheses, and do it. These are a far cry from cookbook labs that many students have experienced and dread."

Forming a Network of Support

Five field stations (St. Croix Watershed Research Station, Science Museum of Minnesota; Southwestern Research Station, American Museum of Natural History, Portal, Arizona; San Diego State University Field Stations, San Diego, California; Hancock Biological Station, Murray State University, Murray, Kentucky; Archbold Biological Station, Lake Placid, Florida) established leadership teams composed of researchers, faculty, and science educators. The teams participated in two workshops, during which they learned about and experimented with forms of active learning, developed inquiry-based field activities, and studied multiple forms of assessment that would provide evidence of student learning. During the first year, the leadership team recruited five 'institutional teams' from colleges and universities from the region near the field station, or in one case, from different universities in states far from the station. The leadership teams designed and implemented faculty development workshops at their own field stations for the institutional teams.

Terry Detling and Bill Spencer discuss strategy for implementing the FIRST program at Hancock Biological Station

"The bottom line," says Diane, "is that faculty who understand the educational value of field stations to promote scientific literacy by all students began to develop long-term plans for reforming their undergraduate science curriculum in their departments. Not only did they consider adding field components to their course, but also designed ways to bring the field into their classrooms on a more regular basis."

These institutional teams will then begin to reform the teaching and learning in their courses. One member from the project staff will work at the field station with the FSML team to support implementation of the professional development institutes. This will ensure a smooth transition and immediate feedback for FSML teams.

Ultimately, all students will have opportunities to gain scientific understanding by direct experiences with the methods and process of inquiry both in a field station/ field site situation and in their own classrooms.

Overcoming Obstacles

As in most research institutions, the incentives are for research and not for education. There are direct payoffs for expending efforts on research (i.e., salary and prestige associated with grant money and publications, tenure and promotion). "Most educators at field stations believe their courses are already inquiry-based and that training in pedagogy and alternative methods is not of value to them," Terry Detling says, which, she adds, differs little from views expressed by faculty in traditional educational institutions.

"Perhaps the most influential effect will be grant support for teaching activities," says Terry, who adds that several field-station faculty at Hancock recently received a large Collaborative Research at Undergraduate Institutions grant from NSF, which focuses on research experiences for undergraduates, using the field station as the research base. "This grant got a lot of attention in our department... [and] may encourage others to submit proposals that combine education and research. As faculty carry out the proposed activities with students, and hopefully find it to be a positive and rewarding experience, attention to research AND education may increase."

Kathy Williams says the new teaching methods are "contagious" at SDSU. "The students and faculty both enjoy the change so much that others take notice and want to try changing their traditional courses as well." Williams notes that spending time to reform a tried-and-true course curriculum is not attractive to many faculty, but the results are rewarding. "Actually I don't know of anyone who's tried these reforms and has gone back to 'passive' education." ◆

Ecological Metadata —in Perspective

by James W. Brunt, NET and John H Porter VCR

Metadata—What it is

Whether you've either just heard about metadata in ecology or you're tired of hearing about the subject, this complicated topic can either fire up a conversation or cause the whole group to scatter. Whatever the response—it is a remarkable evolution from just a decade ago when metadata was something discussed only behind the closed doors of musty computer labs, and only in the closest company of data managers.

Metadata is data about data that data managers try to accumulate without inconveniencing PIs. And to data managers it is considered to be of equal importance to data themselves. Once called 'data documentation' it bore the unsavory connotation of lots of work for no thanks. Strategies for extracting it from the memories of scientists were frequently among the topics of discussion. It would require considerable detective work to find more than a casual mention of documenting data in early LTER data management publications. But nonetheless, LTER information managers *were* working on standards then for the purpose of making sure that LTER data could be understood and used well into the future.

***Anne Frondorf**, Director of the National Biological Information Infrastructure (NBII; see Network News, Spring 1999) and Chair of the Biological Data Working Group of the Federal Geographic Data Committee attended the annual meeting and expressed interest in working with LTER to address needs for ecological metadata.*

And that future is now.

A Short History

The first implementation of a standardized set of metadata came with the development of the first LTER data catalog[1] – this was the first attempt to integrate a minimum set of information about each LTER data set. Content standards were formally established in 1994 and became the precursor to standards published 1997[2]. While these standards described for the user the minimum components that should be included to adequately document a data set for exchange, no recommendation was made about implementation or structure. More elaborate exchange standards for metadata were discussed off and on but it wasn't until the WWW happened that the realization occurred about what was possible with structured metadata. New uses such as internet-based data integration and interoperability became plausible because developers were no longer saddled with the task of writing client software for multiple computer platforms – a task that has discouraged many.

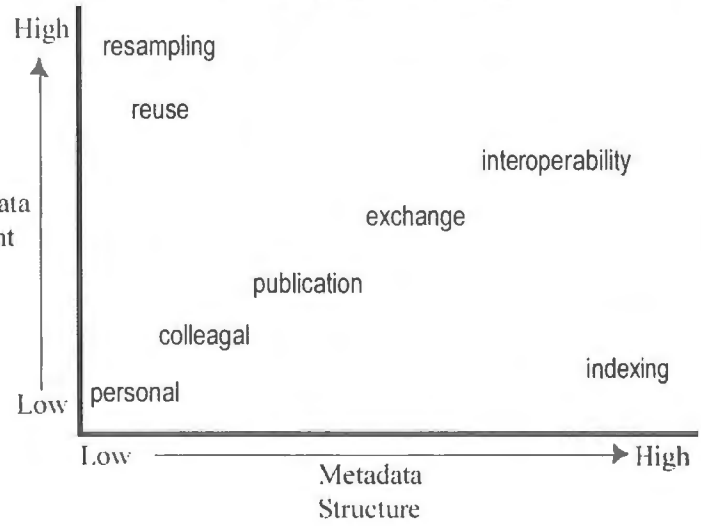
Looking at functional metadata requirements reveals something approximating the graph in Figure 1. It becomes quite clear that structure is extremely important for enabling data integration and interoperability but content is more important for insuring future viability.

