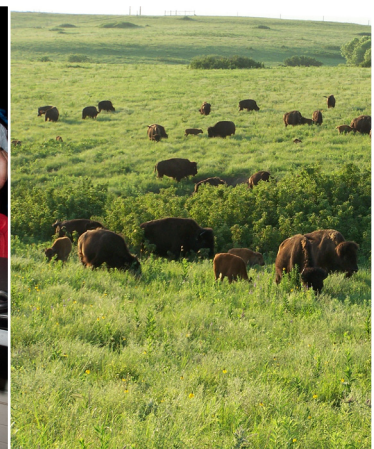


— THE LONG TERM —  
**ECOLOGICAL  
RESEARCH**  
— NETWORK —



**2014 ANNUAL REPORT**

The LTER Network has a vision:  
a society in which exemplary science advances the health, productivity,  
and welfare of the global environment, thereby advancing the health,  
prosperity, welfare, and security of our nation.

To realize this vision,  
LTER strives to provide the scientific community, policy makers, and  
society with the knowledge and predictive understanding necessary to  
conserve, protect and manage the nation's ecosystems, their  
biodiversity, and the services they provide.

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We thank the LTER Network sites for the use of photography in this publication. Credit is due to the site unless otherwise noted. **Front cover (l to r):** Aerial view of lakes in the Northern Highland Lake District of northern Wisconsin (NTL/Carl Bowser); *Eleutherodactylus richmondi*, a semi-fossorial frog that frequents boulder-strewn sites and large fallen logs in the Luquillo Forest (LUQ); A bison herd grazing on a watershed burned every 4 years at Konza Prairie (KNZ/Matt Whiles); Michael Heithaus, FCE Co-Principal Investigator, prepares to place a GPS tag on an alligator (FCE/Jeff Rauch). **Page 2-3 spread:** A view of Lake Fryxell on the continent of Antarctica (MCM/Lars Jensen). **Page 5:** People have altered the plant community in the Sonoran Desert through selection and planting of exotic, desert-adapted species (CAP/Eyal Shochat). **Page 7:** Live coral covering the bottom of the ocean in the offshore fore reef on the north shore of Moorea (MCR/Russell J. Schmitt). **Page 11:** Lookout Creek and old-growth forest at the HJ Andrews Experimental Forest LTER (AND). **Page 17:** Phaedra Budy processes char during ice-sampling (ARC); Tagged adult snowshoe hare outfitted with radio collar. The winter fur (white ears) coming in indicates the photo was taken in the fall (BNZ/Knut Kielland); Midwater copepod, *Euchirella* species (CCE/ Ramus Swalethorpe); Graduate student Christina Wong examines the ecology of residential landscapes (CAP/ Tim Trumble); Ecologist Susan Barrott with students Kally Worm, Lauren Losek, and Emily Hockman at the BioCON Experiment (CDR). **Page 18:** Eddy covariance and meteorological tower in an Everglades marsh during the height of the wet season, 2008 (FCE); Sapelo Island tidal creek (GCE /Steven Pennings); A flux tower rising above the forest canopy at the Harvard Forest, a typical New England forest with mixture of deciduous and coniferous species, that are important for keeping CO<sub>2</sub> out of the atmosphere (HFR/John Budney); Perennial grasslands dominated Jornada landscapes prior to 1900 (JRN); Multicolored Asian lady beetles prey on soybean aphids at the Kellogg Biological Station LTER site (K. Stepnitz). **Page 19:** The community of terrestrial gastropods (snails) in the Luquillo Forest exhibit varying metacommunity structures with elevation (LUQ/Gerry Bauer); Side view of cryoconite holes that have melted out in the Canada Glacier, McMurdo Dry Valleys, Antarctica (MCM/ Andrew G. Fountain); Graduate student Marko Spasojevic identifies plant species in long-term monitoring plots on Niwot Ridge (NWT/I. Ashton); Turbid sediment plumes along the California coast near Gaviota following storms of February 1998 (SBC/Mark DeFeo); The southern end of Hog Island, a barrier island in the Virginia Coast Reserve (VCR/Peter Frank Edwards).



# GUIDING PRINCIPLES

The LTER Network seeks to understand the long-term patterns and processes of ecological systems. To this end, Network scientists focus on six interrelated objectives:

1. **Understanding:** To understand a diverse array of ecosystems at multiple spatial and temporal scales.
2. **Synthesis:** To create general knowledge through long-term, interdisciplinary research, synthesis of information, and development of theory.
3. **Information:** To inform the LTER and broader scientific community by creating well-designed and well-documented databases.
4. **Legacies:** To create a legacy of well-designed and documented long-term observations, experiments, and archives of samples and specimens for future generations.
5. **Education:** To promote training, teaching, and learning about long-term ecological research and the Earth's ecosystems, and to educate a new generation of scientists.
6. **Outreach:** To reach out to the broader scientific community, natural resource managers, policymakers, and the general public by providing decision support, information, recommendations, and the knowledge and capability to address complex environmental challenges.

## LTER NETWORK RESEARCH

Individual scientists, students and educators at the 26 LTER sites contribute toward the LTER mission. Site-level work forms the foundation of knowledge, data, and observational and experimental legacies, while extensive field experience provides predictive information regarding responses to future ecological disturbances.

These efforts add to the basic body of scientific knowledge of long-term, large-scale ecological phenomena, while training programs increase the number of people with expertise in research and environmental problem solving. Ultimately, both site- and Network-level activities develop scientific capital — well-documented research, well-trained scientists and a well-informed citizenry.

The 26 LTER sites represent a wide variety of research emphases and approaches. Each site conducts a series of measurements and experiments directed towards the understanding of fundamental ecological principles, as well as studies addressing ecological issues specific to the site. The most common scientific approaches include observation, experimentation, comparative analysis, retrospective study and modeling.



## GEARING UP TO MEET PRESENT AND FUTURE CHALLENGES

This has been both a challenging and exciting year for the LTER Network. LTER science is stronger than ever, with numerous critically important findings at both the site and network scale described elsewhere in this report. On a more sobering note, this fall, the National Science Foundation (NSF) decided not to renew the Sevilleta (SEV) LTER program. Coincident with this decision, Scott Collins resigned as Chair of the LTER Network and I moved from chair-elect to Chair.

First, our thoughts and condolences go out to all the investigators who have worked so hard for so many years to make SEV an essential part of the LTER Network and of the field of Ecology. This is a devastating loss to our network and our discipline. We thank Scott Collins for his long years of excellent service to the network. SEV will have three years to wind down operations, but in the meantime the site continues to be a full member of the network.

Second, we need to take steps to ensure that we don't lose any more sites. To that end, we have started a series of meetings to discuss issues related to LTER proposals including conceptual models, long-term data, expectations from NSF, probation, etc. The first of these meetings took place on November 10 at NSF in Washington and was attended by a large group of LTER scientists and NSF program officers and was extremely useful in laying the groundwork for a series of activities that will lead to a stronger LTER Network. We then envision a larger meeting associated with the annual LTER Mini-Symposium at NSF in March 2015, a still larger meeting associated with the LTER Science Council meeting in May, and a yet larger meeting at the LTER ASM in September. Our goal is to get a clear sense of what NSF expects from our sites, an understanding of the approaches that different sites have taken to meet these expectations, and a set of "best practices" that sites can use as they prepare proposals.

The challenges of 2014 remind us that we need to redouble our efforts to write strong proposals, rigorously prepare for site reviews, and exploit the unique opportunities provided by the LTER program. Reviewers of the SEV proposal clearly noted that this was a highly productive site carrying out state-of-the-art research on critically important topics. Yet, there were concerns about project cohesion and links to unique long-term data streams. Indeed, there have been many comments from the reviewer community over the years about a lack of integration among different components of LTER projects. This is a great challenge for us all and I am hopeful that our series of meetings over the next few months will help us to avoid further site losses.

