Findings of the LTER Network Office
Cooperative Agreement DEB-0832652
May 1, 2011-April 30, 2012

INTRODUCTION

The Long Term Ecological Research (LTER) Network Office (LNO) advances LTER objectives by supporting research, education, information management, and governance activities of the LTER Network and its committees and working groups. The LNO provides financial and human resources, staff expertise, and organizational support to achieve objectives defined in the LTER Strategic and Implementation Plan (LTER 2011). The LNO responds to the LTER Executive Board and its elected Chair, who annually review and revise actions required by the LNO to achieve these objectives.

The National Science Foundation (NSF) funds the operations of the LNO through two cooperative agreements with the University of New Mexico (DEB-0832652 and DEB-0936498). Under these agreements, the LTER Network Office (LNO) conducts activities in four thematic areas: Synthesis, Cyberinfrastructure, Core Services, and Development/Outreach. The LNO Operational Plan, approved by NSF in September 2010, describes the operational steps needed to successfully complete activities under each of the four thematic areas. This report focuses on progress on activities supported through funding from DEB-0832652.

ACCOMPLISHMENTS DURING YEAR 3

The LNO successfully completed a series of scheduled activities including planning and execution of governance and scientific meetings as well as a new solicitation for research and training working groups. Support for new Network synthesis activities resulted in successful proposals to NSF's Macrosystems Biology program and publications including a special feature of the journal *BioScience*. Support for post-doctoral fellows contributed to successful research working groups that are producing publications, proposals, and new synthetic databases.

Close coordination of site and Network information management activities led to significant progress in improving access to LTER data through site and Network data portals. Software development of the PASTA (Provenance Aware Synthesis Tracking Architecture) framework for the LTER Network Information System (NIS) culminated in the completion of a prototype system on schedule. Improvements in informatics approaches and tools increased quality of LTER data and metadata in anticipation of the completion of a production version of the NIS in 2014.

The LNO continued to provide key services to the Network and sites and managed core operations fundamental to Network activities. Successful proposals to NSF provided funds for the 2012 All Scientists Meeting and dues for membership in the International LTER Network. LNO participation in the 30-Year Review process contributed to a successful evaluation of the LTER program.

Implementation of new strategic objectives in communication included the development of an electronic newsletter to replace the paper version and a re-designed web page. In association with the editors of the *BioScience* special feature, an intensive outreach effort led to widespread distribution of LTER research results through a broad range of media outlets. The LNO contributed to the maintenance of existing and the development of new strategic partnerships. One collaboration with EarthSky Communications led to a proposal for widespread distribution of LTER science through the EarthSky radio network.

FINDINGS DURING YEAR 3

Thematic Area 1 - Synthesis

Science Council. Support annual meetings of the Science Council as well as planning meetings in support of its activities.

The LNO, working with the LTER Chair, a program committee, and scientists at the host Georgia Coastal Ecosystem (GCE) LTER site, organized a very successful 2011 LTER Science Council meeting. The meeting, with a theme of "The Role of Long-Term Ecological Research in Understanding and Responding to Climate Change", included presentations from nine LTER researchers, as well as breakout sessions focusing on potential future research activities.

The meeting was held on Jekyll Island, Georgia, near the GCE LTER site. An afternoon field trip to the site, as well as evening poster sessions, gave LTER researchers an opportunity to become familiar with GCE research. The meeting website is available at: http://intranet2.lternet.edu/content/2011-lter-science-council-meeting. Preparations were also begun for the annual meeting in 2012, to be held at the H.J. Andrews LTER site.

Products from the meeting included:

- Continued progress on seven articles for the *BioScience* special feature

- Preparation for a symposium at the annual meeting of the Ecological Society of America
- Development of a topic and program committee for the 2012 mini-symposium at NSF
- A status report on the Future Scenarios Initiative presented by David Foster.   A version of the project involving six forested LTER sites went forward as a Macrosystems Biology proposal, and efforts are continuing to inform potential stakeholders within federal agencies and NGOs of the value and vision of the larger effort.
- A status report on the Synthesis Data Initiative

All Scientists Meeting. Foster integration within and among Network research projects by organizing periodic meetings of the entire LTER research community.

During 2011, the LNO worked on initial plans for the triennial LTER All Scientists Meeting (ASM) to be held in Estes Park, CO in September 2012. The LTER Executive Board (EB) approved a return to the same venue after results from exit surveys of the 2009 meeting showed that a majority of respondents would choose the location again. Working with the LTER Chair, the LTER Network Office (LNO) formed a program committee, made preliminary arrangements and down payments to the YMCA of the Rockies, confirmed the professional meeting coordinators (the Schneider Group), developed an initial program, and designed a website for the meeting: http://asm2012.lternet.edu/

Research Working Groups. Provide support for Network research goals by funding working groups and intensive research visits for project scientists and facilitating planning and visioning meetings to address the objectives of the Decadal Plan.

The LNO solicited proposals from the LTER community for new synthesis activities in 2012 including Research Working Groups and post-doctoral projects. The Executive Board selected six proposals for Research Working Groups and three proposals for post-doctoral projects for funding. Details of these new proposals, as well as results from previous working groups, are at the revised and updated Intranet page for working groups (http://intranet2.lternet.edu/working-groups).

Twelve cross-site research efforts initiated in 2010-11 resulted in a number of submitted publications and proposals during the last year. Examples include articles appearing in the *BioScience* special feature (Knapp et al. 2012, Jones et al. 2012), synthesis papers related to microbial research, development of a stream hydrochemical database (StreamChemDB), a manuscript on State Changes and Threshold Dynamics submitted

to PNAS, presentations at professional meetings, and a follow-on workshop and proposal from a project on Quantifying Uncertainty in Ecosystem Studies (QUEST). Other products are in development from follow-on activities of these working groups.

Meetings by two of the four research prospectus working groups (Future Scenarios, Disappearing Cryosphere) produced manuscripts for the *BioScience* special feature (Thompson et al. 2012, Fountain et al. 2012).

Thematic Area 2 - Cyberinfrastructure

<u>Basic Cyberinfrastructure Support. Provide basic cyberinfrastructure support to the LTER Network to enable collaboration, communication, and security.</u>

❖ *Operation of video-teleconferencing services for LTER committees and working groups*

LNO staff continues to operate the Polycom video-conferencing bridge that supports group meetings over the internet. In addition to regular meetings of the Executive Board (9), Information Management Executive Committee (9), and the Information Management Committee (22), LNO staff supported conferences for working groups and sites, and water-cooler meetings on topics such as improved data access.

