LTER
Network News
Newsletter of the Long–Term Ecological Research Network
Vol. 20 No. 2 Fall 2007

Wireless Technology to the rescue

Remote sensors expand horizons for ecology

When world famous adventurer Steve Fossett's plane disappeared in the maze of peaks and valleys of the Nevada desert, the world was watching. To search the 17,000 square mile area where the plane is believed to have disappeared, multiple satellites combined with an online database allowed the public to examine photographic surveys for evidence of the crash. This unprecedented effort presents a new direction for wireless technology, and related applications are being used to help LTER researchers address large-scale ecological questions.

The use of wireless technology to gather and transmit data from the field to the investigator is on the rise. In the past five years, several LTER sites have installed systems to improve their field observations and enhance the stream of data required for asking larger ecological questions.

As demand grows for broader reaching, more detailed explanations and predictions of ecological phenomena, so does the need for wireless technology.

This article presents a brief survey of wireless technology in use at several LTER sites. More detailed information is available in the references listed below.

Photo: Renee F. Brown

Wireless specialists help Sevilleta LTER scientists to install a wireless client radio at Bowen Station, the blue gramma site in the Sevilleta Wildlife Refuge.

Photo: NASA/Kim Shiflett

Steve Fossett in the cockpit of his famed Global Flyer. Innovative wireless technology was used to search for his downed plane.

At Niwot Ridge (NWT), a site that has been innovative in the use of wireless transmission of meteorological data, more than half a dozen field sites are linked to the Internet and weather data is automatically collected and archived hourly. The near real time data from

See Wireless, p. 3

LTER site acronyms: AND=H.J. Andrews; ARC=Arctic; BES=Baltimore Ecosystem Study; BNZ=Bonanza Creek; CAP=Central Arizona–Phoenix; CCE=California Current Ecosystem; CDR=Cedar Creek; CWT=Coweeta; FCE=Florida Coastal Everglades; GCE=Georgia Coastal Ecosystem; HFR=Harvard Forest; HBR=Hubbard Brook; JRN=Jornada Basin; KBS=Kellogg Biological Station; KNZ=Konza; LNO=LTER Network Office; LUQ=Luquillo; MCM=McMurdo Dry Valleys; MCR=Moorea Coral Reef; NWT=Niwot Ridge; NTL=North Temperate Lakes; PAL=Palmer Station; PIE=Plum Island Ecosystem; SBC=Santa Barbara Coastal; SEV=Sevilleta; SGS=Shortgrass Steppe; VCR=Virginia Coast Reserve.

In This Issue

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Decadal plan for LTER now released

Over three years of effort by hundreds of LTER scientists went into the new Decadal Science Plan, submitted to the National Science Foundation (NSF) October 1 and released to the public early December. The plan maps out the Network's science agenda for the next 10 years. Entitled "*Integrative Science for Society and the Environment: A Plan for Research, Education, and Cyberinfrastructure in the U.S. Long-Term Ecological Research Network*," it makes an ambitious call for research that extends the Network's foundational strength in ecology and environmental biology to also embrace the social sciences relevant to human-environment interactions.

Through the leadership of the Scientific Task Force and Science Council chair, the plan is the culmination of three years of network-wide planning activities. "Through this effort we were able to achieve our goal of designing a one-of-a-kind long-term, multisite research plan that genuinely integrates social-ecological research," said Scott Collins, Task Force chair.

Phil Robertson, chair of the LTER Executive Board and Science Council, noted that "hundreds of scientists have been actively engaged in the development of the plan, which is truly a broad-based effort that represents the community's collective vision." Robertson added that the ecological community was "particularly excited about the potential for the plan to address important questions about the sustainability of ecosystems on which we all depend—questions that are not now being addressed in any comprehensive way."

The plan, available at *www.lternet.edu/decadalplan/*, has seven parts preceded by an Executive Summary: 1) an Integrated Research Plan that provides a blueprint for the next phase of LTER science and describes plans for network-level research into fundamental questions about socio-ecological relationships in important U.S. and international ecosystems; 2) a description of the *EcoTrends* project, a compendium of long-term ecological trends at and across LTER sites; 3) a strategic plan for education in the Network; 4) a strategic plan for Network cyberinfrastructure; 5) a new governance structure for the Network; and 6) a new social-ecological research framework known as *Integrated Science for Society and the Environment*.

Since planning began almost three years ago, the Network has held scores of workshops and planning meetings that included scientists from all 26 LTER sites as well as many from outside the network. Participants have included ecologists, geoscientists, oceanographers, and other environmental scientists; social scientists such as geographers, economists, sociologists, and cultural anthropologists; information scientists expert in cyberinfrastructure design and implementation; and educators at the university, K-12, and public outreach levels.

Bob Waide, Executive Director of the LTER Network Office, observed that the most exciting and significant element of the plan was the involvement of many different disciplines, and particularly social scientists, to address urgent national needs from a socio-ecological perspective.

The plan outlines how LTER will direct its research and education activities to address environmental grand challenges in three topical areas: land and water use change, particularly with respect to working landscapes and urban systems; climate change including variability and the changing frequency of extreme events; and changes in nutrient mobilization and biodiversity, as particularly related to species introductions.

The plan was presented to the NSF Advisory Committees for Biology and for Environmental Research and Education in October, and discussions about it are now on-going within several Directorates.

McOwiti O. Thomas, LNO

(Wireless, continued from p. 1)

three stations are graphically displayed on the Niwot LTER web page. The data loggers may be fully manipulated from any Internet-linked computer in the world. The field radio links utilize spread spectrum, frequency-hopping broadband technology originally patented by film legend Hedy Lamarr in 1942.

At the North Temperate Lakes (NTL), wireless sensors are integral to investigating new ecological questions not previously possible. Instrumented buoys equipped with one or more dissolved oxygen sensors, a thermistor chain, and meteorological sensors are deployed on selected lakes to provide fundamental information on lake thermal structure, weather conditions and lake metabolism. Data are usually collected every ten minutes, but with occasional periods of shorter, two-minute intervals to address specific questions.

To many researchers, this may seem like an unwieldy amount of data, and some may question the utility of so much information. "In most cases, the data come in at a rate that is much faster than our current ability to utilize it," says Paul Hanson, NTL LTER investigator. "But if you think that the variable will change in important ways at short time scales, you must have a sensor in the field. And with the use of this data, we are starting to understand that dissolved oxygen could be driven by many factors, such as temperature, biology, or weather fronts, depending on the scale. "There will be a co-evolution of science and technology," Hanson says, "and if we advance the technology we can advance the science as well."

The Konza Prairie (KNZ) LTER site has wireless coverage over a large portion of the research site to stream data from several long-term experiments back to LTER data servers on campus. Information includes meteorological and micrometeorological data, soil temperature and moisture monitoring networks in the rainfall manipulation and irrigation experiments, and from three carbon dioxide flux towers operating at the site, where a wireless cloud allows continuous data streaming to the campus server.

The Sevilleta (SEV), the largest terrestrial LTER site, employs a wireless backbone that covers much of the eastern half of the research area and continues to add sites and experiments that use data loggers to its network. "We are using lots of cool sensor technology that is wired to data loggers," lead investigator Scott Collins says, "then the data are sent wirelessly to our computers and servers," easing the need for excessive labor for data-collection on the large and remote research site.

Photo: CAP LTER.

Stevan Earl installs a wireless met station at the North Desert Village site on ASU's Polytechnic Campus.

At the Central Arizona-Phoenix (CAP) site, wireless connections to meteorological stations make data collection easier, saving trips to remote sites. But certain limitations have prevented further deployment of wireless equipment, says CAP researcher, Stevan Earl. "Wireless works well for the climate-related data,"Earl explains, "but physical samples such as insect surveys, measuring plants, and so on, constitute the majority of the data we collect in the field, and currently this can only be done by hand." In addition to the limitations of wireless sensors, the threat of theft is a concern in the CAP urban environment, as a unit recently disappeared from one field site.

While wireless technology presents the tools to address some questions in large-scale ecological research, many challenges remain, such as transmission across hilly terrain or dense vegetation, high costs, and availability of personnel for installation, maintenance, and quality assurance and control of data. Nevertheless wireless technology is critical to the future of LTER technology and might become a required minimum standard installation. "Almost every vendor now has some way of hooking up their equipment wirelessly," says John Porter of the Virginia Coast LTER. In 2003 Porter and colleagues published a pioneering article in BioScience inspired by the use of wireless technology, and they currently are working on a follow up article that will focus on what has been learned using automated and wireless sensors in the field.

Film legend Hedy Lamarr and composer George Antheil invented spread-spectrum, frequency hopping wireless technology in the early 1940s to help the war effort.

More information about international adventurer Steve Fossett: *www.stevefossett.com/*

More information about inventor Hedy Lamarr: *www.inventionconvention.com/americasinventor/dec97issue/section2.html*

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Scott L. Collins, Luís M. A. Bettencourt, Aric Hagberg, Renee F. Brown, D. I. Moore, Greg Bonito, Kevin A. Delin, Shannon P. Jackson, David W. Johnson, Scott C. Burleigh, Richard R. Woodrow and J. Michael McAuley, "New opportunities in ecological sensing using wireless sensor networks." Frontiers in Ecology, vol. 4, pp. 402-407.

