LTER Long Term Ecological Research Network

The Network News

First LTER Education Symposium at NSF

Jim Gallagher and Marty Green present the KBS Schoolyard LTER program at the NSF-LTER Education Symposium.

Sonia Ortega, LTER Network Office

How can urban residents use an understanding of the metropolis as an ecological system to improve the quality of their lives? How can native traditional knowledge be integrated with the teaching of ecological principles? How can LTER research be used to teach a wider spectrum of students?

These and other questions were discussed at the first LTER Education Symposium held at the National Science Foundation, 19 June 2002. Education representatives from six LTER sites participated in this event involving a diversity of habitats

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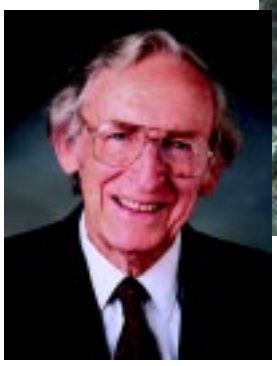
In Memorium

The field of ecology lost two of its leaders recently when Eugene Odum, 88, and his brother Howard, 78, passed away within a month of each other. Eugene Odum was a former University of Georgia professor and first director of that institution's Institute of Ecology. He was responsible for the development of the Marine Institute on Sapelo Island and played a key role in founding the Savannah River Ecology Laboratory. Howard Odum was a professor emeritus at the University of Florida and founder of the Center for Wetlands and the Center for Environmental Policy. Between them, Eugene and Howard Odum published nearly 30 books and hundreds of journal articles and had a profound influence on the development of the fields of ecosystem ecology, systems ecology, ecological economics, and ecological engineering.

The LTER community owes a great debt to Eugene and Howard Odum. Eugene's leadership of the Institute of Ecology and the Marine Institute had a strong influence on the Coweeta and Georgia Coastal Ecosystems sites. Research at the Luquillo and Florida Coastal Everglades sites draws heavily on the pioneering work of Howard Odum. Equally as important was their effect on generations of ecologists, including many LTER researchers.



In memory of H.T. Odum (above) and Eugene Odum

In 1970, Eugene Odum became the first member of the University of Georgia faculty to be elected to the National Academy of Sciences. In 1975, the two brothers were awarded the Institute de la Vie prize for ecology from the French government. In 1987, the Royal Swedish Academy awarded them the Crafoord Prize, which is the equivalent of the Nobel Prize in ecological sciences. The Odums established a foundation to promote research and education in ecology with the prize money.

Their innovative ideas blazed trails that many of us still follow. As colleagues, mentors, or tutors, the Odums had a profound personal effect on the careers of many ecologists. We will miss them.

Message from the Director

Robert Waide
Executive Director
LTER Network Office

LTER Celebrates 20th Anniversary

On 2 August 2002, the National Science Foundation released a report reviewing accomplishments of the first twenty years of the LTER program. The report was crafted by a team of 17 reviewers drawn from a broad spectrum of fields and institutions. Under the leadership of Frank Harris (Oak Ridge National Laboratory) and Leonard Krishtalka (University of Kansas), the review committee examined the achievements of the LTER program through surveys and discussions with LTER and other researchers. They concluded that "Twenty years of research at LTER sites have yielded major synthetic and theoretical advances in ecological knowledge, and have served society by informing solutions to environmental problems. New technologies have enabled complex investigations. A legacy of authoritative experimental and observational data has been archived and is being harnessed for deciphering environmental phenomena. And, in the past 20 years, LTER sites have enriched the education of an entire generation of ecologists, as well as thousands

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The Network News

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LTER 20th Anniversary

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of K-12 students through the Schoolyard LTER."

The report presents 27 recommendations to guide the LTER program during the next decade. "This 20-year review is intended to help NSF and the LTER community chart a course for the LTER program on this new scientific landscape—one that will enable it to meet the needs, challenges and opportunities of science and society in the next decade.The LTER community has taken the first step by envisioning the coming decade as one of synthesis science '...in which the data and knowledge gained over the past twenty years, plus current studies, are brought together to reach new levels of understanding of long term ecological patterns and processes,' ultimately for ecological forecasting. The 20-year review committee strongly concurs with this goal."

The committee recommends that the LTER program embrace "multidisciplinary, multidimensional, scalable, information driven, predictive and model-based, education oriented, and increasingly virtual and global" science. They further recommend the development of a strategic plan for LTER that outlines the scientific focus, niche, and priorities of the LTER program. Reviewers point out the need for delivering research results where they're needed. "Policymakers, funding agencies, organizations, and the public increasingly are asking science to provide solutions to environmental issues and to be more accountable for public investments in research."

Mary Clutter, NSF's assistant director for biological sciences, commented "This report comes at a critical time in the history of the LTER program, and will help guide the development of the program over the next 10 years. The scientific vision in the report is clear, appropriate, and consistent with the current state of LTER science. The next ten years should be the 'Decade of Synthesis.'"

View the entire report online:
http://www.lternet.edu

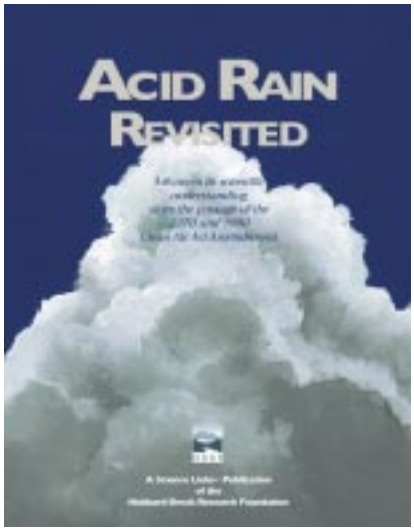
SITE News

HBR's 'Science Links' Puts Findings in Congress' Hands

Melissa Lucash, Kathy Fallon Lambert and Geoff Wilson

Confronted with global warming, genetic engineering, and a suite of complex environmental issues, Congress struggles to establish sound public policy based on current scientific research. Land managers and policy makers likewise often voice frustration about the lack of research in specific areas, while many in the scientific community may feel the policy implications of their own research are apparent.

To address this communication gap the Hubbard Brook Research Foundation (HBRF) initiated a program called Science Links. As part of this program, HBRF convenes working groups of scientists and policy advisors to synthesize and translate research for policy makers.The groups address specific science and policy questions and focus on achieving the three main goals of Science Links: (1) facilitate a dialogue between policy makers, managers and scientists (2) synthesize and translate research results and (3) disseminate research findings in a manner that is accessible and meaningful to policy makers.



For a copy of Acid Rain Revisited visit the HBRF website: www.hubbardbrook.org.

The first Science Links publications, entitled Acid Deposition in the Northeastern United States and Acid Rain Revisited, were released in January 2001. While the first article was published in *BioScience* and written primarily for scientists, Acid Rain Revisited was designed for the public, describing the results in an easy to understand format and outlining the policy

implications of the study. The program also released a report on acid rain, organized a communication training workshop for scientists, and conducted a series of public briefings to disseminate the research findings directly to policy makers. A Science Links project on nitrogen pollution is underway and the results are expected to be released in Spring, 2003.

Baltimore LTER Investigator Accepts Presidential Award

In June 2002, Baltimore Ecosystem Study LTER's J. Morgan Grove was among the recipients of the 2001 Presidential Early Career Awards for Scientists and Engineers, the nation's highest honor at the outset of an independent research career.

The Awards, established in 1996, honor the most promising young researchers. Eight federal departments and agencies, which join together annually to nominate young scientists and engineers whose work is of greatest benefit to the nominating agency's mission, administer the awards. Participating agencies award these young scientists and engineers up to five years of funding to further their research in support of critical government missions.

"The Forest Service, Yale University's School of Forestry & Environmental Studies, NSF, LTER, and IES can all take credit for this," says Grove, who collected the award personally from President George W. Bush in a July 12 ceremony. "Thank you to these organizations for the opportunities they have provided me."

High-resolution Satellite Data Now Available

On 20 Sept. 2002 at the "Historical Imagery Declassification Conference" the raw imagery from the KH-7 and KH-9 intelligence satellites was officially declassified and the rolls of film transferred to the National Archives and EROS Data Center. These satellites provided high-resolution imagery (in some cases greater than 1 meter) during the period from 1963 to 1980 for U.S. intelligence uses.

As part of the celebration of the release staged by the National Imagery and Mapping Agency (NIMA), LTER investigator Bruce P. Hayden addressed more than 150 people attending the conference. In a half-hour presentation on scientific uses of declassified imagery, Bruce presented LTER uses of declassified imagery at the Sevilleta, Jornada, McMurdo and Virginia Coast LTER sites. Satellite-derived scientific products provided by the sites and John Vande Castle at the LTER Network Office focused on the use of imagery for tracking changes in land use, tracking the spread of invasive species, and integrating satellite data with other data resources.

Art McKee Retires

In May 2002, Art McKee retired from the position of Site Director of the Andrews Experimental Forest. Art has been at the Andrews since 1971, served as site director since 1976, and as a leader of the Andrews LTER program since its inception in 1980. In addition to his many research contributions in biodiversity and riparian ecology, Art was a valued source of knowledge about Andrews Forest history. Art provided a steady presence at countless field tours and class visits, providing in-depth knowledge of the site combined with witty repartee. His many friends in the LTER network may wish to contact him at the Flathead Biological Station in Montana.

