LTER

Long Term Ecological Research Network

Strategic and Implementation Plan

Long-term Ecological Research Network (LTER):

Research and Education

2011

Lead Institution

University of New Mexico (Network Office)

Partner Institutions

Arizona State University (CAP)	University of California-Santa Barbara (MCR, SBC)
Cary Institute of Ecosystem Studies (BES)	University of California-San Diego (CCE)
Colorado State University (SGS)	University of Colorado (MCM, NWT)
Cornell University (HBR)	University of Georgia (CWT, GCE)
Florida International University (FCE)	University of Minnesota (CDR)
Harvard University (HFR)	University of New Mexico (SEV)
Kansas State University (KNZ)	University of Puerto Rico (LUQ)
Michigan State University (KBS)	University of Virginia (VCR)
New Mexico State University (JRN)	University of Wisconsin-Madison (NTL)
Oregon State University (AND)	Marine Biol. Lab., Woods Hole (ARC, PAL, PIE)
University of Alaska (BNZ)	
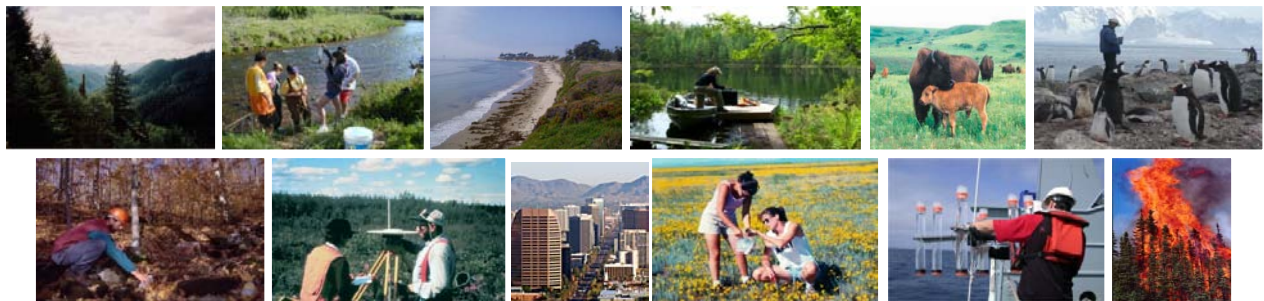
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1. EXECUTIVE SUMMARY

Since 1980 the LTER Network has been a global leader in the quest to understand long-term ecological processes. The Network's abilities to document long-term change in ecosystems and to forecast the effects of change contribute significantly to the nation's environmental security and to global environmental health. Causes of change are often complex and sometimes subtle; their discovery requires careful long- and short-term experimentation, comparative cross-site research, and synthesis – a powerful combination that the LTER Network is distinctively positioned to provide.

Thirty years of LTER research have yielded transformative knowledge about ecosystem change in response to both natural and human influences. Changes ranging from climate alteration to species introductions to land and water use decisions have far-reaching impacts on ecosystem function, community structure, and population and evolutionary dynamics. And ecosystem change strongly affects critical environmental services upon which we all depend. LTER research has advanced ecological theory and helped to provide the empirical knowledge needed to forecast change and to devise effective management and policy responses. This is a foundational strength of the Network.

LTER research has also advanced continental-scale ecology. From early comparisons of populations and processes among two or three sites have come groundbreaking, cross-network analyses of ecological change across multiple biomes. Questions about non-linear behavior and cross-scale phenomena that underlie global environmental change must be addressed at large geographic scales. LTER research has demonstrated the value of a diverse network of sites for asking these sorts of questions, and has contributed significantly to knowledge about large-scale connectivity and global vs. local drivers of change. The Network remains committed to building on these efforts.

Interdisciplinary research has also been a hallmark of LTER science. Today's complex environmental challenges require teams of scientists who rarely have the opportunity to collaborate on long-term questions. This is particularly evident for questions that straddle the boundary between the biophysical and social sciences. The Network has approached this problem with a forward-looking initiative that draws on recent research in coupled natural-human systems and explicitly engages the social and behavioral sciences. Integrated Science for Society and the Environment (ISSE), developed as part of the Network's Decadal Plan, recognizes and seeks to understand the long-term socio-ecological connections among organisms, processes, and ecosystems across varying geographic scales. How people perceive ecological services, how these perceptions affect behavior, and how behavioral change, in turn, affects ecosystems and their delivery of services are central to understanding the long-term sustainability of all ecosystems on earth.

The integration of social and ecological research within the context of LTER sites and scientists, coupled with a rich ecological information base for sites, makes this a particularly promising new research frontier for LTER. *The potential impact of long-term socioecological research that is synthetic across multiple sites is unprecedented, and the LTER Network is uniquely poised to contribute to this effort.*

The overall value of the Network's long-term observations and experiments in diverse ecosystems has never been greater. Profound environmental changes are underway at local to global scales, and we know too little about the drivers and long-term consequences of these changes. The LTER Network presents an outstanding opportunity to gain a significant part of the knowledge necessary to understand and cope with change.

In this document we lay out a vision for achieving this potential, building on our foundation of long-term ecological research and cross-site comparisons to collaborate with other networks and disciplines.

To advance this vision will require maintaining our foundational strength in long-term

observations and experiments in key ecosystems, while also fortifying our capacity to conduct transdisciplinary cross-site research – engaging sites and scientists both within and outside the present network. It will require maintaining and growing our capacity to educate students, working professionals, and the public about long-term ecological changes and their consequences. It will require improving our capacity to make results of our observations and experiments readily available to all for addressing large-scale questions. And it will require strengthening and forging new partnerships with other observational networks in the U.S. and globally.

Current status

The Network is presently comprised of 26 sites funded by NSF to conduct fundamental research on ecological patterns, processes, and interactions within and among major ecosystems of the U.S. and beyond. More than 2000 scientists at LTER sites are collectively engaged and dedicated to interdisciplinary long-term research in environmental science.

The Network's formal vision, developed earlier in this decade and reaffirmed here, is a society in which long-term ecological knowledge contributes to the advancement of the health, productivity, and welfare of the global environment, thereby advancing human well being. *Within this vision, our primary mission is to use long-term observations and experiments to generate and test ecological theory at local to regional scales.*

Progress in achieving the LTER mission begins with the work of scientists and educators at individual sites. Work at the site level forms the basic knowledge, observational and experimental data, and training that will ensure a lasting impact of the overall LTER program. Data and knowledge gained from intensive field experiments are also key to developing cross-site syntheses that allow the development of new theory and predictions of long-term change and responses to human and natural influences. Cross-site synthesis activities often lead to unexpected insights and new hypotheses that feed back to influence the future course of site- and network-level research.

The expansion of LTER research to address long-term continental-scale questions related to the biophysical and socioecological drivers underlying environmental change is a major new focus for the Network. Our evolution from a loose federation of sites to an integrated research enterprise makes this possible. We know of no better way to address many of the most compelling and intransigent environmental problems of today.

Below we summarize and then detail our strategies for building on past success to realize this vision. We prioritize activities in five key areas: Research, Education, Communication, Information Management, and Coordination with other Networks. The timeframe for this plan is five years, to be updated annually.

1.1. Research

The LTER Network has a history of excellence in long-term, place-based, discovery-oriented research. Many ecological phenomena change at decadal to century and longer time scales, and it is essential to maintain experiments and observations across periods appropriate to these scales. The orderly transfer of experiments and interim results from one generation of scientists to the next requires a research design and setting that allows for multiple samplings (some unanticipated), long-term protection from competing uses, and meticulous documentation of experimental protocols and observations. Also essential is a means to store protocols and observations in a manner that is secure and consistently accessible to the scientific community. LTER has led the ecological community in addressing these issues, and in overcoming many barriers to cross-site syntheses of research findings.

The overarching research goals of LTER are (1) to achieve a mechanistic understanding of the ecological responses to past and present environmental change at multiple spatial and temporal scales; and (2) to use this understanding to predict ecological, evolutionary, and social responses to future environmental change and to inform societal strategies to adapt to this change.

The objectives for LTER research are 1) to increase site-based capacities for cross-site research, 2) to conduct synthetic and cross-site research that builds upon existing long-term, site-based data, experiments, and models across the Network, and 3) to perform transformative research at regional to continental scales that expands upon existing LTER infrastructure and human and intellectual capital and capitalizes on emerging observatory networks and technologies.

1.2. Education

The LTER approach to research, coupled with an ability to implement long-term educational initiatives, allows for unique approaches to training future researchers and to learning and teaching ecological concepts. Evaluating and disseminating this approach through the involvement of graduate and undergraduate students, postdoctoral scientists and other professionals, K-12 educators and students, and the general public will help ensure the success of long-term ecology in the future.

