BioMesonet

This description of BioMesonet focuses on the biogeochemical, physical, and hydrological aspects of terrestrial and wetland systems. The final version of BioMesonet will include additional (complementary) components not described here, including ones motivated by organism, animal and species level questions.

Science question

Researchers have a relatively good understanding of how water vapor and CO_2 flux vary within individual ecosystems over short time scales, but a relatively poor understanding of how and why these fluxes differ as a function of current and past land use, species composition, and climate. This situation partly reflects the tendency of fields such as micrometorology to focus on understanding how individual sites work, as opposed to comparing one site with another. Our inadequate understanding of long-time-scale and landscape-scale processes is a major impediment to forecasting the biogeochemical and hydrological consequences of changing land use, species composition, and climate.

Experimental design: measurements in space and time

NEON could make a concerted effort to understand and quantify landscape-scale biogeochemistry and hydrology by deploying observing stations along natural or manipulative gradients of disturbance, climate, nutrient status, and land-use. This approach could be thought of as a marriage between standardized eddy covariance towers and the meteorological strategy exemplified by Oklahoma's Mesonet.

NEON's BioMesonet will provide mesoscale measurements of relevance to environmental and biological variables. NEON is in a position to exploit the economy of scale for these measurements, which would reduce the cost of instrumentation and allow researchers to study the patterns of carbon and water vapor exchange at a higher level of organization than has previously been possible. For example, NEON could promote the development of cheaper, standardized eddy covariance instruments, which would be deployed with complementary measurements such as biomass, NPP, and nutrient cycling along chronosequences to understand how CO_2 exchange and evapotranspiration change during succession. Similar networks could be deployed along natural or manipulated land use, climate, species composition, or nutrient availability gradients.

Within an individual NEON observatory, the BioMesonet towers will be relatively densely distributed (perhaps ~ 200-300 towers nationally) and located across a range of habitats, ecosystems, or land uses/land covers. Remote sensing and GIS approaches could quantify the distribution of natural and anthropogenic variability across the landscape, and allow individual observations to be integrated to larger scales. Replicated at all NEON observatories, the BioMesonet would be nationally coordinated and consistent. As such, a BioMesonet will generate many of the synoptic measurements necessary for effective ecological forecasting.

Specific measurements

Basic infrastructure - power, tower, and housing unit:

On average $25,000 per site, but will vary markedly between sites
5-m tower at grassland site with existing line power $2500
80-m tower in redwood stand with solar power $100,000

Data acquisition, telecommunications (should be open and highly expandable) $10,000

Installation of instrumentation $10,000

Fundamental measurement set (Estimated cost per site):

Incoming (direct and diffuse) and outgoing PAR: $600
Incoming ultraviolet radiation: $2000
Incoming and outgoing solar radiation: $2000
Incoming and outgoing terrestrial radiation: $2000
Profiles of air temperature, humidity and carbon dioxide: $5000
Wind speed and direction (multiple heights): $1200
Soil temperature profile (5): $500
Soil moisture profile (3): $500
Air temperature and relative humidity (top of the tower): $1000
Pressure: $500
Precipitation (rainfall and snowfall): $1000
Eddy covariance system: $20,000

Energy and momentum
Carbon dioxide, water vapor (should be closed path IRGA unless there is major progress on density/WPL problem)

Digital cameras (to record plant phenology): $500

High end measurements at selected sites to focus on primary production

Multiplexing automatic chambers (carbon dioxide fluxes): $30,000

High end measurements at selected sites to focus on water

Leaf wetness: $500
Snow depth: $10,000
Water table depth: $3000
More extensive array of soil moisture sensors: $5000

High end measurements at selected sites to focus on atmospheric pollution

Ozone concentration: $8000
Ozone flux: $8000
Nitrogen deposition (dry): $40000
Nitrogen deposition (wet): $1000
Carbon monoxide: $12000
Biogenic hydrocarbons: $20000

Estimated site costs

The capabilities of the measurement systems should be tightly specified, and the contract put out to bid. The half dozen companies that are capable of providing the equipment should compete on price.