This fall the Andrews Forest group is conducting a search for a new Site Director. Contact: Mark.Harmon@orst.edu

Art McKee (left) enjoying the sunset at the Sevilleta Field Station with Brian Kloeppel

Introducing the LTER Spatial Data Workbench

John Vande Castle, LTER Network Office

As part of a continuing collaboration with the San Diego Super Computer Center at UC San Diego, the Network Office (John Vande Castle and Deana Pennington) has been funded for to further enhance LTER spatial data access and processing. The funding, from the National Partnership for Advanced Computational Infrastructure (NPACI) will be used to include data integration and processing algorithms within the LTER "Spatial Data Workbench" (SDW). This will include the capability to incorporate additional data sets such as topography, climatic variables and species data, and additional analysis and mining procedures for deriving knowledge from these new collections using web-based tools. The SDW incorporates GIS datasets, primarily remote sensing data, acquired for the LTER Network. In addition to Landsat, AVHRR and MODIS data, the SDW will contain hyperspectral AVIRIS data for the Sevilleta, Jornada, Konza Prairie, H.J Andrews and Harvard Forest LTER sites thanks to LTER collaborators Greg Azner and Carol Wessman (SEV and JRN), Doug Goodin (KNZ), Warren Cohen (AND) and Mary Martin (HFR). Further information at: http://www.lternet.edu/technology/sdw/

SDSC and LTER: Demonstrating a Web Services Architecture

Kristin Vanderbilt, Sevilleta LTER

SDSC scientists and several LTER information managers are collaborating on a demonstration project exploring how ClimDB, the cross-site LTER climate database, may be implemented in a web services architecture. This project illustrates how the LTER information management community is building links with partners who have the expertise to guide the integration of new technologies into the Network Information System (NIS).

ClimDB is housed at the Andrews LTER

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SCI2002: International Conference Challenges Ecoinformatics

Karen Baker, Palmer LTER

The SCI2002 conference, attended by more than 1,000 scientists in a wide variety of disciplines with interests in systemics, cybernetics and informatics, was kicked off with a keynote plenary talk by John Porter and Susan Staffort (The Ecoinformatics Challenge: Meeting Ecological Information Needs for the Site, Network, and Community) delivered before an audience of more than 1000 conferees.

To stimulate the exchange of developments in information management and to promote cross-domain dialogue, LTER information managers participated in two Ecoinformatics Challenge sessions chaired by Karen Baker and John Porter at the SCI2002 meeting (http://www.iiis.org/sci2002) held July 14-18 in Orlando, Florida. Twelve LTER papers were published in the conference proceedings:

http://intranet.lternet.edu/committees/information_management/sci_2002/

Highlights of the conference included "Best Paper" distinctions awarded to the following LTER contributions: "The Future Of Ecoinformatics in Long Term Ecological Research" by James Brunt, Peter McCartney, Karen Baker, Susan Stafford; "Integrating Ecological Data: Tools and Techniques" by John Porter and Kenneth Ramsey; "Designing Web Database Applications for Ecological Research" by Dan Smith, Barbara Benson and David Balsiger.

The LTER Information Managment Executive committee met during the SCI 2002 conference in Orlando: (clockwise starting at 7:00) Barbara Benson (NTL), Karen Baker (PAL), Kristin Vanderbilt (SEV), James Brunt (NET), John Anderson (JRN), Tim Bergsma (KBS), Wade Sheldon (GCE), Emory Boose (HFR), Peter McCartney (CAP), and with her back to us is Susan Stafford.

SDSC/LTER Collaboration

continued from page 3

site and is administered by Don Henshaw (Andrews LTER Information Manager). Currently, information managers at each LTER site manipulate their data into the specific ClimDB format and manually trigger a data harvest via the internet, a system which is neither scalable nor extensible. Based on discussions with Peter Arzberger, Chaitan Baru, and Tony Fountain following the LTER Information Manager Executive Committee meeting at SDSC in February 2002, a plan to use ClimDB to demonstrate how web service technology could facilitate the development of a scalable and extensible data harvesting mechanism for NIS modules was initiated.

Web services will provide a new data harvesting mechanism, although the ClimDB database itself will remain unchanged. Web services are software that are exposed to other software over Internet-friendly protocols, and which allow one computer application to interact with another without human intervention (Figure 1). The harvester does not have to know about the underlying structure of the data; all it needs to know is that a web service that provides ClimDB data is available from the Sevilleta. Eventually, this system will incorporate EML, a structured metadata language based on XML that all LTER sites are adopting, to provide details about what data is available, how it is structured, and how to query it.

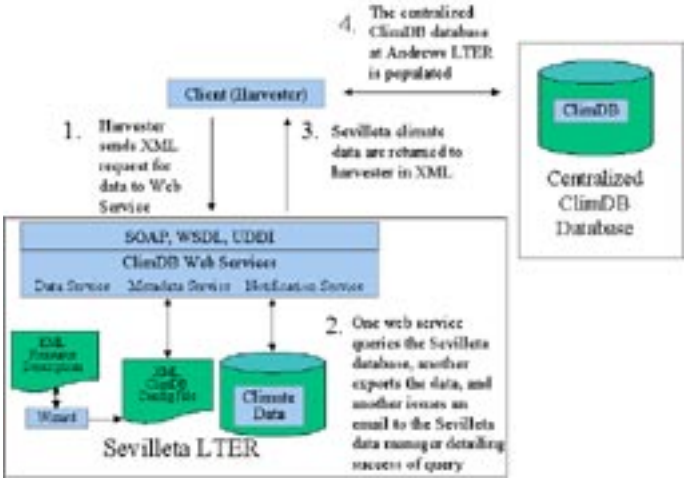

Figure 1. Web services implementation of ClimDB. SOAP, WSDL, and UDDI are an internet protocol, an XML-based language, and a web service registry, respectively, by which web services communicate and describe their functions. (Figure by Longjiang Ding, SDSC).

The project was kicked off in May 2002 with a planning meeting at SDSC attended by information managers and programmers from some LTER sites serving as test locations: Peter McCartney and Robin Schoeninger (CAP), Don Henshaw and Kyle Kotwica (AND) and Kristin Vanderbilt (SEV). Since that time, progress has been swift. Longjiang Ding, SDSC programmer, first successfully created web services for North Temperate Lakes LTER's Oracle database, with assistance from Barbara Benson and Dave Balsiger. Andrews LTER's SQL Server database and the Sevilleta's flat file data have also been wrapped by web services.

Ultimately, the objective of this project is to produce a data harvesting mechanism that will facilitate easy addition of a new site to a NIS module, or addition of new NIS services to an existing site. This partnership between SDSC and the LTER is expected to contribute to more rapid development of NIS modules to enhance opportunities for cross-site synthetic research. This work was supported NSF Grant DEB-9634135 to LTER Network Office.

Engaging Local Stakeholders in Ecological Monitoring Benefits All at Jornada Basin LTER

Participants in this project inlcude: Jeffrey Herrick, Brandon Bestelmeyer, Kris Havstad (USDA-ARS), Patrick McCarthy (The Nature Conservancy), Stephanie Bestelmeyer (Chihuahuan Desert Nature Park), Alicia Melgoza INIFAP, Chihuahua Mexico, and Arlene Tugel (USDA-NRCS Soil Quality Institute), as well as many other participates

The Jornada del Muerto Basin is a complex ecological system in which extreme changes in the relationships between vegetation and soils are evident during human lifetimes.

This complexity is a liability for scientists who must communicate the vagaries of this rugged but delicate system to the human residents who depend on it. But public uncertainty can be science's most formidable foe. Reducing scientific uncertainties about a system requires much basic research and monitoring. While difficult to communicate, this basic knowledge is integral to identifying and predicting consequences of human uses.

Investigators at the Jornada Basin can demonstrate four successful approaches that illustrate how environmental indicators and conceptual models based on basic research in the region are being used to increase appreciation of ecological complexity, reduce environmental conflicts, and improve rangeland management: 1) Workshops to train ranchers, environmentalists and government agency personnel in the U.S. and Mexico, to use monitoring and assessment tools; 2) development of ecological state and transition models; 3) implementation of integrated soil and vegetation management and monitoring plans, and; 4) introduction of schoolchildren to ecological and experimental design concepts.

All of these approaches are grounded in science—using indicator data of basic ecosystem functions collected by the people involved in the monitoring exercises. By providing tools and knowledge we help them understand and apply the concepts they learn, including 'soil-vegetation feedbacks' and 'ecological thresholds.' The common understanding they gain by participating in their own environment enhances their decision-making and helps them achieve diverse goals.

"This project originated with the community itself"

Jornada Basin scientists are helping land management agencies to integrate scientific data with the knowledge of public employees, local residents and ranchers to create conceptual state and transition models to explain how climate, and human management of fire, livestock, and invasive species can have diverse effects on vegetation dynamics. "This project originated with the community itself," says Jeff Herrick, USDA ARS investigator and project manager.

"There was strong demand from wide variety of groups including land management agencies, ranchers and environmentalists," Herrick says. "For us it was important to find out what is important to land managers, to identify the relevant research, and to develop applied research projects to increase the relevance of the ongoing basic research to the managers and other interested groups and individuals."

Over the past eight years, the project has expanded into a large collaborative effort, well supported by a wide range of groups, including (but by no means limited to) individuals working for the NRCS, BLM, Nature Conservancy, Conservation Fund, Quivira Coalition, USFS, NMSU, other ARS locations in Colorado, Idaho and Arizona, CIAT (Honduras), CATIE (Costa Rica) and INIFAP (Mexico), New Mexico State University and other universities, New Mexico Cattlegrowers, USGS.

"Primary financial support is from the USDA ARS Jornada Experimental Range. We have also received funding from the Department of Defense and the Natural Resource Conservation Service and LTER support for the basic research on which this work is based has been invaluable" Herrick says.