Our strategic goals for LTER education are (1) to develop Network-wide leadership, organization, and cyberinfrastructure to support and coordinate long-term education and outreach programs at individual sites; (2) to use network resources to advance basic environmental knowledge and science learning by K-12, undergraduate, and graduate students.; and (3) to develop programs for working with key constituent and under-represented groups including K-12 teachers and administrators; undergraduate students, graduate students, and professors; education policy makers; and citizens.

1.3. Communication

As it has grown as a network, LTER has faced growing challenges in internal communication and also has an increasingly complex need to communicate results of our findings to external partners, including the public. More and more LTER research is finding applications in the work of federal, state, and local agencies that manage environmental resources. Additionally, the synoptic and detailed knowledge of individual LTER sites, and the opportunities for multi-dimensional comparisons among sites, also represent significant opportunities for informing decision makers as well as scientists in other disciplines.

Knowledge from this breadth of perspectives permits LTER scientists to identify and anticipate new issues and challenges, test existing ideas about causation, and help provide the science that underpins the processes of open, participatory and forward-looking decision-making.

Our strategic goals for LTER communication are (1) for the LTER Network to become recognized as a leading resource for long-term ecological research by the broader scientific community, decision makers, and the media; (2) to harness the power of long-term ecological research for decision making through two-way exchange between LTER scientists and policy makers, natural resource managers, funders, and the media; and (3) to strengthen communication within the Network and between the Network and the broader scientific community to advance scientific collaboration and innovation.

1.4. Information Management

Long-term research and synthesis demands the long-term stewardship and ready availability of data. The creation, curation, and dissemination of long-term databases are needed to assure that the data resources needed by researchers will continue to be available. In addition, by adopting policies that promote the timely sharing of data (both inside and outside the LTER Network), scientists can use the data in a variety of ways not anticipated by the original collector, including for regional, national, and global syntheses, thus providing a rich resource for the broader scientific community.

LTER has led the ecological community in developing protocols and practices for documenting, curating and sharing data. Our strategic goals for LTER information management are (1) to provide sources of high-quality, well-documented, and error-checked data at each site that support local science, stimulate synthesis and the creation of new knowledge, and facili-

tate transformative network-wide research at broad scales; (2) to improve existing data practices and information management systems at sites to make them uniformly easy to use, sustainable, and consistent with LTER NIS protocols; (3) to develop a central Network-level data discovery and integration platform that is comprised of databases and servers connected through web services for single-portal data publication, discovery and access; (4) to improve information flow between LTER and other networks; and (5) to evaluate recent developments in computer science, information technology and design, cyber security, community standards, and communication and collaboration technology for potential application in LTER Network and site information management.

1.5. Coordination with Other Networks

Conducting research at the continental and global scale requires a variety of data collected at large spatial scales. A variety of environmental observing systems are being implemented to meet this need. At the same time, a variety of research networks with different missions, geographic scales, and potential longevities are seeking to conduct research at large spatial scales. Maximizing the potential of these observing systems and research networks requires that they coordinate with each other to minimize redundancy and maximize scope and interoperability. The long-term research mission of LTER and its experience in coordination across the LTER network gives it a unique ability to inform this coordination process.

Our strategic goal for LTER with respect to other environmental networks is to help create a Networks Coordination Group to promote cross-network research and improve data sharing among diverse environmental research networks and observatories.

1.6. Network Management

The LTER Network Organizational Chart appears below. The Network currently consists of 26 sites, and is governed by a Science Council that establishes the scientific direction of the network and delegates authority for most business matters to an Executive Board. The Science Council and Executive Board are led by the Network Chair. A National Advisory Board provides external advice, and a Network Office performs a variety of tasks that support network operations. Network governance is detailed in bylaws (www.lternet.edu/bylaws).

Each LTER site is funded directly by NSF, has its own governance, and appoints its own principal investigator (lead PI). Individual LTER sites collaborate with federal and state agencies and nongovernmental organizations.

The LTER Network Office is funded directly by NSF through a cooperative agreement, and performs a variety of tasks to support the LTER Network, including guiding network IM development, facilitating collaborations within and outside LTER, hosting network meetings, and conducting LTER communications.

The U.S. LTER network is the founding member of the International LTER (ILTER) Network, and is represented to the ILTER by an appointed committee.

1.7. Succession Plan

Succession of the governing and advisory bodies of the LTER network, and the leaders of these groups, are specified in the LTER Network Bylaws. With the exception of the Network Chair, who stands for election every 2 years, all members of these LTER Committees serve on a volunteer, rotating, non-compensated basis. Committees are reviewed and evaluated yearly by the Science Council's Executive Board, which also appoints ad hoc committees as needed. The Network Chair may be removed by the Science Council if needed.

1.8. Oversight of the Strategic and Implementation Plan (SIP)

The Executive Board is responsible for oversight of this SIP. The Network Office collates data on network metrics (described below) on an annual basis, and provides an annual report to the Executive Board showing current performance and long-term trends. The Executive Board

evaluates the progress of the network and its component bodies towards meeting the metrics of the SIP and updates the SIP on an annual basis, with input from the National Advisory Board. The Executive Board's annual assessment of progress and recommended updates to the SIP are subject to final approval from the Science Council.

1.9. External Evaluation

Individual LTER sites and the Network Office are evaluated by NSF through periodic site visits and proposal reviews. The Executive Board conducts an annual review of the Network Office and assists in preparation of Network Office proposals. NSF commissions an external review of the LTER network every decade (currently conducted by the Advisory Committee for the Biological Sciences Directorate).

2. RESEARCH

2.1. Research Vision

The LTER Network envisions long-term ecological research coordinated and integrated across a network of diverse sites and observatories that contributes to the development of ecological theory and understanding, and that can be applied to improving the health and welfare of the global environment, thereby advancing the Network's vision to advance human well-being.

2.2. Mission

We will increase understanding of Earth's ecological systems towards providing the scientific community, policy makers, and society with the knowledge and predictive understanding necessary to conserve, protect, and manage Earth's ecosystems, their biodiversity, and the services they provide.
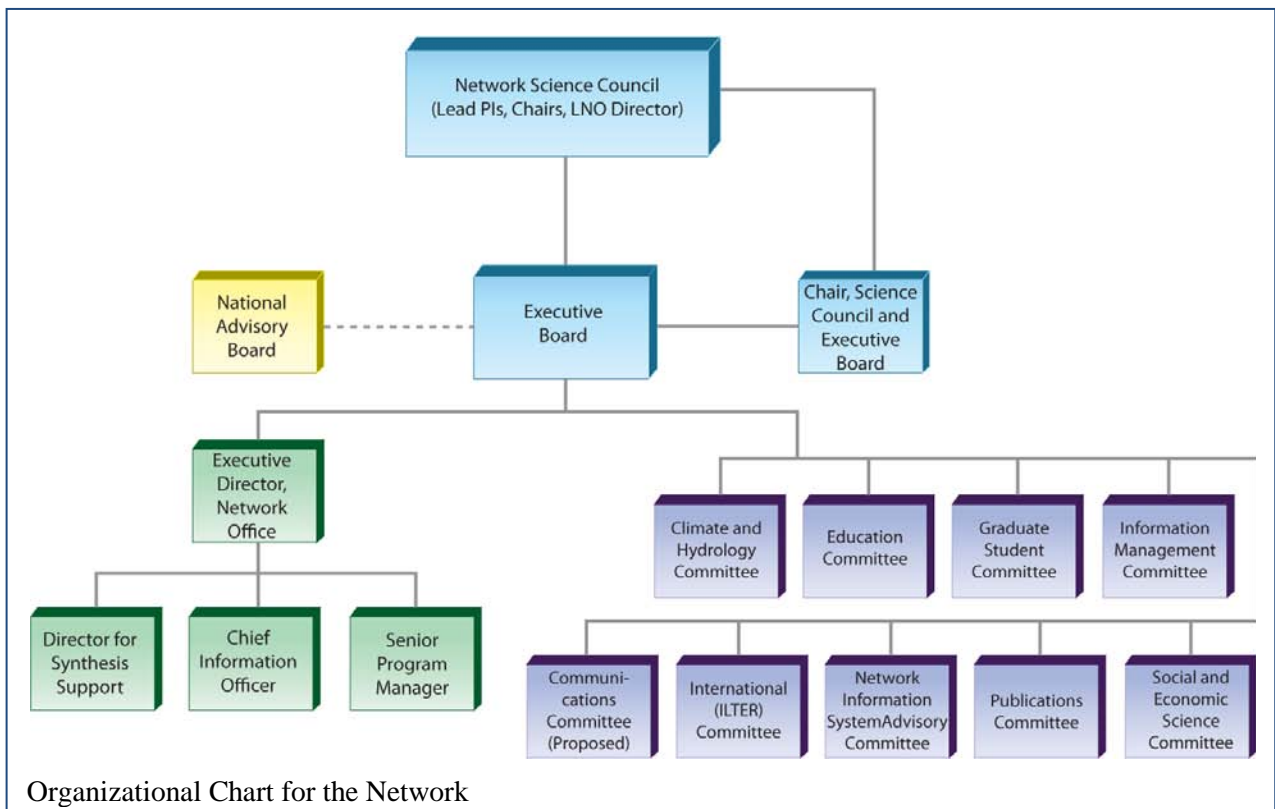
Organizational Chart for the Network

2.3. Situational Analysis

Strengths

A. An exemplary record of site-based, hypothesis-driven research using long-term observations, experiments, data curation, modeling, and regional studies to advance ecological theory and knowledge.