Shaping the Future

At their annual meeting in August, the LTER Information Managers established a new working group whose goal it is to develop LTER standards for ecological metadata. LTER efforts for years have been focused on the long-term stewardship of the data – assuring for their reuse in the future. With this new Metadata Standards Working Group and the development of new partnerships LTER information managers will make great strides toward increasing the use and accessibility of the wealth of ecological data produced by LTER, and subsequently promoting ecological science. ♦

Almost overnight, after WWW servers became available, LTER data sets began springing up on the web, accessible to anyone through an extensive network of site-based servers. LTER was clearly in the forefront of sharing scientific data over the web but it didn't happen network-wide without a little prompting from the CC and Jerry Franklin — Chair of the CC at that time – in the form of a mandate for putting LTER data online. Currently there is information available on more than 2000 data sets collected at LTER sites through a searchable data catalog with hyperlinks to extensive metadata and data (http://www.lternet.edu/DTOC).

Level of Data Use



Further Reading

1 *Long-Term Ecological Research Network Core Data Set Catalog*. 1990. Michener, W.K. (ed), Miller, A.B. (ed), Nottrott, R. (ed).BelleW. Baruch Institute for Marine Biology and Coastal Research: University of South Carolina, Columbia, SC, USA. 322 pp.

2. Non-geospatial metadata for the ecological sciences. 1997. William K. Michener, James W. Brunt, John J. Helly, Thomas B. Kirchner, and Susan G. Stafford. *Ecological Applications* 7:330-342.

Ecological Hydrology—

Intersite comparison of long-term streamflow records from forested basins in Oregon, New Hampshire, North Carolina, and Puerto Rico

JONES, J. A. and D. A. POST Oregon State University

In this study, we examined the relationship between the streamflow hydrograph and precipitation inputs at interannual, annual, seasonal, and daily time scales in order to better understand how streamflow in undisturbed and harvested forested ecosystems is affected by varying sizes and timings of storages in soil and snow and losses from evapotranspiration.

The four LTER sites studied all have forest vegetation and mountainous topography, but they vary in climate and the age and type of forest vegetation. These differences produced quite different responses among the basins when forests were harvested. Comparison among control basins highlighted the different importances of soil and snow reservoirs as well as different roles of evapotranspiration in controlling streamflow among the sites.

Comparison of post-harvest streamflow trajectories indicates that streamflow is strongly coupled to succession, while different successional pathways, forest types, and forest ages may produce quite different streamflow responses to forest harvest.

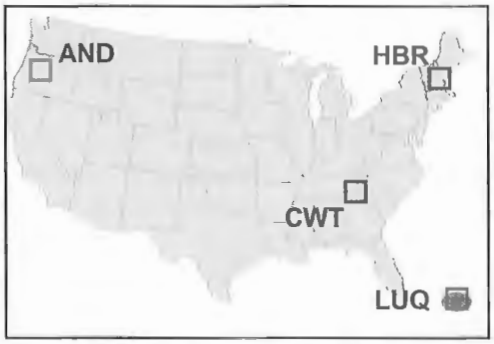


Figure 1.The LTER study sites (HJ Andrews [AND] in Oregon, Hubbard Brook [HBR], New Hampshire, Coweeta [CWT], North Carolina, and Luquillo [LUQ], Puerto Rico). Climates vary from tropical at LUQ to maritime temperate at AND to continental temperate climates at CWT and HBR.

Forests vary in age and type among the sites with 50- to 70-year old deciduous forests at CWT and HBR, versus evergreen broadleaf forests at LUQ, versus 450- year old evergreen needleleaf forest at AND. We examined more than 600 basin-years of daily streamflow records from 18 control (undisturbed) basins at four long-term ecological research (LTER) sites, and an additional few hundred basin-years of daily streamflow records from two clearcut basins at each of three sites: AND, CWT, and HBR.

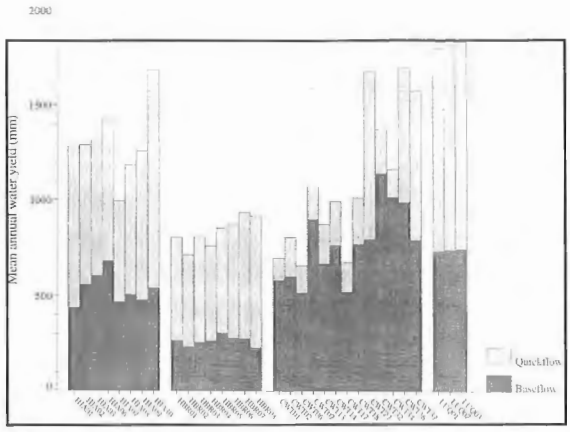


Figure 2. Control basins at the AND, HBR, and LUQ sites had quite homogeneous responses within a site, although they ranged from quickflow-dominated (HBR) to equal partitioning among baseflow and quickflow (AND), while actual evapotranspiration ranged from 35% (HBR) to 50% (LUQ). In contrast, control basins at CWT had quite heterogeneous responses, ranging from slightly quickflow-dominated with AET < 30% (at high elevations) to strongly baseflow-dominated with AET ~50% (at low elevations).