The multidisciplinary project (ecology, soil science, statistics, etc.) is received with enthusiasm in Herrick's office. "The benefits are extremely positive," Herrick says. "The cost is difficult to calculate because so many individuals and organizations have contributed to it. Because it's spread so thinly across so many agencies, I have no clue how to even begin to calculate the cost given the fact that all of the work is collaborative and much of the work was developed to support multiple objectives." So far the project has produced a two volume quantitative monitoring manual (available late 2002 or early 2003), which integrates standard soil and vegetation methods with several new monitoring tools. The Jornada was also one of four organizations that produced a qualitative assessment manual. Workshops based on both of these manuals have been held throughout the US and northern Mexico, and the monitoring tools are now being tested and applied in Central America.

SITE News

Urban LTER Sites Gear up for Renewal Process

New research initiatives in urban ecology in North America, Asia, and Europe provide inspiration and opportunities for dialogue integral for informing ecologists, social scientist, planners, and designers about the future of cities worldwide.

The United Nations estimates that the number of urban dwellers will exceed the number of rural dwellers by 2010. Along with this trend come other long-term environmental changes within and surrounding cities, or "urban ecosystems" as they have come to be known, such as alterations in habitat, climate, and water resources.

The ESA annual meeting symposium "Cities of Resilience" highlighted how ecological principles could be integrated into urban planning, design, policy, and management. Charles Redman and Nancy Grimm (Central Arizona-Phoenix LTER or 'CAP') and Steward Pickett and Mary Cadenasso (Baltimore Ecosystem Study LTER or 'BES') were among the presenters. The CAP LTER focuses on an arid-land ecosystem profoundly influenced, even defined, by the presence and activities of humans and is one of only two LTER sites that specifically studies the ecology of an urban system. The Baltimore Ecosystem study focuses on a five county metropolitan region in which watersheds are used as the stage on which to understand the reciprocal interactions of the social, biophysical, and human-built environments, using watershed function as a synthetic indicator and target for model development. Both urban LTER sites will soon be submitting renewal proposals for the next cycle of funding and are contemplating how the past five years of study will affect the next six years. Both sites are reflecting on the lessons they learned from the first LTER funding cycle and how to apply them and others, to the next.

A Central Arizona - Phoenix LTER (CAP) graduate research assistant collects water samples from the Salt River in metropolitan Phoenix. CAP investigators have found that nitrogen loads in urban waterways can be as much as 10 times the loads in natural systems.

RECONCEPTUALIZING BIODIVERSITY
The Urban Ecology of Central Arizona-Phoenix

At the CAP LTER project, biological, physical, and social scientists work together to study the structure and function of the urban ecosystem, to assess the effects of urban development on surrounding agricultural and natural desert lands, and to study the relationships between residents' decisions and ecological processes. Interdisciplinary investigations of these relationships in the rapidly growing metro-Phoenix area are of broad relevance for the study of social ecological systems, and for "cities of resilience."

Explosive growth is among the issues facing CAP investigators. The Phoenix metro area grew from 300,000 residents to more than 3,000,000 residents in just 50 years. "We acknowledge that cities are

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Research Findings in Urban Ecology: "Plant Diversity and the Luxury Effect"

CAP LTER research has revealed that biodiversity in urban/suburban yards directly correlates with household income. "The line flattens out at about $50k/year," says Charles Redman, co-director at the CAP LTER site, which is brainstorming for their renewal proposal due in 2003.

Although the same plants exist in nearly all parks in all neighborhoods, CAP investigators found more species of birds at parks in "upscale" neighborhoods, which correlates to the native plants in surrounding yards of these neighborhoods.

These findings are surmised from baseline data gathered in CAP's 200-point survey (see Fall 2001 LTER Newsletter: www.lternet.edu/Newsletter). "When investigating urban systems, we must re-conceptualize biodiversity in terms of human choice, and how choices are made and why," Redman says.

taking over the world," says Charles Redman, CAP project co-director. "We don't diminish human impact as entirely negative. Our study proves, as much as anything, that ecological theory must be modified to include urban ecology." It's to these modifications that the next six years of CAP will contribute most, Redman says.

For example, CAP investigators have found that nitrogen loads in urban waterways can be as much as 10 times the loads in natural systems. "Does that much difference result in systemic differences, which our current tools cannot detect or quantify?" Redman asks. "We must constantly consider *how* we look at the urban ecosystem, as well as *what* we look at." Moreover, CAP's urban ecologists are arguing that there may be qualitative differences in ecological processes between urban and non-urban ecosystems. The introduction of completely new chemical compounds, for instance, requires a reconceptualization of biogeochemistry for the urban milieu.

The Washington-Pigtown Neighborhood in Baltimore, where the BES LTER investigators are conducting social economic studies such as quality of life issues, as well as gathering information that can be used by the community directly.

METAPHORS WE LIVE BY
The Baltimore Ecosystem Study LTER

Nearing the end of the first cycle of the Baltimore Urban LTER program , Steward Pickett, Mary Cadenasso and the other BES investigators realize it's time for a new paradigm, a new vernacular, and a new metaphor for considering the ecology of people in a modern metropolitan area.

In their presentation at the ESA symposium, Picket and Cadenasso emphasized the power of metaphors in science, and their ability to motivate creative activity. The phrase "cities of resilience" can serve as a powerful metaphor to stimulate urban planning activities to consult and cooperate with ecological principles. "'Cities of Resilience' can counterbalance equally powerful metaphors, such as 'the garden city' or 'the city beautiful,'" Pickett says, ' which emphasize only the aesthetic value of a city, and not its integrated ecological, social, and infrastructural functions."

Even the term "ecosystem" has become a metaphor, Pickett and Cadenasso point out, "escaping the domain of ecological science." But traditional definitions of ecosystems (i.e. "A unit that covers all organisms of a given area as well as their relationship to the inorganic environment," A. Tansley 1935) do not provide urban ecological researchers sufficient tools for their investigations. "Although Tansley's definition does provide a firm foundation for urban ecological research," Pickett says. In fact, Tansley's 1935 paper was prescient in recognizing the need to include humans and human actions in ecology.

Traditional metaphors for ecological research are characterized by "background assumptions of closure, regulation, connectivity and producticity diversity, natural and integrity or health,' Urban ecology, Pickett & Cadenasso assert, is "open, external, the dynamics are not probabilistic, humans are internal to the system rather than external, and disturbance is internal, rather than external." These points often run counter to traditional views that guide ecological investigation.

According to Holling, "resilience" describes the ability of system to absorb changes in state variables, driving variables and parameters, and still persist (1973). Pickett and Cadenasso believe this idea will be a useful tool for shaping a metaphor for urban ecological research. BES expects to add this concept to its toolkit to motivate improvements in linking ecology and social processes its renewal process.

Microbial Observatories and Microbial Research at LTER Sites

Mathew Kane and Gary Toranzos of NSF, John Vande Castle of LTER Network Office and the principal investigators of the LTER Microbial Observatories

When the first six LTER sites in the LTER Network were funded in 1980, the idea of studying specific ecosystems at temporal and spatial scales was revolutionary. Currently all 24 LTER sites participate in this endeavor, and there is much interest from LTER networks forming in Latin America, Africa, Europe, Australia, and Asia to develop this work further, demonstrating the importance of multiple-scale science initiatives.

Setting up a food-web manipulation experiments at Crystal Bog in Vilas County, WI (North Temperate Lakes LTER). The water is filtered through various size sieves to remove certain components of the microbial food web.The water is then incubated in containers in the lake to see what effect removal of organisms will have on the bacterial community. In this photo, initial samples of the microbial communities are taken for later comparison.

Among all existing organisms, prokaryotes are the most numerous and the most ubiquitous, but ironically, the least understood. Their roles in biological processes is virtually unknown. With this in mind, NSF initiated "The Microbial Observatories Program." The guiding themes of the MO Program (http://www.nsf.gov/pubs/2002/nsf02118/nsf02118.htm) are: the discovery of newly described or poorly understood microorganisms/consortia/communities from diverse habitats, but not simply their discovery—also the exploration of these organisms and their unique genomic, metabolic, ecological and/or evolutionary properties at a particular site or habitat.

In response to this initiative, LTER formed a Subcommittee on Microbial Ecology and drafted a tentative research agenda for LTER-associated MO projects in 1999 (See http://www.lternet.edu/microbial_ecology/). Three years later, it is encouraging to see that eight of the thirty NSF funded Microbial Observatories have been established at LTER sites. LTER sites are "user-friendly" for microbiologists, as data for any Microbial Observatory project can be coordinated with and compared to other data that gathered by LTER participants.

We now know that prokaryotes are the most abundant and ecologically and metabolically diverse forms of life on Earth. Genomic segments have been transferred across the broadest of phylogenetic boundaries, implying that close to its roots, the Tree of Life has more web-like than branch-like connections. The concern over bio-terrorism makes research in microbial ecology very timely. As more robust and sensitive methods are developed to scrutinize prokaryotic biota, we will be better able to understand microbial processes. In this manner within the realm of ecology, microbial processes will no longer be in a "black box."

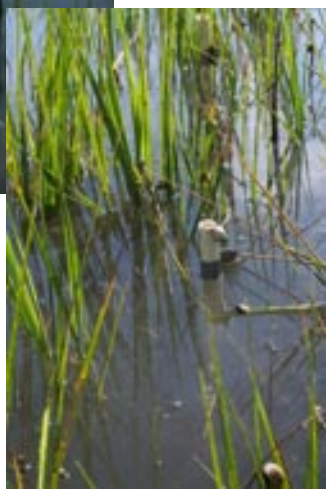
The National Science Foundation hosted a workshop for researchers of all the Microbial Observatories 22-24 Sept 2000. Results from the workshop and links to all the LTER Microbial Observatory Projects listed here can be found at: http://www.lterenet.edu/microbial_ecology

Salt Marsh Microbes and Microbial Processes: Sulfur and Nitrogen (Plum Island LTER) *John Hobbie*

Microbial Observatory research at the Plum Island LTER site identifies prokaryotes in salt marsh sediments and plankton and determines their role in controlling major ecosystem processes. They have found that organic materials, probably of algal origin, dominate both sediment organic-carbon composition and bacterial carbon processing in the Spartina marsh. The diversity of ammonia oxidizing bacteria suggest that salinity is a primary factor in driving community structure, and possibly metabolic function, of these organisms in estuarine sediments. Annual patterns of sulfate reducing bacteria diversity in the rhizosphere show persistent populations throughout the growing season while greater variability was seen in unvegetated creek sediments. Mixing of marine and freshwater communities along the salinity gradients result in a third community unique to estuarine waters, which is related to the flushing time of the estuary and to the high productivity of phytoplankton blooms.