B. Long-term research sites arrayed across diverse marine, freshwater, and terrestrial ecosystems that can be leveraged into local to global networks of sites.

C. A lengthy history of cross-directorate (NSF) and inter-agency collaborations.

D. Ongoing efforts to integrate mechanistic understanding with historical perspectives to forecast the ecological consequences of global environmental change.

E. Leadership in environmental cyberinfrastructure to provide innovative solutions for environmental information management.

F. The Decadal Plan for LTER, which describes a long-term framework and plan for integrated socio-ecological research to address key environmental research goals.

G. Diverse intellectual capital that includes natural and social scientists and engineers with a history of collaboration.

Challenges

A. Increasing the capacity for supporting cross-disciplinary and regional- to continental-scale studies across an extensive network of sites.

B. Effective integration with other research programs, platforms, and observatories, including NEON.

C. Establishment of priorities for an ambitious and comprehensive research program.

D. Enhancement and integration of research activities through collaboration and coordinated education, communication, information management, and cross-network activities.

Opportunities

A. Linkages to diverse national and international observatories, including ILTER and NEON, and research programs in NSF and other agencies (e.g., USFS, NASA, NOAA, DOE, EPA, USGS).

B. Involvement in K-12, undergraduate, and graduate education and public outreach that provides a foundation for training the next generation of environmental scientists in transdisciplinary research.

C. Societal demand for scientific understanding of ecological responses to local, regional, and global environmental change.

D. Emerging technologies (e.g. molecular, genomic, instrumentation) that can be harnessed for measurements to advance research goals.

E. A capacity for research that is convergent with emerging national research priorities in climate change, biodiversity, and coupled natural-human systems.

Threats

A. Lack of flexibility to participate in new initiatives because of on-going time and resource commitments.

F. Lack of explicit plans for transitioning leadership and mentoring young leaders in collaborative, cross-disciplinary research.

G. The loss of individual sites from the Network (site failure).

2.4. Goals and Objectives

Goal 1

To achieve a mechanistic understanding of the ecological responses to past and present environmental changes at multiple spatial and temporal scales.

Specific objectives for this goal include:

A. to increase site-based capacities for cross-site research; and

B. to conduct synthetic and cross-site research that builds upon existing long-term, site-based data, experiments, and models across the Network.

Goal 2

To use the understanding sought in Goal 1 to predict ecological, evolutionary, and social responses to future environmental change and to inform societal strategies to adapt to this change.

The specific objective for this goal includes:

A. to perform transformative research at regional to continental scales that expands upon existing LTER infrastructure and human and intellectual capital and capitalizes on emerging observatory networks and technologies.

2.5. Strategies

A. Be prepared as a network to respond to large-scale funding opportunities by using the Science Council, All Scientist Meetings, and other opportunities to develop cross-site interdisciplinary proposals.

B. Develop existing prospecti and other cross-site ideas into full proposals in a temporally staggered fashion.

C. Encourage the development of additional cross-site research groups to pursue complex, long-term and multi-site research questions by means of conventional, existing, and new funding models at NSF and elsewhere.

D. Integrate research with education and outreach towards building greater societal trust of science and inclusion in science by underrepresented groups.

2.6. Implementation Plan

Objective	Actions Required	By Whom	Location	Time Frame	Status
1A. increase site-based capacities for cross-site research	A. Submit site renewal proposals that promote opportunities for cross-site research	All site Principal Investigators, Co-Investigators, and Senior Personnel	all sites	On-going	Underway
	B. Submit proposals to other programs and agencies to enhance opportunities for cross-site research	All site Principal Investigators, Co-Investigators, and Senior Personnel	all sites	On-going	Underway
	C. Develop new partnerships and collaborations with non-LTER scientists	All site Principal Investigators, Co-Investigators, and Senior Personnel	all sites	On-going	Underway
	D. Promote workshops to increase coordination among sites regarding research questions, methodology, and data management and sharing	Executive Board	all sites	On-going	Underway

Objective	Actions Required	By Whom	Loca-tion	Time Frame	Status
1B. Conduct synthetic and cross-site research that builds upon existing long-term, site-based data, experi-ments, and models across the Network	A. Submit multi-site proposals to appropriate programs and opportunities (e.g. CNH, Dimensions of Biodiversity, Macrosystems Biology)	All site Principal Investigators, Co-Investigators, and Senior Personnel	all sites	2011	Underway
	B. Develop cross-site graduate student and postdoctoral re-search opportunities, e.g. cross-site and traveling scholars	All site Principal Investigators, Co-Investigators, and Senior Personnel + Education Commit-tee	all sites	2011	Needs planning
2A. Perform transformative research at regional to continental scales that expands upon existing LTER infrastructure and human and intellectual capital and capitalizes on emerging observatory networks and technologies	A. Fully develop and imple-ment existing network-wide research initiatives				
	a. Future Scenarios: Land-scape Vulnerability and Resilience to Climate and Land Use Change	Scenarios team (Foster et al.)	Multiple sites	2011	Planned, unfunded
	b. Coastal Zone Climate Change: Understanding and Adaptation	Coastal team (Alber, Hopkinson, et al.)	Multiple sites	2012	Planning started
	c. Inland Climate Change: Social and Ecological Sensitivities and Res-ponses	Inland team (Knapp, Blair, Osvaldo, et al.)	Multiple sites	2014	Planning started
	d. Disappearing Cryosphere: Socioecological Conse-quences for Ecosystem Services	Cryosphere team (Ducklow, Wil-liams, et al.)	Multiple sites	2016	Planning started
	B. Identify and Prioritize the need for new sites	Executive Board	all sites	2011	Needs planning
	C. Develop the next generation of network-wide research initiatives to build on our re-search vision and capitalize on emerging ecological ob-servatory networks	Science Council	all sites	May 2016	Needs planning

2.7. Metrics

A. Increased number and connectivity of cross-site research publications (1AA).

B. Increased number and success of cross-site and cross-disciplinary research proposals (1AA, 1AB, 1BA).

C. Increased involvement of non-LTER scientists and institutional partners in cross-site research (1AC).

D. Increased number of working group synthesis workshops and other synthesis planning opportunities for interactions (1AD).

E. The creation of cross-site graduate student and postdoctoral research opportunities (1BB).

F. Development and submission of network-wide research initiatives (2AA).

G. Need for new sites identified and prioritized (2AB)

H. Workshops to develop next generation research initiatives (2AC).

2.8. Financial Resources

Implementing the research plan will require:

A. Continued cost-of-living increases for site science (1AA).

B. Continued investment in cross-directorate supplements (e.g. social science and international) to build site capacity (1AA).

C. New investment in cross-site graduate student and postdoctoral research opportunities (1BB).

D. Funding for new sites as identified (2AB).

E. Investment by NSF in major network-wide research initiatives (2AA).

2.9. Management Plan

Implementing the research plan will require:

A   Continued oversight by the LTER Executive Board and Network Office to ensure resources for working groups to develop research proposals and prospecti.

B   Annually revising this Strategic and Implementation Plan (SIP) by the LTER Executive Board to adjust priorities and address new opportunities.

3. EDUCATION

3.1. Education Vision

The LTER Network envisions an environmentally literate society in which knowledge based on long-term ecological research is within reach of all citizens and contributes to the development of informed management and decision-making.

3.2. Mission

We will promote and build environmental literacy by providing scientists, policy makers, and society with the long-term knowledge and predictive understanding necessary to conserve, protect, and manage the Earth's ecosystems, their biodiversity, and the services they provide.

3.3. Situational Analysis

Strengths

A. A vibrant network of educators and scientists linked to a variety of educational systems through professional contacts and information technologies.

B. Long-term observation systems, experiments, data sets, and resources that can be used for a broad range of educational activities.

C. Strong K-12 outreach, undergraduate, and graduate programs at sites that are long-term and involve scientists at all levels.

D. A history of site-based initiatives to leverage educational resources in support of LTER goals and constituent groups.