The most recent biennial survey of LNO performance included questions addressing the effectiveness of video-teleconferencing services. Of the survey respondents who had been part of an LNO-assisted teleconference, 75% were satisfied or very satisfied with the results. Based on comments from the survey, the existing video-teleconferencing help sheet for research groups will be updated to include some of the new technologies that are now available including Skype, EVO, and Google+. These technologies should help the LNO reach the 80% of survey respondents that have never used video-conferencing.

❖ *Web presence improvements for collaboration and presentation*

Members of the LNO staff developed a new, fully integrated Intranet framework. The new framework brings together formerly disparate functions, including the document archive, Network News, Databits, Calendaring, Committee pages, working group proposals, reviews, results, and timely news and announcements.

LNO staff worked with the LTER Communications Committee to create a prototype for a new public-facing LTER web presence (homepage). Development of the new homepage involved extensive discussions of user needs and requirements gathering.

Content is currently being rewritten and checked for accuracy before the new prototype's release in May 2012.

New "feedback forms" are prominently displayed on all of the new web installations. Responses are directed to the tech-support software, where they are queued for review.

LNO staff used software tools to track, find, and repair broken links as part of a concerted effort to improve the quality of the LTER Network web experience. In addition, Google Analytics is being used for tracking the usage of new LTER web sites.

Response to user requests have become more rapid with the hiring of Leanne Yanabu as the web designer intern and Yang Xia as the Network Information Manager (NIM); together Yanabu and Xia have significantly improved response and ticket resolution times, and shortened response times have increased the use of the tech-support system by the community.

❖   *Technology improvements.*

The LNO joined the Research Storage Consortium, a group of five center-like research efforts - four of which receive funding from NSF- that has leveraged LNO's influence and funding to purchase a Petabyte-scale managed storage system. The HP9000 IBricks storage system is located in the UNM Center for Advanced Research Computing (CARC), which began to provide access to almost 300 terabytes (TB) of storage in January 2012. Partners in the system include CARC, the University Libraries, DataONE, and the Earth Data Analysis Center. The LNO will use the storage system as secondary storage for our 30TB storage system and virtual server platform that arrived in April 2012. The implementation includes a network-accessible TB of off-site storage for each of the LTER sites.

LNO staff has been testing cloud server installations and has recently brought the first production-grade server for LTER online in the Amazon EC2 cloud. The server monitors PASTA services and provides reports and notifications on system state-of-health. LNO staff will be moving additional production and production warm-standby servers to cloud installations in 2013.

❖   *Communication.*

In 2010, LNO acquired three Mediasite Rich-Media Recorders. Since then, LNO staff have captured and streamed the annual LTER NSF Mini-Symposium from Arlington, VA. Several LTER Working Groups have requested the use of the recorders. The PASTA Working Group captured demonstrations of PASTA workflows in March 2012.

The 2012 Mini-Symposium was watched live by 36 viewers. Over 70 viewers have watched the on-demand version of the symposium's presentations to date. Comparing these numbers to the last two previous symposiums, there has been trend toward on-demand viewership with 54 on-demand views in 2010 and 41 on-demand views in 2011. The comparison does not include the viewership of the individual presentations, which vary significantly based on topic.

Later this year, LNO staff will capture plenary and other presentations from the 2012 LTER All-scientists meeting; live streaming will not be available due to the limitations of bandwidth at the YMCA of the Rockies.

❖ *Cyber-security and Data Management Web-based information events.*

LNO staff prepared and released three cybersecurity and data management briefings in 2011/2012. The titles were "How to Write a Data Management Plan for a National Science Foundation Proposal", "On the Road: Fear and Living with Public Computing", and "Do you have Password Fatigue?" These two-page briefings were well received by readers. The "data management plan" briefing is still circulating on some college research lists.   All but one of the survey respondents who viewed the briefings found them useful.

Information Management. Improve information management (IM) for the Network by supporting communication and coordination among Site Information Managers (SIMs), strategic data integration, data stewardship, curated data storage, and other data operations that promote Network synthesis and the creation of data legacies

❖ *Information Management Committee (IMC) meetings.*

LNO staff supported both Information Management Committee and Information Management Executive Committee (IMExec) meetings this year in September 2011 and April 2012, respectively. The IMC met their goals for these meetings by producing both the LTER Controlled Vocabulary and the Ecological Metadata Language (EML) Best Practices for LTER Sites Version 2. The IMC is now positioned to complete quality standards for LTER data that will be published to PASTA. The IMExec post-meeting survey indicates that 18 of 21 survey respondents found the 2010 meeting productive and a valuable use of time.

❖ *Information Management working groups and Site Information Manager travel*

The LNO supported six IM "product-oriented" working groups and four IM site compensation efforts:

A. Working groups (name, investigator, product):
1. LTER Controlled Vocabulary - John Porter - LTER Controlled Vocabulary
2. Network Database Web Services - Karen Baker - Requirements for Personnel Database
3. LTERMaps Phase II - Theresa Valentine - Map-based interface to site characteristics
4. NIS Workflow best practices - Corinna Gries - in progress
5. Data Package quality definitions - Margaret O'Brien - in progress
6. Site Characteristics re-design - Don Henshaw - in progress
B. IM compensation (name, investigator, product):
1. EML reports and congruency - Margaret O'Brien - report of EML quality across sites
2. Network Database Web Services phase 1 - Mason Kortz - first iteration of personnel database code
3. EML diagnosis and best practices mentorship - Gastil Gastil-Buhl - in progress
4. LTER Atlas – Jamie Hollingsworth – interactive LTER atlas, demonstrated for Science Council in May 2012

In addition, the LNO funded travel for IM compensation recipients to participate in working groups and to work at LNO.

❖ *Maintain Network databases*

The LTER Network databases consist of the Personnel, Bibliography, and Site Characteristics Databases and their associated web applications. The LNO Information Manager is responsible for the maintenance and curation of these data. LNO staff migrated the current web interfaces for the three databases to a new server and implemented a new login and security procedure for working with these databases.

As part of the maintenance of the Site Characteristics Database, LNO staff developed a new site characteristics table that attempts to characterize sites based on common ecological variables (http://intranet2.lternet.edu/content/site-characteristics).

Based on survey results from sites, reworking the database interfaces is highly desired, and the LNO will consider asking the EB to increase the priority and resource allocation to this work. LNO staff participated in requirements analysis and development of code for re-tooling the current database interfaces into a Service Oriented Architecture (SOA) framework similar to the work being done for the NIS Data Portal as part of the Provenance Aware Synthesis Tracking Architecture interface.