Total cost of Fundamental installation: $85,000
Total cost of High end sites to focus on primary production: $120,000
Total cost of High end measurements to focus on water: $110,000
Total cost of High end measurements to focus on atmospheric pollution: $190,000

Tie in and leveraging of other NEON and non-NEON resources

The BioMesonet will provide NEON with a backbone of sites across the country. Much of the infrastructure should be shared by the other sensor groups. The tower, infrastructure, power system, control, telecommunication, and data acquisition systems should be shared with the Organism Tracking System on a routine basis. The Sensor Micronets should be collocated with a subset of the BioMesonet sites – BioMesonet will provide information on how ecosystems vary across the landscape; the Sensor Micronets will go into much more depth at a subset of these sites to fully understand function. The BioMesonet and aquatic measurement suites will overlap in wetlands. The data acquisition and infrastructure capabilities (power, space) should be highly expandable, which will allow for the easy addition of additional measurements as new instrumentation and technologies emerge.

There is close overlap between the BioMesonet and many ongoing and proposed activities (e.g., AmeriFlux, EPA and state pollution networks, NACP, RAWS, SNOTEL, State and county ALERT, USGS stream flow, water use networks such as CIMIS, CUASHI HOs). These data should be incorporated into the overall science effort. Intercomparability between these networks will be a key challenge. Some thought should be given on the front end to either conforming to existing standards (e.g., EPA, WMO), or to intercalibrations with other networks.

Aquatic Habitats: Linked Physical, Chemical, and Biological Processes

Many of the environmental events that are most important to humans are the result of fast transitions (pulses) or localized events (patches). In aquatic habitats these events include toxic algal blooms, local hypoxia, death of macrofauna and macroflora, and general degradation of water quality. These system-level responses are driven by local, episodic or transient events that are not captured by random or coarse periodic sampling. Transforming our understanding of how aquatic ecosystems function requires better capturing and being able to predict the effects of a patch or a pulse event. Thus, concurrent measurements of biological, physical, and chemical parameters at high spatial and temporal resolution are essential for resolving interactions that drive system level processes. To do that requires being able to collect physical, chemical, and biological data simultaneously and at high frequency to describe those events and to be able to drive theories and models that will provide better predictive capacity at scales directly relevant to human activity and decision making.

All aquatic systems are interconnected. Wetlands, in particular, are important and often more transient interfaces between terrestrial and aquatic habitats. Monitoring tools should address possible patches and pulses that may occur across the range of scales (e.g., storm events and associated rapid landscape drainage may contribute to rapid and localized transition events in aquifer recharge zones, wetlands, streams, and lakes).

General science drivers. Rates of recharge and regeneration, impacts of climate change and changing water use practices (irrigation, taping of deep aquifer for agriculture, lowered water tables and degradation of aquifer water quality), surface water quality, causes of eutrophication

Example of observational system using networked embedded real time in situ sensors to trigger sample-base analyses.

Small-lake observatory in developing region (agricultural, urbanization).

Patches and pulses – toxic cyanobacterial bloom in small lake, impacted by changing landscape features/development.

Key Question- what are the controlling processes?

- What is the role of limiting nutrients?
- What are the effects of physical changes – temperature, light, transport?
- What is the role of Interacting variables – temperature + nutrients + light + turbulence?
- How do land use, surface cover, and topography contribute and over what time scales?
- What are the biological response times to changing physical/chemical variables?
- What is the contribution of physical and chemical heterogeneity to biological response?

Information/measurements needed

Mesosensor data

- Local topography and ground cover
  Fundamental: LIDAR, remote sensing of surface spectra (hyperspectral) for assessing plant diversity, coverage, chlorophyll, temperatures etc.
- Meteorological data (landscape and lake surface)
  Fundamental: mobile micro meteorological stations
- Surface-water flow
  Fundamental: point and depth velocity measurements (in situ)
  High end (near future): 3-D velocity measurements over entire aquatic system (lake/stream) by injection of miniature floating or neutral density RFID or GPS devices (not yet deployable, but near future).
- Ground-water flow
  Fundamental: monitoring wells
  High end (near future): Ground penetrating radar, laser-based mass spectrometers (isotopes)

Microsensor data

- Microbiology
  Fundamental: sample based (see listed methods)
  High end : flow cytometry measurements of total cell numbers, size , and fluorescent properties

- Chemical
  Fundamental: see listed microsensors and sample-based analyses
  High end: fast response sensors for chemical monitoring, including nutrients (ca 10 Hz or faster).