On a more positive note, NSF has assured us that it remains firmly committed to a strong and full LTER Network. Indeed, there is active discussion within the agency about a request for proposals to add a new site (hopefully arid land or grassland) to the network to replace the losses of Shortgrass Steppe and Sevilleta. We should therefore look forward to another exciting year of science and network activity.

Sincerely,

Peter Groffman

*Chair, LTER Science Council*





## BUILDING ON THE PAST, ANTICIPATING THE FUTURE

2014 was a year of change for the LTER Network. Here's a summary of important developments, including changes in Network leadership, continued growth of the LTER Data Co-op, progress in education and outreach, and special acknowledgements of accomplishments at LTER sites.

### LTER STUDIES CHANGE – AND EXPERIENCES IT, TOO

Any human endeavor that is planned to last more than 100 years will face many challenges, including changes in leadership and personnel, and the LTER program is no exception. During 2014, the chair of the Science Council, **Scott Collins** of the Sevilleta LTER, stepped down and was replaced by chair-elect, **Peter Groffman**, of the Cary Institute for Ecosystem Studies. Longtime principal investigators at the Cedar Creek, Sevilleta, and Niwot Ridge LTER sites turned their programs over to new leadership after more than a decade of service. One LTER site, Shortgrass Steppe, became inactive after more than 30 years of study, and another, the Sevilleta National Wildlife Refuge, received notice that their funding would not be renewed beyond 2018. Even the National Science Foundation (NSF) was not immune to change, with a turnover of senior leadership in the Biology Directorate and the Division of Environmental Biology, home of the LTER program.

In 2015, the LTER Network will have to adjust to these changes as well as to the re-organization of the LTER Network Office (LNO). A competition is currently underway for a new national office for LTER, whose responsibilities will encompass communication, education and outreach, planning and synthesis, and services to the Network. The transition to the new national office will take place in 2015 after the All Scientists Meeting scheduled for August 31-September 2. Management of the LTER Network Information System will remain with the current office until NSF approves a sustainable plan for future operations.

As part of its continuing commitment to long-term ecological research, NSF has initiated discussions with the scientific community about a possible new competition for additional LTER sites. These exciting new initiatives will invigorate the LTER community as we prepare to celebrate the 35<sup>th</sup> anniversary of the LTER Network.

### FUTURE SCENARIOS

More than three decades of study have established trajectories of ecosystem change that will allow the LTER Network to construct future scenarios for key ecosystems that will help guide management policy for the next century. Growth of the Science Policy Exchange, founded by four LTER sites in the northeastern U.S., will provide an important mechanism to translate long-term ecological research into policy recommendations at regional and national scales. New and expanded partnerships with other national networks like the Forest Service Experimental Forests, the National Ecological Observatory Network (NEON), and the Critical Zone Observatories (CZO) will provide increased capabilities to address important environmental issues. With these efforts and others, the LTER Network looks forward to the challenges of 2015 and the future.



**Peter M. Groffman** is a Senior Scientist at the Cary Institute of Ecosystem Studies in Millbrook, NY. His research interests are in ecosystem, soil, landscape, and microbial ecology, with a focus on carbon and nitrogen dynamics. He received his PhD in 1984 in Ecology from the University of Georgia. Groffman is chair of the Executive Board of the U.S. National Science Foundation funded Long-Term Ecological Research (LTER) Network and a participant in LTER projects in Baltimore (urban) and New Hampshire (northern hardwood forests). Specific recent research efforts include studies of winter climate change effects on nitrogen dynamics in forests, effects of atmospheric nitrogen deposition on nitrogen gas fluxes, nitrate dynamics in riparian buffer zones, effects of a whole watershed calcium addition on soil nitrogen and carbon cycling, and the effects of exotic earthworm invasion on soil nitrogen and carbon cycling.

Groffman is a member of the U.S. National Committee for Soil Science, the NOAA Gulf of Mexico Hypoxia Nutrient Reduction Workgroup, the Working Group on Aquatic Terrestrial Biogeochemistry at the National Center for Ecological Analysis and Synthesis (NCEAS), the Working Group on Trace Gas Fluxes at NCEAS, and the Expert Group on N<sub>2</sub>O and CO<sub>2</sub> Emissions from Agricultural Soils, Organization for Economic Cooperation and Development (OECD) Programme on National Greenhouse Gas Inventories. He was a lead author for the Second (Wetlands) and Third (North America) Assessment Reports of the Intergovernmental Panel on Climate Change (IPCC) and a Convening Lead Author for the 2013 U.S. National Climate Assessment Chapter on Ecosystems, Biodiversity and Ecosystem Services. He currently serves on the editorial board of *Ecosystems* and was chair of the Biogeosciences Section of the Ecological Society of America (ESA) (2009 – 2011), of the Soil Ecology Section of the ESA (1997 – 1999), and of the Wetland Soils Section of the Soil Science Society of America (2002 – 2003).

## CHANGING OF THE GUARD

At Cedar Creek (CDR), **David Tilman**, Lead Principal Investigator (LPI) for over 30 years, was joined by **Eric Seabloom** as co-leader as part of an ongoing transition in leadership. Next year, Seabloom and **Sarah Hobbie** will become the co-leaders of the CDR, and Tilman will remain a co-PI. Tilman, a Regents Professor at the University of Minnesota and a member of the National Academy of Sciences, has received many honors during his long career for his work at Cedar Creek (see page 10), and says “I have been fortunate to receive several awards honoring our work at Cedar Creek. None of this work would have been possible without NSF’s LTER program, to which I am deeply indebted.” Seabloom is Associate Professor at the University of Minnesota and co-leader of the Nutrient Network (NutNet), a global research cooperative replicating experiments at over 70 sites in 12 countries on five continents. Hobbie is a Professor at the University of Minnesota studying the effect of climate, urbanization, and plant species change on biogeochemistry.

At Niwot Ridge (NWT), **Katharine Nash Suding** succeeded Mark Williams as LPI in 2014. Williams is a Fellow at the Institute of Arctic and Alpine Research and Professor of Geography and was elected a Fellow of the American Geophysical Union in 2012. Suding comes from the University of California Berkeley, and is joining the University of Colorado Boulder as an affiliate at INSTAAR and Associate Professor in Ecology and Evolutionary Biology.

At Sevilleta (SEV), **Will Pockman** took over as LPI from Scott Collins. Collins is Regent’s Professor of Biology and Loren Potter Chair of Plant Ecology at the University of New Mexico as well as past President of the Ecological Society of America. Pockman is Professor and Regent’s Lecturer at the University of New Mexico.

## DATA CO-OP GROWS

The LTER Data Co-op comprises the community of ecological data producers and users linked through the LTER Network Information System (NIS). The LNO completed the development of the NIS and initiated operation in 2013. To date, nearly 20,000 data packages have been uploaded and are available through the Provenance Aware Synthesis Tracking Architecture (PASTA). *Nature* now recognizes the LTER NIS as a data repository that meets its requirements for archiving supporting data. Meanwhile, 2014 saw the first identified citation of a NIS-assigned Digital Object Identifier (DOI) from a paper by Thompson et al. (2013) from the





Moorea Coral Reef site. Data in the NIS are now listed by DOI in the Web of Science Data Citation Index, allowing investigators to generate citation reports for their data sets. And, LTER data are being used for broad-scale analyses (e.g., Dornelas et al. (2014). Assemblage Time Series Reveal Biodiversity Change but Not Systematic Loss. *Science* **344**: 296-299) by non-LTER researchers.