Many sites have been refining and reloading their local all-site bibliography entries in response to a 2011 call for updates. LNO staff have assisted with these requests.

❖ *Migrate existing and create new Network databases.*

LNO staff have completed the first operational year of the ClimDB/HydroDB databases following the successful migration from the Andrews LTER site. The LTER Information Manager has been busy cleaning metadata, adding new stations, and helping sites with their updates. LNO staff migrated the web application component from a Windows IIS server to a Linux Apache web server - this change has greatly improved performance of the server. Over 50% of survey respondents said they rely on information provided by the ClimDB/HydroDB database, so keeping this database sound and updated is an ongoing priority.

❖ *Development of NIS derived data products that extend the LNO EcoTrends data and application work.*

The North Inlet (NIN) LTER data and the EcoTrends time-series data have been identified as exemplary datasets for inclusion in the nascent Network Information System. LNO staff have been busy in early 2012 reformatting the archived NIN data to make it PASTA compliant by adding compatible EML documentation and converting the "fixed-column" data structure into more digestible comma-separated value format. These data packages are being prepared by the LNO information manager and checked by Gastil Gastil-Buhl (MCR) as part of an IM compensation program.

Work began in spring 2012 on recovering time-series ecological variables from the EcoTrends database. This work will form the basis for another Operational Plan task that involves writing computational workflows to update EcoTrends data from site-based data found in PASTA.

Network Information System. Complete the design, development, and implementation of the LTER Network Information System in collaboration with NISAC, IMC, and strategic community partners.

The LTER Network Information System (NIS) has seen considerable development this year and is on schedule to release a functional prototype at the end of May 2012. Effort has focused on five major areas of the NIS Provenance Aware Synthesis Tracking Architecture (PASTA): data package management, identity management, system auditing, system monitoring, and a web-browser interface (see figure below).
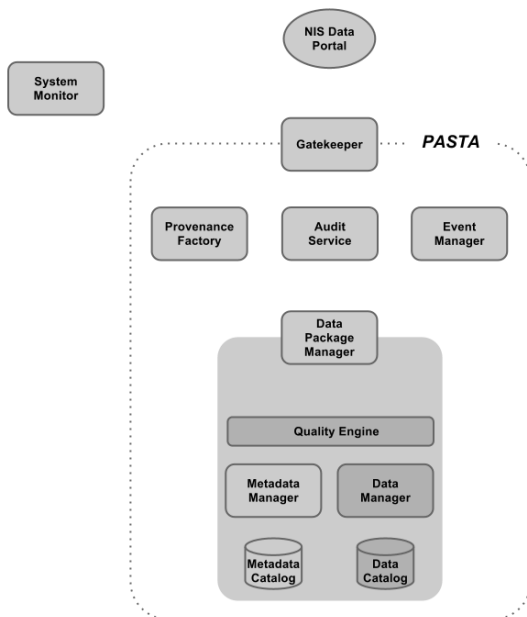
❖ *Data Package Management*

PASTA now supports a full data package life cycle that harvests site-based data packages (both metadata and data) into its persistent archive as Level-1 LTER Network data products. All data packages are screened for accuracy and quality before becoming a data package in PASTA. This screening process is part of the "Quality Engine" component of the Data Package Manager service. The Quality Engine evaluates each incoming data package for metadata and data congruency (i.e., how well does the metadata describe the structural format of the data).

Data packages in PASTA may be discovered using metadata specific terms through the Data Package Manager Service. All data packages in PASTA are considered first-class resources and may be described in the context of RESTful web-service URLs; that is, all data packages are addressable and accessible through a web-service URL as part of the Data Package Manager application programming interface (API).

A data package consists of (1) a resource map, (2) metadata, (3) data, and (4) a quality report. The resource map is a list of URLs that reference each part of a data package (including a self-referencing URL); semantic relationships will be built into the resource map later. Metadata is standardized on the Ecological Metadata Language (EML) 2.1.0

specification and is returned upon request in its native XML format. Science-based metadata content is replicated directly from the original site-based metadata; PASTA-based curation and data location information are the only new metadata added to the Level-1 data package. Data entities are stored and accessible in their original format. The quality report, which is generated by the "Quality Engine" during a successful harvest, is also stored and accessible as an XML document.

❖   *Workflow Manager (Transformation Engine)*

The Workflow Manager Service has changed focus from a fully supported workflow environment to one that manages event notifications when a data package is inserted or updated in PASTA. A first release prototype of this new service, called the Event Manager, was completed in 2010 -2011.

❖   *Metadata Factory (Provenance Tracking)*

A first release prototype of the Metadata Factory was completed in 2010 -2011.

❖   *NIS Data Portal*

General user access to PASTA is being prototyped through the NIS Data Portal. The NIS Data Portal supports user authentication and access to a set of user interface tools for interacting with PASTA. These tools include "data package management", "simple search and discovery", and "event subscription management".

Technically speaking, the NIS Data Portal is not a part of PASTA, but rather, it is a web-browser application that uses the PASTA service oriented architecture to meet the needs of the LTER community as the web user-interface of the Network Information System. It also serves as a reference implementation for the use of the PASTA service API. The NIS Data Portal provides tools for use by both LTER information managers who, together with site scientists, produce data packages and LTER/community scientists, who consume data packages. The NIS Data Portal is available at https://portal.lternet.edu.

❖   *Discovery/Access Application Programming Interface (API)*

In addition, technical programming information about the underlying PASTA services has been published as the "PASTA Discovery and Access API". Each PASTA service provides a set of RESTful web-service methods that form their own unique application programming interface. Collectively, this set of APIs defines the "PASTA Discovery and Access API". This API, which is demonstrated by the NIS Data Portal, is publicly available for other communities to develop rich web-applications that are based on PASTA to access LTER data products.

❖ *Identity Management Services*

Identity management in PASTA is divided into components that provide authentication and authorization services. Authentication is the process of verifying a user's identity. PASTA performs this task for users of the LTER community by comparing credentials (login and password) provided by the user to those stored in a secure database (LDAP). If a user is successfully authenticated, they are assigned a short-lived token that may be used in lieu of credentials for each PASTA interaction. This token does not contain the user's password and, therefore, reduces security exposure if compromised.