- Physical
  Fundamental: see listed microsensors
  High end: fast response 3-D velocity profilers (50 Hz), RFID/GPS floating or neutrally buoyant particles (preferential flow trajectories)

LTER Site Schoolyard Education Program Review Guidelines
Draft: Jan. 5, 2005

Introduction:

The mission of LTER Education programs is to use the uniqueness of the LTER Network to promote learning about long-term ecological processes and the earth's ecosystems. Beginning in 1998, the LTER network formally expanded its education efforts to include K-12 students and teachers—mainly through the Schoolyard (SLTER) program funded by the Division of Environmental Biology at the NSF. They provided supplements ($15,000) upon request to LTER sites to specifically design their own program in relation to the ecological research conducted at the site and the particular needs and resources of the local school district and community.

This document, developed by the LTER education representatives, is intended to serve as a reference for formal reviews of LTER sites as well as for informal self-assessment and planning. These guidelines are for SLTER only, although most, if not all sites are also involved in additional education activities, including but not limited to, education for the general public, undergraduates, etc. Because of the nature of the funding, each site is not expected to achieve all program features in one year, but over several years. Reviewers should keep in mind that each SLTER program is unique and reflects the strengths and interests of that particular site.

Administration

- Site has a designated education representative/coordinator to serve as a liaison between the site research program participants and the broader community.

- Education representative maintains ongoing dialogue with the PIs, co-PIs, information managers, graduate students, and others working at the site as well as an understanding of the site and LTER Network infrastructures.

- Education representative keeps all site personnel informed about the site's education program and coordinated Network activities.

- Site scientists and other site participants show a commitment to the education program. This might include one or more of the following: assisting with program planning and/or curriculum development, participating in teacher workshops and field trips, securing additional funding, encouraging the participation of LTER-funded graduate students, post-doctoral associates and technicians in education activities.

Program Features

- Programs directly relate to and articulate science being conducted at the LTER site, or complement the LTER science furthering LTER goals.

- Programs stem from a site SLTER plan with goals and evaluation strategies. These assessments might range from teacher surveys to advisory committees.

- Programs foster teacher and/or student awareness of the full process of science, including hypotheses development, data collection, data analysis and forming conclusions based on data. When possible, teachers and/or students take part in the entire scientific process.

- Programs illustrate the value of long-term and ecological research.

- Programs relate to teachers' needs (e.g., programs correlate with national, state, and/or local education standards, further developing ecological/environmental science content and science process knowledge).

- Site education materials, including web pages, are developed and maintained with useful information available for teachers, students, administrators, and site participants interested in the program.

Community

- Diversity of participating teachers and/or students accurately reflects the general population diversity of the region being served. Efforts are made to involve underrepresented students and/or teachers serving underrepresented students.

- Programs serve an appropriate number of schools, students, and teachers given their location and budget.

- Site education representatives are aware of the diverse groups in their community (e.g., universities, nonprofit organizations, government agencies, other NSF-funded education programs, school districts) and take advantage of collaborations when possible.

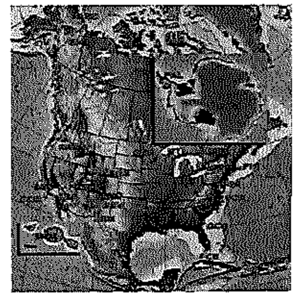
Network-Level Collaboration

- Education representative participates in the LTER Education Committee, including representing the site at Annual and All Scientist Meetings, responding to LTER Education Committee inquiries, and, when possible, contributing to the design of network-level activities.

- Education representative communicates information about site programs to the LTER Network through electronic messages, listserv responses, web posts and/or newsletter submissions.

- Development of or participation in cross-site activities is undertaken as a synergistic opportunity when possible.