Also see CENS: Center for Embedded Networked Sensing *www.cens.ucla.edu*

Patty Bonito, LNO Specials projects

LTER sites engage the Arts and Humanities

Writers and scientists pose for group photo at the Caribou-Poker Creek (photograph by Marjorie Hall).

Golden foliage greeted a dozen writers and a handful of scientists at the Bonanza Creek (BNZ) LTER site outside of Fairbanks on a recent Sunday in September. The focus of their interest was the 2004 Bondary Fire, one of the largest fires of that record fire season, which scorched 6.7 million acres. Together we looked at the ecological consequences and remembered the year that it occurred. Was the ecosystem devastated or was this part of natural rhythms of boreal forests? How did that summer's smoke color the perceptions of Fairbanks residents about boreal wildfires, which had robbed them of that scarce resource called summer?

An evening of discussion and readings of fresh writings at BNZ LTER PI Terry Chapin's house carried the conversation further and led to plans for further collaboration between writers and scientists, as well as presentations to broader public audiences.

This project began as an outgrowth of the Long-Term Ecological Reflections program that regularly brings writers to the Andrews Forest LTER site (see LTER Network News Spring 2005 and online at *www.fsl.orst.edu/lter/research/related/writers.cfm?topnav=167*. Realizing that Bonanza Creek LTER has many science themes in common with the Andrews Forest LTER, such as disturbance and recovery, these two LTER sites are collaborating to initiate similar gatherings of writers, artists, and scientists in Alaska. Future gatherings will hopefully include humanists and scientists from multiple LTER sites.

Photo: Marjorie Hall

Writers and scientists ponder the Caribou-Poker Creek landscape three years after a half-million-acre fire

Budding collaborations between the arts, humanities, and science are developing elsewhere within the LTER network. The North Temperate Lakes (NTL) LTER is in the second year of a project in which artists and scientists share their concerns about the effects of climate change in the Lake States (Wisconsin, Minnesota, and Michigan). In May 2006, 20 artists, seven scientists, and six educators met to discuss climate change and the potential role of art in increasing public awareness about science. The group visited selected field sites and learned about the scientific understanding of climate change and its effects on ecosystems in the NTL-LTER region. The artists then created paintings, sculpture, poetry, and music reflecting their perceptions of the science of climate change, its impacts on northern ecosystems, and the actions that can be taken now to lessen those impacts. These pieces were then assembled into an exhibit along with related scientific information and visuals. The exhibit is now on display in a series of showings in Wisconsin and Michigan galleries and campuses. During the tour, educators visit middle and high schools in each community prior to the exhibit's arrival and engage students in science and art activities focusing on climate change. The students are encouraged to create artwork that is included in the exhibit in their community. A reception and panel discussion are held in each community at the opening of the exhibit. More information, including the art works, can be found at *www.wisc.edu/cbe/K12/paradiselost.html*

Terry Chapin (BNZ), Tim Kratz (NTL), Fred Swanson (AND)

The Things We Know by *Amy Arnston*: "Growing up in the Great Lakes region, water has always been a powerful symbol for me. It symbolizes both birth and death, both change and the eternal. In this exhibition about climate change, this painting speaks to loss." Amy Arnston

LNO renewal proposal under development

The LTER Network Office (LNO) provides a variety of services to the LTER Network under a six-year Cooperative Agreement with the National Science Foundation (NSF). These services include supporting and facilitating LTER meetings, including the All Scientists Meetings, helping sites implement metadata standards, providing leadership in the development of the LTER Network Information System, acquiring and maintaining an archive of remotely-sensed images for LTER sites, and disseminating information about LTER activities and achievements. A new Cooperative Agreement is scheduled to begin in March, 2009, and the staff of the LNO is busy preparing a proposal that will be submitted to NSF next spring.

The proposal will focus on four topic areas—support for synthesis, cyberinfrastructure, core services, and development/outreach—and will be grounded in the new strategic research, education, cyberinfrastructure, and governance plans for the Network. As part of the proposal development process, the LNO will review and revise its own strategic plan to be better aligned with the new Network plans. Discussions with the LTER Executive Board and other LTER standing committees have identified a series of LNO activities to advance Network goals. The proposal will link these activities with outcomes and projected impacts on the LTER Network. A draft of the proposal will be circulated to site principal investigators and the LTER National Advisory Board for comments and reviewed by the Executive Board.

Many of the present activities and services of the LNO will continue under the new Cooperative Agreement, but additions and modifications of some activities will be necessary to address the new Network goals, opportunities for partnerships with emerging networks, new technological approaches, and changing site needs. What won't change is the primary goal of the LNO, which is to facilitate and support efforts to achieve the goals of the LTER Network.

Questions or comments on the LNO and the new Cooperative Agreement should be addressed to me at *rwaide@lternet.edu*.

Bob Waide, Executive Director, LNO

Report: Integrating Social Science into NSF Environmental Observatories

The final report on "Rising to the Challenge: Integrating Social Science into NSF Environmental Observatories," co-authored by Shalini Vajjhala, Alan Krupnick, and Eleanor McCormick, has been released. A copy of the report can be downloaded from the workshop website at *www.rff.org/rff/News/Features/NSF_Report.cfm*.

In early 2006, following meetings of the CLEANER (Collaborative Large-Scale Engineering Analysis Network for Environmental Research) Social Science Committee and Executive Committee, plans were developed for a workshop on improving social science integration into CLEANER and other NSF Environmental Observatories (EOs). This effort was motivated by the realization that first, social, behavioral, and economic science theory and research were centrally important to resolving the major "grand challenge" questions being addressed by the observatories, and second, more coordinated research efforts across social science, natural science, and engineering disciplines were necessary to "rise to these challenges."

The report was prepared for the subsequent National Science Foundation-funded workshop, "Integrating Social Science at NSF Observatories," held on January 24-26, 2007 in Arlington, Virginia, which discussed a wide range of ideas for long-term multidisciplinary research opportunities linking social and natural science data collection at the observatories.

After the workshop, the original report underwent multiple reviews and revisions to come up with this final report, which identifies three research themes—human activities and behaviors, human impacts and responses, and human welfare and development—as opportunity areas for potential advances in core social environmental science research and future collaboration at the EOs.

Like the workshop, the report targets ongoing observatory efforts including National Ecological Observatory Network (NEON), the Water and Environmental Research Systems (WATERS) Network, and parallel developments within the Long Term Ecological Research (LTER) Network, as well as addressing the lessons learned from past observatory initiatives, such as Collaborative Large-Scale Engineering Analysis Network for Environmental Research (CLEANER) and Consortium of Universities for the Advancement of Hydrologic Science (CUAHSI).

The authors worked extensively with program officers from different Directorates at NSF, a multidisciplinary community of environmental scientists (including LTER PIs), and selected observatory leaders, to build consensus, address broader collaborative experiences and perspectives, and ensure technical accuracy of the report.

The authors are hopeful that the report will lay the groundwork for improved integration in EOs planning in the near- and long-terms.

McOwiti O. Thomas, LNO

OBFS data to be queried via ORNL DAAC's search system

The Oak Ridge National Laboratory Distributed Active Archive Center (ORNL DAAC) has announced that data from the Organization of Biological Field Stations (OBFS), along with Long Term Ecological Research (LTER) data, can now be queried from the DAAC's Mercury Search System. OBFS is an association of more than 200 field stations, primarily in North America, concerned with field facilities for biological research and education. Over 120 OBFS data products can be queried from the ORNL DAAC's search system; new OBFS data sets added to the OBFS collection will be automatically added to DAAC's search system.

The ORNL DAAC took advantage of work done by its partner, the ORNL's National Biological Information Infrastructure (NBII) clearinghouse, which is also based on Mercury. NBII worked to make OBFS data records searchable by converting OBFS metadata (in Ecological Metadata Language) into the Federal Geographic Data Committee (FGDC) metadata standard, used by both NBII and the ORNL DAAC.

In addition to OBFS and ORNL DAAC data, a variety of data held by data centers and researchers around the world is also available through the ORNL DAAC's Mercury search interface, including data related to climate, hydrology, vegetation/land cover, land use, soil characteristics, and gas flux/emissions. Mercury also provides links to Web sites containing models for predicting biogeochemical processes. The system allows for free text, fielded attributes (such as site, investigator, parameter, and data set title), spatial, and temporal searching.

Please take a look at the ORNL DAAC's search system (*http://mercury.ornl.gov/ornldaac/*) to find key biogeochemical data and information throughout the world.

Robert B. Cooke, ORNL

LNO Cyberinfrastructure project gets NSF funding

Deana Pennington, research faculty at the LTER Network Office, has received a $1 million grant from the National Science Foundation to continue her work on enabling science communities to incorporate advanced technologies into their research (see related story in "Unique LNO virtual training launches in cyberspace," Network News Vol. 20, No1, or online at *www.lternet.edu/news/Article151.html*).

The project, titled CI-Team: Advancing Cyberinfrastructure-Based Science through Education, Training, and Mentoring of Science Communities, is funded through the Office of Cyberinfrastructure CI-Team program for workforce development in computational science and engineering. It develops a process for mobilizing a group of distributed, interdisciplinary scientists into a community of practice to effectively embed technology-enhanced approaches into their work, and investigates methods for enabling collaborative research design. The project uses a combination of activities informed by creative thinking and problem-solving theory, social science, and organizational learning theory. All activities integrate research with education through problem-based, experiential learning by a community of practice while solving real problems.