Both authentication and token validation (i.e., is the token "real" and "not expired") is performed by a single sentinel-service called the "Gatekeeper". All interactions with PASTA must go through the Gatekeeper before reaching their final destination. Not all interactions, however, require user authentication. By default, a non-authenticated user may access any data package resource that is considered "publicly" available.

Managing access to data packages and other PASTA resources is the domain of authorization. The authorization service uses "access control rules", defined in the same syntax used by EML, to determine if a user is allowed to (1) execute a PASTA service and (2) access a resource in PASTA. Because the authorization process is standardized across all PASTA services, any service may implement access control over a resource it manages. Together, authentication and authorization form the backbone of identity management.

❖ *Persistent Identifier Services*

The objective of the Persistent Identifier was accomplished through the web-service design of the entire project and is no longer a target for direct software development.

❖ *System Monitor*

The System Monitor operates outside of the PASTA framework to monitor more effectively the "state-of-health" for all PASTA services. The System Monitor is a 3rd party application called "Nagios" that provides a web-browser interface for reporting purposes and an application programming interface that allows custom monitor software to be integrated into the Nagios infrastructure. To date, the System Monitor uses the default Nagios application to monitor PASTA services and to alert system administrators of any service malfunction.

❖ *Audit Services (formerly, Data Access Server)*

Audit services provide an end-point for other PASTA services to record "event-based" information. Event based information includes any note-worthy event that is deemed important to record for real-time or future use. The Audit service is a web-service that receives and stores event information and provides a report interface to retrieve and filter the recorded event information. Recording an event is available only to services internal to PASTA, but a report may be generated and accessed from outside of PASTA. Filters include date and time, category (debug, information, warning, and error), and the service that created the record.

❖ *Integration of Network databases into the LTER NIS.*

- Integration path for EcoTrends and ClimDB/HydroDB - The implementation plan for ClimDB/HydroDB was developed by the Chief Information Officer (CIO) and Network developer and reviewed by NISAC in 2011. It involves a stepwise process of increasing the use of PASTA to supply data to the ClimDB/HydroDB web application until the functionality of the new NIS data portal exceeds the functionality of the old application. Once the functional prototype is in place, the NIM will begin prototyping the workflows to extract data from PASTA and insert it into the ClimDB/HydroDB web application database. Likewise, the IMC is developing an EML template for the inclusion of current harvestable ClimDB/HydroDB data into PASTA.

  Select EcoTrends time series data will be harvested into PASTA and be made available through the NIS data portal. The LTER NIM will assess the feasibility of producing annual updates based on the availability of site data in late 2012. The most feasible annual updates will become prototypes for the workflow processing projects described below.

- Online analysis and processing of LTER NIS data - Online analysis and processing of LTER NIS data will occur when the PASTA release is finalized.

- Site-based data integration into LTER NIS Data Modules - Working groups and LNO staff are developing a service-oriented approach (SOA) to managing the network databases (see above). The inclusion of these databases into the same SOA framework as PASTA will make them virtually integrated into the NIS. The first production class prototype will be available for the personnel database in late 2012. The PASTA developers participate in the working groups but are not responsible for the direction and functionality. Milestones are on-track for the

personnel database only. The bibliography and site characteristics databases are beginning use case descriptions in 2012.

- Project Specific Data Services - Project Specific Data Services will occur when the PASTA release is finalized.

<u>IT, Database, and Web Consulting. Provide IT, database, and web consulting to LTER sites and synthesis working groups.</u>

❖ *Technical support*

The Senior Web Designer, Marshall White, recently completed work on website development projects requested by Sevilleta (SEV) and Luquillo Experimental Forest (LUQ) LTER sites. These sites wished to develop a web presence utilizing the Drupal content management system and requested help from the LNO in doing the initial setup of these sites. White and the System Administrator also provided technical support to Hubbard Brook Experimental Forest (HBR) in developing their web and database server in a virtual environment. The System Administrator aided the Controlled Vocabulary Working Group and the Network Databases Working Group in establishing virtual servers for their work.

In 2012, the Executive Director (ED) and CIO will develop a revised process for handling support requests that exceed the bounds of normal daily tasks. The initial process for handling requests developed and vetted by the CIO does not have an adequate system for advertising the availability of resources and determining priority of resources.

Evaluation of need and usefulness of the technical support service to sites is difficult because of the phrasing of questions in the annual survey is aimed specifically at short-term technical support responses, rather than longer-term technical support.

❖ *Site visits*

The CIO made visits to information managers and investigators at Coweeta Hydrological Laboratory (CWT), Georgia Coastal (GCE), Shortgrass Steppe (SGS), Niwot Ridge (NWT), and McMurdo Dry Valleys (MCM) in 2011. The ED was present for the NWT, SGS, and MCM visits. These visits were for information exchange and were well received by the sites. Continuing these visits is critical to maintaining good relations with site management personnel. No site visits are planned yet for 2012 because of the All Scientists Meeting.

2011 is the first year that site visits were conducted and so evaluation of this service in the annual survey will not be possible until the next survey.

Thematic Area 3 - Core Services

<u>Facilitation of Meetings and other LTER Activities. Provide financial and logistical support for meetings of Network governance and scientific communities</u>

During the 2011-2012 project period, the following meetings were successfully held: one Science Council meeting in Jekyll Island, GA; two Executive Board meetings – one in Arlington, VA and one in Jekyll Island, GA; one LTER Mini-Symposium in Arlington, VA, in conjunction with a National Advisory Board meeting. There was one NISAC meeting in Albuquerque, NM, one Information Management meeting in Santa Barbara, CA, and finally one Information Management Executive Committee meeting in Albuquerque, NM.

Name of meeting	Date	Location	Attendees	Cost
Science Council	May 18-20, 2011	Jekyll Island	59	$ 89,251
Executive Board	May 17, 2011	Jekyll Island	16	Part of SC Costs
Information Management	September 27, 2011	Santa Barbara	26	$ 34,224
Executive Board	Feb 29-March 2, 2012	Arlington, VA	16	$ 34,100
LTER Mini-symposium	March 1, 2012	Arlington, VA	8	Part of EB Costs
National Advisory Board	March 2, 2012	Arlington, VA	12	Part of EB Costs
IMExec	April 3-4, 2012	Albuquerque	7	$6,982
NISAC	April 9-10, 2012	Albuquerque	11	$7,512
TOTALS			**155**	**$ 172,069**

The 2011 LNO Evaluation Survey results demonstrated that participants rated LNO's meeting facilitation as "does a great job organizing and supporting meetings". General satisfaction results showed 91% were Very Satisfied/Satisfied with ease of making travel arrangements, 80% were Very Satisfied/Satisfied with timeliness and ease of reimbursements, and 89% were Very Satisfied/Satisfied with the adequacy of pre-meeting information about logistics. Finally, in the category of additional services or

modification to existing services respondents would like LNO to provide in support of LTER meetings, 89% responded none.