Challenges

A. Network-wide coordination and communication among site-based education programs.

B. Network-wide cyberinfrastructure support for education-related cooperation among sites and education partners, including support for student data collection and analysis.

C. Limited engagement with under-represented groups at all levels.

D. Limited connection between sites and community colleges, independent schools, and citizen science programs.

E. Disparities in educational programs among sites due to different state standards, research emphases, and demographic settings.

F. Lack of metrics to assess/evaluate educational programs.

Opportunities

A. A wealth of teaching and learning materials located at individual sites.

B. The Network's ISSE framework provides an explicit focus for educational activities.

C. Changing educational standards that emphasize experiential and hands-on learning.

D. Successful cross-site educational programs that could be replicated elsewhere or expanded.

Threats

A. Growing financial constraints at partner institutions (K-20).

B. The loss of individual sites from the Network.

C. Few systematic programs to prepare higher education students for cross-site or interdisciplinary work.

3.4. Goals and Objectives

Goal 1

Develop Network-wide leadership, organization, and cyberinfrastructure to support and coordinate education and outreach programs at individual sites.

Specific objectives for this goal include:

A. Hire a network-level Education Coordinator to spearhead Network-wide education initiatives and facilitate partnering with funders to maximize connections to existing programs.

B. Document, support, and coordinate activities led by education coordinators at individual sites in relation to cross-site, regional education and outreach programs.

C. Conduct regular Network-wide program evaluation and targeted self-studies, including developing metrics for assessing the effectiveness of current programs.

D. Evaluate the need for and feasibility of enhancing cyberinfrastructure support for Schoolyard LTER, in conjunction with the Information Management Committee and a new Communications Committee.

Goal 2

Use network resources to advance basic environmental knowledge and science learning by K-12, undergraduate, and graduate students.

Specific objectives for this goal include:

A. Develop a Network-wide educational development program organized around the ISSE framework and learning progressions in environmental literacy.

B. Develop environmental literacy materials to meet the needs of diverse communities, particularly traditionally under-represented

groups and settings - political, socioeconomic, ethnic and cultural, age, and gender.

C. Assess models for effectively implementing environmental literacy programs in the network.

D. Create a coordinated repository of data, curriculum materials, and web sites for facilitating sharing of professional teaching and learning publications across sites.

Goal 3

Develop programs for working with key constituent and under-represented groups including K-12 teachers and administrators; undergraduate students, graduate students, and professors; education policy makers; and citizens.

Specific objectives for this goal include:

A. Increase the number of sites offering professional development and the variety of professional development opportunities for teachers and administrators to give them the knowledge, skills and materials they need to take advantage of LTER resources, working directly with LTER scientists.

B. Increase training opportunities for undergraduate and graduate students to engage in interdisciplinary science (REUs, IGERTs, URMs).

C. Develop near-peer mentoring, promote collaboration in undergraduate research, and integrate curricula across biophysical and social science disciplines.

D. Develop Citizen Science programming and initiatives through collaborative relationships with existing citizen science programs, supporting the development of novel proto-

cols, engaging citizen groups, and organizing opportunities for sharing best-practices, data exchange, and collaboration.

3.5. Strategies

A. Expand staff and funding resources for education and outreach at individual sites and across the Network by developing new NSF-supported programs and improving the coordination and linkage between existing programs with an education and outreach directive.

B. Increase participation by LTER sites in education and outreach by coordinating existing skills, knowledge and resources; exchanging best practices; and providing training to sites.

C. Establish strategic partnerships with constituent groups able to promote and assist with the development and dissemination of instructional materials among students, teachers, administrators, and the public, with particular attention to the needs of traditionally under-represented groups.

D. Develop metrics and tools to guide education and outreach activities at site and Network levels and to direct the development of resources and professional opportunities.

E. Identify and employ as appropriate cyber technologies that will enhance communication between partners and the dissemination of educational and outreach materials.

F. Conduct regular external evaluation of LTER education and outreach programs and adapt as necessary.

3.6. Implementation Plan

Objective	Actions Required	By Whom	Location	Time Frame	Status
1A. Hire a network-level Education Coordinator.	A. Plan, propose, and fund position	EB / LNO	LNO	2011	Needs planning

Objective	Actions Required	By Whom	Loca-tion	Time Frame	Status
1B. Document, support, and coordinate activities led by education coordinators at individual sites in relation to cross-site, regional educa-tion and out-reach programs	A. Survey and present report on higher education and public outreach activities	Education Com-mittee	LNO	2011	Under-way
	B. Survey / report K-12 activities	S. McGee	LUQ	2011	Under-way
	C. Begin periodic teleconference or webinars	Education Com-mittee	LNO	2011	Under-way
	D. Annual education coordina-tion meetings to provide train-ing to site coordinators, share resources, and coordinate ac-tivities.	Education Com-mittee	tbd	2011+	Needs planning
1C. Conduct regular Net-work-wide program evalua-tion and targeted self-studies, including developing metrics for assessing the effectiveness of current programs	A. Develop metrics for assessing effectiveness of current higher education and public outreach programs, including career outcomes for participants.	Education Com-mittee	LNO	2011+	Needs planning
1D. Evaluate the need for and feasibility of enhancing cyberinfrastruc-ture support for Schoolyard LTER, in conjunction with the Information Management Committee and a new Communi-cations Commit-tee	A. Assess needs and feasibility with particular emphasis on collaboration and support for student data collection and analysis.	Education Com-mittee + NISAC	LNO	2011	Needs planning
2A. Develop a Network-wide educational development program orga-nized around the	A. Assemble group and seek grant support (e.g. from DoEd I3, MSP)	Education Pros-pectus team (Moore, Anderson et al.)	All sites	2011	Needs planning

Objective	Actions Required	By Whom	Loca-tion	Time Frame	Status
ISSE framework and learning progressions in environmental literacy					
2B. Develop environmental literacy mate-rials to meet the needs of diverse communities, particularly traditionally under-represented groups and settings - political, socioe-conomic, ethnic and cultural, age, and gender	A. Assemble group and seek grant support	Education Com-mittee	All sites	2012	Needs planning
2C. Assess models for effectively implementing environmental literacy pro-grams in the network	A. Assemble group and seek grant support	Education Com-mittee	All sites	2011	Needs planning
2D. Create a coordinated repository of data, curriculum materials, and web sites for facilitating sharing of professional teaching and learning publica-tions across sites	A. Assess needs and feasibility of coordinated repository	Education Com-mittee + NISAC	LNO	2011	Needs planning
3A. Increase the number of sites offering profes-sional develop-ment and the	A. Submit more site and cross-site proposals to work with teachers	Education com-mittee (& Educa-tion Coordinator when in place)	All sites	2011	Under-way

Objective	Actions Required	By Whom	Loca-tion	Time Frame	Status
variety of professional development opportunities for teachers and administrators to give them the knowledge, skills and materials they need to take advantage of LTER resources, working directly with LTER scientists	B. Create a platform for collecting and sharing professional development materials for other sites to adapt	Education Coordinator + Education committee	LNO	2011+	Needs planning
3B. Increase training opportunities for undergraduate and graduate students to engage in interdisciplinary science (REUs, IGERTs, URMs)	A. Promote interdisciplinary training by sharing successful models of REU, IGERT, GK-12, and other programs	Education Committee	LNO	2011	Under-way
3C. Develop near-peer mentoring, promote collaboration in under-graduate research, and integrate curricula across biophysical and social science disciplines	A. Assemble group and seek funding support to develop undergraduate teaching modules	Education Sub-committee (Fahey et al.)	All sites	2012	Planning started
3D. Develop Citizen Science programming and initiatives through collaborative relationships with	A. Assess current and identify best citizen science programs suitable for LTER network adoption	Education Committee	All sites	2011	Needs planning

Objective	Actions Required	By Whom	Loca-tion	Time Frame	Status
existing citizen science pro-grams, support-ing the development of novel protocols, engaging citizen groups, and organizing opportunities for sharing best-practices, data exchange, and collaboration	B. Explore partnership with NEON to implement citizen science programs	Education Com-mittee	All sites	2011	Needs planning

3.7. Metrics

The metrics for assessing implementation of the education plan will include:

A. Network Education coordinator in place (1AA).

B. Regular monthly and annual meeting of site education coordinators to plan, survey sites, prepare reports, and organize working groups (1BA-D, 3BA).

C. Metrics in place for effectiveness assess-ments (1CA).

D. Cyberinfrastructure needs assessed (1DA).

E. Create repositories for sharing curriculum (2DA) and professional development mate-rials (3AB)

F. Proposals submitted and funding received in support of new programs to improve envi-ronmental literacy (2AA, 2BA, 2CA), profes-sional development (3AA), and traveling scholars (3DA).