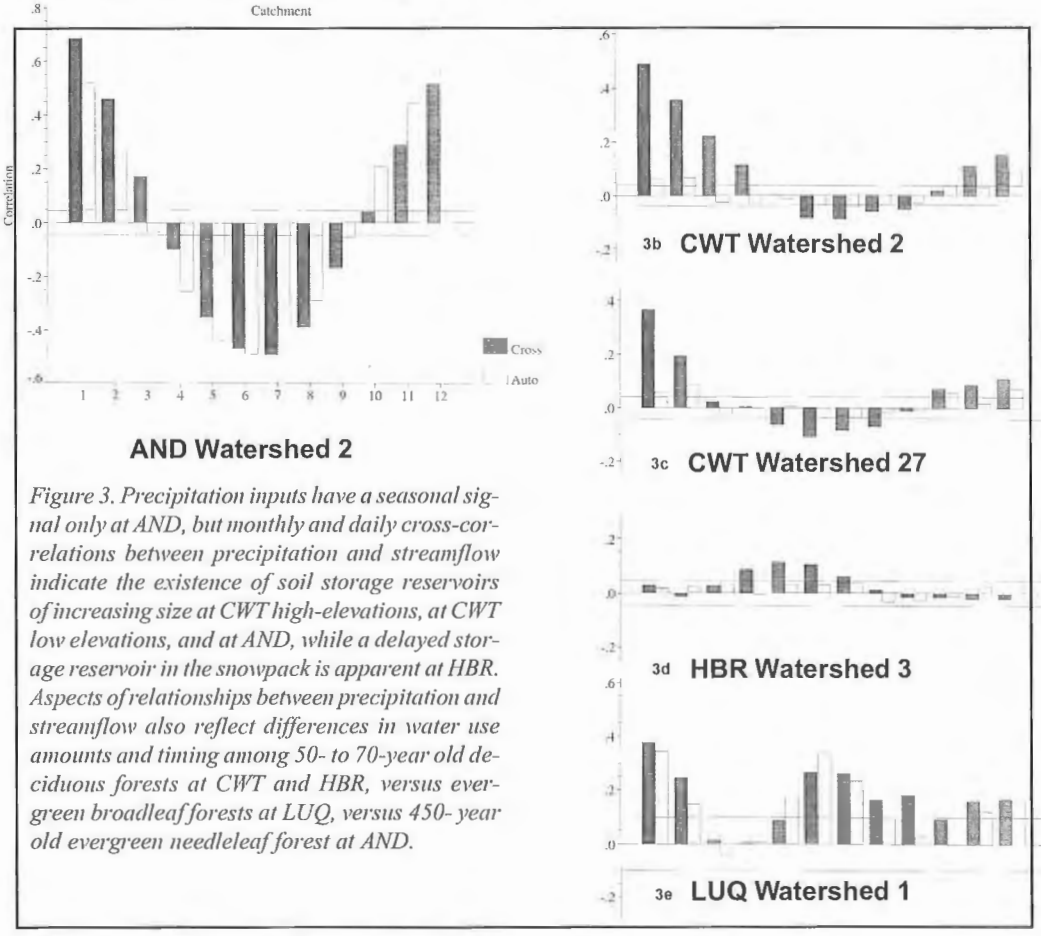


Figure 3. Precipitation inputs have a seasonal signal only at AND, but monthly and daily cross-correlations between precipitation and streamflow indicate the existence of soil storage reservoirs of increasing size at CWT high-elevations, at CWT low elevations, and at AND, while a delayed storage reservoir in the snowpack is apparent at HBR. Aspects of relationships between precipitation and streamflow also reflect differences in water use amounts and timing among 50- to 70-year old deciduous forests at CWT and HBR, versus evergreen broadleaf forests at LUQ, versus 450- year old evergreen needleleaf forest at AND.

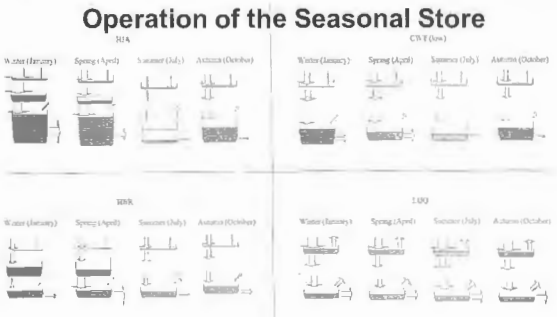


Figure 4. Seasonal water balances reveal important differences in forest and climate influences upon streamflow among control basins at the four sites. The AND site has the largest and most seasonally variable soil and canopy storage reservoirs as well as large snow reservoirs and a strong summer ET signal from evergreen needleleaf forest, and moisture storage in these reservoirs is synchronized by seasonally varying precipitation, contributing to the greatest observed seasonal differences in streamflow among the four sites. At the opposite extreme, the LUQ site has little seasonal variation in precipitation and ET from evergreen broadleaf forest and virtually constant canopy and soil moisture storage, with near-constant streamflow. A spring maximum snow reservoir at HBR, combined with a summer ET signal from deciduous forest vegetation but little variation in canopy or soil moisture storage, contributes to the second most seasonally variable streamflow signal of the four sites. At CWT, the summer ET signal alone combined with a relatively large soil moisture reservoir and seasonally constant precipitation inputs produces only small seasonal variation in streamflow.

please turn to page 15 for Figure 5 and Conclusion

Students Attend US—Japan LTER Workshop

11-19 June, 1999
Otsu and Tomakomai, Japan

Story and photos by Susan Sherrod, Niwot Ridge LTER

In mid-June 1999 a group of 10 U.S. LTER graduate students and scientists toured research sites in the Otsu and Tomakomai areas of Japan, guided by Japanese LTER researchers. As representatives of the U.S. LTER Network, our objectives were to exchange information about the research conducted at Japanese and U.S. LTER sites, to lay the groundwork for future collaboration among our researchers, and ultimately to strengthen our interactions with our international colleagues.

The weeklong interaction with Japanese Long Term Ecological Researchers was as positive and optimistic as it was diverse. We found the consistently high caliber of research remarkable, as well as the generous accommodations. The diversity of ecological disciplines represented by our groups resulted in rewarding scientific and social dialogue with much promise for future collaboration.

Chris French (LTER Network Office) coordinated the visit which was funded by the National Science Foundation and the Japan Society for the Promotion of Science. The participating U.S. scientists were two faculty, John Magnuson (NTL) and Myron Mitchell (HBR), and eight students, Robert Daoust (PIE), Nicole Gerlanc (KNZ), Craig Layman (VCR), David Lewis (NTL), Stephanie Madson (CWT), and Anne Rhoads (HBR), Kristina Russell (VCR), and myself, Susan Sherrod (NWT).

A formal two-day conference held at the Tomakomai Experimental Forest was the academic core of the trip but our attention and activities were occupied daily - and nearly hourly - with local field trips to survey the research activities of our hosts. Aquatic and forest ecology encompassed most of our discussions and activities, and this report is organized by these broad disciplines.