LNO Survey 2005
Numeric Results Summary



Except where noted as ranked responses, the following scale applies:

5 = Strongly agree
3 = neutral,
1 = strongly disagree

	Value Distributions						Mean	Median	Mode
I. Administration & Service Activities	1	2	3	4	5	*Ttl*			
1. LNO provides support to LTER governance to facilitate travel/organization, and documentation	0	0	2	8	10	*20*	4.40	5	5
2. Our site uses Request Tracker for services requests	2	5	4	5	4	*20*	3.20	3	2
3. Request Tracking system provides useful/timely feedback from LNO	2	0	6	7	4	*19*	3.58	4	4
4. LNO reponses to requests for information timely and effective	0	1	3	11	5	*20*	4.00	4	4
5. Our site satisfied with the level of information regarding LNO activities	0	1	6	12	1	*20*	3.65	4	4
6. Should LNO change email alias policy?	3	3	5	7	2	*20*	3.10	3	4
7. General performance of the LNO meets/exceeds expectations	0	1	7	11	1	*20*	3.60	4	4
II. Computational and Communication Infrastructure									
1. LNO efficiently maintains Network websites, databases, mailing lists, etc.	0	1	3	10	6	*20*	4.05	4	4
2. LNO provides easy access to sites for network databases such as personnel and site databases	0	3	3	10	3	*19*	3.68	4	4
3. The public and intranet sites maintained by the LNO provide useful information	0	1	4	11	4	*20*	3.90	4	4
4. Archived documents on the intranet web page are easy to find/access	1	6	8	5	0	*20*	2.85	3	3
5. Our site would like assistance in collaboration tools (video conferencing, whiteboarding)	2	3	8	5	1	*19*	3.00	3	3
6. Our site would like assistance from the Network Office in website design/construction	3	4	4	4	5	*20*	3.20	3	5
7. General performance in computational/communication infrastructure meet/exceeds expectations	0	1	6	12	0	*19*	3.58	4	4
III. Information Management and Methods Development									
1. LNO provides tech support to help sites adopt IM standards approved by the CC	1	4	5	8	2	*20*	3.30	4	4
2. An important LNO activity is workshop organization/support to facilitate standard protocols	0	0	2	11	7	*20*	4.25	4	4

	Value Distributions						Mean	Median	Mode
	1	2	3	4	5	*Ttl*			
3. To whom do you look for information about the development of the Network Information System:									
Site information manager	0	2	3	8	7	*20*	4.00	4	4
LNO	1	2	10	3	3	*19*	3.26	3	3
NIS Advisory Committee	3	2	4	4	6	*19*	3.42	4	5
4. Satisfaction with detail/timeliness of NIS development information	1	3	7	6	3	*20*	3.35	3	3
5. Satisfaction with LNO assistance with EML implementation	3	6	3	7	1	*20*	2.85	3	4
6. General performance of LNO in IM and methods development meets/exceeds expectations	1	5	6	6	2	*20*	3.15	3	3

IV. Network Development, Community Outreach & Training

1a. Importance of LNO to continue interaction and communication facilitation between network and…									
Scientific and educational societies	0	1	0	12	7	*20*	4.25	4	4
Governmental agencies	0	0	0	10	10	*20*	4.50	5	5
Research centers	0	0	3	10	7	*20*	4.20	4	4
NGOs	0	1	5	8	6	*20*	3.95	4	4
Policy makers	0	0	3	11	5	*19*	4.11	4	4
1b. LNO has been effective in establishing interactions with the broader community	0	2	6	8	3	*19*	3.63	4	4
2a. Training activities are important LNO outreach activities	0	0	2	10	8	*20*	4.30	4	4
2b. Personnel from our site have attended training and the LNO has been effective outreach activity	1	3	0	8	6	*18*	3.83	4	4

2c. LNO should continue with the following:

(Rank order responses 1-8, 1 = highest priority, 8 = lowest priority)

	Mean	Mean Rank	Imp. Value*
Ecological informatics	3.32	3	12
GIS	5.58	7	1
Remote sensing/spatial analysis	5.58	6	3
Ecological Metadata Language	3.16	2	12
Database Development	2.95	1	13
Wireless Networking	5.05	5	5
Sensor networks	4.47	4	7
Emerging technologies	5.89	8	4

* Number of sites ranking in top 3

	1	2	3	4	5	Ttl	Mean	Median	Mode
3. General performance meet/exceeds expectations	0	2	6	9	2	*19*	3.58	4	4