G. Undergraduate teaching modules developed and shared (3CA).

H. Citizen science program initiated in consulta-tion with NEON (3EA-B).

3.8. Financial Resources

Implementing the education plan will require:

A. Investment in new Education Coordinator position and associated support.

B. Funding for annual education committee meetings and for working groups to produce cross-site proposals.

C. Cyberinfrastructure support for student data collection and repositories for professional development and curriculum materials.

D. Funding for educational material production and dissemination in print and on-line for-mats.

3.9. Management Plan

Implementing the education plan will require:

A. Day to day management of the education plan by the Education Coordinator (new posi-tion) who will report quarterly to the LTER Education Committee and Executive Board.

B. Annual revision of this plan by the LTER Education Committee to establish priorities, develop and share best practices, review progress and set future directions.

C. Continued oversight by the LTER Executive Board and Network Office to ensure re-sources for working groups to develop re-search proposals.

D. Regular external assessment of practices and achievements to ensure progress forward is in line with needs of constituent groups and best practices in the field.

4. COMMUNICATION

4.1. Communication Vision

The LTER Network envisions a future in which long-term ecological research is communicated in a way that improves the scientific basis for decision making.

4.2. Mission

We will establish a two-way exchange between the LTER science community and decision makers, including the public, and to share information of interest in a timely, consistent, and easily understood manner.

4.3. Situational Analysis

Strengths

A. LTER sites, scientists and staff with national and international expertise who are experienced with and committed to engaging diverse constituencies including K12 students, teachers, and the public.

B. A history in the LTER Network of communicating findings to resource managers and other decision makers.

C. Long-term program commitment that provides consistency in the information base, knowledge, and relationships that provide a strong foundation for communication efforts.

D. Expertise and resources within the Network Office that can contribute to the implementation of a communication strategy.

E. Existing partnerships with government agencies and non-governmental organizations provide numerous opportunities for knowledge transfer at the national and international levels.

Challenges

A. How to make research findings tangible and visible to diverse constituents.

B. Establishing effective dialogue with end users.

C. Understanding regional and audience diversity and developing strategies and messages to address effectively.

D. Uneven distribution of communication knowledge, technologies, and costs within the LTER Network.

Opportunities

A. Frequent opportunities for communicating directly with key constituencies.

B. Opportunity to engage with other scientific communities and networks working on issues of human – environment interactions, e.g. Global Land Project (GLP), National Ecological Observatory Network (NEON), Ecological Society of America, and others.

C. The Network produces important and compelling science that is relevant to society and of broad interest to the public and decision makers.

Threats

A. Limited resources for communication – funding, time, staffs, and expertise.

B. Institutional barriers can be significant – incentives and priorities for research-focused personnel within academic institutions are often lacking.

4.4. Goals and Objectives

Goal 1

Become recognized as a leading resource for long-term ecological research by the broader

scientific community, decision makers, and the media.

Specific objectives for this goal include:

A. Build capacity across the Network to engage target audiences through communication activities.

B. Strengthen LTER's name recognition and reputation among decision makers and the media as a source of rigorous, long-term ecological research information.

C. Increase opportunities for scientists to highlight LTER accomplishments to funders and other target audiences.

Goal 2

Harness the power of long-term ecological research for decision making through two-way exchange between LTER scientists and policy makers, natural resource managers, funders, and the media.

Specific objectives for this goal include:

A. Engage decision makers in developing questions and informing distillation activities, particularly related to issue-bade synthesis efforts.

B. Expand the Network's capacity to disseminate high-impact scientific findings to local, national, and international media.

Goal 3

Strengthen communication within the Network and between the Network and the broader scien-

tific community to advance scientific collaboration and innovation.

Specific objectives for this goal include:

A. Promote a shared mission and sense of community by strengthening communication channels for reaching all LTER participants.

B. Advance network-scale science, synthesis, and other collaborative activities by facilitating regular interactions across sites and among all LTER participants.

4.5. Strategies

A. Expand staff, expertise, and funding resources for the distillation of science and engagement of target audiences by developing new NSF-supported activities.

B. Increase participation in existing LTER and NSF communication efforts through increased marketing, streamlined internal communication, and exchange of best practices through peer-to-peer programs.

C. Expand strategic partnerships with national observatories, scientific societies, other scientific institutions, and non-governmental organizations to increase the presence and involvement of LTER in existing communication programs hosted by other entities.

D. Start with pilot projects and conduct regular monitoring and external evaluation of current and new communication activities. Adapt and expand communication efforts based on measurable results and feedback.

4.6. Implementation Plan

Objective	Actions Required	By Whom	Location	Time Frame	Status
1A. Build capacity across the Network to engage target audiences through communication activities	A. Form a standing LTER committee for Public Engagement and Communication	EB	LNO	2011	Underway
	B. Develop funding for adding 1-2 FTEs as staff or equivalent contractor support to meet current demands and explore the potential for establishing a new LTER Science Translation and Outreach Program (LTER STOP) through	EB	LNO or other	2011	Needs planning

Objective	Actions Required	By Whom	Loca-tion	Time Frame	Status
	regional coordinators, centralized staff, or cross-site activities.				
	C. Develop a proposal for a new site supplement program to support engagement and communication efforts at LTER sites and support site efforts by developing and sharing best practices	EB	All sites	2011	Needs planning
1B. Strengthen LTER's name recognition and reputation among decision makers and the media as a source of rigorous, long-term ecological research information	A. Expand online communications products and tools				
	a. Create a new LTER gateway website with emphasis on external audiences	LNO contractor	LNO	2012	Needs planning
	b. Review existing models and create new Science Spotlight series to develop and deliver LTER multi-media content in a variety of formats.	LNO oversee contractors, interns, graduate students	LNO and sites	2011	Needs planning
	B. Engage the LTER community in developing new multi-media content				
	a. Host 2 LTER Science Blogs, one by students and one derived from the Spotlight content	LNO Public Information Officer (PIO) coordinates	LNO and sites	2011	Needs planning
	b. Sponsor LTER video, photography, and new media contest for LTER students and scientists	LNO PIO coordinates	LNO and sites	2012	Needs planning
1C. Increase opportunities for scientists to highlight LTER accomplishments to funders and other target audiences	A. Develop or expand programs to reach DC-based decision makers				
	a. Expand mini-symposium and develop a strategy and annual schedule for decision maker briefings	EB, NSF Public Affairs	LNO and NSF	2011	Needs planning
	b. Coordinate with scientific societies to host information sessions with decision makers	LNO PIO	LNO and sites	2012	Needs planning
	c. Consider program to host decision makers for immersions in field science at LTER sites	Comm. Committee	LNO and sites	2012	Needs planning
	B. Select 4-6 sites each year to organize and host site visits by elected officials (local, state, and federal)	EB	All sites	2011	Needs planning
	C. Publish and distribute an annual "LTER Contributions" document	LNO, EB	LNO	2011	Underway

Objective	Actions Required	By Whom	Loca-tion	Time Frame	Status
2A. Engage decision makers in developing questions and informing distillation activities, particularly related to issue-based synthesis efforts	A. Equip LTER supported cross-site synthesis efforts with full-scale communications and outreach	EB	All sites	2011	Needs planning
	B. Create new publication forms to distill and disseminate relevant research				
	a. Develop a new LTER publication series focused on distilling and translating results perhaps with ESA "Issues in Ecology"	Comm. Committee	All sites	2011	Needs planning
	b. Explore online publications and "knowledge exchange" with science publishers	Comm. Committee	LNO and sites	2011	Needs planning
	C. Create an outreach toolkit for sites with materials and best practices, and host peer-to-peer outreach	Comm. Committee	LNO and sites	2011	Needs planning
2B. Expand the Network's capacity to disseminate high-impact scientific findings to local, national, and international media	A. Develop new programs to build and sustain connections with journalists				
	a. Explore partnership with an ecological science-based field journalism program	Comm. Committee	LNO and sites	2011	Needs planning
	b. Organize annual journalists' field trips to LTER sites	Comm. Committee	All sites	2011	Needs planning
	c. Find and explore partnerships with journalists and media outlets (e.g. Earth & Sky, National Geographic, DC trade media, science bloggers).	Comm. Committee, PIO, NSF Public Affairs staff	LNO and sites	2011	Needs planning
	B. Provide expanded guidance to sites on the 3Rs – Releasing Research Results				
	a. Partner with NSF Public Affairs staff to develop written guidelines for sites that outline the process for releasing new scientific results	LNO PIO with NSF Public Affairs staff	LNO and NSF	2011	Needs planning
	b. Host LTER communications webinar with NSF Public Affairs staff to share guidelines with LTER IMs, education, and outreach personnel	LNO PIO	LNO	2011	Needs planning
	C. Expand LTER resources for journalists				
	a. Provide a searchable online database of LTER subject matter experts	LNO CIO	LNO	2011	Needs planning
	b. Partner with scientific societies or others to develop "LTER rapid response teams"	Comm. Committee	LNO and sites	2012	Needs planning