## EXPLORING THE FUTURE OF LTER DATA MANAGEMENT

During 2014, the LTER information management (IM) community continued its commitment to making quality ecological data available to the broader scientific community. Closer collaboration with organizations such as the Earth Science Information Partnership (ESIP) created new opportunities for shared initiatives, while ongoing submissions to the new NIS has increased the number of site contributed datasets now available through the data portal ([portal.lternet.edu](http://portal.lternet.edu)) to over 4400. Additional quality checks have been incorporated into the data submission process to ensure the highest possible quality of the data submitted. Information managers from multiple sites have engaged in dialog with colleagues about the future needs of the IM community in order to inform the process of defining the next generation of data services provided to LTER sites. This work will continue into 2015.

A group of information managers, led by **Iñigo San Gil** (MCM), continued to develop the Drupal Ecological Information Management System (DEIMS) as one approach to management of site data. The group provided support for Ecological Metadata Language for those LTER sites that would like to test DEIMS. In addition, the DEIMS group improved content indexing from the three major search engines (Google, Bing, Yahoo), which will improve discoverability.

## ADVANCES IN EDUCATION AND OUTREACH

The LTER Education and Outreach Committee (EOC), consisting of education and outreach coordinators from each of the LTER sites engaged in a series of professional development presentations. Each month, a different LTER site or EOC Subcommittee highlighted an existing program or posed a timely discussion topic for feedback or assistance in developing new initiatives. Presenters (and topics) included:

## MAPPING LIVES SAVED BY THE NEW EPA CARBON RULE

A two-part study by the Science Policy Exchange (with leadership from HFR and HBR) analyzed the future impacts of the nation's first-ever carbon pollution standards, released by the EPA in June 2014. The first study produced maps of the greatest potential air quality benefits, which will occur in states in and around the Ohio River Valley, as well as the Rocky Mountain region. The second study analyzed several policy options for the EPA carbon standards. The standard that is moderately stringent, with the greatest amount of energy efficiency, provides the largest health co-benefits—with the potential to save thousands of lives in the U.S. every year from premature death related to air pollution. The maps were published widely in the news media, including the *Washington Post*, *Huffington Post*, and *USA Today*.

- Elena Sparrow (BNZ) and PhD candidate Katie Villano Spellman (BNZ): *Flowering Phenology of Native Vaccinium Species and Non-Native Melilotus Albus: Building Resilience to Invasion Through Citizen Science*
- Clarisse Hart (HFR) and Art Schwartzchild (VCR): *LTER EOC Higher Ed Working Group Projects and Status Report*
- Scott Simon (SBC): *Professional Development Subcommittee Highlights*
- Stephanie Bestelmeyer (JRN): *Data Jam*
- Mary Spivey (CDR): *Geraniumania*
- Kim Eichhorst (SEV), Steve McGee (LUQ), and Noelia Rodriguez (LUQ): *The First Virtual Symposium LUQ LTER Schoolyard Program and La Escuela del Bosque, New Mexico*
- Ross Boucek (FCE): *CAST: Coastal Angler Science Team*
- Alan Berkowitz (BES): *Learning Progressions for Environmental Science Teaching*

In addition, the Undergraduate and Graduate Education subcommittees hosted a series of LTER-wide graduate student mixers at professional meetings with high LTER participation. In 2014, mixers were hosted at the annual meetings of the Ecological Society of America (18 sites represented) and American Geophysical Union. The student mixer program was initiated by Art Schwartzchild (VCR) and Clarisse Hart (HFR) with seed money collected from PIs at VCR. Art and Clarisse have continued to host mixers by soliciting other sites to serve as hosts.

The Undergrad/Grad Subcommittee also collaborated with LNO leadership and the LTER Diversity Working Group to develop and distribute a network-wide survey to assess the experiences of LTER summer research students, drawing responses from 150 students at 14 sites. Key results were shared with the LTER Science Council and Executive Board in spring 2014.

The **Digital Repository/LTER Education Digital Library (LEDL)** is a collection of resources that facilitate training, teaching, and learning about long-term ecological science. The LEDL website, launched in the fall of 2013, has an initial collection of 10 reviewed and annotated digital resources. An additional three resources were submitted in 2014 and are currently being reviewed by our partners in the project, the Climate Literacy and Environmental Awareness Network (CLEAN). The new lessons include: 1) Investigating Behavior of Krill (PAL); 2) video on Adele Penguins (PAL); and 3) a US Cropland Greenhouse Gas Calculator (KBS).

CLEAN has offered to include LTER climate-based resources in their periodic review process. This allows for an intensive peer-review of resources by educators and scientists at no cost and, if accepted, posting in LEDL, CLEAN, and Climate.gov websites.

The **LTER Schoolyard Series** exhibited at the National Science Teachers Association (NSTA) national conference in April and the National Marine Educator's Association (NMEA) in July of 2014. The newest book in the series, *Kupe and the Corals*, written by Jacqueline L. Padilla-Gamino and illustrated by Marjorie Leggitt, was published in August by Taylor Trade Publishing in a variety of language versions, including English, English/Spanish, English/Hawaiian, French/Tahitian, and English/Tahitian. A French/Paumotu version is also available as a digital file. Several more titles are currently in the production or editorial development phase, including projects and proposals from HBR, PIE, SBC, JRN, and KNZ.

A print catalog featuring all of the current titles in the series was produced earlier in the year, and the series now has a stand-alone website featuring all of the titles at [www.lterschoolyardseries.com](http://www.lterschoolyardseries.com). Additionally, Apple Education agreed to partner with the

## FCE SCORES A PRESTIGIOUS AWARD

The Florida Coastal Everglades (FCE) LTER received the 2014 Provost's Award for Excellence in Research and Creative Activities from Florida International University (FIU), which was awarded at the Homecoming football game on October 18.

Provost Ken Furton, FCE lead principal investigator Evelyn Gaiser, President Mark B. Rosenberg and Dr. Len Scinto during the presentation at Ocean Bank Field at FIU Football Stadium (Screengrab courtesy of FCE LTER).





LTER Schoolyard Series late in 2014 to convert titles into an enhanced ePUB3 format. The ePUB3 beta version of the first book in the series, *My Water Comes from the Rocky Mountains*, is currently in production and is scheduled for release in early 2015.

Meanwhile, the Organization of Biological Field Stations, representing more than 250 research centers around the globe, granted the Harvard Forest its Human Diversity Award in 2014. The award highlights the Forest's Summer Research Program, now in its 25th year of training undergraduates from around the country in ecology and conservation. The award noted the program's strengths in inclusive outreach methods that reach a wide range of applicants, creating an inclusive and nurturing environment for program participants, and tracking program outcomes with the aim to improve program diversity, sensitivity, and effectiveness.

In other developments:

- Forest Isbell, who spent time at Cedar Creek Ecosystem Science Reserve (CCESR) as a post-doctoral researcher, is CCESR's new managing director.
- The 24<sup>th</sup> Annual Woods Hole Film Festival in Falmouth, MA, had a sold out crowd during a 70 minute preview screening of a unique documentary narrative funded by the National Science Foundation entitled '*Antarctica: Beyond the Ice*' that depicts over two decades of innovative research from the Palmer (PAL) LTER program. PAL Education and Outreach coordinator, Beth Simmons, and two teachers on a Research Experience for Teachers (RET) project are working to integrate the pieces into an 'AntarcTECH science curriculum' for the STEM Academy in Sandwich, MA.
- Researchers at the Kellogg Biological Station (KBS) LTER site, among the first to begin a long-term study of integrated pest management (IPM) and sustainable agricultural practices, realized that farmers throughout the world could benefit from their interdisciplinary work. In 2014, KBS took its highly regarded program overseas rather than bring farmers from all over the world to KBS to learn the techniques.
- In 2014, scientists from the North Temperate Lakes (NTL) LTER and the Center for Limnology at the University of Wisconsin published a report in the journal PLOS ONE that involved nearly a quarter of a million observations in 3,251 lakes spread across eight states and seven decades. However, the researchers themselves didn't collect a single bit of data. Every observation came instead from "citizen scientists" – lakefront homeowners, boaters, anglers and other member of the public wanting to know a little more about what's going on in "their" lake. Although the citizen scientist dataset was not sufficient to explain all patterns observed, the scientists suggest that their data and information can play a role in shaping future research.
- The new, Harvard Forest-based Scenarios, Services, and Society (S3) research coordination network supported by NSF held its first workshop in 2014. The RCN – a network of scientists, students, decision-makers, and other stakeholders – will synthesize existing science, catalyze new research, and produce science products to understand and advance sustainable land-use trajectories in New England. The network will also provide training for scientists of all ranks in techniques of stakeholder engagement, linking science with action, and science communication. Learn more at [s3rcn.org](http://s3rcn.org).