Research working groups funded by the LNO:

Topic	Principal Investigator	Date	Location	Attendees	Cost
State Changes	Ellison	May 2-5, 2011	Harvard Forest LTER	9	$11,453
Ocean Modeling	Miller	May 5-6, 2011	San Diego	9	$4,937
Snow and Rain	Nolin	May 5-6, 2011	Sevilleta	13	$11,202
Humanities and Arts	Swanson	May 6-8, 2011	Andrews	13	$12,154
IM-Vocabulary	Porter	May 18-20, 2011	LNO and Jekyll Island	13	Part of SC meeting
Local Eco Knowledge	Sayre	June 6-7, 2011	Andrews LTER	13	$9,200
Fungal Microbial	Porras-Alfaro	June 17-18, 2011	Sevilleta	29	$8,299
Plant and Grasslands	Suding	Sept. 6-8, 2011	San Diego Sevilleta	16	$3,442
Stream Chem DB	Johnson	October 13-14, 2011	Andrews	12	$5,410
MapS II	Valentine	November 1-3, 2011	LNO	5	$3,312
Cartographic	Hollingsworth	November 4-18, 2011	LNO	3	$6,500
Drupal	San Gil	November 8-11, 2011	LNO	15	$9,488
Leaf Decomposition	Follstad-Shah	November 10-13,2011	Coweeta LTER	10	$4,345
Resilience of River Basins	Jones	November 16-18, 2011	Sevilleta LTER	23	$18,281
Social Networking	Christian	November 29-30, 2011	LNO	6	$9,930
PASTA	Gries	February 21-24, 2012	LNO	6	$7,435
High Quality Data Packages	O'Brien	March 6-7, 2012	Santa Barbara	6	$3,527
Site DB	Henshaw	April 5-6, 2012	LNO	7	$2,078
TOTALS				**208**	**$130,990**

Persistent record of LTER Activities. Ensure a persistent record of LTER activities, achievements, and decisions by creating, acquiring, and archiving datasets, documents, still and video images, and audio recordings

The LNO has instituted the use of LoboVault, the University of New Mexico's Institutional Repository.   With purchased terabytes, we are now able to archive data associated with workshops, meeting records, and reports, as well as audio and video recordings, in our own LTER Community in UNM Research Centers. We now have staff on board to ensure careful and consistent archival of data so that it is easily accessible and archived in a timely manner. For example, searches may be conducted from the public UNM website, by date, author, title, or subject, or searches may be conducted using Google, because UNM Libraries is responsible for maintaining all public links to the repository.

Acquisition of Data, Hardware, and Software. Facilitate the acquisition of commercial and public data, hardware, and software products for site-based and Network synthesis activities

John Vande Castle, Director for Synthesis Support, worked closely with LTER researchers interested in spatial data and analysis across the LTER Network, and the Spatial Data and Analysis Committee to set priorities for data acquisition for the Network. A webpage has been created to preserve reports from this group and includes links to associated work within the LTER Information Management groups: http://intranet2.lternet.edu/committees/lter-spatial-data-and-analysis.

One of the recommendations of the Spatial Data and Analysis Committee was to obtain a better archive of NASA's (National Aeronautics and Space Administration) Landsat satellite data for LTER sites. Landsat data obtained as the result of external funding for LTER Site data research in 1991 and additional data from NASA's funding of sun photometer deployment and atmospheric correction work at LTER sites in the 1990's have been maintained in an LTER data archive. The currently available Landsat data have been included in the LNO Metacat harvest and are available on-line. During 2011, the data was moved to a new, more stable server.

Following the recommendation of the Spatial Data and Analysis Committee, John Vande Castle worked with Kyle Cavanaugh, a post-doc at the Santa Barbara Coastal (SBC) LTER site, to develop a proposal to the LNO for funding to obtain a collection of cloud-free imagery for all LTER sites from the NASA Landsat-5 archive. The proposal was successful, and the LNO will be working with the post-doc during the summer of 2012 to obtain the data, convert the metadata to EML and make data available on-line

through the LTER NIS. This support is documented in the LTER Working group page at: http://intranet2.lternet.edu/content/development-and-analysis-database-landsat-thematic-mapper-imagery-support-cross-site-research

<u>Coordination of Proposal Preparation. Coordinate the preparation of proposals and supplements to respond to opportunities for Network funding.</u>

Two supplemental proposals were successfully submitted and awarded in 2011. The first, proposal number DEB-1118642 for $470,000, supports two activities: $440,000 for participation of a minimum of 280 LTER scientists and students, plus meeting coordination for the 2012 All Scientists Meeting (ASM) and $30,000 for dues to the International LTER Network. The ASM will provide a timely opportunity to develop new synthesis activities based on the Strategic and Implementation Plan (SIP) for LTER and will form the basis for future working groups, science themes, and proposals from LTER scientists.   The ILTER Network dues will enable the U.S. LTER to continue as a voting member of ILTER in support of the new governance structure and funding model based on monetary contributions from member networks.

The second proposal, DEB-1148803 for $60,000, supports specific LTER needs:
1) Coordination, training, and help-desk support, and
2) Support for development of metadata tools and interoperability solutions, as well as information dissemination to the community.
3) This supplement also allows Dr. Iñigo San Gil to continue to support LTER site information management.

Management and Reporting. Manage the LTER Network and the LNO and report on the fiscal and administrative activities of the LNO

LNO staff effectively managed the two awards supporting LTER Network activities. Successful management required a solid grasp by the staff of fiscal principles as applied to sound management and general knowledge of University policies and procedures to comply with Federal Circulars A-21 and A-110. In concert with the Restricted Accounting department at UNM, the fiscal reporting was completed successfully and on schedule.

Management of two large awards, one of which is funded through the American Recovery and Reinvestment Act of 2009 (ARRA), has been complicated by the recent NSF directive to expend ARRA funds at an accelerated pace. Deadline for expenditure of these funds is now September 30, 2013, a year earlier than the deadline in the

award. To meet this directive, LNO staff have had to carefully plan and implement modifications in spending plans and project timelines, and obtain approval for these modifications from NSF before implementation.