The project is being conducted with a group of scientists engaged in forecasting the impact of climate, population, and land cover/land use change on plant distributions in the American Southwest, and investigating human and environmental consequences of those changes. The project partners the scientists with technology and cyberinfrastructure specialists to design collaborative research that overcomes technical barriers to complex scientific analyses.

Deana Pennington, LNO

Web blogs catching on in LTER

A Web log or "blog" is a journal posted on the Internet. As many as 77 million blogs worldwide chronicle personal reflections on political, technical, or creative endeavors, inviting readers to post feedback and create a discussion. Some blogs are quite popular and a few, influential.

Blogs are gaining momentum and recognition as sources of information and authority. Moving beyond the fringe, they are social focal points, with many regular readers and commentators communicating directly with each other in a public forum.

As well, LTER investigators are entering the "blogosphere," creating and maintaining their own forums on the Internet to communicate over distance, and to stay informed of happenings at their sites.

At the Jornada Basin LTER site in southern New Mexico, a new blog (*http://jrnsite.wordpress.com/*) allows LTER site personnel to share observations related to particular studies, natural history, acute events, or other phenomena. Anyone can read and submit comments on the blog entries, but only a predefined set of people are allowed to make and edit entries, "specifically the few technicians and myself who are in the field frequently," says John Anderson, who approves comments from first-time posters to prevent spam.

Investigators at McMurdo Dry Valleys LTER site use web logs (*www.mcmlter.org/blogs0708.html*) to communicate across the vast distances between their field sites and their homes. "Our blogging is very informal," says Chris Gardener, McMurdo's information manager. "It's a great way to inform family and friends what you're doing in Antarctica," Gardener says, "and we team up with local teachers back home and allow their students to ask us questions in the field."

Gardener has created a Web page that links to everyone's blogs, and subscribers are notified of new entries. He now plans to create a page that updates automatically using XML feeds. "Last year, this area was the most visited portion of the website during the height of our field season in December and January," he says. "It's too early to tell yet, but it is pretty popular again this year."

After reading and responding to blogs for some time, James Brunt, associate director for information management at the LTER Network Office, decided to create his own blog (*http://lno.lternet.edu/blog/jbrunt*). "I try to keep the material of general interest to socio-ecological information management," he says. "I'm really trying to reach the LTER sites with this information." Brunt began his blog in September 2007, taking advantage of the website content management system's capability to support web logs without extra effort.

He notes that blogging is similar to emailing in "the immediacy with which I can put together some thoughts." But, he adds, "I find I have to spend a little more time organizing and editing which probably makes the content better (than email)."

Patty Bonito, LNO

NSF concludes 2007 LTER mid-term site reviews

The 11 LTER projects reviewed in 2007 comprise the largest cohort for a site review year. These sites reach almost to both poles and range from the open ocean to mountaintops, representing a scientifically and geographically diverse and logistically challenging combination. Consequently, NSF staff from across the Foundation facilitated particular reviews or came along as observers, in addition to the two LTER Program Directors in the Division of Environmental Biology (DEB) in the Directorate for Biological Sciences (BIO), Henry Gholz and Martyn Caldwell.

Top: The site review team listens as CCE LTER researchers demonstrate various equipment on one of the research vessels; *Right*: PI, Nancy Grimm, chatting to site reviewers at CAP LTER; *Bottom*: The black mini-cooper with vanity plates (inset) was *belle de jour* and a topic of conversation during the CAP LTER visit. (Photos by John Porter)

Phil Taylor and Dave Garrison, Program Directors in the Division of Ocean Sciences in the Geosciences Directorate at NSF, coordinated the coastal and marine reviews of the California Coastal Ecosystem (CCE), Moorea Coral Reef (MCR), and Plum Island Estuary (PIE) projects. The reviews of the two urban LTER sites, the Baltimore Ecosystem Study (BES) and Central Arizona-Phoenix (CAP), were facilitated by Tom Baerwald, Program Director in the Division of Behavioral and Cognitive Sciences (Directorate for Social, Behavioral and Economic Sciences) and included social scientists on the review team. Roberta Marinelli, Program Director in the Office of Polar Programs' Antarctic Division, is coordinating the final 2007 review of the McMurdo Dry Valleys (MCM) project, which will actually occur during the Southern Hemisphere summer in January 2008. Lou Pitelka and Dan Childers, both Program Officers in the Division of Environmental Biology, were observers of the CAP and CCE reviews, respectively, while Yong Jiang, a Sea Grant Fellow in Bio-Oceanography, came on three reviews. Also participating in the BES review were Jessica Corman, Angela Early, Elaine Franklin, and Elizabeth Gaige, Science Assistants in BIO.

Despite the diversity of LTER projects in this cohort, some common issues emerged from this year's reviews, generally reflecting the maturity of science across LTER. For example, synthesis of site data and knowledge to demonstrate progress across various subprojects at the sites, the use of modeling for integration, and development of a cross-site research focus, were common themes. As some of these sites have been members of the LTER network since the very beginning (e.g., NWT began in 1980), the challenges of maintaining critical long-term core datasets was hardly a surprising topic brought up during most all of the reviews.

The 2007 site review year marked a "first" in the LTER community: Bob Waide, the LTER Network Office Executive Director, appropriately enough became the first person ever to have visited all 26 LTER sites when he attended the MCR site review in July. Waide's unique accomplishment was quickly matched when Henry Gholz visited CCE in September; he now has the dubious honor of having been to all 26 sites for the purpose of conducting mid-term reviews.

These mid-term reviews are an essential part of NSF's ongoing evaluation cycle of the LTER program. NSF recruits a team for each review that consists of five independent, external scientists. The team visits the site, reviews the accomplishments and plans of the project, and writes a report to NSF containing an evaluation and recommendation. The report is then forwarded to the site's Principal Investigator (PI), with comments added by NSF in a cover letter. The site reviews also serve as opportunities for site scientists and staff to interact and discuss ideas with the review team. An LTER mid-term site review occurs during the third year of each project's six-year funding cycle. Accordingly, the 11 sites reviewed in 2007 will have their renewal proposals reviewed by a renewal panel in April 2010. Similarly, the six projects that had mid-term reviews in 2005 (CWT, KNZ, AND, NTL, PAL and SGS) will have their renewal proposals reviewed by a renewal panel in April 2008. The final cohort of nine LTER sites (CDR, FCE, GCE, HFR, JRN, LUQ, SBC, SEV and VCR) will have its next mid-term reviews in 2009, with subsequent renewal proposals considered by an April 2012 panel.

Personnel Changes in NSF/LTER

We note that Martyn Caldwell will be rotating out of NSF in July 2008. Martyn will remain in the DC area during his well-deserved retirement. Dan Childers, formerly PI of the Florida Coastal Everglades, has replaced Martyn working with Henry on LTER in DEB.

Jessica R. Corman and Henry Gholz, NSF-BIO

Current affairs at the Andrews LTER

New Eco-Informatics Summer Institute at Andrews

In summer 2007 the Andrews Forest hosted OSU's first Eco-Informatics Summer Institute. Eco-Informatics is defined as the interaction of mathematics, computer science, engineering, and ecology. It is an emerging field that trains young scientists for careers in this information- and technology-rich world. Building on the existing Integrative Graduate Education and Research Traineeship (IGERT) program in Eco-Informatics at OSU, students undertook research in topics such as forest carbon cycling, air drainages in forests, and forest fires. Thirteen undergraduate students lived and conducted their research at the Andrews Forest for ten weeks. In addition to interdisciplinary research and education, mentoring, and hands-on experience with field work and data analysis, participants gained the foundation to develop and seek support for their own graduate studies. This National Science Foundation-funded program is coordinated by Desiree Tullos, Biological and Ecological Engineering, OSU. Tullos comments,

Photo: Desiree Tullos

2007 Eco-Informatics Summer Institute Students.

"The program highlighted the opportunities and challenges of integrating a range of ideas and perspectives, from math and statistics majors to environmental and ecological sciences, and from institutions across the US (Willamette, Univ. of Washington, Illinois, Louisiana State, Maine, Texas, Clarkson, Reed, Stanford, Cal Tech, OSU)." More information at *www.eco-informatics.engr.oregonstate.edu/*

'Reflections' at Andrews LTER now in print

The work of writers participating in the Long-Term Ecological Reflections program is increasingly appearing in print. A short essay, "The Owl, Spotted" (OnEarth Fall 2006) describes poet Alison Deming's encounter with a Northern Spotted Owl during a field outing with Steve Ackers, leader of the Spotted Owl crew at the Andrews Forest. She writes:

Spotted Owl at the Andrews LTER. (Photo by Al Levno.)

"The owl doesn't make a sound.

She perches on a branch high above us.

She is still. …

What is the consciousness of a spotted owl? There she perches perceiving us, and here we sit perceiving her. We exchange the long, slow, interspecies stare—no fear, no threat, only the confusing mystery of the other. Steve knows her language well enough to speak a few words: the location call, a bark of aggression. Perhaps that means she thinks we are owls. We do not look like owls. But we do, briefly, behave like owls, catching and offering prey, being still, and turning our eyes to the forest."