A Microbial Observatory for the Northern Temperate Lakes LTER *Eric Triplett*

The research objective at North Temperate Lakes LTER is to characterize the diversity of freshwater microbial populations and their relationship to ecosystem processes in lakes that represent the major trophic types of temperate landscapes: oligotrophic (clear water, few nutrients), humic (brown water, rich in dissolved organic carbon), and eutrophic (nutrient rich, high biomass of algae and bacteria). Their reserach combines molecular methods for describing naturally occurring microbial communities with more traditional measures of microbial processes and microscopic assessments of algal and bacterial populations. During the ice-free period for



Justine Lyons, a Ph.D. student at the University of Georgia, retrieves samples at the Sapelo Island Microbial Observatory for a project investigating interactions between bacterial and fungal decomposers.

PVC pipes (right) serve as artificial stems to anchor decaying plant material infiltrated with a single fungal species. (Photos: Mary Ann Moran)

two successive years, our data reveal that while bacterial community composition within a particular lake can exhibit rapid changes, the greatest variability in BCC was observed between lakes.

Prokaryotic Diversity of a Salt Marsh/ Estuarine Complex at the University of Georgia Marine Institute, Sapelo Island (Georgia Coastal Ecosystems LTER) *Mary Ann Moran*

Our efforts focus on the composition and functioning of microbial communities in coastal salt marshes in the southeastern U.S. Research on decomposer communities has uncovered a diverse bacterial community that is physically associated with a low-diversity acomycete-dominated fungal community. These communities vary with season and decomposition stage, but show little spatial heterogeneity in the marsh ecosystem. Gene sequencing approaches to describing microbial communities have revealed considerable 'microdiversity' within salt marsh bacterial taxa; the ecological importance of this 16S rRNA microdiversity is not yet well understood, but may be a critical issue for linking microbial structure and function. Sequence data from these and other molecular ecology studies need to be integrated with ecological information about samples, collection conditions, and environmental characteristics. We have constructed a prototype web-accessible public database that links 16S rRNA gene sequences with associated environmental information (www.simo.marsci.uga.edu).

Diversity of Nitrogen-Cycling Microorganisms at the H.J. Andrews LTER *David Myrold*

Investigators at the H.J. Andrews hope to determine links between vegetation types and microbial communities, to examine the spatial variability along meadow-to-forest transects, to correlate microbial community structure with nitrogen cycling processes, and identify key and potentially novel nitrifying and denitrifying bacteria. Findings indicate that nitrification potentials are consistent along meadow-to-forest transects and only changed significantly after crossing a boundary. Nitrification and denitrification potentials are more than ten-fold higher in the meadow than forest soil, consistent with past studies. Similar shifts are observed in microbial community composition.

Observing Patterns of Prokaryotic Diversity along Land use Gradients of the CAP *Fred Rainey*

The Central Arizona-Phoenix Long Term Ecological Research (CAP LTER) site is investigating changes in bacterial diversity across land use gradients and the ubiquity of certain bacterial groups throughout the compact yet diverse environment. We have found a significant difference in the proportion organisms between urban and desert samples. Using culture-independent tools we have seen distinct shifts of bacterial diversity dependent on land use as well as the discovery of taxa that have the abilities to remain throughout the site.

Spatial Scales of Genetic and Phenotypic Diversity Among Streptomycetes in Native Soils (takes place at Cedar Creek LTER) *Linda Kinkel*

The main objectives for this research is to spatially quantify genetic and phenotypic diversity among the antibiotic-producing microorganisms Streptomycetes. The research also looks at the effects of different plant species on microbial genetic diversity. We know that at CDR, genetically similar organisms tend to be tightly clustered in space and there is a very high diversity of antibiotic activities among Streptomycetes in at all spatial scales. Studies of the resulting antibiotic inhibition and resistance show the inhibition effects increase with soil depth and that organisms were better at inhibiting isolates originating from different locations than from the same location in soil, and the associations of Streptomycetes vary significantly with different plant species.

Microbial Biogeochemistry and Functional Diversity across the Forest-Tundra Ecotone in the Rocky Mountains (Niwot Ridge LTER) *Steve Schmidt*

Microbial studies near Niwot Ridge focus on changes in microbial biogeochemistry and diversity associated with the transition from the snow covered winter period to summer growing season in alpine tundra and sub-alpine forests of the Rocky Mountains. The comprehensive seasonal approach has provides new insight into both microbial diversity and biogeochemical functioning in the highly seasonal environment. They have found a large temporal variation in microbial activity, with pronounced biogeochemical changes evident during snowmelt. The research in general implies that soil microbial communities are very dynamic at any given site.

A Cold Microbial Observatory: Collaborative Research in an Alaskan Boreal Forest Soil (Bonanza Creek LTER) *Jo Handelsman*

A particular interest at Bonanza Creek is the role of microorganisms in the phosphorus cycle and the limitation of phosphorus on ecosystem productivity. The goals are to describe the diversity of the microbial life in the soil and discover mechanisms by which microbes in the soil extract phosphorus from the environment. Preliminary analyses suggest that there is potential for discovering novel bacterial groups and mechanisms of utilization of phosphorus.

NETWorking

Workshops Further Wireless Effort

Greg Bonito, LTER Network Office

Wireless technologies are becoming increasingly important to network infrastrucre at biological field stations.In May 2002, two wireless sensor network workshops were held at the Sevilleta Research Field Station in central New Mexico.The workshops were supported through a Research Coordination Network project, the Resource Discovery Initiative for Field Stations, funded by the National Science Foundation. These workshops ran three days each, and were facilitated by wireless communication experts Dave Hughes and Tom Williams. Each workshop consisted of 23 attendees representing more than 40 biological field stations and LTER sites. The workshops provided hands-on experience setting up wireless sensor networks so participants could set up their own wireless sensor networks.

Wireless networks tend to be cost effective and allow instrumentation of difficult-to-access places. Topics covered at the workshops included wireless local area networks (WLAN's), wireless network architecture, antennas, radio transmitters, receivers, power issues, wireless communication standards & protocols, FCC guidelines & limitations, and the underlying theories and principles that allow these systems to operate. The instructors used a tag team approach, trading off between real world examples, anecdotes, theoretical perspectives, and hands-on sessions aimed at testing participants' practical understanding of how these wireless networks can be constructed. Sessions were informal, encouraging questions, comments, and discussion.

Dave Hughes (at computer) demonstrates how to connect their computers to radio receivers for collecting data from a remote weather station (Photo: John Vande Castle).

These workshops instigated a number of projects incorporating wireless systems in the field.For example, at the Kellogg Biological Station, Tim Bergsma and others will be using Campbell Scientific's RF400 (900Mhz spread spectrum) radios, powered by solar panels, to relay weather station data from the field to the station where it is posted on the Web.

Ryan Kelsey reports that Black Rock Forest in New York has been testing 802.11 (an IEEE specification allowing for wireless transmission as an unlicensed use of the 2.4 GHz band) wireless solutions for its current remote stations and plans to continue expanding their capabilities.

Konza Prairie LTER included wireless infrastructure in their ClimDB/HydroDB supplement proposal, which has been approved with enough funding to create a wireless cloud at Konza and to connect 1 stream station via 802.11b specifications.

The Center for Environmental Studies / Central Arizona - Phoenix LTER has discussed the possibility of installing a wireless 'alarm' system that would be triggered by rainfall events and would then relay a message via phone and/or e-mail to the technicians on-call to visit sites for sample collection. John Anderson at the Jornada LTER will install a wireless setup at a remote weir site, using Campbell Scientific's RF400 spread spectrum radio, later this fall.

At the Kemp Natural Resources Station in northern Wisconsin workshop participants are creating a wireless network cloud for the station and are installing two sets of wireless monitoring equipment. One will be a micro-meteorological station that will measure a host of weather parameters in old-growth forest. The second installation will be a wireless submersible sonde that will monitor the condition of Tomahawk Lake. Their ultimate goal is to publish the information to the Web, making the data available both to remotely-located researchers and local grade schools.

Don Hockaday reports that the University of Texas Coastal Studies Laboratory has included wireless applications in an appropriation request for intensive studies on watershead impacts on a subtropical lagoon system. They have also submitted a section to build a wireless cloud over some 2,000 square miles of south Texas for data collection and relays.

The El Verde Field Station in Puerto Rico has been downloading weather data from the weather stations directly to the lab using a radio connection for a while, thanks to Dave Hughes initial grant to use wireless communications in scientific projects. Alonso Ramirez reports that they are also working on installing a WLAN at El Verde Field Station and another at the Institute for Tropical Ecosystem Studies.

The LTER Network Office has loaned out 802.11b and FreeWave wireless units for testing at Niwot Ridge LTER, for wireless data transmission around the site. Coweeta LTER is considering using wireless data transmission for the WebCam NET supplied to them as part of the Schoolyard LTER effort.

Dr. Hortiz reports that the Inter American University Bayamon Campus is working right know with a wireless project to collect data from dataloggers in the field (via 900 Mhz radios) and send them wirelessly to the office of the Project Director to post on the web.