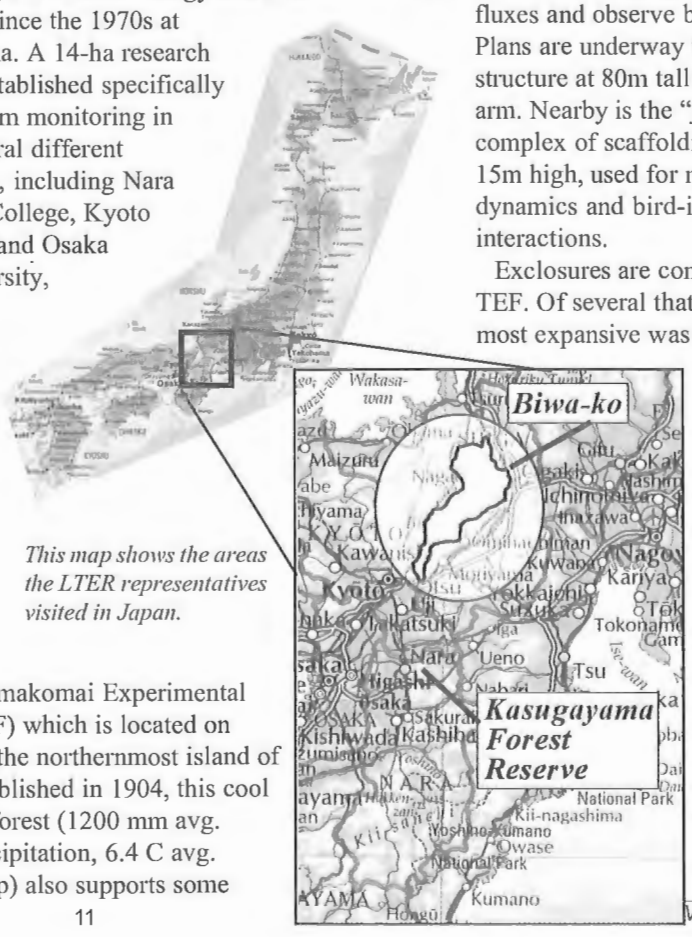
Forest Ecology

Our first full day in Japan was spent in the region of the Kasugayama Forest Reserve, near the city of Nara. Dr. Mamoru Kanzaki (Kyoto University) and two of his graduate students, Kenta Tanaka and Toshiko Kawasaki guided the visit. The Kasugayama Forest Reserve is a natural monument and is protected not only by the Nara Provincial Government but, being a holy site, by the local Kasuga Shrine as well. Shika deer, considered sacred, roam freely in the area and introduce considerable grazing pressure to certain areas including the grass-covered mountain Wakakusayama.

The group at the research vessel dock, Lake Biwa

Five major vegetation types are distinguishable in the research area, including late successional evergreen oak forest, secondary deciduous oak forest, Japanese cedar ("sugi"), and secondary forests of *Pinus densiflora* and *Podocarpus nagi*. Typhoons dominate the disturbance regime and create a mosaic of canopy gaps with average regeneration times of about 200 years. However, recent increases of Shika deer populations have severely impeded the revegetation of these canopy gaps.

Active research on ecosystems, plant community, and insect ecology has been underway since the 1970s at Kasugayama. A 14-ha research plot was established specifically for long-term monitoring in 1991. Several different universities, including Nara Women's College, Kyoto University and Osaka City University, pool their research efforts to offset research costs.



This map shows the areas the LTER representatives visited in Japan.

The second major forest site we visited was the Tomakomai Experimental Forest (TEF) which is located on Hokkaido, the northernmost island of Japan. Established in 1904, this cool temperate forest (1200 mm avg. annual precipitation, 6.4 C avg. annual temp) also supports some cultivation and grazing activities. Periodic eruptions from nearby Mt. Tarumae have produced the bulk of TEF's volcanic soils, which support both non-native (25%) and young secondary forest regenerating after typhoon damage (75%). Japan's Ministry of Education, Science, Sports, and Culture, in support of studying and preserving biodiversity, funds the bulk of TEF research.

Research projects at TEF focus on stream hydrology and biogeochemistry, forest-stream interactions, species composition and productivity, forest canopy structure, functions, and atmospheric interactions, and the impacts of herbivores on nutrient availability, plant C allocation, and reproductive capacity. Drs. Tsutom Hiura, Masashi Murakami, and Shigeru Nakano led our field excursions, which included visits to a number of specialized research structures. One was the canopy gondola, a 25m tall crane with a 40m arm from which researchers are suspended in a cage and measure gas fluxes and observe birds and insects. Plans are underway to build a similar structure at 80m tall and with a 90m arm. Nearby is the "jungle gym," a complex of scaffolding rising about 15m high, used for measuring canopy dynamics and bird-insect-plant interactions.

Exclosures are commonly used at TEF. Of several that we observed, the most expansive was the 1.2-km stream canopy exclosure, constructed in April 1999, to elucidate the reciprocation between food webs of the forest and stream (S. Nakano, PI). The netting used is 1-mm mesh, small enough to prevent passage of birds or insects. Just two

cont. next page

Students Attend US—Japan LTER Workshop

continued from page 11

months into the experiment, Nakano and colleagues were discerning many forest-stream interactions; for example, populations of the insectivorous flycatcher have emigrated from the exclosure area. In addition, fish that are dependent on terrestrial insects falling from overhanging trees have also vacated the 1.2-km stretch.

Energy and nutrient fluxes between the forest and stream will also be studied with the use of this stream canopy exclosure. TEF researchers also use exclosures in the forest canopy (15 m^2 exclosures) to evaluate the role of birds in the terrestrial food web (M. Murakami, PI), and around individual trees growing close to waterways to determine how particular tree species contribute to forest-stream interactions (M. Murakami, PI).

The research facilities at TEF are comfortable and include laboratories, a 38-bed dormitory, and a museum and other archives. Field equipment includes a 30-m tower with three observation arms, an artificial stream, a 14-m canopy ecophysiology analysis tower, and a CO^2 flux monitoring station.

Aquatic Ecology

Long-term research of aquatic systems is also a major component of ecological activities in Japan. On this visit, our reviews of aquatic research emphasized two lakes, Lake Biwa (Biwa-ko) and Lake Toya (Toya-ko).

On the main island of Honshu, the large surface area of Biwa-ko (670 km^2) makes it the largest lake in Japan and indispensible for wetland habitat (1145 ha) and drinking water for the 14 million residents of Osaka, Kyoto, and Kobe. Since the 1960s intensive industrial and agricultural development has severely degraded water quality.