## CELEBRATING 10 YEARS OF CLASSROOM FIELD RESEARCH



**K-12 students are introduced to phenology as part of the Harvard Forest schoolyard program.**

This year the Harvard Forest Schoolyard LTER Program celebrated 10 years of K-12 field research in 70 schools across New England. Each year, the program brings more than 3,500 students outside to collect and analyze long-term field data in their schools' backyards.

The program's ecologist-developed field protocols help students explore LTER-focused themes of climate and seasonal change, invasive insects, watershed ecology, and - a new project in 2014 - carbon dynamics and land-use change. A growing number of classroom data records stretch back more than seven years. As one teacher recently put it, "My students collect authentic and meaningful data. They know science can help us understand the world we live in and offer answers to global questions, such as climate change."

In summer and spring workshops, teachers learn field methods directly from Harvard Forest ecologists. In winter data workshops, ecologists guide teachers through the challenging work of data analysis.

Throughout the year, teachers and students submit their field data to a publicly available online database developed by the Harvard Forest information manager, which now includes user-friendly data graphing tools. Collectively, Schoolyard classrooms have contributed more than 22,000 data points to the Forest's long-term data record.

The Harvard Forest program encourages peer mentoring among teachers, who develop and share creative, flexible lesson plans that enhance the scope and impact of the field studies throughout the curriculum. All field protocols and teacher-developed resources are freely available online for use by other educators in the LTER Schoolyard network and beyond.

Explore data, resources, and the new blog at [harvardforest.fas.harvard.edu/schoolyard-liter-program](http://harvardforest.fas.harvard.edu/schoolyard-liter-program).

# FEATURED SITES

In this section we profile LTER sites whose work was reviewed by NSF in 2013-14



Lookout creek and old-growth forest at the HJ Andrews Experimental Forest LTER.

## ANDREWS (AND)

For 35 years, the AND LTER program has studied how climate, natural disturbance, and land use as controlled by forest governance interact with biodiversity, hydrology, and carbon and nutrient dynamics. Nestled in the Cascade Mountains of Oregon, AND is known for comprehensive science, policy, and public understanding of forests, streams, and watersheds, including the roles of dead and down wood, the life history of the northern spotted owl, and legacies of past forestry treatments.

Current research examines how climate and land use changes interact to affect forest and stream ecosystems in the Pacific Northwest, and specifically the patterns, causes, and consequences of flows of air, water, and nutrients through mountain landscapes.

The AND program is widely known for active engagement with the public, land managers, and policy makers, thereby influencing management, policy, and public perceptions of the values and services of public land.





A 'traditional' southern Appalachian valley farm in the Upper Little Tennessee Watershed showing a range of land uses still common across the region. Cows are fenced off from the stream in the foreground, and the property backs up against public forest lands.

## COWEETA (CWT)

The CWT LTER program is dedicated to testing theories and developing a mechanistic understanding of ecological dynamics of the southern Appalachians. CWT research seeks to understand how topographic and climatic gradients, climate variability and change, diverse biotic communities, and human actions interact to affect the primary production; nutrient cycling and fluxes; population and community dynamics; and natural and human induced disturbance in land and water habitats of the temperate deciduous forests in the highlands of Appalachia.

CWT's core study area is the relatively undisturbed basin defined by the USDA Forest Service's Coweeta Hydrologic Laboratory surrounded by an increasingly dense built environment. The area supports exceptionally high biodiversity and endemism shaped by the interaction of topography and shifting climate over time. The juxtaposition of research within and beyond the Coweeta basin allows for long-term detailed studies of relatively undisturbed systems at the core and of the interactions of ecological and social processes under conditions of disturbance caused by humans at regional and global scales.

Decades of research has shown that the variation in topography, climate, and soils across CWT's study biome strongly controls ecosystem productivity, soil moisture, individual fitness, competitive relationships, decomposition, disturbance, as well as flows of carbon and nutrients. CWT researchers seek to improve knowledge of general ecosystem function through time and geographic scales, and to predict anthropogenic change and inform resource management priorities at the regional level. CWT also maintains a vigorous dialogue and education program with local communities to understand and help shape the future landscape.

## BALTIMORE ECOSYSTEM STUDY (BES)

Cities are ideal ecosystems to study interactions between human and natural processes and their change over time. In addition to long-term data on the flow and chemistry of streams, and productivity in different habitats, BES LTER conducts experiments on specific human-natural links. For example, experiments in vacant lots investigate how functional (i.e., processes, functions, or characteristics) and phylogenetic (i.e., evolutionary relationships among organisms) biodiversity interact in harsh environments, and by engaging stakeholders, help maximize city ecosystem services.

By investigating disease vectors, researchers expose shifting ecological and social drivers over time and geographical spread. For instance, there are more adult mosquitoes in under-served neighborhoods, where unmanaged trash provides habitat for their larvae, in contrast to high income neighborhoods where such habitat is set apart from human activities.

BES long-term vegetation data has informed Maryland's tree planting strategies, and these activities have extended to schools, for which BES educators provide professional development and classroom support to thousands of students.



Research on vacant lots, while focusing on basic processes of ecosystem biodiversity, is well integrated into local communities. It also trains incarcerated individuals in implementing, maintaining, and sampling experiments.



Long-term watershed-level fire and grazing treatment at KNZ result in a mosaic of ecological states, including high- and low-diversity prairie and areas undergoing conversion to shrublands and woodlands.

## KONZA PRAIRIE (KNZ)

Temperate grasslands, such as the highly productive tallgrass prairies of North America, are subject to multiple global change drivers, including climate change, land-use change, woody plant encroachment, and excess nutrient loading. Conserving the biological diversity and ecosystem services provided by grasslands requires a comprehensive understanding of how these ecosystems respond to current and future environmental and land-use changes.

KNZ research is building on a foundation of long-term experiments and measurements to understand the direction of change in tallgrass prairie. Decades of watershed- and plot-level experiments at KNZ have produced a range of ecological states and legacies, reflecting similar changes occurring in grasslands globally. For example, KNZ research has revealed evidence of thresholds, abrupt state changes, and tri-stability in response to altered fire frequency in areas where grassland, shrubland, and woodland meet. Because the histories and trajectories under which these ecological states and legacies have occurred are known, scientists can rigorously investigate the dynamics of change and the mechanisms underlying the sensitivity and resilience of grasslands to major global change factors.

KNZ also supports on-site K-12 activities, undergraduate and graduate education and training, community outreach and engagement with grassland managers and conservationists. Collectively, KNZ research and associated cross-site and comparative studies are contributing to improved management, conservation, and restoration of grasslands globally.

## NORTH TEMPERATE LAKES (NTL)

NTL seeks to understand how and why lakes and their surrounding landscapes change over time. Research in two contrasting lake districts provides insights into how individual lakes, as well as lakes across landscapes, regions, and the globe are affected by phenomena such as shifting climate conditions, large storm events, invasive species, harmful algal blooms, or changes in environmental policies.