For more about these systems, please contact one of the workshop participants listed on the Web version of this article: http://www.lternet.edu/Newsletter or contact Dave Hughes (dave@oldcolo.com) or Tom Williams (tomw@oldcolo.com)

Workshop participants taking their final exam; hooking up a spread spectrum radio to the MET station to transmit data to a receiver located inside the Sevilleta. *Note: Dave Hughes has his hands in his pockets (*Photo: Pablo Bryant).

Ecoinformatics Training in Maputo, Mozambique

William Michener, LTER Network Office

Following the ELTOSA biodiversity conference and ILTER meeting at Inhaca Island in Mozambique, William Michener, Peter McCartney, John Porter and Kristin Vanderbilt traveled to Maputo, the capitol of Mozambique, to teach a two-day (25-26 July 2002) ecoinformatics workshop at Eduardo Mondlane University.

Eighteen individuals, ranging from Information/GIS Managers to Research Program and Field Station Directors, from Mozambique, Namibia, Kenya, Botswana, Tanzania, and South Africa attended the course.Training topics included: lessons learned during database development in the LTER network; data sharing and data policies; information management system basics including: system components, data collection strategies and hardware and software considerations; making information available on the WWW; metadata; quality assurance and quality control; data models for ecological databases; designing databases using MS Access; querying databases via SQL; linking databases to the WWW; workshop synthesis, evaluations and follow-up activities. Three hands-on exercises provided working experience in creating Web pages, creating a MS Access database and data entry forms, and linking an Access database to the Web.

Several of the "students" had significant experience with particular software or concepts that they brought into the discussion. In particular, Judith Kruger (South Africa) and Piotr Wolski (Botswana) added numerous helpful suggestions and comments. Joh Henschel (Namibia) and Feetham Banyikwa (Tanzania) both expressed considerable interest in expanded ecoinformatics training in their countries. Dr. Banyikwa is interested in having in-country training for up to two weeks in DBMS, GIS, and WWW programming.

Most importantly, the attendees perceived a need for continued networking among information management personnel in the various southern Africa countries. All felt they would benefit substantially from sharing tools, concepts, and experiences on an annual basis-as has been the experience for LTER information managers in the U.S.

Following the Maputo workshop, LTER scientists/information managers (Michener, Porter and Vanderbilt) traveled to Kruger National Park for a South Africa site visit that was organized by Judith Kruger and Harry Biggs. As part of the site visit, the LTER group presented a tag-team seminar on LTER Information Management and Database Development that was well attended by KNP scientific staff. They also reviewed the KNP GIS, database digital entry efforts, database management efforts funded by the Mellon Foundation, and the natural history collections onsite. Following formal meetings at the Park headquarters, the team visited numerous habitats and met with several Rangers and trackers, reviewing KNP data collection and reporting efforts.

U.S. LTER Information Managers working with their southern African counterparts.

Overall, the LTER Information Management contingent felt that the Training Workshop and South Africa site visit were quite successful. Kristin Vanderbilt observed that "the African students were by far the most motivated group" she has taught as an information management workshop instructor. She noted that they were "keenly interested in information management", and many impressed her with their "sophisticated knowledge of computers."

The LTER team recognized an obvious and pressing need for continued networking and informatics development in southern Africa. South Africa serves as a case in point. Despite their relatively high degree of funding (internally, as well as supplemental funding from the Mellon Foundation), there was significant concern about the immense backlog of invaluable data that have been or are being lost due to data entropy processes and their difficulty in maintaining progress without supplemental funding from Foundations. Nevertheless, we were all impressed by the enthusiasm of the scientists and rangers that we met, the considerable need for long-term ecological research and the informatics underpinnings, and the exceptional opportunities for international collaboration in southern Africa.

DIRT: Extending an LTER Project to ILTER

Kristin Vanderbilt, Sevilleta LTER

The DIRT (Detritus Input and Removal Treatments) project, which has been part of the Harvard Forest and Andrews Forest LTER research programs for several years, took on an international dimension in November 2000 with the establishment of DIRT experimental plots at the Sikfokut Forest ILTER site in Hungary. This collaboration between Hungarian and U.S. scientists is a example of how research questions can be successfully addressed across networks to extend the range of inferences possible and to strengthen ties between LTER and ILTER communities.

The long-term objective of the DIRT project is to examine how rates and sources of plant litter inputs (aboveground and belowground) affect the accumulation and dynamics of soil organic matter and nutrient cycling in forests over decadal time scales. Short-term objectives include studies of soil enzymes, the soil community, soil respiration, and nitrogen cycling to evaluate how rapidly different forest ecosystems respond to litter manipulations. A network of DIRT sites has been established on which parallel measurements will be made in order to address these questions at locations with different climate, soil, and vegetation characteristics.

The DIRT experiment was initiated at Harvard Forest LTER, MA in 1990 by Knute Nadelhoffer with the construction of 18 litter manipulation plots based on six treatments (Table 1). A DIRT experiment was also initiated in 1991 at Bousson Experimental Forest, PA by Rich Bowden of Allegheny College. Kate Lajtha of Oregon State University established a DIRT experiment at Andrews Forest LTER, OR in 1997. While these U.S. sites have different forest types and fertilities, a site with a high rate of nitrogen deposition was sought in order to extend the pollution gradient over which controls on soil organic matter formation and nutrient cycling could be studied. Kate Lajtha identified Sikfokut Forest as a high N deposition candidate for a DIRT site while on a field trip there during the 1999 Central and Eastern European ILTER Conference. Dr. Janos Toth of the University of Debrecen, the director of Sikfokut, was interested in collaboration and the project was born. Funding to establish the DIRT plots at Sikfokut came from the Hungarian Academy of Science.

Treatment	Manipulation
Control	normal litter inputs
Double Litter	twice aboveground litter inputs
No Litter	aboveground litter excluded from plots
No Roots	roots excluded from plots by lined trenches
No Inputs	no aboveground litter and no roots

Table 1. Five treatments common to all DIRT sites.

Janos Toth and Kate Lajtha secured funding from the Hungarian Academy of Science and NSF for reciprocal scientist exchanges between the US and Hungarian DIRT sites, which has enabled several US researchers to visit Sikfokut to demonstrate methods for measuring soil processes. Bruce Caldwell (Oregon State University) has led the soil enzyme research work at Sikfokut. Rich Bowden demonstrated the soda lime technique for measuring soil respiration in May of 2002. Kate Lajtha and two graduate students measured N mineralization at Sikfokut in April 2002. Kristin Vanderbilt, with NSF International Postdoctoral Fellowship funding, helped establish the plots, installed Prenart lysimeters to monitor soil solution chemistry and is also studying changes in the soil community. Hungarian visits to U.S. DIRT sites include that of Istvan Fekete, Ph.D. student at the University of Debrecen, to Andrews Forest in March 2002. Janos Toth and Maria Papp from the University of Debrecen will visit Andrews Forest and Harvard Forest DIRT sites in September 2002.

Results of the DIRT study will have many applications, particularly with respect to understanding how global change may influence soil carbon stocks. The DIRT experiment will greatly enhance what little is known about long-term processes of humification and controls on soil C fluxes in forests. Already, cross-site comparisons of soil respiration between Harvard Forest and Bousson DIRT plots indicate that site fertility has a significant effect on total respiration and partitioning of respiration between roots and aboveground litter (Bouden, pers. comm.). Soil enzyme data from Andrews Forest and Sikfokut suggest that the microbial community respond to reduced litter levels within a few years of treatment (Caldwell, pers. comm.).

Sikfokut Forest nicely complements the US DIRT sites, and will be a valuable reference point for how a forest subjected to decades of high N deposition responds to changes in litter quantity.

NEON Spells Opportunity for the Ecological Research Community

NEON, the big program with the colorful acronym that has been bouncing off the walls of various institutions over the past several years, has become a motivational carrot in some circles, a phantom pariah in others, and a punctuation mark in the saga of ecological research funding for all.

The path toward funding for the National Ecological Observatories Network, or NEON, reached a critical juncture recently when the Senate appropriatons subcommittee that includes funding for the National Science Foundation (NSF) crossed it off the list. An evening session at the recent Ecological Society of America Annual Meeting (August 2002, Tucson, AZ) proved that despite setbacks, the program is far from dead.

The first order of business at the ESA NEON symposium was to further define the program. Not a simple task, as ecological research has a profound tradition of defining science as it is developed. The NSF has described NEON as a "network of networks that will develop the capability to conduct integrated ecological research at regional to continental scales." The overall message is "that we don't have enough information to address ecological problems or to predict ecological changes," says Joann Roskoski, Executive Officer, NSF Directorate for Biological Sciences.

NEON is a tool for the community to ask research questions, Roskoski says. "For example, invasive species: how fast will they move and why and what will happen as a result?" Each observatory will be run by a consortium of institutions. Observatories will have a heavily instrumented core site, with lab facilities and satellite sites which together provide a regional "footprint" to address a wide variety of pressing ecological issues, Roskoski says.

The process began in 1999 when NSF supporting the first of nine community-based workshops in which the research community developed the research capability, infrastructure needs, and management protocols of the proposed network. "We rely heavily on the community for input and feedback" says Scott Collins, Ecology Program director at NSF.

Through these workshops the community helped to define the goals and scope of the project. "The information technology component of NEON will facilitate the flow of data in real time," Roskoski says. "And it will stimulate development of new technology."

> *"The Senate must hear from the community, on this and **all** funding issues. They really do listen. And silence can be just as loud."*

The President's most recent budget request included $40 million for two prototype observatories, $12 million in FY2003, $12 million in FY2004, and $16 million in FY2005.It was approved and sent to the Senate Appropriations sub-committee, which includes funding for NSF and other agencies such as HUD, EPA and VA. The sub-committee removed it from the budget for FY 2003.The bill's next hurdle is the House appropriations committee. "We're hoping we can convince the House to leave NEON in [the budget]," NSF's Roskoski says."Then the final decision will be made by the House-Senate conference committee."