One important modification is to accelerate expenditure of participant support funds originally planned to cover cross-site working groups through 2014. To fulfill fiscal and administrative responsibilities, LNO staff now review expenditures on a monthly basis and align those expenditures with planned meetings and workshops in the Operational Plan. As noted above, the governance meetings and workshops represented 363 participants in 26 meetings.

Thematic Area 4 - Development and Outreach

<u>Strategic Communication Plan. Create a strategic communication plan for better enhancing public information and outreach for the Network via a seamless system of information and outreach to the public.</u>

Efforts to communicate information about LTER and its accomplishments to the research community and the greater public have grown tremendously over the years, necessitating the development of a strategic plan for communication.

To meet the growing communication needs of the LTER Network as envisaged in the Decadal Plan, the LTER Network Office began the process of developing a strategic plan for communication (SPC) in 2009. The process began by identifying the existing communication goals, objectives, demands, techniques, and tools, as well as projected demand for communication within the LTER Network in the coming decade. The LTER Executive Board charged LNO with the task of developing a forward looking and adaptive ("living") strategic plan for communication. The LNO put together a planning team and acquired the services of a facilitator to guide the process of developing the SPC. Assisted by the LNO Public Information Office, the planning team developed a system to solicit input from the larger LTER community, as well as advice from communication specialists. This process was completed in December 2010, and a draft plan written, reviewed, and approved by the LTER Science Council and EB. It was subsequently published and unveiled in January 2011.

Milestones envisaged in SPC planning were incorporated into the LTER Strategic and Implementation Plan (SIP) to provide operational guidance for LTER sites and the LNO. The next steps, as envisaged in the planning document, include various evaluation and feedback processes that are currently in progress. Among these are the annual LNO

survey and the monitoring of web statistics to identify hits and misses whenever a communication effort is undertaken.

Communication and Outreach. Effectively communicate information about the LTER Network—purpose, activities, and achievements—through an array of proven, high-visibility mechanisms.

The Strategic and Implementation Plan identifies a series of communication objectives for the LNO. The Executive Board, in coordination with the Communications Committee, established priorities for each objective. The LNO addressed several of the highest priority items during the current project year.

- Outreach for *BioScience* special issue - In early 2012, LNO worked with a number of sites to publicize a special section of *BioScience* focused on LTER. The special section was guest edited by Dr. David Foster of the Harvard Forest LTER and comprised six articles co-written by teams of scientists drawn from across LTER. The articles were both retrospective in nature, reporting on results synthesized from various studies over 30-plus years of LTER, and forward looking—an attempt to peer into the future and predict what current trends portend for the future wellbeing of the Earth.

  In association with the editors of the *BioScience* special section, LNO undertook an intensive outreach effort, which included a national press release that was picked up by major news outlets; working with LTER sites to issue regional press releases; working with NSF to issue a similar press release; and with the American Institute of Biological Studies (AIBS), the publisher of *BioScience*, to issue its own press release to highlight the special feature. This unprecedented outreach effort resulted in the widespread distribution of LTER research results through a broad range of media outlets. We expect the media coverage to continue for some time as specialized journalists continue to dissect the various papers and the findings and give them their unique interpretations or perspectives.

  The exemplary cooperation between LNO, LTER sites, NSF, and AIBS is also set to continue with several planned outreach activities tied to the special *BioScience* issue, including a possible joint outreach with AIBS and NSF to Congressional and Federal agency personnel in Washington, DC., and helping prepare or issue invitations to Congressional delegations in districts that host LTER sites to visit those sites during their coming August recess.

- E-newsletter - In line with the objectives of the SIP, LNO eliminated the print edition of the LTER Network Newsletter in favor of an electronic version. This change trimmed printing and mailing costs and reduced environmental impacts. The electronic newsletter also provides more flexibility; it is now much easier to publish timely stories and there are no limits to the number of stories that we can carry. The first e-newsletter was published in spring 2011, followed by a second edition in the fall. The goal is to increase the frequency of publication to as many as 12 issues a year—though that depends entirely on how well the LTER community responds to the opportunity to publish in the Network newsletter.

- Site and Network brochures - On the recommendation of the EB, the LNO discontinued the practice of periodically updating site brochures. Instead, sites will make the decision as to whether or when they want to update a brochure. However, the Public Information Officer (PIO) is available to provide help if asked. Similarly, the SPC recommended that the existing Network brochure be replaced by an LTER annual report that is envisaged to feature the same kind of information that is currently contained in the brochure as well as more detailed information about sites' scientific accomplishments.

- Existing and new website - The Public Information Officer and Web Designer kept content of the existing LTER website current while a new website was under construction. One of the priority communication objectives of the SIP was the design and creation of a website that would be more in keeping with modern communication principles. In spring 2011, a special website sub-committee of the Communication Committee was formed to help identify the functional requirements for the new LTER gateway website. The design team, including the Executive Director, the PIO, and two LNO web designers, has since been engaged in implementing these functional requirements. The process has now reached a critical stage and the ED and PIO have taken the lead in developing and/or reviewing the content that is being posted to the new website.

- LTER traveling exhibit/display panels - To meet the changing needs for exhibit material, the PIO developed a new design for the LTER traveling exhibit that was first employed in 2009. In 2011, four new panels were added to the exhibit, bringing the total number of available panels to 11. Panels feature sites that are near meeting venues (the idea being to showcase and promote those sites to not only the meeting attendees, but also to potential local visitors). The new design involves modular panels that can easily be interchanged. The new design is also

very light; the panels can be handled by one person, are easily folded and stored in duffel bags, and can even be hand carried on airplanes—unlike the old design that required two people to set up and had to be shipped by road to meeting venues at great cost to the Network.

- Representation at meetings and conferences - LNO highlighted LTER accomplishments at the annual meeting of the Ecological Society of America (ESA), and at the annual LTER mini-symposium at NSF. For ESA, the PIO developed material for the exhibits (including the new display panels), co-staffed the exhibition booth together with representatives from the sites that were featured in the year's exhibit, and organized a very successful mixer to encourage participants to visit the LTER booth and interact with scientists and students. For the mini-symposium, the PIO issued a press release and communicated the details of the meeting online.

- The Executive Director and the PIO worked together to produce an entry for LTER in the Springer Encyclopedia of Sustainability Science and Technology, which is due out in 2012.

External Relations. Build and maintain strategic partnerships and collaborations that benefit science, cyberinfrastructure development, and education in the LTER Network, as well as the broader community of scientists, students, and educators.

The LTER Network benefits from a number of strategic partnerships that complement or augment LTER science and cyberinfrastructure. The LNO works to develop and maintain priority partnerships as defined by the SIP and the Executive Board.