These issues have received considerable public attention, including implementation of the 1979 National Anti-Eutrophication Ordinance and other prefectural measures. Despite these policy implementations, however, the water quality of Biwa-ko has not clearly improved and eutrophication remains a threat. Ecological research in the watershed hence focuses on returning the lake and its environment to sustainable levels of recreation, fishing, agriculture, and other land and lake uses. This research is well funded by the prefectural government.

Craig Layman and Myron Mitchell test drive the canopy crane, Tomakomai Experimental Forest LTER

The Lake Biwa Research Institute (LBRI), sponsored by the prefecture, classifies its research into four major categories. Project-based research is largely interdisciplinary and supports three-to-five-year programs such as assessing the effects of forest clearing in the Biwa-ko watershed, the effectiveness of controls of non-point source pollution, and trends of dissolved organic matter.

Priority-subject research is designed to provide information on a very short time scale, such as for the development of a management policy or to lay the framework for a project-based research project. Continuing basic research is carried out by each of the LBRI faculty members within their field of specialty. Lastly, the lake shuttle project is an effort to improve the design and construction of underwater research vessels. In addition to these broad areas, monitoring remains active as does research on watershed management and environmental policy.

Dr. Tetsuya Narita of the Ecological Research Center (Kyoto University) led our excursion onto Biwa-ko. We sailed from the eutrophic south basin of the lake to a site in the mesotrophic north basin with a depth of about 50m, where several graduate students directed the collection of water samples. Measurements included transmissivity, photosynthetically active radiation, conductivity, dissolved O_2, temperature, salinity, pressure, chlorophyll, and pH, and zooplankton.

We spent one morning at the extraordinary Lake Biwa Museum, a collection of artifacts and information emphasizing the relationship between humans and their use of the lake. Thirty scientists work at the museum, which offers remarkable descriptions of the lake's geological history, its history of human settlements 10,000 years ago, the contemporary relationship of the lake with its (human and non-human) users, and the largest freshwater aquarium in Japan. The museum also has outdoor exhibits of forests in different geological time periods, farming fields, streams, and ponds. The Lake Biwa Museum is frequented by large numbers of people of all ages and origins and is surely an asset to the public outreach efforts of the nation's scientists.

The second major lake that we visited was Toya-ko, a 70-km^2 caldera lake located in the Shikotsu-Toya National Park in Hokkaido. The water of Toya-ko was contaminated in 1939 with the by-products of local sulfur mining, which depleted native populations of fish. Recent applications of lime and calcium carbonate have raised the pH from 5 to neutral, and the water is now used to generate hydroelectric power and for public consumption.

Established in 1936, the Toya Lake Station for Environmental Biology (Hokkaido University) historically researched "the Practical Exercise of Fish Culture and Environmental Biology," but currently emphasizes (1) wise use, including sustainable fisheries production, (2) imprinting and homing mechanisms of kokanee salmon to the maternal river, and (3) the reintroduction of sockeye salmon to Toya-ko to stable levels by 2001. Dr. Hiroshi Ueda showed us the facilities of the Station, including a hatchery house, fishponds, aquaria used for rearing kokanee and masu salmon, and a laboratory.

The Conference

On June 16th and 17th at TEF, several dozen researchers attended the International Young Researchers' Workshop on Long-Term Ecological Research, organized by the Center for Ecological Research (Kyoto University) and TEF. Researchers discussed their respective LTER sites, as well as individual research. M. Miyahara of the NSF's Tokyo office emphasized that Japanese researchers are eager to host scientists from other countries, including graduate students and post-graduate scientists. A variety of arrangements are possible with Japanese hosts.(See http://www.twics.com/~nsftokyo/home.html for details.)

We would be remiss if we did not mention the exceptional hospitality of our Japanese hosts. They paid meticulous attention to every detail of the days that we spent as their guests, including transportation, conference preparation, social events, and last but far from least important, beautifully prepared, elaborate, and delicious meals. Adequate reciprocation of their hospitality will surely be a challenge and a pleasure. ◆

INTER *National* *Developing LTER Networks Around the Globe*

The First Meeting of the North American Regional LTER Network (NAR)

Scientists from Mexico, Canada and the United States are now working toward a regional framework to facilitate LTER research and collaboration across the North American continent.

The August 1999 ESA annual meeting in Spokane served as the venue for an all-day, public workshop, which offered an opportunity to North American Regional ecologists to explain their research and the related issues they are addressing.

The national chairs of the networks, James Gosz (U.S. LTER), Hague Vaughan (Environmental Monitoring and Assessment Network, Canada) and Gerardo Ceballos (National Autonomous University of Mexico), introduced the history, structure and policy that drive their networks. Following the presentations, scientists described current cross-site research, including the fifteen-year-long collaborative hydrological modeling project, which involves scientists at Coweeta (U.S.) and Chamela (Mexico) field stations.

In summary, communication and international interactions, science-driven questions and comparisons, opportunities for data sharing, common experiments, monitoring, and joint meetings are some of the issues driving the regional network effort.

At a planning meeting followed the workshop on Wednesday 11 August, NAR representatives discussed numerous potential collaborations, focusing on continental-scale projects in a round-table discussion format.

Topping the list of topics, the Global Terrestrial Observing System will form a global network of validation sites for remotely acquired imagery. GTOS will produce many significant products, including global net primary productivity (NPP) estimations for various ecosystem types.

The imagery will be acquired using a Moderate Resolution Imaging Spectroradiometer (MODIS)—the key instrument aboard the Terra (EOS AM-1) satellite, now in operation. The MODIS instrument will view the Earth's entire surface every few days, acquiring data in 36 spectral bands. These data will improve the understanding of global dynamics and processes occurring on the surface of the Earth, in the oceans, and in the lower atmosphere. North American Region ecologists can provide much-needed validation information for land cover and leaf-area index (LAI). The information will then be synthesized with a project that will estimate net primary productivity for various land-cover types across the globe. Validation over broad spatial scales will improve the GTOS system as a whole. Each individual site is important for calibrating the system for the entire continent.