Panel addressing questions concerning NEON: (from left) Sam Scheiner, Ann Bartuska, Vince Versage, Jim Gosz, Scott Collins, Joann Roskoski.

(Despite budget increases in other areas of science (NIH budget 'doubling' and double-digit increases in other NSF directorates), the Senate appropriations sub-committee recommended only a 3.4 percent increase for the Directorate of Biological Sciences (in which ecological programs are located) for the October 2002 through September 2003 fiscal period.)

Placing a dollar amount on such a large-scale, amorphous project has been a difficult challenge. "The total number of observatories appears to fluctuate," Roskoski admits. "Current estimates are for 17 observatories, 16 in the United States and one in Antarctica. Each observatory would cost about $20 million to construct," a sum not usually dealt with in ecological research. "It's something new to think about —tools at this scale," Roskoski adds. "Selection of sites will be based on peer review."

Vince Versage, a Federal Relations Representative for the University of New Mexico among other prominent research institutions, reminds the session attendees that the onus is upon the community also to promote funding increases in their discipline."It's not the President or NSF who decide how federal money is spent," Versage says. "There was not a tremendous noise from supporters crying out in favor of NEON. The Senate must hear from the community, on this and all funding issues. They really do listen. And silence can be just as loud."

"This is a huge wake-up call," says ESA President Ann Bartuska. "We need to get out of the lab and into the public policy arena."ESA has tools and expertise to assist scientists who are interested in making such noise in Washington, including several template letters on their Web site (www.esa.org). One of the letters addresses the DEB directorate, and includes a paragraph on NEON. "If you are interested in doing congressional visits," Bartuska adds, "we'll help facilitate your meetings when you're in D.C."

Part of the common misconception of NEON is that it will preclude other research funding says Scott Collins. "But this is just a great mechanism for NSF to go after big money for ecological research: to do research at different scales, and to open additional research funds for getting involved. But if you want to get big money it requires a lot of work. It can happen—we just have to mobilize our efforts."

NETWorking

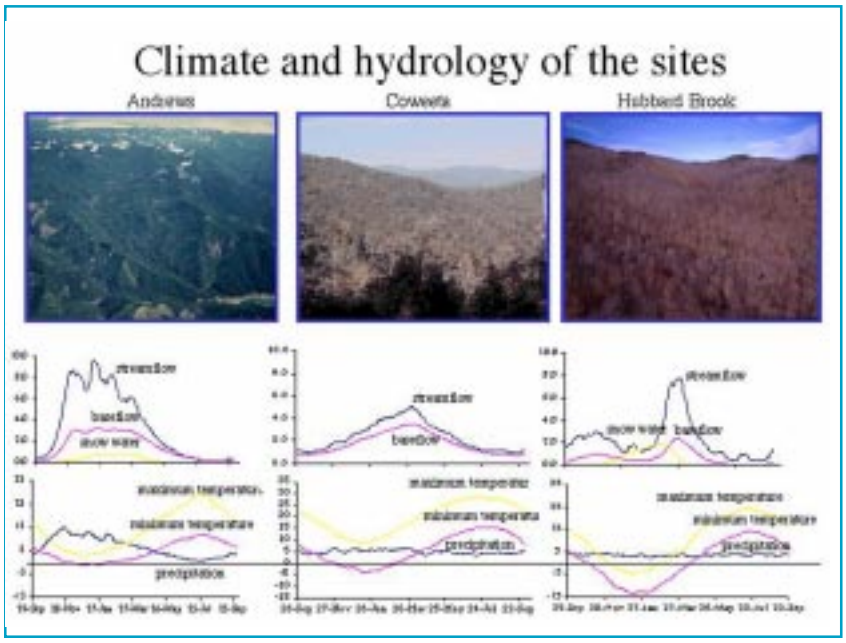
Eco-hydrology insights from forest harvest experiments: An Intersite Comparison

For this sutdy, Julia A. Jones, David A. Post of the Andrews LTER site conducted a comparative analysis of forest removal experiments at the Andrews, Coweeta, and Hubbard Brook Experimental Forests.

Multiple paired-basin forest removal experiments have been conducted at each of these sites. We reanalyzed primary data from these LTER sites to understand how climate, forest type, soil moisture or snow storage reservoirs influence hydrologic response to forest harvest experiments. Streamflow responses were examined in nine sets of small treated/control basin pairs that differ in forest type, soils, and snowpacks, but all had 100% forest harvest followed by forest regeneration. Study sites and basin pairs varied in forest type (deciduous forest at CWT and HBR, conifer at AND), snowpack (no snowpack at CWT, transient snow at AND, and seasonal snow at HBR) and soil depth.

We conducted new analyses using original daily streamflow and climate data from each site. We separated baseflow from quickflow because we expected different responses to forest removal from water delivered rapidly vs. slowly to streamflow.

We found that forest canopy removal was associated with a variety of streamflow responses depending upon the site, season, and time period relative to forest harvest. The greater leaf area, longer times since stand establishment, and vegetation physiology at the conifer forest site (AND) may all contribute to its larger, more persistent streamflow response to forest removal compared to the deciduous forest sites. The currently standing conifer forest at the Andrews site was initiated by wildfire about 500 years ago, whereas the deciduous forests (CWT, HBR) were regenerating from early 20th century selective timber harvests and other disturbances (windthrow from hurricanes at Hubbard Brook, chestnut blight at Coweeta) at the time they were cut. Post-harvest streamflow increases at the conifer site (AND) imply that the old-growth conifer forest was using much more water during fall and spring, when moisture is not limited, than during the dry summers. In contrast, post-harvest streamflow increases at the deciduous sites (CWT, HBR) were confined to the summer and fall, and spring where seasonal snowpacks were present (HBR). Streamflow changes were most persistent at the conifer site (AND), and ephemeral at the deciduous forest sites (CWT, HBR), implying that early successional vegetation and the second growth forests removed at the deciduous forest sites differ little in their water use.



Vegetation species in early succession, which tended to be deciduous or broadleaf in these sites, appear to be higher water users per unit leaf area than the species removed. In contrast, the thirty-year-old regenerating mixed-conifer stands have very different, and much lower, water use than the old-growth forests removed at the conifer forest site (AND).Although changes in forest canopy were brought about by experimental harvest in this study, the streamflow responses are illustrative of vegetation changes that may occur from natural processes, such as wildfire, windthrow, or climate change.

The main finding of this project is that it is possible to predict the magnitude and timing of hydrologic responses to forest removal based on understanding of the principle hydrologic processes at a given site (e.g. evapotranspiration by certain forest types, amount of snow and snowmelt timing, soil depth and texture). Some large changes occurred in streamflow during particular times of year, especially summer and fall and spring. Some of the changes were ephemeral, others were persistent. These findings imply that changes in hydrologic regimes are occurring and have occurred in most systems affected by anthropogenic or climate change.

Next steps include studies to understand the implications of hydrologic responses at various times of year for community dynamics and fluxes of energy and materials.

Datasets at the daily time step were relatively easy to obtain from the three sites (AND, CWT, HBR) although quite a bit of time and some travel was required. Most sites with long-term hydrologic and climate records are not as well prepared as the LTER sites used in this study. Moreover, data are typically not maintained in similar formats or units, so quite a lot of time was spent matching and converting datasets to make them comparable. The ongoing CLIM-DB and HYDRO-DB projects (Fred Swanson, Don Henshaw and Suzanne Remillard), are attempts to develop automated systems for data collection and formatting to overcome these difficulties.

Acknowledgements:
Research supported by NSF grants to Andrews, Coweeta, and Hubbard Brook LTERs and DEB-95-26987 (LTER Intersite Hydrology). Data and comments were provided by: Wayne Swank, Lloyd Swift, and Ned Gardiner (Coweeta); Charlie Cogbill, Jim Hornbeck, Wayne Martin and John Campbell (Hubbard Brook); and Don Henshaw, Suzanne Remillard, and Fred Swanson (Andrews)

Central and Eastern European Network Continues to Develop

Brian Kloeppel, Coweeta LTER

Central and Eastern European countries continued to demonstrate their strong commitment to LTER at the recent Central and Eastern European (CEE) International LTER Annual Meeting on 29 August 2002. The meetings were organized by Drs. Blanka Mankovsk‡ and Julius Oszlanyi. Countries represented at the CEE ILTER Meeting included the Czech Republic, Hungary, Poland, Romania, the Slovak Republic, and the United States.

Meeting participants on an ILTER/IUFRO Air Pollution Effects on Forest Ecosystems Field Trip. (Photo: Brian Kloeppel)

During her presentation, Dr. Edit Kovacs-Lang announced that her group in Hungary had been awarded a $1 million grant from the Hungarian Academy of Sciences to expand studies occurring in several biomes in Hungary .

Sander van der Leeuw (University of Paris) suggested linking the CEE ILTER network with other countries in western Europe. There is currently an effort in the European Union to develop a European-wide network of ecological research sites. Sander offered to function as an integrator and lead proposal writer for this large group effort. The suggestion was well received and further discussion regarding this topic ensued over the next two days.

It was also decided that this quickly evolving CEE network needs to continue to meet yearly to foster more cross-country projects. Dr. Maciej Zalewski agreed to host the next CEE ILTER meeting at the International Centre for Ecology in Warsaw, Poland in May 2003. The Romanian delegation is considering hosting the annual meeting in 2004.

U. S. Representatives at this meeting included Andrzej Bytnerowicz, Jim Gosz, Brian Kloeppel, Robert Musselman, and Kristin Vanderbilt.