Stories by Lina DiGregorio, Education Coordinator, AND

An article about the "Reflections" program co-written by Frederick J Swanson, Charles Goodrich, and Kathleen Dean Moore was published in the Ecological Society of America's Frontiers in Ecology and the Environment magazine and is available for download at *www.esajournals.org/archive/1540-9295/preprint/2007/pdf/10.1890_070076.pdf*

Transition

Elizabeth W. Sulzman
1966-2007

Elizabeth Sulzman, a scientist and beloved colleague with the Andrews Forest Program, died unexpectedly on June 10, 2007. An award-winning professor and scientist in the Oregon State University's Department of Crop and Soil Sciences, Elizabeth is remembered for her enthusiasm for teaching and research. Her boundless energy and sparkling grin endeared her to all who knew her. Elizabeth started at OSU and the Andrews Forest LTER after earning a bachelor's degree in biology from Yale and MS and PhD degrees in ecology from Colorado State University. Her work at the Andrews LTER focused on carbon dynamics at the DIRT plots. Results of her work indicated that increases in leaf litter stimulate microbial digestion of older carbon as well as the newly added carbon, resulting in lower net carbon storage. Her graduate students and colleagues are continuing to pursue this important work. (Photo Oregon State University.)

NTL scientists providing leadership in GLEON

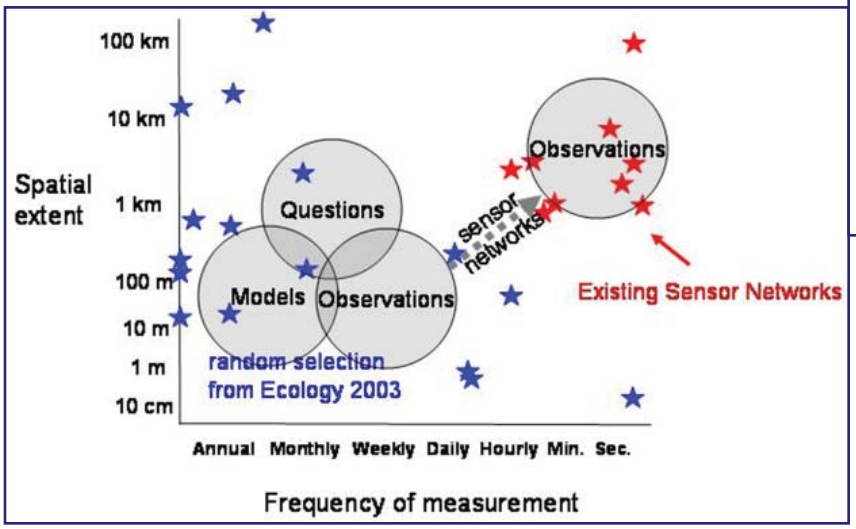
Scientists at the North Temperate Lakes (NTL) LTER site have provided leadership in the emerging Global Lake Ecological Observatory Network (GLEON— www.gleon.org/), an international, grassroots network of limnologists, ecologists, information technology experts, and engineers who have a common goal of building a scalable, persistent network of lake ecology observatories (Kratz et al. 2006, Hanson 2007). Data from these observatories will allow us to better understand key processes such as the effects of climate and land use change on lake function, the role of episodic events such as typhoons and storms in resetting lake dynamics, and carbon cycling within lakes.

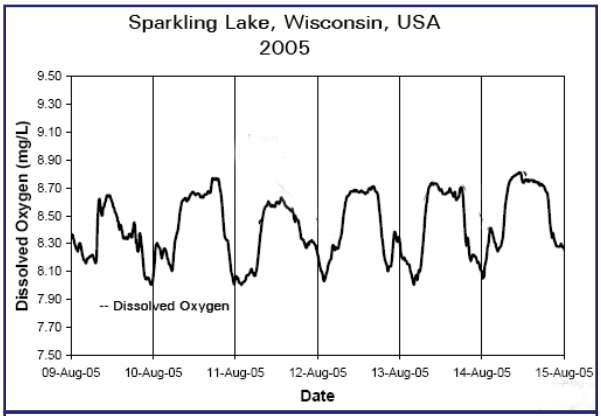
The observatories will consist of instrumented platforms on lakes and reservoirs around the world capable of sensing key limnological variables and moving the data in near-real time to web-accessible databases. A common web portal will allow easy access to data by researchers and the public. A series of web services supported by this portal will allow computation of metrics—for example, estimates of rates of important processes such as gross primary production and respiration—based on the high frequency data.

The focus to date on the technology of sensor networks has caused data gathering capacity to leap ahead of the models and questions required to exploit these data. Ecological research is based on the inextricable links between observations, models, and questions (Figure 1). When any one node in the paradigm is pushed to a new time or space domain, the other two must follow. Sensor networks have pushed observations to a new domain in which high-frequency data are collected over extended spatial extents, requiring us to explore new ways of modeling ecosystems and challenging us to identify the most compelling scientific questions given these new data. To facilitate this development, we need to enhance discussion and transfer of ideas among ecologists and between ecologists and information technology experts. An example of observations that outstrip models and questions is the incomplete understanding of nighttime increases in dissolved oxygen concentration observed in lakes throughout the GLEON network (Figure 2). This phenomenon is currently unexplained, but is likely caused by either horizontal or vertical movement of higher oxygen concentration water past the sensor at night. This example of scientific discovery shows the promise of sensor networks to uncover previously unobserved phenomena.

Currently, Tim Kratz (NTL) is chair and Paul Hanson (NTL) is a member of the GLEON Steering Committee. Peter Arzberger, chair of the LTER Advisory Committee, also serves on the GLEON steering committee, while Barbara Benson (NTL), Evelyn Gaiser (FCE), and Sally McIntyre (SBC, ARC) also participate in the network. A related network, the Coral Reef Ecological Observatory Network (CREON), has similar goals and is being led by Sally Holbrook (MCR). The GLEON network has members in Argentina, Australia, Brazil,

See GLEON, p. 10





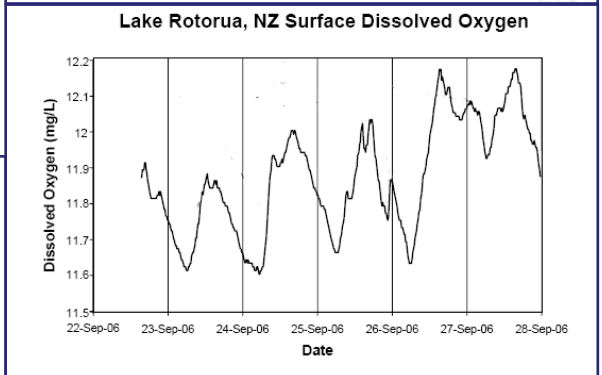


Figure 1 (*left*): The relationship between spatial extent and measurement frequency in ecological field studies (after Porter et al. 2005).

Figure 2 (*above*): Common responses of dissolved oxygen in disparate GLEON lakes.

(GLEON, Continued from p. 9)

Canada, China, Finland, Israel, Japan, New Zealand, South Korea, Sweden, Taiwan, the United Kingdom, and the United States (Figure 3)

GLEON is supported by awards from the National Science Foundation, the Gordon and Betty Moore Foundation, and several domestic funding agencies within the participating countries.

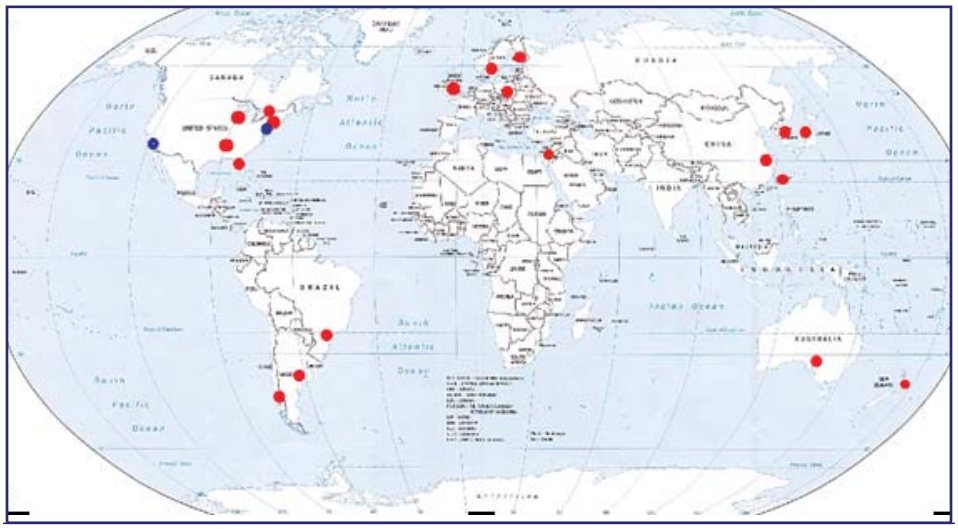


Figure 3. Map of current GLEON sites. Red dots indicate lake sites; blue dots indicate sites for cyberinfrastructure support and development.

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Tim Kratz (NTL), Paul Hanson (NTL), Barbara Benson (NTL), and Peter Arzberger (UCSD)

Shortgrass Steppe does "Ag Day"

Photos: Sallie Sprague

Little boys and girls (*inset*) had immense fun investigating "pickled" bull and rattle snakes, bones, and stuffed small mammals, at the SGS LTER booth during Colorado State Univerisity's AG Day, September 8, 2007. (Photos by Sallie Sprague.)