National Ecological Observatory Network (NEON) – Executive Director Bob Waide and Chief Information Officer James Brunt maintained active communication with the NEON cyberinfrastructure team, including visits to NEON headquarters. Brunt also continued to participate as a plan reviewer for NEON information management.

DataONE – Mark Servilla continued to participate as a member of the cyberinfrastructure development team for DataONE, maintaining the strong link between LTER and DataONE. In addition, Bob Waide attended the annual meeting of the DataONE Users Group in Santa Fe, NM in July 2011 to continue planning for the LTER Member Node. The LTER Network will derive benefit from being a DataONE LTER Network data at national and global scales for subsequent analysis and synthesis.

EZID – Mark Servilla and James Brunt have developed and procured an agreement with the California Digital Library EZID program to have unlimited access to Digital Object Identifiers (DOI) for data and metadata managed by the LTER Network Office in the Network Information System.

InCommon – Mark Servilla and James Brunt have developed and procured an agreement to make the LTER Network part of the InCommon identity management federation framework. This agreement paves the way to use CILogon for NIS identity management, allowing InCommon member institutions to logon with local credentials.

EarthSky – Bob Waide was the principal investigator on a proposal to NSF jointly with EarthSky Communications, Inc. The goal of the proposal was to introduce key NSF-supported LTER scientists to a large public audience in the U.S. and around the world, in order to present their most important research results and to demonstrate the breadth of LTER Network scientific activities. EarthSky's role was to produce eight 90-second interview podcasts for broadcast to EarthSky's network of 1,800+ outlets across the globe. The proposal was unsuccessful, but re-submission is planned for May 2012.

National Phenology Network (NPN) – Iñigo San Gil from the LNO served on the NPN Board of Directors, further strengthening the relationship with LTER. NPN developed several site-specific projects with Andrews, Cedar Creek, Jornada, and Harvard Forest LTER sites.

National Center for Ecological Analysis and Synthesis (NCEAS) – Bob Waide and Scott Collins represented the LTER Network at a panel symposium, *Trends in Ecological Analysis and Synthesis,* organized by NCEAS in March 2012. Discussions at that meeting highlighted the strong relationship with LTER and initiated continuing collaboration with NCEAS 2.0.

Genomics Standards Consortium (GSC) – The LTER Network Office is a core member for the NSF RCN grant to support the activities of the GSC. The GSC meets twice a year, with some satellite meetings and RCN sponsored activities in between. Iñigo San Gil and Linda Amaral-Zettler represent the LTER in the GSC.

American Institute for Biological Sciences (AIBS) – The LNO collected funds from LTER institutions to renew LTER's membership in AIBS. Bob Waide served as the LTER representative on the AIBS Public Policy Committee and provided information on AIBS initiatives and opportunities to the LTER community. AIBS provided advice and assistance in implementing elements of the LTER Strategic Communication Plan, in planning a media campaign for the *BioScience* special feature, and in organizing Congressional visits in association with the LTER Mini-symposium.

International Long Term Ecological Research Network (ILTER) – The LNO wrote a successful proposal to NSF for a supplement to maintain the U.S. LTER Network as a voting member of ILTER. The LNO managed a second supplement to provide the U.S. LTER International Committee with travel funds to participate in ILTER meetings.

S212 Water Science Software Institute – Bob Waide concluded a series of discussions with this developing institute by negotiating a position for LTER on their Steering Committee. Scott Collins was invited to serve on the Steering Committee in January 2012.

Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI) – The LNO transmitted an invitation from CUAHSI to participate in a program to provide USGS (US Geological Society) standard reference materials to LTER analytical laboratories for quality assurance/quality check (QA/QC) tests. Several LTER sites took advantage of this opportunity.

Organization for Biological Field Stations (OBFS) – Bob Waide represented LTER at the annual meeting of OBFS, and James Brunt represented LTER at an OBFS-organized workshop to develop a strategic plan to build and acquire the resources needed to better enable scientists, educators, and land managers to pursue the projects that science and the education community need at off-campus locations, such as LTER sites.

National Biological Information Infrastructure (NBII) – The long-standing partnership between NBII and the LTER Network ended in 2011 as the agency was eliminated. Metadata crosswalks and content management tools developed through this partnership will continue to be useful to LTER information managers. The LNO retained Dr. Iñigo San Gil, whose salary had been provided through a Cooperative Agreement with NBII, and will share his time with the McMurdo LTER site and a Macrosystems Biology award located at the University of New Mexico. Dr. San Gil will continue to support eight LTER sites that are implementing the Drupal Ecological Information Management System (DEIMS).

Training. Provide or coordinate training for LTER scientists and information specialists in support of Network science and cyberinfrastructure development.

In November 2011, the LNO solicited proposals for training activities from LTER scientists and information managers. Evaluations by the Executive Board identified five proposals that were worthy of funding.

- Acquisition and management of data from remote locations – PI, Don Natvig

- Tools and training for sensor network establishment and management – PI, Donald Henshaw

- Integrating local knowledge into Long Term Ecological Research - MALS training and planning workshop – PI, Roger Ruess

- Drupal Environmental Information Management System (DEIMS) workshop: A workshop for new and advanced DEIMS users – PI, Kristin Vanderbilt

- Retrieving and using information from web services to improve EML content – PI, Corinna Gries

Additional information on these proposals is at http://intranet2.lternet.edu/working-groups.

Contributions

Within discipline

Development of your own discipline

A major objective of the LNO is the development of a Network Information System to provide access to LTER data to the ecological community. A detailed operational plan has been formulated to guide development, and this plan offers frequent opportunities for major involvement of stakeholders from the ecological and ecoinformatics communities. Significant scientific and broader impacts will result from development of distributed data services and their use for new synthetic research, co-development of standards of practice for ecological information management, development of new cyberinfrastructure tools, and increased access to data for education and underserved groups. Improved access to high-quality, long-term data will result in increased opportunities for synthesis, thereby leading to improved knowledge of key ecosystems.

Through participation in cutting-edge informatics projects (e.g., DataONE, Dryad, Knowledge Network for Biocomplexity) and partnerships with emerging networks (e.g., NEON, WATERS, CZO, ULTRA) and key agencies (e.g., Forest Service), the LNO provides leadership in the field of ecology, especially in critical areas involving the development of national standards and knowledge networks. The LNO makes available to its partners the experience and knowledge gained through 30 years of operations as

a research network. By these collaborations, the LTER Network and its partners obtain increased power to address critical national challenges.