EMAN-representative Hague Vaughan expressed interest in exchanging validation information for NASA data access as "Canadian remote sensing data is too expensive for ecological research to afford" Vaughan said. The new satellite system (Terra) offers frequent updates and results in rapid turnaround for examining changes in land cover and land use.

"Scientists are not used to thinking at kilometer-to-100-km scales, but we must learn to think bigger – far beyond the normal realm of our science."
Jim Gosz, Chair, ILTER Network

Other themes within GTOS include Global Observation of Forest Cover (GOFC), the Terrestrial Carbon Cycle Initiative (in preparation), and in the year 2005, the need to determine a country's carbon budget under the Kyoto Protocol. (*For more information, see the GT NET-NPP demonstration project in the Spring 1998 issue of the LTER Network Newsletter—also available on-line at http://www.lternet.edu/research/pubs/newsletters.html*).

The NAR Network may be instrumental in identifying the carbon budgets of countries in relation to the Kyoto Protocol (a.k.a. The UN Framework Convention on Climate Change).

On 10 December 1997, 160 nations reached an historic agreement in Kyoto, Japan on limiting emissions of carbon dioxide and other "greenhouse gases." The Kyoto Protocol calls for the industrialized nations to reduce their average national emissions over the period 2008-2012 to about five percent below 1990 levels, creating the need to quantify what 1990 carbon density was, and to track how much carbon dioxide is being sequestered and released from each country.

Determining various countries' vegetation cover types becomes important to determining a carbon budget, and emphasizes the need for networks of ecologists who understand the carbon budgets of their sites. Canada and the United States signed the agreement in 1997. As a "developing country," Mexico is exempt from any restrictions on CO_2 production, but may figure into a program for international trading of greenhouse gas emissions, for which Mexico's ecologists will need to understand the carbon density of its ecosystems as well.

All of these projects rely on accurate land classification products. "Up until now," said Jim Gosz, chair of the International LTER Network, "such products have been sketchy and of little value to ecologists."

Historically, IGBP classifications have been based on life characteristics and are fairly general. NASA believes its products are "true" but ecologists have found that reality varies greatly from this "truth" in some cases.

"For example," Gosz said, "at the Sevilleta LTER Site in New Mexico, a grassland was misclassified as shrubland," a large discrepancy that was identified by Sevilleta ecologists. International networks of ecologists can help improve land-cover classifications through ground-truthing and other cooperative exercises. Sites that participate in validation projects are entitled to NPP products such as one-km imagery of NPP, NEP, one-km imagery of land cover, LAI 500-m imagery NDVI, and 250-m imagery NDVI.

FLUXNET is another project that may flourish through a regional network of ecologists. FLUXNET integrates long-term, worldwide CO2 flux measurements of carbon dioxide, water vapor, and energy exchange from a variety of worldwide ecosystems into consistent, quality assured, documented datasets. This and other increasingly important technologies require knowledge of ecosystems at broad spatial scales, increasing the scale at which validation occurs.

MEX-LTER representative Manuel Maass expressed an interest in developing an exchange of ecological expertise across borders. "We would like to begin a system for technology transfer, in which graduate students or post-docs with needed skills would work in ecosystems in one of the other NAR countries," Maass said. These and other projects will take shape at the All Scientists Meeting August 2000, Snowbird, Utah (see http://www.lternet.edu/network/meetings/allsci/2000/). ◆

Thanks to John Porter for contributing his notes for this article.

INTERNational *Developing LTER Networks Around the Globe*

South Africa Hosts the ILTER Business Meeting

The annual business meeting of the International LTER Network was held on August 16th at Kruger Park, South Africa, with ten member countries represented. It was followed by a symposium on LTER and a national planning workshop organized by the National Research Foundation (NRF) of South Africa. The NRF is promoting the development of a South African network and is communicating with the neighboring countries of Namibia, Tanzania and Zambia to encourage their efforts at a national and regional level. Representatives from those countries were present for the ILTER meeting and other events.

GTOS Update— John Vande Castle (U.S. LTER Network Office) presented an update on GTOS initiatives and the arrangements for the Net Primary Productivity demonstration project. ILTER members reported that China, Israel, Korea, Costa Rica, Venezuela, South Africa, Hungary, Ukraine, the Czech Republic, the United Kingdom, and the United States have already nominated sites which want to be involved in this project. Jim Gosz will provide instructions to the group and liaison with GTOS.

IBOY/NOLIMITS/Y2K-ASM—Many members also expressed interest in participating in other international projects described by Jim and others. These included the International Biodiversity Observing Year sponsored by DIVERSITAS; representatives from Canada, China, South Africa and the UK have agreed to design a multi-scale project on the relationship between avifaunal diversity and NPP. After sending their draft plans to all ILTER members, the other countries may decide to participate later.

The group also discussed a number of ideas for ILTER workshops at the LTER All Scientists Meeting (ASM) in August 2000. These included a Canadian proposal on how to involve the public and students at LTER sites, one by Mexico on a North American LTER graduate training program, and one from Taiwan on disturbance effects. The ASM will be the venue for the next ILTER business meeting.

Growth of the ILTER Network-Focus on Regions— Scientists and networks in a region are in a good position to assist neighboring countries with network development as they are likely to face similar political and economic situations. They are also likely to find relevant and efficient opportunities for cross-site research.Several regional represent-atives reported network develop-ments.

Central Europe—Tadeusz Prus of Poland reported on ILTER meetings in Poland and Hungary. Central European countries that

continued next page

International LTER Activities at Coweeta LTER

Brian Kloeppel, Coweeta LTER

Investigators in the Coweeta LTER program have long enjoyed a productive relationship with international scientists. Collaborations and exchanges occur at a variety of levels including 1) scientific field tours by international visitors to Coweeta Hydrologic Laboratory, 2) short-term (weeks) scientist exchanges between the United States and other countries, 3) sabbatical leave (months) for both Coweeta investigators overseas and for international scientists at Coweeta, and 4) research projects located outside of the United States by Coweeta investigators that are funded by a variety of sources.