The Shortgrass Steppe (SGS) LTER made its first appearance at Colorado State University's College of Agriculture's Ag Day on Saturday, September 8. Ag Day is held south of the CSU Stadium each September to coincide with a home football game. All the departments and many of the student associations in the College of Agriculture bring displays to showcase their activities for alumni and guests attending that day's game. This is accompanied by a barbecue that is based purely on Colorado products. It's a lively event and the weather was perfect for this year's activities.

Nicole Kaplan, Kim Melville-Smith, Caroline Yonker, and Sallie Sprague assembled and staffed a 'booth' with many of our educational tools, an abbreviated food web poster, a short description of the SGS LTER project, drawings of the new field station, laptop computers with the historical slide show from our 2007 SGS Symposium, samples of some of our most common plants (blue grama, buffalo grass and *Opuntia* cactus), an Olney soil profile, stuffed small mammals, pickled reptiles, and some of the tools of our trade. We had good attendance that often had all four of us talking to visitors at the same time. The pickled snakes (bull and rattle) were especially eye-catching and attracted many folks, young and old, to our booth.

University President Larry Penley was one of the visitors to our booth. He complimented the research completed by SGS LTER faculty, staff, students and associates, as well as our booth. President Penley was very interested in knowing how the plans for the new facility were progressing. Overall we felt that this was a very successful outreach effort and expect to attend Ag Day again next year.

Sallie Sprague, SGS

VCR investigating carbon cycling in a lagoonal salt marsh

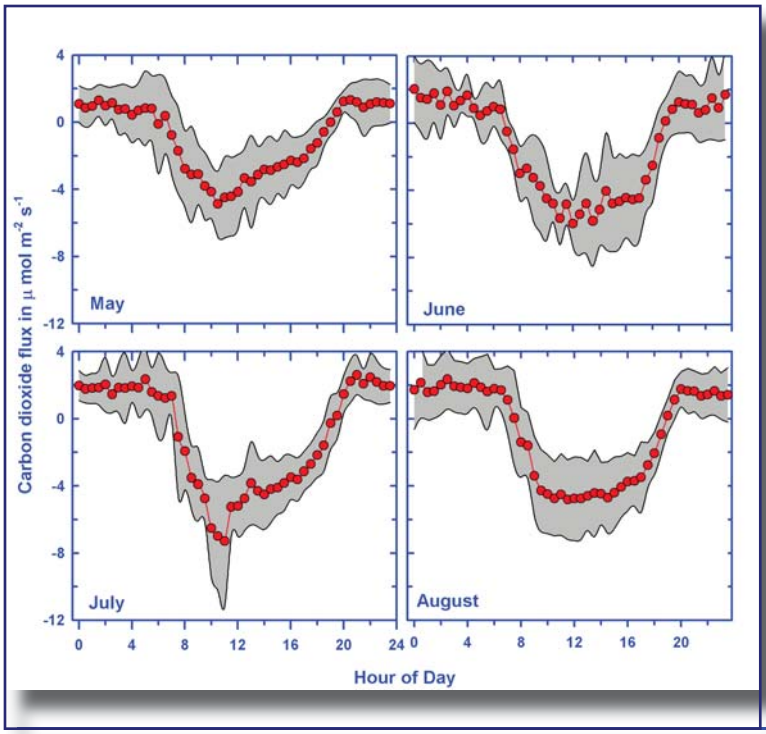
In April 2007 a flux tower was established at the Virginia Coast Reserve (VCR) LTER to investigate the environmental forcings that influence carbon and energy exchanges between the local salt marsh and overlying atmosphere. The new flux tower will make it possible to understand and quantify the long-term processes governing the fluxes of materials in and out of tidal estuary systems. The salt marsh ecosystem exists at the interface between terrestrial and aquatic ecosystems.

The eddy covariance-based flux tower was established in a lagoonal salt marsh (Figure 1) at the Eastern Shore of Virginia. The site is dominated by *Spartina alterniflora* (smooth cord grass). The flux tower (Figure 2) includes various instruments to study the assimilatory response of the local ecosystem to changing environmental forcings. The relatively large tidal amplitude, coupled with short vegetation, provides an interesting scenario where the plant canopy can be completely submerged at various times of the day, thus providing an ideal setting for understanding the ecosystem-level response and function due to submergence.

Instruments deployed on the tower are interfaced with data loggers that are controlled by a data acquisition system. The system and associated instruments are powered by a battery bank kept charged by solar panels. The data acquisition system allows large data storage and is connected to VCR LTER's existing wireless network.

The wireless connectivity allows for real-time data monitoring and system troubleshooting. All instruments on the tower allow the determination of fluxes of energy, water vapor, and carbon dioxide. The data obtained so far reveal strong seasonal trends in carbon assimilation patterns (Figure 3). Fluxes reached maximum values in July, coinciding with the maximum vegetation growth, and decreased in August, indicating the onset of plant senescence. Compared to other ecosystems, the magnitude of carbon assimilation indicates that the salt marsh contributes substantially to the removal of atmospheric carbon dioxide.

Top: Flux tower set up showing the base enclosure for the battery bank and the data acquisition system. The 20-foot tower sits on a wooden platform established on the marsh surface on wooden pilings. *Left* : Aerial photograph of the tower site (the red arrow indicates the flux tower).(Photos by James Kathilankal).



Average diurnal patterns of carbon dioxide fluxes for the months of May, June, July and August of 2007. Carbon assimilatory rates reach maximum values of 6 to 8 μ moles m^{-2} s^{-1} in July, indicating a highly productive ecosystem.

The resulting data sets show that the salt marsh ecosystem provides a unique opportunity for developing numerical models to investigate carbon sequestration by the ecosystem in response to current and future conditions. In particular, the data sets allow scientists to study ecosystem functions in response to perturbations caused both by storms and sea-level rise. Research is now underway to develop an integrated model incorporating a hydrodynamic module coupled with a transport module for simulating the air-sea carbon transfer, and a process based biophysical module for determining the carbon exchange from the *Spartina alterniflora* canopy. The study is expected to advance our understanding of the ecological processes taking place in these terrestrial-oceanic interfaces, which are susceptible to sea-level rise and climate change.

James Kathilankal, Jose D Fuentes, Paolo D'Odorico, Karen J McGlathery, Jay C Zieman (VCR)

SEEDS Program grows with LTER

When President George W. Bush recently named the Ecological Society of America (ESA) one of the recipients of the 2006 Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring (PAESMEM), ESA's Strategies for Ecology Education, Development, and Sustainability (SEEDS) was recognized as being instrumental in winning the presidential award. "We view the ESA SEEDS Program as the jewel in our crown," said ESA President Norman Christensen. "It is truly one of the initiatives of which we are most proud and today's award underscores its tremendous value."

ESA is eager to continue developing its mutually beneficial relationship with LTER sites to offer exciting field trip and research opportunities for underrepresented students in ecology. In November 2006, Coweeta Hydrologic Laboratory joined the growing family of LTER sites to host a field trip through ESA's Strategies for Ecology Education, Development, and Sustainability (SEEDS) Program. Others include BES (November 2003), SEV (November 2005), KNZ (June 2006), SBC (October 2007), and BNZ (June 2008).

A recent article by Armstrong et al. (2007) highlights the SEEDS program and notes that underrepresented students rank family support, research experience, and a positive view of an ecology career as important factors in a student's decision to pursue an ecological career path. SEEDS field trips offer highly stimulating and engaging opportunities for students to interact with professional ecologists in a nurturing environment.

"The researchers discussed ecology, but also other areas of life that tie into what you want out of life and out of a career. They were extremely personable and offered advice that I will keep for future decisions." SEEDS student, Nov 2006

Seventeen students, two faculty advisors, and two coordinators made the trip to Coweeta Hydrologic Laboratory and the University of Georgia (UGA). Among those who welcomed them were Dean John Gittleman and ESA President Alan Covich. Students also discussed Graduate School opportunities at UGA with Curtis Byrd and Jessica Anderson.

The SEEDS students toured facilities at the Odum School of Ecology and made five stops at research sites around the Coweeta Basin during the weekend field trip. The stops highlighted land-use change projects, watershed function and process studies, the role of technology in ecosystem research, and the range of ecosystems present in the southern Appalachian Mountains. The group also visited the Cherokee Native American Museum in Cherokee, NC, to better appreciate the land ethic and land use of the Cherokee Nation, where Coweeta is located.

Beyond the field trip, two of the SEEDS students returned to Coweeta this year: Serge Farinas (Clayton State University near Atlanta, GA) was a summer research intern assisting in research comparing technologies used to measure long-term soil moisture; Fabiana Silva (New College in Sarasota, FL) began a one-year position at Coweeta to further develop the Education and Outreach programs at Coweeta.

According to one SEEDS student, LTER sites are ideal locations for students to "understand how doing long-term research is important to understanding ecological processes." It is also a great opportunity to expose LTER sites to a diverse user group and to potentially recruit students to the site's research and graduate programs. For more information about the SEEDS program, please visit *http://esa.org/seeds*.

Photo albums and complete field trip reports including student highlights and conceptual sketches are available online at *http://www.esa.org/seeds/fieldtrips/past.php*.

Reference

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Brian Kloeppel (CWT) and Teresa Mourad (ESA Education and Diversity Programs)

Photo: Randy Fowler

Photo: Pam Snow

HF Forest Ecologist, Dr. David Orwig, with Teachers

Photo: Pam Snow

Teachers practice field site labeling with Dr. John O'Keefe.