Objective	Actions Required	By Whom	Loca-tion	Time Frame	Status
3A. Promote a shared mission and sense of community by strengthening communica-tion channels for reaching all LTER participants	A. Develop orientation process to support new scientists, staff, and students	Comm. Committee	LNO	2011	Needs planning
	B. Distribute coordinated monthly E-newsletters to consolidate and stream-line	PIO	LNO	2011	Underway
	C. Review and address needs for ease, accessibility and frequency of confe-rencing	LNO CIO	LNO	2011	Needs planning
3B. Advance network-scale science, synthesis, and other collabor-ative activities by facilitating regular interactions across sites and among all LTER partici-pants	A. Organize and host more "some collabo-rators" and "among site" meetings and workshops	Comm. Committee	sites	2011	Needs planning
	B. Sponsor exchange program for staff or scientists from one site to visit annual meetings of other sites	LNO coordi-nate, SC	sites	2012	Needs planning

4.7. Metrics

A. Creation of Communications Committee to oversee, track, and execute the Communica-tions plan (1AA).

B. Network Communication staff and supple-ment programs in place (1AB-C).

C. Creation of new Network web site and increase in number of discrete visitors and page views for the LTER website(1BA-B).

D. Increase in media coverage of LTER as measured by LexisNexis or other search tools (1CA-C).

E. Increase in number of individuals within target audiences who request information for LTER sites or LNO (2AA-C)

F. Increase in number of non-LTER individu-als who received LTER e-newsletter (2BA)

G. Increase in number of cross-site initiatives that result in activities and publications aimed at decision makers and the media (2BB).

H. Increase in extent to which major decisions affecting ecological systems refer to LTER and are consistent with LTER science (2BA-C).

I. Increase in number of students, staff, and scientists who understand and embrace the LTER approach as determined through sur-veys and other feedback formats (3AA-B).

J. Increased level of satisfaction in communi-cation and information sharing across the LTER network as reflected in the number of cross-site activities that are advanced and in LTER survey results (3AC, 3BA-B).

4.8. Financial Resources

Implementing the communication plan will require:

A. Funding for 1-2 FTEs as staff or equivalent contractor to meet current communication demands and explore the potential for a new

Science Translation and Outreach Program (1AB).

B. Budget for additional contractors to undertake specific projects including web designers, science writers, and audio and video content producers (1BA, 2AB).

C. Funds for journalism partnership and new publication series (or staff/contractor time to develop grants) (2BA).

D. Dedicated funds as part of the LTER cross-site synthesis efforts for outreach & communications (2AA).

E. Funding for new LTER site supplements dedicated to the communications goals outlined here (1AC).

4.9. Management Plan

Implementing the communications plan will

require:

A. Standing LTER Communications Committee to establish priorities, develop and share best practices, review progress and set future directions.

B. Day–to-day management of the communication plan by the Communication Coordinator who will report quarterly to the Communication Committee and Executive Board.

C. Annual revision of the communication plan by the Communications Committee with oversight by the LTER Executive Board to ensure resources are needed.

D. Regular assessment of practices and outcomes to ensure goals are being met.

5. INFORMATION MANAGEMENT

5.1. Vision for Information Management

The LTER Network envisions a scientific community in which information management contributes to long-term data stewardship through development and implementation of data and design practices that support scientific research across LTER sites and among LTER and other environmental observing programs.

5.2. Mission Statement

We will design, develop and implement a sustainable information infrastructure that supports long-term data curation, work with standards, and the development of distributed information systems to ensure long-term access to the high quality data necessary to support environmental science at all levels.

5.3. Situational Analysis

Strengths

A. A wealth of long-term and historic data are archived and maintained at each of the LTER sites and increasingly accessible for understanding ecological phenomena at multiple scales.

B. LTER has a long history of information management with an information manager at each site bridging science and data curation, a long-standing Network Information Management Committee that has a strong track record of productive collaborations, and a NISAC community linking ecological research needs with the IM community.

C. Information management is an integral part of LTER research endeavors and within- and cross- site research builds on the extensive data generated by sites over time.

D. Metadata exchange standards have been implemented by all sites, and members of the network actively contribute to standards maintenance and development.

Challenges

A. Cross-site integration is inhibited by the diversity of data types, formats, sampling strategies, and collection methods, and the locally specific and context dependent nature of site data.

B. Implementing standardized approaches to information management requires further work by scientists and information managers.

C. Sites have uneven access to specialized information management expertise at home institutions.

D. A large backlog of data awaits inclusion in site and network data catalogs.

E. There is a tendency for tension between site and network information management responsibilities which, together with increasing complex site information management tasks, can complicate efforts to make data accessible.

Opportunities

A. A wealth of data presents an unprecedented opportunity to scale certain findings up in space and time as well as locally validate the meaning of large scale observations.

B. Resources are available through the Network Office to develop a Network information architecture.

Threats

A. Competing demands of site and network information management tasks may prevent timely input from sites required for the development of the Network Information System.

B. Increased information management requirements at the site and Network levels have outstripped available resources to perform new tasks.

5.4. Goals and Objectives

Goal 1

Provide sources of high-quality, well-documented, and error-checked data at each site that support local science, stimulate synthesis and the creation of new knowledge, and facilitate transformative network-wide research at broad scales.

Specific objectives for this goal include:

A. Fully document site data in accordance with Network standards.

B. Develop quality control standards for LTER data that meet needs identified by projects requiring data synthesis across the LTER Network, and implement these standards at each site to create a high level of confidence in LTER data.

C. Increase the amount of data shared by LTER sites.

D. Archive and document models and their data outputs and make them accessible to other researchers.

E. Digitize or parse, and clean legacy data into an accessible electronic format.

Goal 2

Improve existing data practices and information management systems at sites to make them uniformly easy to use, sustainable, and consistent with LTER NIS protocols.

Specific objectives for this goal include:

A Develop consistent data management protocols such that sites will organize, quality control, and present data of the same theme in a comparable fashion.

B Develop standard site-level data publication capabilities that support delivery to the web and to the LTER central data system (NIS, see goal 3B).

C Support communication and coordination among site information managers, including collaborative design.

Goal 3

Develop a central Network-level data discovery and integration platform that is comprised of databases and servers connected through web services for single-portal data publication, discovery and access.

Specific objectives for this goal include:

A. Develop and deploy a dynamic, consistent, and up-to-date database of network and site information that can be used to support Network communication and synthesis activities.

B. Develop and deploy network-wide data collection, storage, and delivery operations that promote Network synthesis and the creation of data legacies and open access to LTER data products.

Goal 4

Improve information flow between LTER and other networks.

Specific objectives for this goal include:

A. Formalize a plan to develop and coordinate information management standards and protocols with the National Ecological Observing Network (NEON), including making LTER legacy data accessible to the NEON IM program.

B. Partner with the USFS to develop a central data discovery and integration platform for the 80 USFS Experimental Forests, many of which have been collecting field data for more than 50 years, to make their legacy data compatible with the objective above.

C. Mentor and facilitate development of integrated data management systems by environmental observatories that are collecting similar types of information, including but not limited to ULTRAs, LTREBs, OBFS sites, the National Phenology Network, the Genomics Standards Consortium, the Critical Zones Observatory program, the Ocean Observing Initiative, the Arctic Observing Network, and Earthscope.

Goal 5

Evaluate recent developments in computer science, information technology and design, cyber security, community standards, and communication and collaboration technology for potential application in LTER Network and site information management.

Specific objectives for this goal include:

A. Investigate and implement mechanisms for improving the efficiency of IM approaches used network wide and at sites.

B. Support advances in data synthesis.

C. Improve interfaces between existing data systems and products and improve their utility for advancing scientific discovery and knowledge.

D. Support scientific collaboration across disciplines, organizations, and geographic locations.

5.5. Strategies

A. Establish standard and consistent metadata practices for the LTER Network with the expectation that each site will set a reasonable timetable for achieving these standards (Objectives 1A-B).

B. Enhance data sharing by requiring sites to explicitly document on their web page any data sets that are being withheld, along with a justification for why the site is doing so. Coordinate information on data obtained from each site annually and prepare a status report for Network use. (Objective 1C).

C. Identify the barriers at each site to meeting the objectives of Goal 1 and take corrective actions. (Objective 1A-E).

D. Obtain the resources necessary for sites to review and revise each of their LTER-funded data sets and selected legacy data to improve standardization and enhance usability. (Objectives 1A and E)

E. For each major category of LTER data (beginning with the five core areas and expanding to other data domains), establish working groups of domain scientists and in-

formation managers to set dataset and presentation protocols for the LTER Network. (Objectives 2A-C).