Developing an Initiative for Long-term Ecological Research in the Caribbean

Victor H. Rivera-MonroyFlorida Coastal Everglades LTER

To develop and advance a research agenda for long term ecological studies in the Wider Caribbean Region, two workshops were hosted by the Florida Coastal Everglades-LTER (FCE-LTER) program at Florida International University (March 20-23 2001) and the Center for Ecology and Environmental Technology, University of Louisiana at Lafayette (March 21-24 2002).

Thanks to the efforts of Dan Childers, lead Investigator of the FCE-LTER program and funding from the LTER Network office we had the opportunity to bring together Caribbean coastal scientists representing a considerable diversity of tropical coastal ecosystems. Ernesto Weil (Puerto Rico), David Bone (Venezuela), Jorge Herrera-Silveira (Mexico) in collaboration with scientist from Florida International University (Dan Childers, Jenny Richards, Rudolf Jaffe, Joel Trexler), the Smithsonian Environmental Reserch Center (Candy Feller), South Florida Water Management District (Chris Madden, Carlos Coronado-Molina), the University of California at Davis (Eliska Rejmankova), and the University of Louisiana-Lafayette (Victor H. Rivera-Monroy, Robert R. Twilley, Ernesto Mancera) discussed several issues related to the effect of human impacts on ecosystem health in the Caribbean region. In addition to these sponsored participants, over 20 scientists and students participated in these workshops.

The main products of the workshops were the development of a conceptual model of the terrestrial, oceanic, and atmospheric controls affecting Caribbean coastal systems, and a categorical quantification of these important environmental driving variables for 13 Caribbean coastal research sites; these sites were represented by workshop attendees. As a corollary of this effort, a multi-authored synthesis paper is in preparation where the conceptual model and matrix of environmental drivers are presented as a template for coordinating cross-Caribbean coastal research. It is expected that this collaborative effort will provide an opportunity to integrate research priorities into a long-term research agenda. The Caribbean region is one of the top five biodiversity 'hot spots" identified around the world (i.e., an area with exceptional concentration of endemic species but undergoing an exceptional loss of habitat) and where 19 RAMSAR Convention sites and 21 coastal Biosphere Reserves are located.

The LTER Network office is greatly acknowledged for sponsoring both workshops.

Right: Workshop participants enjoy steamy crawfish cooked by co-host Robert Twilley. (counterclockwise) Dan Childers, David Bone, Susan Heyel, Mike Favaloro, Todd Herbert, Stephanie Cogburn, Chris Madden.

Left: Candy Feller (foreground) dancing the Cajun "two-step" after eating a VERY spicy crawfish. Others (counterclockwise) are Osvaldo Perez, Ernesto Mancera, Paola Reyes (shoulder), Jorge Herrera-Silveira, Carlos Coronado-Molina, Dawn Gallagher, Hans Rick, Silke Rick (back), and Edward Castaneda.

Coweeta LTER Links Science and Education

Brian Kloeppel and Susan Steiner, Coweeta LTER

The Coweeta LTER Program has a long history of formal and informal outreach to user groups in local, national, and international communities. Our outreach includes: 1) tours guided by scientists and technical staff as well as schoolyard activities for students and teachers at several grade levels; 2) training of undergraduate, graduate, and post-doctoral scientists; and 3) distribution of technical and general ecological information from our web site, from publication reprints, and from products directed towards the general public such as brochures, maps, and magazine articles.

Students recording their observations and hypotheses after collecting forest litter samples on the Coweeta LTER terrestrial gradient project (above). Sixth grade science instructor Michele Hubbs reviews the reswults of the riparian vegetation recovery survey, wihch was led by Coweeta LTER's Susan Steiner (right).

Scientists and staff at Coweeta Hydrologic Laboratory provide guided scientific field and laboratory tours for a wide variety of audiences on topics including ecosystem function, stream biology, vegetation management, water quality and yield, and forest road design and construction.

The Coweeta LTER Program continues its long tradition of training undergraduate, graduate, and post-doctoral scientists. The financial support for these scientists varies from full graduate research stipends to providing study sites, equipment, vehicles, and/or housing that are purchased, managed, and/or maintained with Coweeta LTER funding.

We continue to distribute electronic data and information through our web site to scientists within and outside the Coweeta LTER Program, to students, and to the general public. Use of the Coweeta web site has more than doubled each year since going online in 1995 and in 2001 received 417,761 hits from 33,225 computers. In addition to the distribution of digital sources, we will continue to distribute on demand publication reprints, maps, and popular magazine articles.

The Coweeta Schoolyard Education Program includes projects with middle school, high school, and community college students. These programs range from structured activities with sixth grade students to data collection that is lead by teachers (after training by Coweeta staff) at the high school level, to student inquiry-based learning at the community college level.

The sixth graders meet with Coweeta researchers on eight Saturdays during the school year to actively participate in ongoing research. A group of eighteen students, along with their three teachers, meet for half-day sessions to gather data on diverse topics such as riparian zone restoration, forest productivity, climate and weather, and stream macroinvertebrates. Following introduction and discussion, the students collect data, which includes making vegetation stem counts, collecting leaves from litter traps, inventorying stream macroinvertebrates, or measuring tree stem respiration. The students are closely supervised for accuracy, understanding of scientific methods, and usage of specialized equipment. Each of the students keeps a field book to chronicle their activities, observations, new terminology, and conclusions about each project.

The high school teachers are leading research projects that are related to ongoing Coweeta studies. For example, students monitored the effects of restoration on a portion of two streams that are on their school property. After restricting cattle access to the streams, a fecal coliform study was conducted by Coweeta researchers. Four years later, the high school students remeasured the fecal coliform in the recovery area to monitor the effects of the riparian zone recovery. Coweeta staff provided initial equipment and training and the students and their teacher ran subsequent measurements.

A study to promote inquiry-based learning for community college students is led by Deanne Oppermann, instructor at Southwestern Community College, and Brian Kloeppel. Students assist in the measurement of tree stem respiration on three sites that vary in topographic position within a watershed. In addition, students review online data from the same three sites that have been collected by previous students. The students are then asked a series of leading questions to promote their understanding of the controls on tree stem respiration. Students are required to use the data and equipment available to them to prove or refute their hypotheses. A written project report is used to assess students on their understanding of the controls on tree stem respiration and forest carbon cycling.

Education and Outreach on the WWW

Coweeta LTER Program	http://coweeta.ecology.uga.edu
Carolina Environmental Program	http://www.cep.unc.edu/newhighlands
USDA Forest Service Conservation Education	http://na.fs.fed.us/spfo/ce/index.cfm
Long Term Ecological Research Network	http://www.lternet.edu/education
Organization of Biological Field Stations	http://www.obfs.org
National Science Foundation	http://www.nsf.gov/home/ehr

LTER Education Moving Forward

continued from page one

and regions. The presentations were excellent and they attracted over 50 people.One third of the attendants were from the NSF Education and Human Resources Directorate, one-third from other NSF Directorates and one-third from 11 organizations including National Oceanic and Atmospheric Administration, Ecological Society of America, National Council for Science and the Environment, National Wildlife Federation and Howard University, who approached the presenters with many questions and interest following the presentations.

With the increased interest in environmental education at the NSF, this event was an opportunity to bring a sample of the types of education projects going on at LTER sites. Ideally, this symposium could become an annual event where we bring different sets of LTER projects every year, or we select topics of interest to LTER/NSF and organizations involved in environmental education.

At the symposium, we learned about the many possibilities for integrating research with education at LTERs, we learned about how to link graduate students with K-12 schools, how to form partnerships with schools and even how to turn the $15,000 NSF-LTER education supplement into an $800,000 endowment!

In the evening after the symposium, we attended a ceremony and reception to honor the recipients of the NSF Distinguished Teaching Scholars Awards. At the reception, the NSF Director, Deputy and several Assistant Directors expressed much interest in learning from LTER representatives about their education projects. I received messages from NSF Director and Deputy Director in support of LTER education activities.

This summer, LTER education representatives from 6 other sites participated in an evening session at the annual meeting of the Ecological Society of America in Tucson, AZ. The session provided an overview of education opportunities at LTERs and Biological Field Stations.Mark Stromberg represented the Organization of Biological Field Stations (OBFS). Robert Bohanan, Stephanie Bestelmeyer , John Moore, Susan Steiner, Marianne Krasny and Monica Elser represented LTERs. Participants talked briefly about how they promote education projects, involve minority students in LTER education and research, bring rigorous science to K-12 teachers, and partner with non-profit organizations.

The follow up discussion centered on what can be done to increase the utilization of field stations, how to fire up scientists to get involved in education projects, how to share data from different sites to use in K-12 schools and what technology to use, and the potential of bringing faculty from community colleges to LTERs and OBFS.

LTER Education Symposium- Presentations

- Welcome and Introductions
  Henry Gholz, National Science Foundation
- The LTER Education Program: Historical Perspective
  Sonia Ortega, LTER Network Office
- Ecology Education in Baltimore, an Urban Ecosystem
  Alan Berkowitz, Institute for Ecosystem Studies
- Traditional, Native and Global Ecology Education in Alaska
  Elena Sparrow, University of Alaska, Fairbanks
- Teacher-Scientist Partnerships for Science Literacy
  Jim Gallagher, Michigan State University and
  Marty Green, Plainwell Middle School
- Seamless Environmental Education at North Temperate Lakes: K-12 students, teachers and graduate students working together
  Robert Bohanan, University of Wisconsin, Madison
- Graduate Students Link with K-12 schools at Shortgrass Steppe
  John C. Moore, University of Northern Colorado
- Marine Science Education on the Eastern Shore of Virginia
  David Smith, University of Virginia
- Concluding Remarks
  Robert Waide, LTER Network Office

PIE Students sample fish at the Parker River Wildlife Refuge in Plum Island Sound (above) and record vegetation along transect lines (below).