V. Publications and Public Outreach

	1	2	3	4	5	Ttl	Mean	Median	Mode
1. Following publications meet/exceed expectations:									
a. LTER Newsletter	0	1	9	5	5	*20*	3.70	4	3
b. Individual site brochures	0	1	11	5	3	*20*	3.50	3	3
c. All-LTER Brochure	0	0	7	8	4	*19*	3.84	4	4
d. Multimedia Database	0	3	10	3	2	*18*	3.22	3	3
e. Document Archive	0	5	10	3	2	*20*	3.10	3	3
f. LTER Newwork Public Website	1	2	8	6	3	*20*	3.40	3	3
g. LTER Intranet Website	1	2	10	4	2	*19*	3.21	3	3
h. Presence of LTER exhibit at ESA, AAAS, etc.	0	1	7	8	3	*19*	3.68	4	4
2. General performance of LNO in publications/public outreach meets/exceeds expectations	0	0	7	11	1	*19*	3.68	4	4

VI. Synthesis

	1	2	3	4	5	Ttl	Mean	Median	Mode
1. LTER ASM should be focused on specific products such as publications and proposals	0	1	8	8	3	*20*	3.65	4	4
2. Support for working group meetings proviced LNO facilitates cross-site research	0	1	3	10	6	*20*	4.05	4	4

3. The following would facilitate cross-site research most:
(Rank order responses 1-5, 1 = highest priority, 5 = lowest priority)

	Mean	**Mean Rank**	**Imp. Value***
Increased support for post-docs	2.55	2	12
Increased help with managing data in working groups	3.25	4	3
Support for mini-sabbaticals to work on synthesis	3.00	3	9
Increased support for small group meetings	2.05	1	13
Increased support for large group science meetings	4.15	5	3

* Number of sites ranking in top 2

	1	2	3	4	5	*Ttl*	Mean	Median	Mode
	Value Distributions								
4. General performance of the LNO in facilitating synthesis meets/exceeds expectations	1	2	6	11	0	*20*	3.35	4	4
VII. International LTER									
1. The LNO should continue to seek mechanisms to increase collaborations between US and international researchers	0	3	1	11	4	*19*	3.84	4	4
VIII. Education									
1. My site would benefit from the following LNO Education activities:									
Network-wide Education Opportunities (meetings, workshops, proposal collaborations)	0	3	7	8	1	*19*	3.37	4	4
Schoolyard LTER website features (slides, other site's proposals, news and information)	0	3	9	5	2	*19*	3.32	3	3

Questions generated by Network Science Working Groups (Jan/Feb '05)

- **ECOLOGICAL EFFECTS OF CLIMATE CHANGE**
- **What properties of ecosystems explain their differential responses and sensitivities to climate change?**
- Under what conditions are non-linear responses, including thresholds, to climate forcing mediated by biotic interactions vs. external factors?
- What are the characteristics of heterogeneity that serves to amplify or dampen a response to climate variability?
- Under what conditions do ecological responses to climate forcing demonstrate emergent properties that cannot be generalized across scales?
- How does climate change, including extreme events, modify natural disturbance regimes to mediate ecological responses and feedbacks?
- How do anthropogenic stressors and climate change interact to alter ecological response?
- How do differences in ecosystems modify their responses to climate change to modify ecosystem services?
- How do climate change-induced alterations to ecosystems modify feedbacks to the climate system? (Really a climate question, not climate effects.)

- ALTERED BIOTIC STRUCTURE
- Does environmental change lead to different rates of change among different biotic components? Do differential rates of change contribute to differences in sensitivity of ecosystems?
- Does environmental change sever feedback loops between aspects of biotic structure?
- How does homogenization of biotic structure erode the ability of communities and ecosystems to respond or adapt to environmental change, particularly increased climatic variability?
- Does environmental change impact levels of diversity equally? Are there cascading effects of change at one level of diversity?
- Is there recovery of integration following decoupling?
- Can we manipulate biotic structure and ecosystem function to optimize the tradeoffs between gains from ecosystem services v. losses of ecosystem sustainability?

- COUPLED HUMAN-ECOLOGICAL SYSTEMS
- How did the socioecological system develop into its current state and how will it change in the future?
- What are the key spatial and temporal interactions within coupled human and environmental systems?
- Why do humans do what they do to environments?
- How do environments respond to what humans do?
- How do humans respond to environments?

- ECOLOGICAL EFFECTS OF ALTERED BIOGEOCHEMICAL SYSTEMS

- What are the effects of chemical alterations such as nutrient enrichment on biotic structure and biogeochemical pools and processes?
- What are the effects of climate change and climate variability on ecosystem structure and functioning, and what are the feedbacks?
- How does human land and water use and management influence biogeochemical pools and processes?
- What are the important linkages among ecosystems that are influenced by humans?