F. Obtain the additional resources needed to implement new protocols and standards across the Network. (Objectives 2A-C).

G. Define uniform content for the Network's site characteristics database (SiteDB), promote compliance, and establish a procedure for frequent review and revision of site information. (Objective 2A).

H. Establish the standardized site web interfaces as the de facto portals for access to site information. (Objective 2A)

I. Establish a mechanism to allow sites to maintain up-to-date information using a common, LNO-hosted interface via web services and harvesting protocols. (Objective 2B).

J. Carry out the steps described in the NIS operational plan. Encourage and support

synthesis projects that define and produce new derived datasets. (Objectives 3A and B).

K. Establish a group of domain scientists and information managers to prioritize the development of new derived data sets based on the opportunity for increasing the pace of synthesis. Focus resources for working groups on the highest priority data sets.

L. Formalize a working relationship between the LTER Network, NEON, and other observatories to establish recommendations for coordinated information standards and protocols. (Objectives 4A-C).

M. Establish goals for collaboration with each environmental observatory. Use existing avenues to insure interoperability and comparability of data. (Objectives 4A-C)

5.6. Implementation Plan

Objective	Actions Required	By Whom	Location	Time Frame	Status
1A. Fully document site data in accordance with Network standards	A. Document and create rich EML for data collected and available at each site	Site IM, PI, co-PIs	All sites	existing data sets now through 2012, ongoing thereafter	Underway
	B. Prioritize data sets that are most likely to contribute to Goals, and establish standards reflecting their importance.	Synthesis working groups, site IMs	TBD	existing data sets now – end of 2012, ongoing thereafter	Needs planning
1B. Develop quality control standards for LTER data that meet needs identified by projects requiring data synthesis across the LTER Network, and implement these standards at each site to create a high level of confidence in LTER data	A. Define general qa/qc approaches	Site IM, PI, co-PIs	All sites, TBD	2011	Needs planning
	B. Identify barriers at sites	Site IM, PI, co-PIs	All sites	2011	Needs planning
	C. Define specific qa/qc approaches for each data set	Site IM, PI, co-PIs	All sites, TBD	2011	Needs planning
	D. For each dataset identify qa/qc issues	Site IM, PI, co-PIs	All sites, TBD	2011	Needs planning
1C. Increase the amount of data shared by LTER	A. Obtain a commitment from each site to abide by LTER data	Executive Board	All sites	2011	Underway

Objective	Actions Required	By Whom	Location	Time Frame	Status
sites.	sharing policies				
1D. Archive and document models and their data outputs and make them accessible to other researchers	A. Develop, or adopt standards for model and model output documentation and archive	LNO IT personnel, site IM, modelers at sites	All sites	2012-2016	Needs planning
1E. Digitize or parse, and clean legacy data into an accessible electronic format	A. Identify and prioritize datasets	Data Council consisting of PIs, IMs, scientists from outside LTER	distributed with meetings	2012	Planned, not funded
	B. Develop efficient strategies for digitization and parsing	Site IMs in collaboration with central team	All sites	2012-2016	Planned, not funded
	C. Fully document datasets for inclusion in PASTA (see other actions)	Site IM, PIs	All sites	2012-2016	Planned, not funded
2A. Develop consistent data management protocols such that sites will organize, quality control, and present data of the same theme in a comparable fashion.	A. For each major data project or category (e.g. 5 core areas), working groups of PIs and site IMs will establish data presentation protocols	Members of each working group	TBD	2010-2012	Underway
	B. Prioritize development of standardized attributes (name, scale, unit) for data parameters that are common across sites	Working groups composed of scientists and IMs from appropriate domains	LNO	On-going	Planned, not funded
	C. Prioritize measurements to be standardized or described using an observation ontology	Working groups composed of scientists, IMs, and knowledge modeling experts	LNO	On-going	Needs planning
2B. Develop standard site-level data publication capabilities that support delivery to the web and to the LTER central data system	A. Create persistent data identifiers for tracking and citation of LTER data	Network office-working groups of PIs and site IMs	LNO	2011	Needs planning
	B. Refine consistent data access mechanism via link in metadata (Data Access Server).	LNO IT personnel and Site IMs	LNO	2011	Underway
	C. Develop tools for efficient metadata creation and maintenance (e.g. for construction, synchronization, and editing)	LNO IT personnel and Site IMs	LNO	2011	Underway
	D. Develop tools for metadata evaluation (e.g., interface to congruency checker)	LNO IT personnel and Site IMs	LNO	2011	Underway
2C. Support communication and coordi-	A. As detailed in LNO operational plan: on-	LNO CIO and web support person	LNO	On-going	Underway

Objective	Actions Required	By Whom	Location	Time Frame	Status
nation among site information managers, including collaborative design	line and on-site training, working groups, annual meetings B. Document site information management systems for dissemination	Site IMS	All sites	On-going	Underway
3A. Develop and deploy a dynamic, consistent, and up-to-date database of network and site information that can be used to support Network communication and synthesis activities.	A. Develop, deploy, and continually improve network databases connected through web services	LNO IT personnel, site IM working groups	LNO, All sites	2010-2012 with maintenance ongoing	Underway
3B. Develop and deploy network-wide data collection, storage, and delivery operations that promote Network synthesis and the creation of data legacies and open access to LTER data products	A. Continue to implement the operational plan for the LTER Network Information	LNO IT personnel, tiger teams (site IMs and scientists), complementary projects, external partners	LNO	2010-2014	Underway
4A. Formalize a plan to develop and coordinate information management standards and protocols with the National Ecological Observing Network (NEON), including making LTER legacy data accessible to the NEON IM program	A. Map site-level measurements (or network-level as available) to NEON data products	Working groups composed of scientists and site IMs	LNO	2012-2015	Needs planning
4B. Partner with the USFS to develop a central data discovery and integration platform for the 80 USFS Experimental Forests, many of which have been collecting field data for more than 50 years, to make their legacy data compatible with the objective above.	A. Establish WGs composed of scientists and IMs to coordinate with USFS	LNO leads	LNO, All sites	2011+	Needs planning

Objective	Actions Required	By Whom	Location	Time Frame	Status
4C. Mentor and facilitate development of integrated data management systems by environmental observatories that are collecting similar types of information, including but not limited to ULTRAs, LTREBs, OBFS sites, the National Phenology Network, the Genomics Standards Consortium, the Critical Zones Observatory program, the Ocean Observing Initiative, the Arctic Observing Network, and Earthscope.	A. Communicate our metadata standards to other networks B. Crosswalk between our metadata specifications and other specifications C. Provide leadership to develop initiate and continue community-wide efforts to integrate data management systems	Working groups composed of scientists and IMs LNO/NBII LTER Chair, Executive Board, Executive Director	LNO, All sites LNO Distributed	On-going On-going 2011-2014	Planned, not funded Underway Needs planning
5A. Investigate and implement mechanisms for improving the efficiency of IM approaches used network wide and at sites	A. Investigate website management tools (Content Management Systems, web services) B. Investigate potential implementation of metadata management tools C. Evaluate options for coordinating and/or centralizing certain IM functions.	LNO IT personnel and site IMs LNO IT personnel and site IMs LNO IT personnel and site IMs	LNO Distributed LNO and all sites	2010-2012 2011-2013 2011-2012	Underway Needs planning Planned
5B. Support advances in data synthesis	A. Evaluate community standards B. Evaluate workflow approaches for data harmonization	Brunt, Servilla, some site IMs Brunt, Servilla, some site IMs	LNO LNO	On-going On-going	Needs planning Needs planning
5C. Improve interfaces between existing data systems and products and improve their utility for advancing scientific discovery and knowledge	A. Investigate user behavior, needs, and expectations	LNO IT personnel and site IM	LNO, sites	On-going	Underway
5D. Support scientific collaboration across disciplines, organizations, and geographic locations	A. Introduce scientists to new collaboration and communication software	LNO personnel, site IMs	LNO	On-going	Needs planning

5.7. Metrics

A. Increase in the proportion of datasets collected at each site that are available and NIS compliant (1A).

B. Decrease in the number of errors in site data as measured by QA/QC standards (1B).

C. Successful development of model code and model data archive (1D).

D. Increase in the availability of datasets for synthesis projects (site metric) (1C and 1E).

E. Increase in proportion of available datasets that are harmonized among sites (site metric) (2A).

F. Number of standardized attributes, units, vocabularies, ontologies (2A).

G. Increase in proportion of site datasets that are ingested into the NIS (2B).

H. Increase in use and citation of Network databases (e.g., siteDB, Clim/HydroDB, EcoTrends) (3A).

I. Successfully compete the NIS as described in the LNO Operational Plan (3B).

J. Increase in number and use of dataset downloads (site metric) (3A-B).

K. Increase in the fraction of datasets cited in publications (site metric) (3A-B).

L. Successful partnership with NEON that leads to shared standards and increased accessibility of LTER data to NEON (4A).