Harvard Forest's Summer Institute for Teachers

ecology research in the schoolyard

Thirty-six teachers and environmental educators participated in this year's Summer Institute for Teachers at Harvard Forest. Thirty-three K-12 teachers from throughout Massachusetts and Southern New Hampshire came to HF to learn directly from Forest Ecologists, Dr. David Orwig and Dr. John O'Keefe. Staff from the Massachusetts Audubon Society, Plum Island LTER, the Nashua River Watershed Association, and the Boston Science Museum attended the training to learn how to integrate ecological field research into their work with children as well. These participants will, in turn, lead their students in implementing field research beginning in the fall of 2007. Research topics include: Buds, Leaves and Global Warming, and Hemlock Trees and the Pesky Pest, the Woolly Adelgid.

Pam Snow,
Environmental Educator, HFR

Photo: Pam Snow

Photo: Pam Snow

Above: HFR Forest Ecologist, Dr. John O'Keefe conducts a classroom session during the seminar at Harvard Forest. *Right*: Teachers observing the Hemlock Woolly Adelgid.

Grads share their research at MCM annual meeting

Graduate students attending the annual MCM meeting pose for photographs outside the Institute of Arctic and Alpine Research (INSTAAR) at the University of Colorado at Boulder, CO., August 29-31, 2007.

Graduate students from the McMurdo Dry Valleys (MCM) LTER capped off their list of accomplishments with presentations at the annual MCM-LTER science meeting in Boulder, Colorado August 29-31. Matt Hoffman and Hassan Basagic from Portland State University gave talks on the modeling of glacial meltwater production and quantifying precipitation in the Dry Valleys. Liz Bagshaw from the University of Bristol in the United Kingdom exhibited her work on the biogeochemistry of glacial cryoconite holes. Bagshaw, who has also presented her work at the American Geophysical Union and the International Glaciology Society meetings, and Hassan have papers in press in the Journal of Geophysical Research. Marie Sabaka from Montana State University discussed the mechanisms controlling the biodiversity of wind-blown sediment.

Also presenting were two Ohio State University students, Sarah Fortner and Becki Witherow, who gave presentations on the geochemistry of glaciers, streams, and lakes in the MCM. During the period 2006-2007, Fortner was the recipient of the NSF-GK-12 Fellowship that couples science graduate students with elementary school science teachers, while OSU funded Witherow to conduct stable isotope measurements at Oxford University (UK) as part of her dissertation work.

Karen Cozzetto and Lee Stanish, both Ph.D. students at the University of Colorado, also presented their research on climate teleconnections on stream flow and the ecology and evolution of stream diatoms, respectively. As a guest attendant, Lydia Zeglin from the University of New Mexico and the Sevilleta LTER, presented her work on the microbial diversity at lake margins. Congratulations to all of the McMurdo LTER students for great presentations and their numerous accomplishments!

Becki Witherow, MCM

Teaching LTER in cyberscape

New college course links investigators and students via the Internet

"From Yardstick to Gyroscope" a novel approach to interdisciplinary teaching and learning

Investigators from Coweeta, Florida Coastal Everglades and Baltimore Ecosystem Study LTER sites are offering an interdisciplinary course for college students in January 2007. The course's structure and content will model the nature of LTER science--crossing disciplines and spanning timezones, using state-of-the-art, interactive distance-learning technology.

While teaching courses using cybertechnologies is becoming increasingly common, "I haven't seen a course that attempts to bridge multiple universities and disciplines" in quite this way, says Laura Ogden, an investigator at the Florida Coastal Everglades LTER and a lead instructor. The course has grown out of the LTER's cross-site and transdisciplinary approach, Laura says. And, as in LTER research, "figuring out how to make this happen--in practice rather than theory--has been the challenge."

The course's ususual title reflects the focus on research methodologies. "The 'yardstick' and 'gyroscope' metaphors reflect the breadth of social science methods and approaches to measuring knowledge," from empirical and quantitative to qualitative and interpretive, says Ogden.

The course materials and archived content will be hosted on WebCT, which is the system used at UGA and widely used around the country, says Coweeta LTER's Ted Gragson. Presentations will be offered through Wimba LiveClassroom, an Internet-based tool specifically for multipoint simulcasting that combines text messaging, video, slides, and whiteboard.

The instructor of the day will present via video and audio in real time, and students will be in a classroom watching a large screen and participating through their computers. Students can post questions either by audio (through the web or over phone lines) or by texting. "If the person asking the question also has video, all participants will see the individual or the class asking the question," Gragson says. "When the instructor answers the question, the video reverts back to them."

The course is offered both through UGA and FIU. However, there will be exceptions for other individuals to access both WebCT content as well as join live presentations on Wimba, through the Coweeta LTER web site, Gragson says. "We are told that the technical limit on the number of passive viewers is a couple of hundred," Gragson says, "while the practical limit on how many could actually ask questions is much smaller."

This is the first time this course has been offered and the technology, while proven, is still not widely used. "We went through a variety of technical approaches to offering this course and talked to a lot of people who had used distance learning before settling on WebCT/Wimba," Gragson says. "My guess is that the biggest challenges will stem from the lack of familiarity or the inherent differences between a live and a virtual classroom." For example, taking turns asking questions in a distributed virtual classroom is much more important than in a physical classroom where everyone is present. "Many of these types of problems can be overcome by simply making sure everyone understands the particularities of the medium," says Gragson.

"There might be some courses similar in the use of the technology," says Morgan Grove, the third lead instructor and a social scientist at Baltimore Ecosystem Study LTER site, "but for the organization of the course, we basically made it up."

View the syllabus at: *http://coweeta.ecology.uga.edu/ecology/web_learning/syllabus.html.*

Patty Bonito, LNO

SBC employs SPOT satellite imagery to integrate Giant Kelp forest observations

Giant kelp forests are amongst the most productive ecosystems on Earth. They provide food and shelter for a highly diverse community of fish, invertebrates and under story algae. Kelp forests are also highly dynamic ecosystems. Maximum growth rates for giant kelp (Macrocystis pyrifera) fronds can exceed a foot a day while entire kelp forests can be wiped out by a single winter storm

Kelp forests in California occur as discrete patches ranging in area from 0.1 to 37 hectares that are distributed linearly along a relatively narrow coastal band (typically less than 2 km wide). Santa Barbara Coastal (SBC) LTER ecologists conduct monthly diver surveys over fixed transects of the abundances of kelp plants, fronds, and blades, their vertical structure, and the turnover of plants from which estimates of biomass and net primary productivity of the SBC-LTER kelp forests are made. These transects extend only over a small proportion of the kelp forests and logistical constraints limit data collection to only three kelp forests. Thus, to fully understand the spatial and temporal dynamics of kelp forests in California, we need new approaches to integrate transect-scale measurements of biomass and productivity over spatial scales that encompass kelp forest habitat at local and regional scales.