Example of subquestions -
1. *What are the effects of chemical alterations such as nutrient enrichment on biotic structure and biogeochemical pools and processes?*
A. *What are the effects of human driven changes in chemical inputs (C, N, P, etc and pollutants) on i. biotic structure and ii functioning of ecosystems, including biogeochemical pools and processes?*
B. *How do changes in the source, quantity, and quality of OM (as a result of changing biotic structure or allochtonous inputs) affect nutrient avail and sequestration?*
C. *How do inputs of trace metals and pollutants influence ecosystem dynamics, especially carbon storage and cycling?*
D. *Can we forecast the recovery potentials and thresholds for different ecosystems?*

Heterogeneity
Interactions
Self-organization
Thresholds

Graduate Student Committee Report

CC meeting, Key Largo, FL, April 6-7, 2005

Submitted: March 24, 2005

A brief overview of the activities of the last few months—

1. The time of the graduate student committee has been almost completely consumed by planning of the LTER Graduate Student Collaborative Research Symposium which will be held April 13-17 at HJ Andrews in Oregon.

We have 60 graduate student participants (including12 ILTER student participants), 5 workshop leaders, and two plenary speakers. Graduate students will lead at least 6 collaborative research workshops.

Please contact troxlert@fiu.edu if we can provide any additional details.

2. We have planned a joint ESA student section-LTER graduate student "Lunch Chat", similar to the format we had at the last ASM. We have about 20 LTER and ESA participants that will join us for informal chats with students of the ESA meeting in Montreal in August.

3. TTG submitted a "year in review" article for the LTER Newsletter.

TTG

Article V
LTER Network Executive Committee

Section 1. Executive Committee: There shall be established an Executive Committee of the LTER Network comprising the elected Chair of the Coordinating Committee serving as Chair of the Executive Committee, and six additional members elected by the Coordinating Committee. The Coordinating Committee may determine by vote at the time of each election that specific areas be represented in the Executive Committee (such as Data Management). For such specified areas, the elections shall be from nominees representing that area. Other Executive Committee members representing the LTER community are elected from nominations from the Coordinating Committee. Elected members of the Executive Committee shall have terms of three (3) years or until a successor is duly elected. Terms of the members of the Executive Committee will be staggered, so that the terms of one-third of the members expire each year. During the first Coordinating Committee meeting of each calendar year, two new members will be elected to replace those whose terms are expiring. The Coordinating Committee may determine by vote at the time of each election that specific areas be represented in the Executive Committee (such as Data Management). For such specified areas, the elections shall be from nominees representing that area. Candidates can be nominated by any member of the LTER Network, but only those candidates who agree to serve beforehand will be eligible for election. The two candidates receiving the most votes will be elected. Current and past Executive Committee members can serve additional terms if duly elected by the Coordinating Committee. In the event that an elected member of the Executive Committee is not able to fulfill his or her term, the Executive Committee will choose a replacement to complete the term. The Executive Director of the Office shall serve as an ex officio member of the Executive Committee.

Climate Committee Report
2005 Spring Coordinating Committee, Key Largo, FL
Douglas G. Goodin, Committee Chair

The LTER Climate Committee is charged with overseeing climate data, observations, and records across the LTER network. In addition, members of the committee have organized cross-site research initiatives to address climate-related questions in ecological research. Members of the climate committee continue to consult with site PIs and data managers to insure that climate observation standards are uniform across the network, and that climate data are available in a format that facilitates cross-site application as well as being accessible to the entire ecological research community. Recently, members of the committee have been working to address methods for calculating evapotranspiration using the existing minimal climate data set. This is in response to requests from the user community for these data.

Members of the Climate Committee are also involved in a cross-site research initiative to study the effects of extreme climatic events on ecosystems. A two-day workshop was held in June, 2004 to outline the extreme events project and formulate a set of hypotheses and questions to guide the research. Based on this workshop, a preliminary analysis of extremes at a subset of terrestrial LTER sites is currently underway. Results of this analysis will be presented at the ASCE conference on global change and hydrology in Anchorage, AK, in May, 2005.