Over the past two decades, long-term observations and modeling efforts have highlighted diverse consequences of changes in climate dynamics on lakes. For NTL lakes located in both the human-dominated landscape of southern Wisconsin and rural, forested northern Wisconsin, winter ice duration has declined, water levels are more variable, and larger storms now deliver more runoff. These changes have multiple and often unexpected outcomes, such as affecting the spread and population dynamics of aquatic invasive species and confounding efforts to reduce phosphorus inputs to lakes and their eutrophication.

NTL work includes multiple K-12, undergraduate, graduate, and continuing education activities. The NTL program is also committed to outreach efforts, fostering scientist-artist collaborations, hosting an annual open house, and even using citizen scientist-generated data to pursue research on lake landscape dynamics. NTL research has led to real-world management outcomes, informing the efforts of individuals, non-governmental organizations, academics, and local, state, tribal, and federal agencies as they work to protect the integrity of these important freshwater resources.



NTL scientist Ted Bier holds up an ice core from Lake Monona, an NTL-LTER study lake in Madison, Wisconsin. Although these lakes develop a thick ice layer over the winter, the duration of the ice-on season has been decreasing at a rate of almost two days per decade.

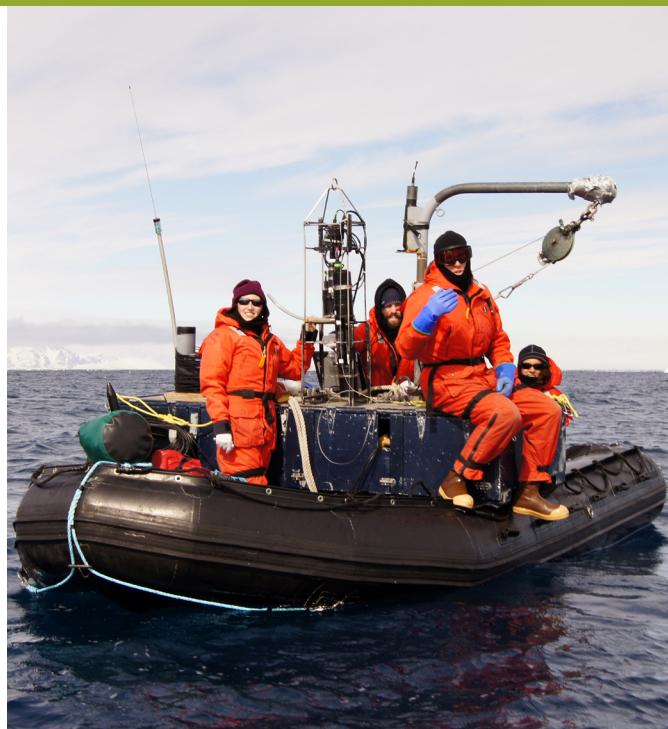


## PALMER STATION ANTARCTICA (PAL)

The West Antarctic Peninsula (WAP) has one of the fastest winter warming rates on earth, which is accompanied by significant declines in sea ice and accelerated melting of glaciers and ice sheets. Since the initiation of PAL in 1991, investigators have studied many aspects of this region including the pelagic marine ecosystem, sea ice habitats, regional oceanography, and terrestrial nesting sites of seabird predators.

A focal point of PAL LTER is investigating the effect of environmental factors and climate on inter-annual variation and long-term ecosystem change. A pivotal study reported in Saba et al. 2014 (see list of publications on p.21) found that inter-annual changes in wind speed can reverberate through sea ice, the water column, and the food web from bacteria to an apex predator, the Adélie penguin.

The results of the study will guide PAL investigators in their endeavors to better understand how long-term changes in climate will impact the ecosystem and how these changes will migrate from North to South along the WAP.



Members of the PAL LTER and Oscar Schofield (Rutgers University) field teams conducting local sampling in the nearshore region about 3 km from Palmer Station, Anvers Island, Antarctica, December, 2014. Photo by Elaine Hood (USAP).



An eddy covariance tower at PIE is used to measure the exchange of carbon dioxide between the marsh and the atmosphere.

## PLUM ISLAND ECOSYSTEMS (PIE)

The goal of the PIE LTER is to develop a predictive understanding of the long-term response of coupled watershed and estuarine ecosystems at the land-sea interface to changes in climate, land-use, and sea level. A major focus is to determine whether salt marshes can survive these rapid environmental changes.

The persistence of salt marshes, and the ecosystem services they provide, depends upon the ability of the marshes to keep up with sea-level rise through carbon storage and the gradual accumulation of inorganic sediment. PIE scientists are carrying out detailed studies of the carbon budget using eddy covariance techniques to measure CO<sub>2</sub> fluxes between the marsh and atmosphere and by measuring tidal fluxes of carbon and inorganic sediments. Additional studies monitor sediment buildup on the marsh platform and examine how salt marsh grasses respond to nutrient inputs and water levels.

PIE scientists work closely with governmental and private organizations to implement policies that will help protect the marsh in the face of rising sea-levels and human development. K-12 education programs focus on hands-on activities for students that include contributing to a long-term database monitoring the impact of marsh restoration activities.

# FUTURE SCENARIOS

The 2014 LTER Mini-Symposium highlighted recent interdisciplinary efforts to understand, anticipate, and adapt to global change through the process of scenario thinking and ecological forecasting. These approaches expand theories of social-ecological change, vulnerability, resilience, and adaptability, and illustrate how long-term data are essential to understand or predict future environmental responses to natural and anthropogenic disturbances. Six speakers from New England to Alaska presented results that use long-term data to improve our understanding of future socio-ecological change.

The advantages of using scenarios include:

- They illustrate alternative future outcomes in ways that anyone can understand.
- They raise many questions about choices and priorities that are appropriate for public discussion.
- They frame new challenges for modeling and research needed to improve our understanding of long-term change in natural systems (agriculture, forests, water supplies, fisheries etc.)

Through public engagement the scenarios raise new questions and topics that should be addressed by future scientific research. Thus they engage the public in the scientific process.

## A LONG VIEW: INTEGRATING STORIES, ART, AND BIOPHYSICAL MODELS TO EXPLORE LONG-TERM CHANGE

**Steve Carpenter**, *North Temperate Lakes LTER*

At NTL-LTER, we have developed four scenarios to depict contrasting states of the Yahara Watershed in 2070. The scenarios show different approaches to land use and land management. NTL researchers are using models to calculate changes in food production, water supplies, water quality, fishing and hunting opportunities, and other ecosystem services. The goal is to understand how land use and land management interact with climate variability to affect food, water, and outdoor recreation opportunities in the region. We hope that the scenario stories and art will help make our findings more accessible to the general public, and open up a broader conversation about land use and land management in the region. The Yahara Watershed includes Madison, the capital city of Wisconsin, and five lakes which are the iconic landscape feature of the region. The current population of the watershed is about 372,000 people and the area is 1389 square kilometers.



An aerial image of Lake Mendota and the Madison skyline. Courtesy of Jeff Miller/UW-Madison Communications.

## CAP LTER SUSTAINABLE FUTURES SCENARIOS

**David Iwaniec**, *Central Arizona Phoenix LTER*

The Central Arizona-Phoenix Long-Term Ecological Research (CAP-LTER) project focuses on Phoenix, an arid urban ecosystem in the Sonoran Desert, and collaboratively addresses city-planning needs by developing sustainable future scenarios for the city by evaluating plausibility-based pathways (what is most likely to happen) and desirability-based pathways (what we would like to happen). This collaborative approach supports the development of the Phoenix General Plan and allows researchers and decision-makers to work as full partners and include extensive public engagement. The scenarios were used to explore possible futures, develop sustainability targets and goals, and articulate future visions through the use of visualization and narratives.