See SPOT, p. 16

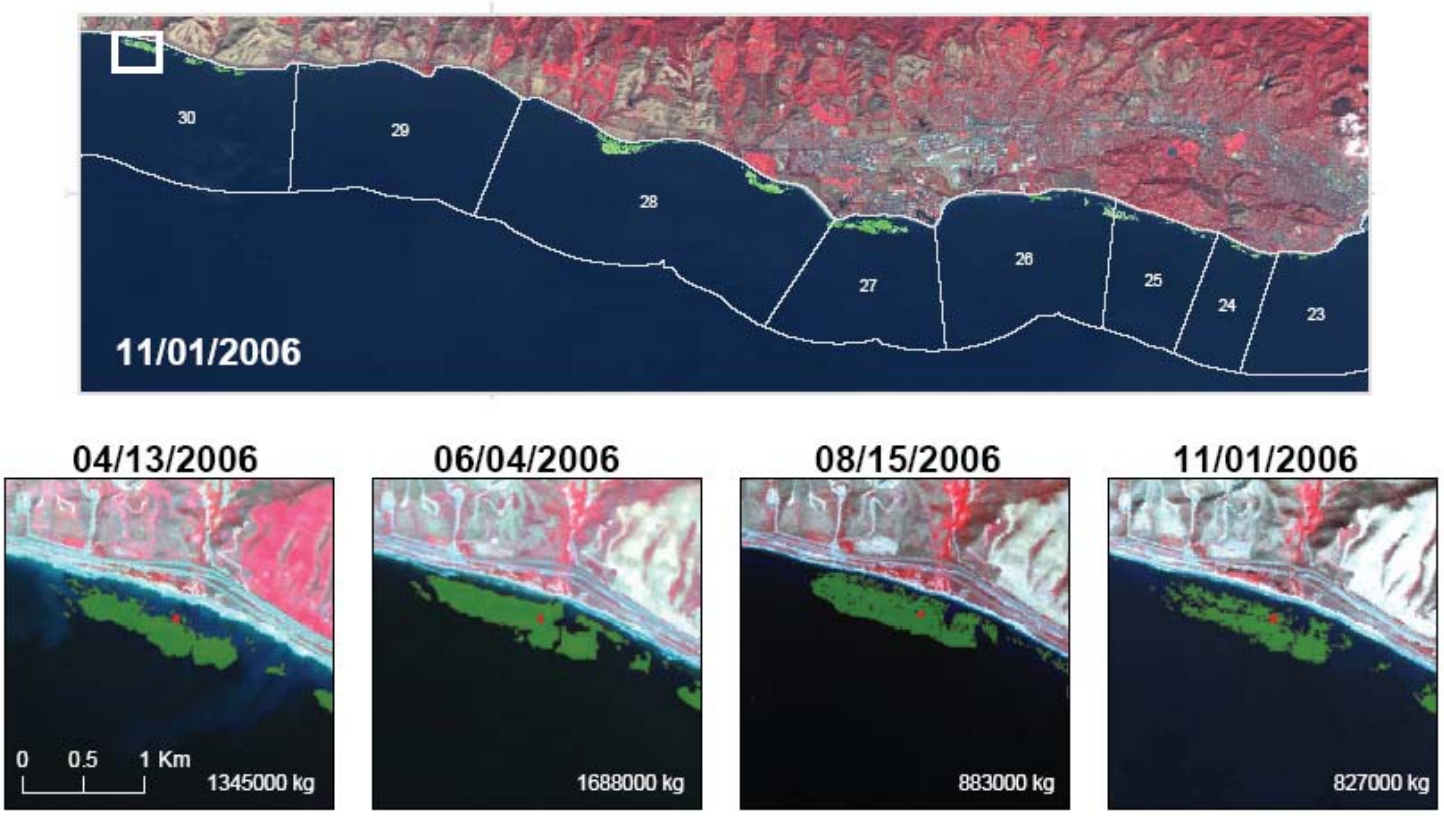

Figure 1: (*upper panel)* SPOT-5 false color imagery overlain by classified kelp cover (green) for the mainland coast of the SBC-LTER spanning from Arroyo Quemado (AQ) in the west (highlighted box) to the city of Santa Barbara in the east. Image is from November 11, 2006. California Department of Fish and Game (CDFG) administrative kelp bed delineations are also shown as the numbered polygons. (*lower panels*) SPOT-5 false color images overlain by classified kelp cover (green) for four analysis periods near the SBC-LTER sampling site at AQ (the highlighted box in the upper panel). Images are available on April 13, June 4, August 15 and November 1 of 2006. The red pixels in the lower panels represent the location and the size of the SBC-LTER diver transects at AQ. Also shown is the total kelp wet biomass for the four subscenes. Note the two-fold changes in kelp biomass over the seven months in this time sequence. ©2007 CNES, Licensed by Terra Image USA, California, USA.

(SPOT, continued from p. 15)

Remote sensing data have long provided a method for integrating field point and transect data sets from local, to regional, to global scales. Currently, we use high spatial resolution, multi-spectral imagery from the SPOT-5 satellite to integrate the SBC-LTER diver observations to regional scales. SPOT is an acronym for Système Pour l'Observation de la Terre, a French series of high resolution Earth remote sensing satellites. Three SPOT satellites are currently in operation above the earth. Giant kelp, like most terrestrial plants, has a spectral signature characterized by high near-infrared reflectance and much lower reflectance in the green and red spectral regions. SPOT-5 provides multi-spectral imagery with ability to distinguish these spectral bands at a 10 meter spatial resolution appropriate for assessing changes in the giant kelp forests.

The process of assessing kelp canopy coverage begins with an atmospheric correction to the green, red and near-infrared bands of SPOT-5 multi-spectral imagery using the dark-pixel method. The resulting corrected multi-spectral imagery is transformed using a principal component analysis, which results in two dominant spectral modes of variability. The first mode shows positive contribution from all three spectral bands and accounts for issues of sediment loads and variations in the atmospheric correction procedure. The second mode shows spectral patterns consistent with the reflectance signals expected for giant kelp and is used to assess kelp covered pixels. The resulting cover observations compare well with annual aerial survey results published by the California Department of Fish and Game (CDFG; from the fall of 2004) on an administrative bed scale ($r^2 = 0.92$ with a slope between the two cover measures that is insignificantly different from 1). This comparison provides a good first order validation of our SPOT-5-derived determinations of giant kelp cover.

Examples of SPOT-5 derived kelp cover distribution are shown in Figure 1 below. The bright green pixels are classified kelp cover. The upper panel of Figure 1 shows a regional perspective of kelp forest cover for November 11, 2006 while the lower four panels shows the time evolution of kelp cover at the local scale at the SBC-LTER site at Arroyo Quemado (AQ). These maps provide an integrated assessment of kelp canopy area and changes in kelp canopies from the scale of diver transects (Figure 1, red dots) to local (Figure 1, lower panels) and regional (Figure 1, upper panels) scales. Sequential images illustrate how the morphology of kelp forests change in time (lower panel). Here, the kelp forest growing season at AQ is observed from April to June (increase of 5.7 hectares), followed by the gradual deterioration of surface canopies from June to November (decrease of 7.9 hectares) due to senescence and disturbance by surface waves. These images clearly show the dynamic nature of giant kelp forests.

Areal cover is one measure for a kelp forest; however, assessments of kelp biomass are more useful for understanding and modeling ecosystem interactions. The SBC-LTER monthly diver transect surveys are made over a 160 m^2 region (~16 SPOT-5 multi-spectral pixels) and provide estimates of kelp plant biomass per unit area among many other parameters. The location of the AQ diver survey transect is indicated by the red pixels in the lower panels of Figure 1. Comparison of diver estimates of kelp biomass and SPOT-5 determinations of the Normalized Difference Vegetation Index (NDVI; calculated using the green and near-infrared bands) from all three SBC-LTER sites shows an excellent correspondence ($r^2 = 0.71$; $n = 37$). This provides a robust empirical algorithm for estimating kelp biomass from SPOT-5 multi-spectral imagery on local to regional scales. The four subscenes shown in the lower panel of Figure 1 document two-fold changes in kelp standing crop in less than seven months at this site. Our methodologies for assessing kelp cover and biomass using SPOT imagery are detailed in a manuscript recently submitted for publication in *Remote Sensing of the Environment* (Cavanaugh et al. submitted).

The ability to remotely characterize giant kelp cover and biomass on local to regional scales opens many new doors for study of kelp ecosystem dynamics by researchers at SBC-LTER. Since January 2006, we have been acquiring SPOT-5 10 m multi-spectral and 5 m panchromatic imagery on a bimonthly basis for all of the Santa Barbara coast and the northern Channel Islands. With recent NASA support, we plan to use these processed images to assess the spatial and temporal dynamics of giant kelp forests on a regional scale, evaluating the growth, persistence and disturbance in individual forest stands. This assessment will be used in conjunction with studies of kelp spore dispersal and disturbance frequency to build on previous efforts by SBC-LTER researchers to develop a spatially realistic metapopulation model of Southern California kelp forests, which was previously limited by the coarse resolution of historical kelp biomass time series.

This project demonstrates the value and promise of remote sensing data sets for scaling-up detailed ecological assessments to describe larger scale regional ecosystem dynamics. We expect that many researchers within the LTER community use SPOT or similar (i.e., Landsat) imagery in their work. Unfortunately, there is currently a dearth of high-quality Landsat imagery and SPOT data has remained difficult to acquire due to its high cost. In an effort to address these issues, UCSB, partnering with Terra Image USA, has established the *SPOT at UCSB* program to provide U.S. educational institutions SPOT imagery of the U.S. and Canada at a reasonable cost (more than 85 per cent off retail cost for member institutions). The *SPOT at UCSB* program provides members access to our growing archive of more than 1.4 million SPOT scenes as well as the ability to task the suite of SPOT satellites for their particular study sites. Imagery from most of the LTER sites are being tasked already and we are interested in additional suggestions of tasking sites. Details of the *SPOT at UCSB* program (including our online catalog) are available at *www.spot.ucsb.edu* or by calling 805-893-8475.

David Siegel, Kyle Cavanaugh, Brian Kinlan and Daniel Reed (SBC)

LTER unveils cyberinfrastructure strategic plan

The plan for cyberinfrastructure (CI) support for future LTER research has just been released as part of the "'Decadal Science Plan for LTER". The CI strategic plan was commissioned as part of the overall LTER Network planning process with the express purpose of identifying CI critical to meeting LTER's research and education objectives. As part of this process, the CI planners convened a large and diverse group of information technology (IT) professionals from science and technology centers, large IT development projects, and national observatory initiatives.

In a series of meetings, this group identified areas where improvements in cyberinfrastructure were necessary. The LTER CI planners articulated the input from this group into specific suggestions in areas such as data management, data integration, and modeling, as well as crosscutting issues like system architecture, collaborative environments, strategic CI partnerships, workforce training, education, and outreach activities (see accompanying box for details). The plan then went through a number of iterations and reviews by the LTER National Advisory Board (NAB) and the Network Information System Advisory Committee (NISAC) before going out for comment from the larger community.

Trying to predict and plan for technology 10 years out is always tricky. It's even trickier if you're trying to anticipate the support needed for new and innovative scientific studies that haven't yet been articulated. The LTER cyberinfrastructure planners confront these issues by focusing on advanced capabilities and needed functionality. The authors and contributors, knowing the dangers of specifying exact technologies too far into the future, have opted for building capacity with an

See "Plan," p. 18

New visions for research that seeks understanding of human-natural systems through advances in collaborative, synthetic socio-ecological science at multiple temporal and spatial scales are inextricably intertwined with improvements in cyberinfrastructure (CI).