The LNO plays a key role in emphasizing the importance of informatics in ecology and in disseminating knowledge about ecoinformatics throughout the ecological community. We provide leadership in the important areas of data sharing, data standards, connectivity, and the acquisition and implementation of new technologies through our relationships with other distributed networks (e.g., Organization for Biological Field Stations, US National Phenology Network, and the International LTER Network) and research programs (e.g., Macrosystems Biology).

Other disciplines

Development of other disciplines of science and engineering

By emphasizing equal collaboration with social scientists, the LNO seeks to advance our understanding of complex systems, including human-driven systems. Through its support of the goals of the LTER Decadal Plan, the LNO facilitates the creation of an integrated, interdisciplinary approach to the study of systems comprising both natural and built elements, and thus increases our capability to address critical national issues. The LNO plays a key role in organizing people, tools, and ideas to promote the synthesis science that will address the increasing need to understand social-ecological systems from local to global scales.

The LNO conducts research in the field of ecoinformatics through projects that involve the most important participants in the development of a robust and efficient national cyberinfrastructure for ecological research. Our participation in the Knowledge Network for Biocomplexity (KNB), Science Environment for Ecological Knowledge (SEEK), DataONE, and Dryad projects jointly with the National Center for Supercomputing Applications, the National Center for Ecological Analysis and Synthesis, the National Evolutionary Synthesis Center, Oak Ridge National Laboratory, the Global Biodiversity Information Facility, and other partners, as well as our work on the LTER Network Information System, contributes to the fields of cyberinfrastructure, computer science, and informatics. For example, the LTER Network Information System will have significantly broader impacts, making contributions by leveraging the value of metadata to facilitate the extraction, transformation, and loading of source data into a data warehouse with a rich, shared lexicon, while supporting experimental data reproducibility and quality assessment through the capture of data provenance and quality metrics. This will be the first production use of structured data provenance as an

integral component of an ecological data warehouse system, and will be the first implementation of data quality metrics for ecological data in a production system.

Human resource development

The LTER educational activities facilitated by the Network Office include development of web-based information on ecology for use by K-12 students, support of Schoolyard LTER sites at secondary schools, assistance to undergraduates and graduate students in identifying educational and research opportunities, facilitation of the activities of the LTER Graduate Student Committee, and the development of proposals aimed at the integration of education at all levels into LTER research programs. One product of this effort was a successful Math and Science Partnership proposal, submitted through Colorado State University, which involves four LTER sites and their local school districts. As part of this project, the LNO will develop a clearinghouse for training and research opportunities for educators involved in the project. In the long-term, the LNO is working with the LTER Executive and Education Committees to define a strategic plan for integrating education and research seamlessly across all educational levels.

Research and Education

Physical, institutional, and information resources for science and technology

The Long Term Ecological Research Network Office (LNO) occupies a 2,700 square-foot suite comprising seven offices, an 8 person technical workspace, a 12-person conference room, and a 40-person conference room in the CERIA building on the main campus of University of New Mexico. This space is ideally positioned to support the activities and research proposed. For collaborative technology, the LNO supports a Polycom MGC50+ IP video conferencing bridge that can support video conferences up to 48 persons. In addition, there are Polycom units that can be easily relocated. LNO also supports Mediasite rich media recording and streaming technology that can be relocated.

The UNM campus is wired with a 10 Gigabit redundant fiber backbone for intra-campus networking needs. Research activities at UNM enjoy connectivity to the Internet II and National Lambda Rail via the Albuquerque GigaPOP.

Computing Facilities to Support Training

The LNO maintains a 24-seat dedicated information technology training laboratory that compliments the above facilities. This training laboratory is optimized for student-to-instructor communication, while remaining ergonomically comfortable for long periods of

instruction. The center piece of this laboratory is a fire-wall protected, 24-student pod facility with the Dell quad-core Pentium desktop computers for each student, including dual 20 inch flat-screen monitors that can be shared through the instructor's computer and multimedia/video system and simultaneous capture and stream sessions to the Internet. In addition, this facility supports code development, workshops focused on information management and analysis, and synthesis projects. In addition to training activities sponsored by the LNO, the facility is available as a resource to the community.

Computing Facilities to Support Research

The LTER Network Office hosts computer facilities for the office operation and LTER Network Information System Infrastructure. This includes a climate-controlled server room with 12 Dell Multi-Quad-Core PowerEdge servers with over 40 Terabytes of disk storage, redundant power supplies and UPS). These servers provide the core communication, collaboration, and data processing, storage, and delivery components of the LTERnet.edu domain. Six of these machines are dedicated virtual hosts. The combination of virtual machine technology with Linux and Windows operating systems on the Intel platform allows for maximum flexibility in incorporating new developments and technology. The Center supports both PostgresSQL and MySQL relational database management systems, although Microsoft SQL Server is available for special purposes. The implementation includes a network-accessible TB of off-site storage for each of the LTER sites. In addition, there are modern multi-processor development and test machines.

The LNO, as part of the UNM Research Storage Consortium at UNM, has leveraged funding of a Petabyte-scale managed storage system. The HP9000 IBrix storage system is located in the UNM Center for Advanced Research Computing (CARC), which began providing access to the initial 300 terabytes (TB) of storage in January 2012. Partners in the system include CARC, the University LIbraries, DataONE, and the Earth Data Analysis Center. The LNO will use the storage system as secondary storage for our 30TB storage system and virtual server platform that arrived in April 2012

LNO staff recently brought the first production-grade server for LTER online in the Amazon EC2 cloud. The server monitors PASTA services and provides reports and notifications on system state-of-health. LNO staff will be moving additional production and production warm-standby servers to cloud installations in 2013.

The LNO supports 3 Mediasite rich media recorders for capturing and streaming live events such as the annual NSF LTER Mini-symposium.

Beyond science and engineering

<u>Public welfare beyond science and engineering</u>

Three of the objectives of the LTER Network directly address public welfare beyond science and engineering:

To create a legacy of well-designed and documented long-term observations, experiments, and archives of samples and specimens for future generations.

To promote training, teaching, and learning about long-term ecological research and the earth's ecosystems, and to educate a new generation of scientists.

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.

To achieve these objectives, the LTER Network has recently developed a Strategic and Implementation Plan that describes goals, activities, and outcomes in scientific areas related to public welfare. This plan outlines the role of the LNO in achieving Network goals, and the LNO annually reports progress towards those goals to the LTER Network.