PIE Builds SLTER with Partnerships

The PIE LTER Schoolyard program is partnering with Mass Audubon to expand their Salt Marsh Science Project. The Plum Island site on the Parker River Wildlife Refuge has the potential to become the biggest salt marsh restoration project on the North Shore of Massachusetts.

Middle School students from Newbury, Newburyport, Rowley and Ipswich are studying the invasive reed, Phragmites, in Plum Island Sound marshes, focusing on the effect of tidal restrictions, and collect data on fish abundance, salinity and vegetation. Students shared their data at the 5th annual Coastal Science Conference held at the Nock Middle School in Newburyport.

The Schoolyard program provided professional development for teachers to learn field protocols, and complementary frameworks-based classroom activities.

SLTER-supported educators, Liz Duff and April Ridlon provided classroom and field support for students, whose data is compiled in their own online database: www.massaudubon.org/saltmarsh

Delivering Research Findings

Canada's Ecological Monitoring and Assessment Network

When he inherited the network of 80-odd independent research and monitoring sites in 1998, Hague Vaughan, Director of the Ecological Monitoring and Assessment Network (EMAN) Coordinating Office at Environment Canada, realized immediately that his primary tasks would be to better integrate efforts across jurisdictions, agencies and disciplines, to extend partnerships beyond the Network, and to "make the science it produces work better within the society it's intended to serve."

Within these overarching goals, Hague sees his tasks as very specific: standardizing monitoring among existing programs so as to make data and information comparable and delivering the results to decision makers as feedback so as to allow policies, programs and development to be adaptive and responsive to environmental changes.

"The bad thing about monitoring is it takes a long time to do, even longer to produce intelligible results, and much longer than that to get the information to the policy makers and the public," Hague reflects. "Monitoring and research are all very important and we all know this, but it's in the translation and transmission of results that the process usually breaks down.

"At EMAN we don't dictate to anybody what will be done, but we do deliver the findings."

At the recent Ecological Society of America annual meeting in Tucson Arizona, Vaughan and EMAN Science Advisor Brian Craig attended as many symposia and oral sessions as humanly possible.

"We're here to steal ideas," Hague says. In the sessions, many scientists speak in terms of 'making the information available,' "But for EMAN,"Vaughan says, " we must *deliver* it. We must continuously demonstrate the relevance of ecological monitoring and related research to management and the public. We've seen funding cuts to research and monitoring programs occur left and right because no one knows why the work is important!"

EMAN's *modus operandi* exclusively involves partnerships. Among those partners are the people—municipalities and neighborhoods of Canada.

Brian Craig manages the outreach program called NatureWatch. "We are creating tool kits of equipment and instructions for communities to use to monitor the environment in their own neighborhoods. We get standardized data which provides early indications of change and the community gets sound information on whether the local environment is being degraded" Craig, who is also the data manager for this project, says the data, as well as continued outreach efforts, are valuable for management. "It's totally win-win. That's how we do it. We need and value that data and well as the community input."

Hague Vaghan (left) and Brian Craig of the Ecological Monitoring and Assessment Network discuss a symposium at the Ecological Society of America Annual Meeting (Tucson 2002).

Despite the hard work and commitment required for NatureWatch, the community has much to gain from the exercise. "Basically it's empowerment," Vaughan says. "Our land-use decisions are usually made at the local level. By involving them directly in monitoring the ecological processes that are going on in their own neighborhoods, communities can make educated and experience-based decisions about their own futures." Vaughan emphasizes that community involvement is very democratizing. "There is no dominance by any single organization—not even Environment Canada (the government agency), because the partners become autonomous through their knowledge. EMAN partners are engaged because they get more out of it than they put in, otherwise they wouldn't stay with us. We only work in areas of shared interest: command and control is not an issue.

"We take the monitoring data produced by some partners and synthesize it; push preliminary risk-based information toward policy, government and individuals contributing what's needed to make programs, decisions and behaviours adaptive. With partners who run established research or monitoring programs, we merge at the information level—rarely at the data level. So in this way it's different than LTER. But we share much of the same spirit and the same science. It's just that we tend to focus on enhancing the effectiveness of ecological monitoring, on products and outcomes" Like LTER, standardization in data collection and management are important ongoing issues. "But we try to motivate by promising to send the message both ways— if the collection end is standard, it's easier to make a convincing argument to policy makers to bring about real change."

In Canada, much research is done outside of universities so policy makers have a larger say in government research priorities and funding In comparison to the US. They have less independence between science and policy. The Environment Canada mandate includes interjurisdictional waters, transboundary issues, species at risk, migrating birds, indigenous lands, ice, and water. But its higher order objectives involve creating a society where people make responsible informed decisions about sustainability and the environment and that to Hague means that Environment Canada needs partnerships to cooperate in deliver-

ing solid integrated information on changes, choices and possible trade-offs. "Our projects must prove beneficial to everyone involved and must deliver timely, relevant, useful and accessible information to suit the specific needs of the decision process" Vaughan calls it 'demand-driven science.'

Most of Vaughan's efforts go into forming partnerships with other organizations, including NGOs and community groups. "The net effects are to make the environmental groups more scientific, and the ecosystem monitoring more relevant to the community," Vaughan says. "You must offer timely feedback on monitoring and research to managers, to funders, and to the community. We try to make clear the links to policy, so everyone knows what's going on and can in turn offer feedback. All of this demonstrates the relevance of ecological monitoring information and brings a greater appreciation of, and security to, our science agency partners" In turn Vaughan says these community players readily buy into the EMAN concept because it meets their needs, offering them a network of support, access to information, and avenues to policy making.

EMAN uses a suite of commonly understood indicators for early detection of ecosystem change, which were adopted upon consulting with a large cadre of advisors, including the USFS. "But still we operate at the community level, including indigenous people (called "First Nations" in Canada). This way we're not perceived as a threat. We don't tell people what to monitor, we just help them do it. And we ensure the results reach the constituents."

Vaughan believes the environmentalists can be tremendous allies. "We give [environmental, non-governemental organizations] tools to foster scientifically sound decisions so they can move back from confrontation and toward partnerships." Among the closest partners is the Canadian Nature Federation (CNF-formerly the Canadian Audubon Society). "The birders are now looking at habitat, invasives, connectivity and landscapes as well as wielding scientific language in their arguments," Vaughan says. "It's all about decision-making, consequence and human relationships."

The study of the relationships between humans and their environment is a life-long interest for Vaughan who studied the Ecology of the Mayan Empire for his PhD. at the University of Florida.

"In my Maya work, I established that the minimal unit of study was that within which society, economics, culture, climate and environment are intimately interacting components. The trajectory was of an ecosystem moving through time and if you tried to study a part in isolation, say cultural change or vegetational change, you couldn't make sense of it because there were inevitably pieces missing. When we make decisions today based on only economic or social or even only environmental factors, they will always be incorrect to some degree which in many cases will be very great indeed."

What is EMAN*?*

The Ecological Monitoring and Assessment Network (EMAN) is a cooperative partnership of federal, provincial and municipal governments, academic institutions, aboriginal communities and organizations, industry, environmental non-government organizations, volunteer community groups, elementary and secondary schools and other groups/individuals involved in ecological monitoring in Canada to better detect, describe, and report on ecosystem changes.
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EMAN was established in 1994 with the following four objectives:

- to provide a national perspective on how Canadian ecosystem are being affected by environmental stresses;
- to provide scientifically defensible rationales for pollution control and resource management policies;
- to evaluate and report to Canadians on the effectiveness of resources management policies; and,
- to identify new environmental issues at the earliest possible stage.

Long Point World Biosphere Reserve volunteer measuring salamander captured between cover boards: EMAN (Photo: Brian Craig EMAN).

What is NatureWatch?

The Ecological Monitoring and Assessment Network (EMAN), in partnership with the Canadian Nature Federation (formerly the Canadian Audubon Society), has established a series of NatureWatch programs to collect reliable information and contribute to local, regional and national monitoring programs.

NatureWatch encourages community partnerships to expand geographic coverage and increase observations. Communities gain scientific information on local changes, to inform decision-making. NatureWatch protocols are designed by scientific experts for validity and reliability, and are available for use by people regardless of their monitoring experience.

Through NatureWatch, monitoring project managers can expand the capacity of local monitoring information collection by engaging the broader community.

Learn more about EMAN *and* NatureWatch *on the Web site:*
http://www.eman-rese.ca/eman

A Walsh public school student using a surber sampler to collect aquatic invertebrates: EMAN (Photo: Brian Craig EMAN).

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Calendar

Coming events of interest to the LTER Community

Kellogg Biological Station (KBS) LTER Site Meeting:
4-5 Oct 2002

Bonanza Creek LTER (BNZ) Site Meeting: 18-19 Oct 2002

Baltimore Ecosystem Study (BES) LTER Open House and Annual Meeting 23-25 Oct 2002

EcoInformatics Training Workshops for Biological Field Stations
21 Oct - 1 Nov 2003

Konza Prairie (KNZ) LTER Site 14th Annual Workshop 2 Nov 2002

Florida Coastal Everglades (FCE) LTER Site Meeting: 5-6 January 2003

Sevilleta (SEV) LTER Site Meeting: 9-10 Jan 2003

Luquillo (LUQ) LTER Site Meeting: 17-20 Jan 2003

Spring LTER Coordinating Committee Meeting 6-8 May 2003

Hubbard Brook (HBR) LTER Site Meeting 8-9 July 2003

Niwot Ridge (NWT) LTER Annual Meeting and Workshop 22 Aug 2003

International LTER Annual Meeting: Bejing China 5-12 Sept 2003

4th LTER All Scientists Meeting 18-21 September 2003 Seattle Washington

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