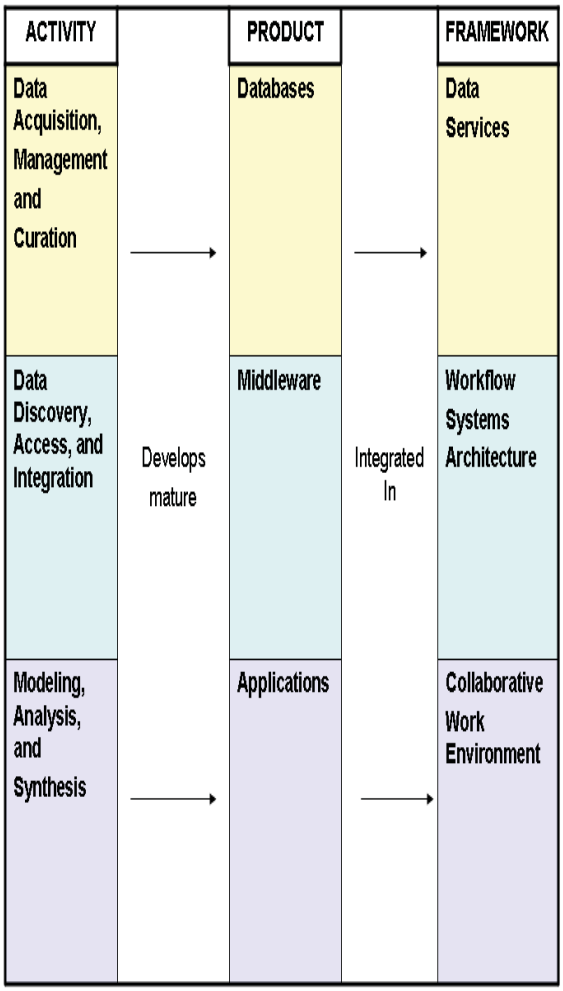

Diagram of envisioned CI activities, products, and frameworks.

Don't forget to read *DataBits*, the Information Managers' newsletter, online at *www.lternet.edu*.

(Plan, continued from p. 17)

understanding that exact implementations will be specified and planned as the "Decadal Plan" progresses.

The LTER program will draw heavily on existing strengths and partnerships in building this new cyberinfrastructure. These strengths include the availability of existing long-term data and Network-level derived data products, use of community standards for metadata, policies for sharing data, broad ecoinformatics expertise, active informatics research, and the LTER Network Office serving as the focal point for development efforts. Existing partnerships with the National Center for Ecological Analysis and Synthesis (NCEAS), the San Diego Supercomputer Center (SDSC), and the National Center for Supercomputer Applications (NCSA) are collaborative strengths, as are new and growing associations with emerging observatory platforms such as the National Ecological Observatory Network (NEON), the Ocean Observatory Initiative (OOI), and the Water and Environmental Research Systems (WATERS) Network.

A survey of LTER sites administered twice during the planning period also identified several hurdles that need to be cleared before implementing the new wide-reaching research plan. Critical issues that require immediate attention include uneven information management and IT expertise among sites; diverse forms of data and methods for collecting and managing data; wide variations in internet connectivity (particularly at field sites); and inconsistent access to collaboration technologies. Recommendations in the CI plan reflect the critical nature of these issues. For example, getting additional technical resources to the sites is stated as one of the highest priority cyberinfrastructure needs. Meeting these critical needs will no doubt be foremost in the minds of the Network Information System Advisory committee (NISAC) when they begin to address implementing the CI strategic plan this fall. The NISAC committee, currently co-chaired by Deb Peters (Jornada LTER) and Wade Sheldon (Georgia Coastal LTER), will be the key governance body addressing implementation of the CI plan. The committee is made up of five site principal investigators, four information managers, and five Network Office representatives.

To build the capacity called for in the CI strategic plan represents a significant new investment in people and information technology for LTER. These investments translate into activities that will be challenging to implement but will no doubt be the first step towards achieving a fully integrated research network capable of sweeping advances in ecological understanding.

For further reading you can find the "Decadal Plan for LTER" at *www.LTERNET.edu/decadalplan/*

James W. Brunt, LNO

Six strategic CI strategic plan initiatives to support new science activities

1. Build community-based services and a service-oriented architecture (SOA): A scalable, community-based, service-oriented architecture will provide data services to ensure secure and efficient access to data stored in site data repositories, as well as provide computational services for numerically demanding analyses and models and for large-scale multi-site experiments that include sensor networks, satellite sensors, and high performance computing.

2. Build CI capacity to increase data acquisition, management, and curation at the site level: Near-term goals for increasing LTER sites' capacity for collecting high-quality data and participating in Network-wide experiments, integration, modeling, and synthesis activities will require significant enhancements to staffing and technology.

3. Build CI capacity to increase data discovery, access, and integration: Advances in data integration require the development of innovative prototype systems utilizing data warehousing and distributed query systems technologies, linked to research in applying knowledge representation and semantic mediation approaches to harmonize heterogeneous data.

4. Build CI capacity to increase modeling and analysis activities: Facilitating and coordinating LTER Network-wide analysis and modeling activities aimed at understanding and forecasting changes in regional, continental and global dynamics of social-ecological systems will require significant investment in computing services, software development, and staffing. This effort will require developing scalable computing resources, advanced analytical environments such as scientific workflow systems, and a community-based repository for archiving model code.

5. Build capacity to increase collaboration: Collaborative work environments allow scientists residing in different locations to analyze, discuss, annotate, and view data using collaborative analytical tools and video teleconferencing. LTER researchers need access to these tools at both central and remote locations.

6. Integrate cyberinfrastructure into social-ecological research, education, and training: Integration of new cyberinfrastructure including advanced tools for analysis and synthesis within the LTER research process will require linking centrally-developed training, education and outreach programs to other training resources that can be remotely accessed by scientists, students, and technicians.

LTER scientists participate in 2007 George Bush US-China Relations Conference

Official group photograph of the participants at the 2007 George Bush US-China Relations Conference in Washington, DC, October 2007, including three LTER Principal Investigators and National Science Foundation staff.

In October 2007, Hugh Ducklow (PI, PAL), Nancy Grimm (PI, CAP) and Scott Collins (PI, SEV) were invited to participate in the 2007 George Bush US-China Relations Conference held this year in Washington DC. The goal of the conference series, hosted by Texas A & M University, The Chinese People's Association for Friendship with Foreign Countries, The George Bush Presidential Library Foundation, and The George Bush School of Public Service, is to "promote one of the world's most important relationships and to help strengthen and expand its academic and business collaborations." Plenary speakers included several current and former Cabinet Secretaries, and the banquet dinner was hosted by former President George H.W. Bush.

Hugh "Duck" Ducklow, a Red Sox mega-fan, ducked out of the Bush-hosted banquet early to catch game 1 of the World Series while another Red Sox devotee, Scott Collins, proudly bragged about his ticket to attend Game 5 to be played later in Denver.

In a somewhat less lofty but nonetheless highly successful roundtable session on International Polar Year (IPY) and collaborative research in polar regions, Collins discussed the challenges and benefits of collaborative and integrative science, Grimm highlighted a number of on-going international research collaborations involving US LTER scientists, and Ducklow described US polar LTER research and the potential for collaborations between US and Chinese scientists in arctic and Antarctic regions. The session was also attended by the National Science Foundation's Roberta Marinelli (OPP), Henry Gholz (LTER Program Director, who moderated part of the roundtable session), and Karl Erb (Director OPP) who presented additional opportunities for US-China collaboration in polar regions. More information about this conference can be found at *http://china-us.tamu.edu/about_conference.php*.

Scott Collins, SEV

Calendar

Coming Events of Interest to the LTER Community

Publications

Cover photos of two books, *Linking Restoration and Ecological Succession* (left) and *Environmental Disasters, Natural Recovery and Human Responses* (right), co-authored by Luquillo LTER researcher Lawrence (Lars) Walker and acknowledging LTER funding. Walker, a professor in the School of Life Sciences at the University of Nevada and Las Vegas, says the books deal with many synthetic issues of interest to LTER, particularly disturbance and recovery and human interactions with both.

JANUARY 2008

January 3 – 4: CI Team Strategy Meeting, LTER Network Office, Department of Biology, University of New Mexico, Albuquerque, NM. For more information contact Celina Gomez (*cgomez@lternet.edu*) for more details.

January 8 – 10: SEEK-Ecological Meeting, LTER Network Office, Department of Biology, University of New Mexico. For more information contact Deana Pennington (*dpenning@lternet.edu*) for more details.

FEBRUARY 2008

February 12 – 13: IM Executive Meeting, LTER Network Office, Department of Biology, University of New Mexico. Contact Nicole Kaplan (*nkaplan@lternet.edu*) for more details.

MARCH 2008

March 2 – 7: American Society of Limnology & Oceanography, Ocean Sciences Meeting Orlando, FL. See *http://www.aslo.org/meetings/aslomeetings.html* for details.

APRIL 2008

April 6 – 10: The 23rd Annual Landscape Ecology Symposium of US-IALE (the US Regional Association of the International Association for Landscape Ecology)will be held in Madison, Wisconsin. For more information visit: *http://www.usiale.org/madison2008/*

MAY 2008

May 6: LTER Executive Board Meeting, Baltimore, MD. Contact George Garcia (*ggarcia@lternet.edu*) for more details.

May 7: LTER Science Council Meeting, Baltimore, MD. Contact George Garcia (*ggarcia@lternet.edu*) for more details.

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