High summer temperatures and lots of asphalt surfaces in the Central Arizona-Phoenix LTER study area create conditions for urban heat islands.



# RECOVERY OF ACID LAKES IN THE ADIRONDACK REGION OF NEW YORK: MODEL PROJECTIONS UNDER DIFFERENT SCENARIOS OF EMISSIONS CONTROLS

Charley Driscoll, *Hubbard Brook LTER*

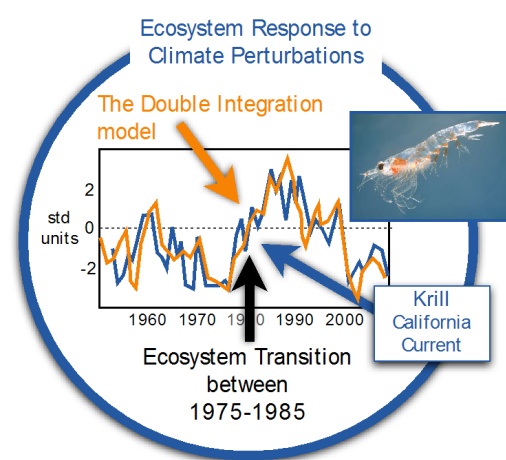


Ice out on Mirror Lake, Hubbard Brook, NH. Photo by Don Buso, Cary Institute of Ecosystem Studies.

Acidic deposition has impaired the structure and function of acid-sensitive forest watersheds in the northeastern U.S. over the past century. Today, despite three decades of air quality programs, many surface waters in the Adirondack region of New York have lowered pH and 128 lakes remain classified as “impaired” due to elevated acidity. We used ecosystem measurements and process studies at the Hubbard Brook LTER to develop the biogeochemical model, PnET-BGC, and improve the understanding of the response of forested watershed to effects of air pollution, changing climate, and land disturbance. Working with the New York State Department of Environmental Conservation and the U.S. Environmental Protection Agency, we related decreases in atmospheric sulfur and nitrogen deposition to changes in Adirondack lake water chemistry. Our analysis suggests that under current air quality management programs most impaired Adirondack lakes will recover over centuries, but that recovery could be accelerated by additional emission controls. About 30% of the impaired Adirondack lakes will not recover regardless of the level of reduction in acid deposition. These lake-watersheds are either naturally acidic or have been acidified by acidic deposition beyond the point of recovery.

## OCEAN ECOSYSTEMS: FORECASTING RESPONSES TO CLIMATE FORCING

Emanuele Di Lorenzo, *California Current Ecosystem LTER*



Long-term ecological indicators in the ocean are often characterized by strong amplitude transitions that persist for decades (see figure). As we try to understand the role of climate in driving these long-term changes in marine ecosystem, it becomes critical to develop basic theories of how marine populations respond to climate perturbations. Researchers from the California Current Ecosystem LTER have developed a simple conceptual model, referred to as the “double integration model” (Di Lorenzo and Ohman, 2013), which helps explain strong state transitions that occurred in marine krill populations between 1975-1985 (see figure at left).

To understand the “double integration model” think of a person, Mark, who is walking down the street and gets a hit by a bicycle. While the hitter (e.g. the bicycle) is long gone, Mark is experiencing pain. This pain will last for a while because of the “physiological” memory of his system (e.g. the body). Now assume Mark goes for another walk while still in

pain, and gets hit again. The new hit will make Mark’s pain even larger, since he is already in pain. Because Mark has the ability to feel the cumulative effects of these multiple hits, we say that Mark has the ability to “integrate” the hits multiple times (e.g. the double integration model). If we apply this simple concept to an ocean ecosystem, where the hits are replaced by weather perturbations over the California Current, we recover the orange timeseries in the figure. This timeseries closely tracks the long-term changes in the krill (blue timeseries). This result indicates that the “double integration” effect of random climate perturbations (e.g. weather) can lead to strong responses in marine populations. This is an important property that may explain the tendency for marine populations to exhibit large-amplitude prolonged changes in their condition (e.g. compare the decadal of 1980-2000 with 1960-1980).

## LAND USE SCENARIOS, ECOSYSTEM SERVICES, AND LINKAGES TO SOCIETY: A NEW ENGLAND CASE STUDY

Kathy Lambert, *Harvard Forest LTER*

The Harvard Forest LTER has integrated stakeholder engagement, land use and ecosystem service modeling, and science communication to understand the drivers and consequence of land use and climate change and inform decision-making in New England. We use modeling to analyze four divergent but plausible land use scenarios developed together with stakeholders in Massachusetts. Our methods involve stakeholders and link spatially explicit large landscape simulation with ecosystem service models in order to ensure salience of the results to society. This expanded research approach enhances our science and its utility to decision-makers and sets us up well to expand the Massachusetts project to northern New England with the support of an NSF RCN-SEES award.



View northwest from Bare Mountain in the Connecticut River Valley. Photo by David Foster.

## FIRE AND ICE: CLIMATE CHANGE AND CHANGING DISTURBANCE REGIMES IN NORTHERN ALASKA

Gus Shaver, *Arctic LTER*

As the world's climate warms, the far northern regions of the Earth are changing rapidly including a general “greening” of much of the Arctic that is probably related to an increase in plant growth and a net storage of carbon in arctic soils, which are mostly underlain by permafrost or permanently frozen ground. This direct response to climate change is accompanied by changes in the frequency and extent of natural disturbances including “thermokarst”, or thermal erosion of permafrost, and a surprising increase in tundra wildfires. The Arctic LTER project uses ecological forecasting and scenarios to determine how the direct effects of a warming climate interact with climate-related disturbances to determine regional carbon and energy balances and how they change. Results of these scenarios are helpful because they allow us to set priorities for future research (“What is the most important thing we need to know next?”) and because they allow us to explore how the Arctic might play an important role in regulating the future global carbon budget.

Although large-area disturbances have been rare in the historic past in northern Alaska, by visiting old wildfire scars of known age it is possible to reconstruct the amounts of carbon lost by combustion in the initial burn and to reconstruct the rates and patterns of carbon recovery by regrowth of vegetation and reaccumulation in soils. It is also possible to measure directly the current rates of carbon fixation and loss by tundra plants and soils in wildfire scars of different age. These data can then be incorporated into models that predict long-term change in carbon balance under a wide range of scenarios of climate change and frequency, severity, and extent of disturbance.

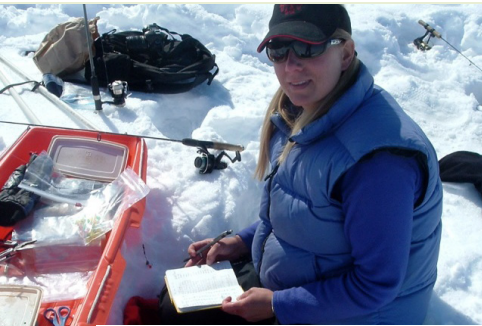
Results of these scenarios indicate that disturbances such as wildfire represent “hot spots” of change that can dominate the regional carbon balance over much larger areas. For example, one fire in northern Alaska in 2007 released as much carbon by combustion alone as is stored in a typical year in an unburned tundra area almost 100 times larger. This loss by combustion was about 50 times greater than the predicted carbon gain due to climate warming for the whole North Slope of Alaska in a typical year. Exploring the implications of these changes in scenarios, the conclusion is that it is more important to know how the total area burned each year will change in the future than it is to know the burn severity or the number and spatial distribution of future wildfires.



Glacial thaw slump on lake NE-14 near Toolik Lake, North Slope of Alaska, in 2007. This feature was roughly 100 m across the widest point at the time this photo was taken. However, the feature has since expanded significantly. Photo by W.B. Bowden.