M. Successful partnership with USFS that provides a pathway to integrate LTER and Experimental Forest data (4A).

N. Number of data collection and processing protocols available to partners like OBFS (4C).

O. Documentation of local IM systems (site metric) (5A).

P. Number of informatics papers, presentations, reports and technical specifications (site and network metric) (5A)

Q. Number of scientists participating in information management working groups (e.g., Tiger Teams, attribute standardization, vocabulary development) (5B).

R. Number of workflows for synthesis projects (5B).

S. Number of graduate students who publish data with their theses (site and network metric) (5C).

T. Increases in interdisciplinary, inter-institution, and international collaborations (5D).

5.8. Financial Resources

Implementing the information management plan will require:

A. Remedial activities to fully document site data will require a one-time infusion of support (1A, 1C, 1E, 4A).

B. Funding for an information management team at each site that will require approximately 3 FTE annually, including a lead information manager trained in ecology and ecoinformatics (1A-C, 5A-D).

C. Specific one time projects for technological developments will need separately specified financial resources depending on the effort needed for information management (1B, 1D

D. New synthesis projects will need to budget funds specifically for developing new derived data products (3A, 4A-C).

5.9. Management Plan

Implementing the information management plan will require:

A. The Network Information System Advisory Committee (NISAC), with input from the Information Management Committee (IMC), will establish priorities, develop and share best practices, review progress, and set future directions.

B. A new "Data Advisory Council," including representatives from outside the Network (e.g. NEON, USFS, OBFS, and LTREB) will be responsible for developing priorities to document and homogenize existing and derived data sets.

C. Activities related to building the NIS infrastructure at LNO will be managed according to the detailed LNO Operational Plan.

D. Continued oversight by the LTER Executive Board and Network Office to ensure resources for working groups.

6. COORDINATION WITH OTHER NETWORKS

6.1. Vision for Coordination

The LTER Network envisions collaboration, research, and synthesis activities across environmental research networks and observatories such as NEON, the Ocean Observatories Initiative (OOI), and the ILTER Network that will provide comprehensive, integrated, and synthesized science at regional to continental scales that no single network can achieve on its own.

6.2. Mission

We will lead the creation of a Networks Coordination Group to promote collaboration among research networks to improve abilities to 1) track environmental change, 2) understand the causes of changes observed, and 3) build models to help foresee and manage future environmental change.

6.3. Situational Analysis

Strengths

A. A strong history of using long-term observations and experiments to address transdisciplinary questions at multiple spatial scales.

B. An explicit focus on fundamental questions about human-environment interactions and interdependencies.

C. Strong existing connections to other networks as research partners or co-located observing sites (e.g. NEON, ULTRA, ILTER, CZO).

D. A history of leadership in environmental information management.

Challenges

A. Engaging groups and networks that have diverse objectives and are at different developmental stages.

B. Ensuring good communication among networks to foster interactions.

C. Maintaining participation of other networks and observatories in a network of networks without overtaxing LTER's existing human and financial resources.

D. Reaching consensus on how best to ensure complementary research toward predicting environmental change.

E. Determining strategies for designing interoperable data management systems across networks with divergent goals and priorities.

Opportunities

A. A recent proliferation of ecological research and observation networks and programs collecting ecological data at site to continental scale (e.g., NEON, ULTRA, ILTER, OOI, CZO).

B. Awareness among emergent networks of the need for coordination.

C. Convergent and complementary goals across networks, such that LTER can better meet

its research and education goals by helping to integrate activities of other networks.

Threats

A. New environmental observatories that are so large and complex that cooperation with existing networks such as LTER may be a low priority.

B. Limited funds and human resources to commit to an open-ended initiative involving a large number of observatories and their diverse objectives.

C. Prior lack of success of existing grass roots efforts may make groups hesitant to engage.

D. Lack of coordination between data repositories.

6.4. Goal and Objectives

Our goal is to help create a Networks Coordination Group (NCG) to promote cross-network research and improve data sharing among diverse environmental research networks and observatories.

Specific objectives include:

A. Create and fund a Networks Coordination Group (NCG), including especially LTER, ILTER, NEON, and CZO, and a part-time director.

B. Establish a shared understanding among participating networks of mission, goals and objectives for the NCG.

C. Actively participate in NCG activities and promote cross-network activities that advance the goals of all participants.

D. Work towards data interoperability among member networks.

6.5. Strategies

A. Solicit interest among potential members of an NCG and establish a charter and operations plan.

B. Solicit funding to support NCG coordination activities, including part-time staff.

C. Explore and initiate coordination activities in areas of mutual interest: research, education, communication, and information management.

6.6. Implementation Plan

Objective	Actions Required		By Whom	Loca-tion	Time Frame	Status
1A. Create and fund a Networks Coordination Group (NCG), including especially LTER, ILTER, NEON, and CZO and a part-time director	A.	Establish LTER working group to lead LTER's role in creation of the NCG.	EB	LNO	2011	Needs planning
	B.	Solicit interest from potential NCG members and hold initial meeting to set initial objectives	LTER NCG Committee	LNO	2011	Needs planning
	C.	Solicit funding for initial activities, including staff	NCG	LNO	2012	Needs planning
	D.	Hire a part-time director	NCG	tbd	2012	Needs planning

Objective	Actions Required	By Whom	Loca-tion	Time Frame	Status
1B. Establish a shared under-standing among participating networks of mission, goals and objectives for the NCG	A. NCG meets face-to-face to prepare a white paper on the network of networks	NCG	tbd	2012	Needs planning
1C. Actively participate in NCG activities and promote cross-network activities that advance the goals of all participants	A. Participate in NCG activities that further LTER goals in: a. Research b. Education c. Communication d. Information management	LTER NCG Com-mittee	tbd	2012	Needs planning
1D. Work towards data interoperability among member networks	A. NCG meets to discuss data management issues and draft proposals	NCG	tbd	2013	Needs planning

6.7. Metrics

A. Creation of an NCG with participation from other networks and funded staff position (1AA-D).

B. Cross-network policy and management whitepaper (1BA).

C. Activities in research, education, communi-cation, and information management that represent cross-network efforts (1CA.

D. Data sets created that are shared and intero-perable across networks (1DA).

6.8. Financial Resources

Implementing the networks coordination plan will require:

A. Funding for NCG activities, including meetings and a part-time director (1AC-D, 1BA).

B. Funding for LTER NCG Committee meetings and NCG participation (1CA, 1DA).

6.9. Management Plan

Implementing the information management plan will require:

A. A new LTER Networks Coordination Group Committee will lead the establishment of the NCG and represent LTER within the Group. The Committee will ensure that LTER inter-ests are represented in the NCG and that other LTER committees contribute to the success of NCG in areas of shared interest (research, education, communication, and information management).

B. Continued oversight by the LTER Executive Board and Network Office to ensure resources for LTER NCG participation.

APPENDIX A – ABBREVIATIONS AND ACRONYMS

CIO – Chief Information Officer (LNO)
CNH – Coupled Natural-Human Systems
CZO – Critical Zone Observatories
ILTER – International Long-term Ecological Research
IMC – Information Management Committee
IMs – Information Managers
ISSE – Integrated Science for Society and the Environment
LNO – LTER Network Office (Albuquerque)
LTER – Long-term Ecological Research
NCG – Network Coordination Group
NEON – National Ecological Observatory Network
NISAC – Network Information System Advisory Committee
OOI – Ocean Observatories Initiative
PIO – Public Information Officer (LNO)
SIP – Strategic and Implementation Plan
ULTRA – proposed Urban Long Term Research Areas

Implementation Plan Status Categories
    Underway – already doing this task with existing funds
    Planned – a plan exists to complete this task with funding on-hand
    Planned, unfunded – a provisional plan awaits funding
    Planning started – a provisional plan is being developed
    Needs planning – no plan yet in place

APPENDIX B – CODE OF ETHICS AND HUMAN SUBJECTS

Research, education and other activities undertaken LTER Network participants will be pursued with high ethical standards. Science and education operate on trust. At all institutions hosting LTER sites there are formal policies that describe ethical standards for research and scholarship. Institutional committees are available to investigate ethical lapses, including charges of scientific misconduct such as data falsification, plagiarism, abuse of confidentiality, and failure to report fraud. Programs to orient graduate students and postdocs on responsible conduct of research are available and required at all institutions, per NSF policy.

All research and education within the Network will be conducted using accepted procedures and policies with respect to environmental and human health and safety. At Network institutions policies and procedures such as Institutional Review Boards are in place to ensure compliance with Federal Regulations regarding animal welfare and the protection of human subjects involved in research