Coweeta Hydrologic Laboratory hosts on average 1,427 visitors in 57 groups each year. Of these, approximately 40 visitors in 10 groups are international scientists with primary interests in watershed ecology, biogeochemistry, terrestrial carbon dynamics, and aquatic ecology. Field tours of research sites and techniques, distribution of publication reprints, discussion of long-term trends in data sets, and discussion of forest and riparian management practices comprise most of the field tour activities.

Long-term housing is available at Cowecta Hydrologic Laboratory for visiting scientists who wish to conduct studies while on sabbatical leave. Scientists who collaborate with colleagues at the University of Georgia, Virginia Tech, or other institutions in the Coweeta LTER program may also conduct field work at Coweeta while processing samples and analyzing data in the university lab of their colleague.

In addition, numerous current (1998 to present) studies are being led by Coweeta LTER investigators with frequent collaboration by scientists in the host country (see table below). Funding is from a variety of sources including host universities, the World Bank, the USDA Forest Service, and the National Science Foundation. Coweeta investigators have found these international collaborations to be productive, a rich source of learning by all investigators involved, and the source of enjoyable and long-term friendships with international colleagues. ◆

Country	Research Topic	Investigator(s)	Funding
Brazil	Ecology and Biodiversity	Coleman	University of Georgia
China	Forest Hydrology	Swank	Nanjing Univ. and USDA Forest Service
China	Plant Ecology	Kloeppel	World Bank
Iceland	Stream N Dynamics	Webster, Meyer, Sanzone, Tank	NSF, Fulbright
Jamaica, and Domin. Rep.	Biodiversity of the Greater Antillies	Miller	NSF
Japan	Carbon Cycling	Vose, Koneko	Forestry and Forest Products Institute of Japan
Mexico	Forest Hydrology and Biogeochemistry	Vose, Swank, Maass	USDA Forest Service and National Univ. of Mexico
Poland	Forest Ecology	Kloeppel, Korczyk	NSF
Turkey	Forest Hydrology	Swank	NSF
United Kingdom	Forest Hydrology and Ecology	Swank	Univ. of Durham-Hatfield Coll. & USDA Forest Service

South Africa Hosts the ILTER Business Meeting

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were not yet ILTER members were invited, and communication continued with those scientists. As a result, the Ukraine has now formally applied for membership in ILTER and Slovakia is actively discussing a national network and pursuing official endorsements.

The meetings provided further impetus to the plans for a multinational research project in the Carpathian mountains that will involve several networks in the region. Scientists from the US LTER network who have expressed interest in collaborating with Central European partners were able to obtain support from NSF to participate in research planning discussions at both meetings.

East Asia—Hen-biau King of Taiwan reported that the region expects to have five members soon, and already has more than 40 sites. Scientists from Taiwan are working with partners at H. J. Andrews and Luquillo in the U.S. to develop a cross-site research project on the effects of disturbance. They are also encouraging regional involvement in a project on Decomposition Processes in cooperation with H J Andrews site. China will send a scientist to Andrews to work with staff there. The aim is to develop a longitudinal profile through East Asia. Eun-Shik Kim of Korea is organizing the October regional meeting in Seoul; there will be a research-planning workshop associated with it that will involve a group of US LTER scientists funded by NSF.

North American Regional Network—see article page 13.

Latin America—Francissco Barbosa reported that a small working group formed at the last regional meeting is charged with drafting an outline for a regional pilot project on the influence of El Nino in the region. Government funding and approvals have just been provided in Brazil that will greatly accelerate the consolidation of an operational network there.

Uruguayan and Brazilian LTER scientists are planning cross-site research on coastal processes. Venezuelan sites are initiating research on the impact of cattle grazing on grassland systems, and other topics. Site selection is underway in Colombia, and the next regional meeting will be held there. Argentina may soon have an ILTER network. Bolivia and Paraguay also have expressed interest and have sent representatives to regional meetings.

Other Regions—The assembled members unanimously accepted formal requests for ILTER membership from the Ukraine and Namibia. This brings network membership to nineteen countries, as reflected in the updated map on the ILTER web site at http://www.ilternet.edu/networks/.

New Publications—A new brochure summarizing the objectives of the ILTER network and the characteristics of the national member networks will be published with the help of the U.S. LTER Network Office, using US LTER network brochure as a model. In addition, the group agreed that the increase in member countries, the add-ition of new sites in some countries, and the evolution of regional network interactions justify an update to the 1998 book about the members of ILTER network. The book will also describe ILTER research initiatives now being planned and initiated at the regional and worldwide level.

Future Meetings—The ILTER 2001 meeting will be in London, in conjunction with a meeting on "Detecting Environmental Change" organized by the UK's Environmental Change Network. The 2002 meeting in Canada, associated with the annual meeting of the Environmental Monitoring and Assessment Network. ◆

Ecological Hydrology—

An Intersite comparison

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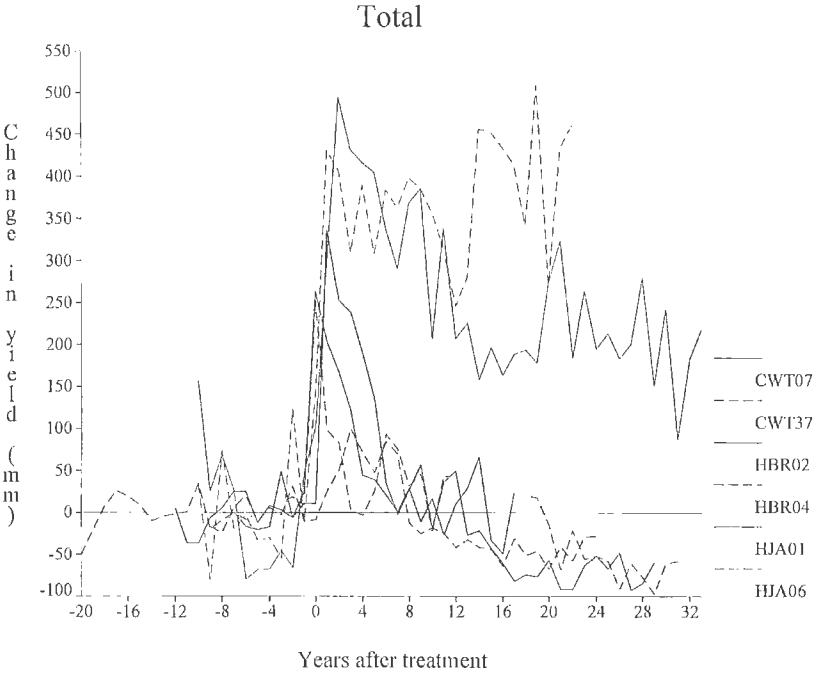