LTER research not only advances ecological science but also has a positive impact around the globe. Every year, LTER scientists report important discoveries that have practical applications for enhancing human society worldwide.



## ARCTIC (ARC)

**CLIMATE CHANGE AND ARCTIC CHAR** Arctic LTER researchers predicted the effects of climate change on populations of arctic char (*Salvelinus alpinus*) in two Arctic lakes, finding that an increase in consumption rates (28-34%) under climate change scenarios led to much greater growth rates (23-34%). The results indicate that arctic char populations (not just individuals) are extremely sensitive to small changes in the number of ice-free days.

## BONANZA (BNZ)

**HAR(E)D TIMES** The abundance of snowshoe hares across the boreal forests of Canada and Alaska suggest that the population peaks and cycles in synchrony with food availability due to successional dynamics and long-range movements of predators such as lynx. The cyclicity of these species appears to be controlled by ecological processes operating at different time scales.



## CALIFORNIA CURRENT ECOSYSTEM (CCE)

**OCEAN BIOLOGY COUPLED TO OCEAN PHYSICS** Researchers at the CCE site discovered that multi-decadal variations of ocean plankton in the California Current are remarkably well explained by time-lagged responses to ocean variability. Long-term changes in plankton populations can be expressed as smoothed or “integrated” responses to changes in ocean circulation.

## CENTRAL ARIZONA-PHOENIX (CAP)

**SOCIAL-ECOLOGICAL FACTORS** CAP research has shown complex interactions between social and ecological systems at household and neighborhood levels, including: 1) household income is correlated with plant and bird diversity; 2) past land uses influence current soil characteristics; 3) people tend to manage their front and back yards differently due to homeowners’ association restrictions and social considerations; and 4) preferences and attitudes for residential landscapes are influenced by history, gender, culture, and economics.



## CEDAR CREEK (CDR)

**CLIMATE CHANGE CONSTRAINS CARBON CAPTURE** Recent experimental results indicate that water and nutrient limitations may shape how grassland communities respond to rising carbon dioxide ( $\text{CO}_2$ ). Elevated  $\text{CO}_2$  stimulated plant biomass by 33% when summer rainfall and/or nitrogen levels were high, but not at lower supply levels.

## FLORIDA COASTAL EVERGLADES (FCE)

**DROUGHT AND CARBON LOSS** FCE studies of carbon dynamics during extended dry periods showed an increase in carbon losses and changes in greenhouse carbon balance (amount of  $\text{CO}_2$  sequestered/ $\text{CH}_4$  released). Simulations show that prolonged droughts, anticipated with climate change and reduced water availability, will decrease the capacity of wetlands to fix and store carbon.



## GEORGIA COASTAL ECOSYSTEM (GCE)

**BLUE CARBON** The sources and sinks of carbon in the coastal ocean are important, but little understood components of the global carbon budget. GCE research reveals extremely high levels of metabolism of wetland-dominated estuarine systems in the global ocean and the overall importance of organic C burial in wetland sediments—called ‘blue carbon’—representing a significant portion of the net air-sea flux of  $\text{CO}_2$  to the coastal ocean.

## HARVARD FOREST (HFR)

**OLD FORESTS STORE CARBON** Research based on ground and air measurements at the Harvard Forest shows that as global warming has brought earlier springs and later autumns to the NE United States over the past 20 years, northeastern forest trees have been able to store as much as 26 million metric tons more carbon dioxide than before.



## JORNADA BASIN (JRN)

**SCALE-DEPENDENT FEEDBACKS IN DESERT GRASSLAND** JRN researchers showed that the patch size of dominant perennial grasses in a dryland environment was related to its rate of reproduction, with grass plants within medium-sized plots being more productive than those in smaller patches or in the interiors of the largest patches, adding to better understanding of dryland vegetation dynamics.

## KELLOGG BIOLOGICAL STATION (KBS)

**EXOTIC LADYBEETLES DISPLACE NATIVE SPECIES** Across North America ladybeetle communities, important predators of pest insects, are increasingly dominated by exotic species. KBS researchers found that exotic species that dominate tend to be larger and more voracious and can out-compete native species with which they share diet. In response, some native species have shifted to foraging in woodlots in agricultural areas, where prey is scarcer.







## LUQUILLO (LUQ)

**PRODUCTIVITY AND COMMUNITY STRUCTURE** Spatial variation in population (species abundances), community (species richness, evenness, diversity), and meta-community characteristics of snails in the Luquillo Mountains are molded by variation in productivity. Thus, changes in productivity driven by climate change could have widespread ramifications for the biodiversity and structure of local species.

## MCMURDO DRY VALLEYS (MCM)

**HIDDEN ECOSYSTEM IN ICE** Researchers at the McMurdo Dry Valleys in Antarctica have found that water-filled holes just beneath the glacier surface are biological hotspots for cyanobacteria and other life in an otherwise clean icy landscape. Unlike glaciers in temperate regions, these holes freeze over entombing the organisms in a subsurface pool of water that freezes and melts out annually.



## NIWOT RIDGE (NWT)

### HETEROGENEITY PROVIDES RESILIENCE TO ENVIRONMENTAL CHANGE

Long-term research at NWT indicates that alpine tundra landscape has maintained its remarkable diversity over the past 25 years, despite increased warming and nitrogen deposition. The key to this resilience appears to be environmental heterogeneity. This resilience, however, is being threatened by shrubs, which are expanding at exponential rates.

## SANTA BARBARA COASTAL (SBC)

**SIMULATIONS OF FRESHWATER PLUMES** Freshwater plumes from creek runoff can deliver large amounts of material to coastal marine ecosystems, but are difficult to measure because they are sporadic, short-lived, and buoyant. SBC researchers have developed state-of-the-art simulations that help quantify the delivery of nutrients and other dissolved substances to coastal marine ecosystems.



## VIRGINIA COAST RESERVE (VCR)

**BARRIER ISLANDS ARE BISTABLE** Barrier island response to climate change is difficult to predict and was thought to occur gradually. VCR researchers have demonstrated the bistable nature of barrier islands (i.e., a tendency for islands to exist in a topographically high or low state), which implies that barriers are likely to change abruptly in the future as sea level rises and strong storms increase in frequency.

# 2014 HONORS AND AWARDS

This section honors LTER scientists who received special recognition in one form or another during the year.