Figure 5. Trajectories of streamflow response over 20- to 30-year periods after forest harvest vary markedly among the three LTER sites where forest harvest was conducted (AND, CWT, HBR). Total streamflow yield was considerably above pre-harvest levels even after 30 years at AND, but had returned to pre-harvest levels within 10 years, and then dipped well below pre-harvest levels, at CWT and HBR. Possible explanations for these differences include the fact that at AND, leaf area and water use of 30-year-old Douglas-fir conifer stands may be much lower than that of the 450-year-old forest that was harvested, whereas early successional deciduous forest species at CWT and HBR may attain pre-harvest leaf area and water use quite rapidly. Differences between CWT and HBR in sizes of soil and snow reservoirs did not appear to affect post-harvest total streamflow trajectories, but at AND the high amounts and strongly seasonal precipitation, combined with deep soil reservoirs may overwhelm the ability of early successional vegetation to utilize water surpluses.

CONCLUSIONS AND FURTHER WORK

This comparative analysis of "black box" streamflow data raises many intriguing hypotheses about ecological controls on streamflow, including how the physical structure of the canopy affects interception, and how the species composition and water use behavior of various species interact with climate and soil moisture storage. In addition, different successional patterns may contribute to diverging post-harvest streamflow trajectories, while the different disturbance histories of the sites prior to forest harvest experiments also may have produced differences in their responses. These hypotheses deserve further process-level study at these LTER sites. In addition, ecological hydrology will benefit from expansion of this approach to analysis of streamflow records to other LTER or non-LTER sites. ◆

South Africa — Opportunities for Long Term Research

Text and photos—James R. Gosz, Chair, ILTER Network

The ILTER meeting in South Africa also allowed participants to view some of the important research efforts in Kruger National Park as well as to view the important fauna and flora of the Park.

One of the most impressive studies is a burning experiment that was initiated in 1954 and has continued unaltered to the present. The experiment was laid out as a randomized block design with four replicates comprising different seasons and frequencies of burning. 208 plots are involved (7 ha each) in the combination of burning frequency (no burn,1, 2, 3 4, 6 yrs) and season of burn (spring, early summer, mid-summer, autumn, mid-winter). This experiment is performed on 4 different regions of the National Park that differ in geology, soils and vegetation.

Results also differ markedly in the different regions of the Park. In some areas there is relatively little difference among the treatments while in others the density of woody plants and herbaceous species diversity varies significantly. Use of the plots by large herbivores also varies with different treatments and on different areas.

These experiments provide an excellent opportunity for other scientists to evaluate other components of these ecosystems. There is an interest in the Park for studies on small mammals, birds, invertebrates, nutrient dynamics and soils. These long-term experiments have created interesting and valuable changes to the ecosystems of this region that have relevance to many of our current issues of global change and management. ◆

Fig. 1 demonstrates that animals utilize these areas even immediately following the burn (still warm!). In this case, zebras use the areas as rest areas during the day because of their ability to escape predation.

Fig. 2 demonstrates a burn frequency of every 2 years during August with relatively little woody vegetation and low herbivore impact while Fig. 3 shows an annual burn with heavy herbivore impact.

Fig. 3

Fig. 2

Figures 4 and 5 demonstrate the heavy woody vegetation that can occur without fire for the entire period and the use by herbivores that select that habitat.

Fig. 5 Kudu

Fig. 4 Water buck

Alaskan Boreal Forests

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of climatic impact.

Population and biogeochemical processes are inextricably intertwined in the Alaskan boreal forest. Animal diversity and impact are greatest in early succession, where they respond to, and affect, the rates and patterns of plant succession, root allocation, and biogeochemistry. The associated changes in species composition from willow to alder to poplar to spruce during floodplain succession cause changes in nitrogen inputs, N mineralization and nitrification rates, microbial immobilization, and the degree of N limitation to primary production. The changing soil environment, due to both plant and animal impacts, alters microbial community composition, which determines methane oxidation rate.

At larger scales, the effects of climate on insects and fire influence the size and frequency of disturbance and the competitive interactions between spruce and grass during early colonization. These interactions may be influenced by herbivores and pathogens sufficiently to influence the trajectory and rate of succession. The structure of the terrestrial ecosystems in turn is the primary determinant of the chemistry and community composition of streams and lakes. In LTER3 we will explore the factors influencing these interactions between population, biogeochemical and landscape processes. ◆

Typical northern floodplain forest of interior Alaska, with stunted black spruce in boggy areas and white spruce, shrub birch, alder and willow in the narrow frost-free border along an active river. (Photo by Jerry F. Franklin)

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Calendar

Coming events of interest to the LTER Community

October 14–15—Baltimore Ecosystem Study Annual Meeting. Contact Deborah A. Cosentino Baltimore Ecosystem Study Project Facilitator
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Oct 11-16, 1999—East Asia Pacific Regional ILTER meeting, Seoul, Korea

October 23— 11th Annual Konza Prairie LTER Workshop, Kansas State University, Division of Biology

November 10-11, 1999—Biological Scale Process Modeling Workshop II San Diego Supercomputer Center

February 10-11, 2000—NPACI All Hands Meeting, San Diego

February 16-18, 2000—(tentative) Latin American Regional LTER meeting Villa de Leyva, Colombia

February 17-18, 2000—LTER Executive Committee meeting, Washington, DC

February 19-22— American Association for the Advancement of Science Annual Meeting, Washington DC.

April 10-13, 2000—BES/ESA joint symposium: Ecology: Achievement and Challenge, Coronado Springs Resort, Florida

August 2-4, 2000—The LTER Network's All-Scientists Meeting, Snowbird, Utah Please see the Web site for details: http://www.lternet.edu/network/meetings/allsci/2000/

August 6-10, 2000— ESA's 85th Annual Meeting Snowbird, Utah

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