1. **Elizabeth Borer** (CDR) was chosen to participate in the Leopold Leadership program run by the Stanford Woods Institute for the Environment at Stanford University.
2. **Craig Carlson** (SBC/MCR) was awarded the 2015 G. Evelyn Hutchinson Award from the American Society of Limnology and Oceanography (ASLO).
3. **Jeannine Cavender-Bares** (CDR) was chosen to participate in the Leopold Leadership program.
4. **Peter Doran** (MCM) joined Louisiana State University as the first holder of the John Franks Endowed Chair.
5. **Sergio Fagherazzi** (VCR) received the Augusto Ghetti Prize from the Venetian Academy of Arts and Sciences in 2014 for his studies on the Venice Lagoon, Italy.
6. **Florida Coastal Everglades** LTER received the Provost's Award for Excellence in Research and Creative Activities from Florida International University.
7. **Janet Franklin** (CAP) was elected to the National Academy of Sciences.
8. **Katherine L. Gross** (KBS) was appointed chair of the Advisory Committee for Biological Sciences (BIO AC) of the National Science Foundation.
9. **Steve Hamilton** (KBS) received the 2014 Petoskey Prize for Environmental Leadership by the Michigan Environmental Council (MEC).
10. **Harvard Forest** LTER was awarded the 2014 Human Diversity Award by the Organization of Biological Field Stations in recognition of its Summer Research Program, now in its 25th year of training undergraduates from around the country in ecology and conservation.
11. **Diane McKnight** (MCM) was awarded the 2014 Hydrology Career Award by the American Geophysical Union.
12. **Mark D. Ohman** (CCE) was named a Fellow of the American Association for the Advancement of Science (AAAS) and cited for "distinguished contributions to marine plankton research, notably in using zooplankton populations to document and investigate mechanisms of ocean response to climate variability."
13. **John Prisco** (MCM) received the Edward O. Wilson Biodiversity Technology Pioneer Award for his outstanding scientific research, advocacy and public outreach regarding biodiversity.
14. **Peter Reich** (CDR) was listed in Thomson Reuters "The World's Most Influential Scientific Minds 2014" for Environment/Ecology.
15. **Roger Ruess** (ARC) was issued the 2014 Emil Usibelli Distinguished Research Award by the University of Alaska, Fairbanks.
16. **Elena Sparrow** (ARC) was issued the 2014 Emil Usibelli Distinguished Service Award by the University of Alaska, Fairbanks.
17. **Katharine Suding** (NWT) transitioned in as Principal Investigator for the NWT LTER program.
18. **David Tilman** (CDR) received the Balzan Prize for Basic/Applied Plant Ecology in recognition of his outstanding scholarly contributions in ecology. In December 2014 he was also awarded the Premi Ramon Margalef Award for Ecology by the Spanish state of Catalonia. The year also saw Tilman listed in Thomson Reuters "The World's Most Influential Scientific Minds 2014" for Environment/Ecology.
19. **Monica Turner** (NTL) became president-elect of ESA (August 2014-August 2015), but will assume full presidency from August 2015-August 2016.
20. **Enrique Vivoni** (CAP) was named a recipient of the 2014 Walter L. Huber Civil Engineering Research Prize by the American Society of Civil Engineers.
21. **Diana Wall** (MCM) was inducted into the American Association for the Advancement of Science (AAAS)





## A short listing of important LTER papers published in major ecological journals in 2014.

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- Farrer, E.C., Ashton, I.W., Knape, J., and Suding, K.N. 2014. Separating direct and indirect effects of global change: a population dynamic modeling approach using readily available field data. *Global Change Biology* 20:1238-1250. doi: 10.1111/gcb.12401.
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## HEMLOCK: A FOREST GIANT ON THE EDGE



### HEMLOCK *A Forest Giant on the Edge*

**Foster, D. R., Baiser, B., Barker Plotkin, A., D’Amato, A. W., Ellison, A. M., Orwig, D. A., Oswald, W. W., Thompson, J. R. 2014. Hemlock: A forest giant on the edge. Yale University Press, Yale University.**

A new LTER book, *Hemlock: A Forest Giant on the Edge*, edited by Harvard Forest director David Foster and co-authored by seven Harvard Forest research colleagues, draws from a century of long-term studies at the Forest. The authors reflect on eastern hemlock’s irreplaceable value to human culture, ecosystems, and scientific research – and what the tree’s decline can tell us about the challenges facing nature and society. The book is geared toward a broad audience and excerpts have been published in *Orion*, *Northern Woodlands*, *Arnoldia*, and *Forest History Today*.

According to Peter Raven, President Emeritus, Missouri Botanical Garden, the book is “a nuanced and lovely account of the challenges facing the Eastern hemlock today, projecting its greatly diminished future in our woods, and reflecting on the rapid alteration of our planet to which we all too often remain blind.”

Added Margaret Lowman, author of *Life in the Treetops* and *It’s a Jungle Up There*: “[This book] has the potential to serve as an important, even landmark volume, about the landscape history of New England and North America in general.”

Learn more at [harvardforest.fas.harvard.edu/hemlock](http://harvardforest.fas.harvard.edu/hemlock).



## CORE RESEARCH AREAS

Five research themes, known collectively as the Core Areas, are central to LTER Network science:

1. Pattern and control of primary production
2. Spatial and temporal distribution of populations, selected to represent trophic structure
3. Pattern and control of organic matter accumulation in surface layers and sediments
4. Patterns of inorganic inputs and movements of nutrients through soils, groundwater and surface waters
5. Patterns and frequency of site disturbances

These Core Areas require the involvement of many scientific disciplines, over long time horizons and broad geographical scales. Core Area data are collected at regular intervals, so information about an ecosystem's existing condition can be established prior to any experimental manipulation.

## CROSS-SITE RESEARCH AND SYNTHESIS

The scientific infrastructure that the Network has built over the years – including the maintenance of databases and protocols in support of data discovery and acquisition – promotes and facilitates cross-site and regional analyses, leading to larger-scale synthesis and the development and testing of ecological theory.

The LTER Network offers the greater ecological research community, including students and foreign scientists, the opportunity for long- and short-term projects appropriate to individual sites, a group of sites or the Network as a whole.

## INTERNATIONAL COLLABORATION

As a founding member of the ILTER Network, the U.S. LTER Network plays a central role in studying global ecological issues. Many LTER sites perform observations and conduct experiments with global partners. For example, LTER sites are working to study global comparisons of forest structure through the Center for Tropical Forest Science at the Smithsonian Tropical Research Institute. That program includes sites in 21 countries, encompassing 4.5 million individual trees from 8,500 species.

## INFORMATION MANAGEMENT

When the LTER Network was first founded, scientists manually entered relatively small amounts of ecological data on an annual basis. Today, network sensors acquire much larger volumes of data each week. To address these changes, each research site has developed a system that supports its unique data life-cycle needs, from data acquisition through publication.

Successful communication and coordination between the LTER Network Office and site information managers supports the LTER Network's research agenda, and has helped produce these results:

- Common metadata standards
- Standard approaches to information management
- Centralized information architecture for strategic data integration
- Data stewardship
- Curated data storage that promotes Network synthesis
- Creation of data legacies

## EDUCATION

LTER research provides a variety of unique educational opportunities to students at all academic levels – K-12, undergraduate, graduate and post-doc. The LTER science community includes academic and government scientists and educators, graduate and undergraduate students, and professional staff. As centers of excellence in ecological research, LTER sites hosted by universities, government agencies and non-profit research institutions also provide important training grounds for the next generation of scientists and leaders.

**THE LTER NETWORK** is recognized internationally as one of the longest-lived and most successful large groups conducting ecology research. For more than three decades, the Network has provided the scientific expertise, research platforms and long-term datasets necessary to document and analyze pressing environmental changes. With nearly 2,000 scientists, educators and students, the Network consists of 25 competitively chosen sites in the continental U.S., Alaska, Antarctica and islands in the Caribbean and Pacific. These sites span agricultural lands, alpine tundra, barrier islands, coastal lagoons, cold and hot deserts, coral reefs, estuaries, forests, freshwater wetlands, grasslands, kelp forests, lakes, open ocean, savannas, streams and urban landscapes.



#### SITE KEY

AND – Andrews Forest  
 ARC – Arctic  
 BES – Baltimore Ecosystem Study  
 BNZ – Bonanza Creek  
 CCE – California Current Ecosystem

CDR – Cedar Creek  
 CAP – Central Arizona - Phoenix  
 CWT – Coweeta  
 FCE – Florida Coastal Everglades  
 GCE – Georgia Coastal Ecosystems  
 HFR – Harvard Forest  
 HBR – Hubbard Brook

JRN – Jornada Basin  
 KBS – Kellogg Biological Station  
 KNZ – Konza Prairie  
 LUQ – Luquillo  
 MCM – McMurdo Dry Valleys  
 MCR – Moorea Coral Reef  
 NWT – Niwot Ridge

NTL – North Temperate Lakes  
 PAL – Palmer Antarctica  
 PIE – Plum Island Ecosystems  
 SBC – Santa Barbara Coastal  
 SEV – Sevilleta  
 VCR – Virginia Coast Reserve



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