LTER Information Managers 1999 Annual Meeting Report

Edited by Don Henshaw 27 Oct 1999

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1.0 Introduction and Overview (S. Stafford (CHAIR))

Representatives from 20 of the 21 LTER sites attended and actively participated in the 1999 LTER Information Managers Meeting, in Spokane, Washington, August 4-6, 1999. The Cedar Creek LTER was not represented for the second year in a row. Other attendees included James Brunt and Richard Dahringer from the Network Office; Tony Fountain LTER-SDSC Post-Doc located at SDSC, Matt Jones from NCEAS, and Ann Frondorf - Program manager of the USGS's NBII program.

The major themes of this meeting were:

- The Big Picture: BON, NEON, KDI, BIC
- NIS
- Education, Outreach, and Training (EOT)
- Metadata Standards

2.0 "The Big Picture" – Major Initiatives (S. Stafford (CHAIR))

The arena in which we live is changing. It is NOT "business as usual" at NSF these days. For the first time, the Biological Sciences Directorate (BIO) will be the recipient of funds "off the top" of the NSF budget, rather than taking the modest increase that comes from the yearly Division and program annual increment. The initiatives and the implications for the LTER network are given in Table 1. These potential funding opportunities will require a "state of readiness" that we have yet to achieve.

When Datatask and other interested LTER IM's and partners met for a Datatask meeting at NCEAS in February 1999 (http://www.lternet.edu/research/im/meetings/99febdatatask/) we brainstormed how best to position ourselves to take advantage of these new initiatives. It was clear that there was significant value in partnering with other agencies and units. Table 2 outlines how these partners could be and what capabilities the LTER network could achieve and incorporate.

The role of IM has changed over the 2 decades of history of the LTER. Figure 1 shows the evolution from data to information to knowledge. While the 1980's were primarily concerned with ***data*** custodial issues, the 1990's have focused on deriving ***information*** from the data, and the next century will focus on issues of ***knowledge.***

Table 1. Projected Funding Activities and Possible LTER Role

Opportunity	**Activity**	**Potential LTER Roles & Resource Needs**
Advanced Networking (vBNS etc.) Timeframe: now	Very high-speed connections between major research universities	Opportunity to test and demonstrate advanced collaborative technologies (e.g., real-time video conferencing, application sharing) and sharing of massive datasets. VBNS is available at most sites. Needs: Personnel time to investigate and coordinate resource use. Training in new tools aimed at using the high-speed network. Some sites may require an upgrade of local networking equipment.
NSF Biocomplexity Initiative ($50M) Timeframe 2000	Research on Biocomplexity	LTER should be able to take a leadership role in many aspects of biocomplexity research. Information sharing by LTER sites will be increasingly important in this research. Needs: Further development of the LTER Network Information System to better facilitate integration of data and information.
Information Technologies Initiative (IT^2) ($114M) Timeframe: 2000-	Major research initiative administered through NSF CISE	Focus on high-end, computationally intensive and theoretical topics, such as ecological modeling. Needs: Develop working partnerships with computer scientists and ecological modelers. Ongoing efforts with SDSC (e.g., post-doc T. Fountain) may be important.
Biodiversity Observing Network (BON) Timeframe: 1999-2000	Network of approximately 50 sites which serve as focus for multi-taxa, multi-temporal systematic research	The nascent BON will have information and coordination needs similar to those at LTER sites. LTER could play a leadership role in developing systems for coordination and information management, perhaps in collaboration with partners in the museum, field station and synthesis communities. NET could play significant role in coordination of BON. Needs: Development of systems for collecting and sharing data across diverse sites, some of which have relatively modest

National Environmental Observatory Network (NEON) Timeframe: 2001-2002	Large, one-time, augmentation of research infrastructure at approximately 20 sites nationally at $5-10M per site	infrastructures for information management already in place. Success of NEON will depend on developing systems and standards that make possible the collection and sharing of data from a broad body of common instrumentation. LTER information management could operate at several levels within NEON: • Participating sites: LTER information management infrastructure and techniques could be applied to data at LTER sites that are also NEON sites. Needs: Augmentation of resources at NEON/LTER sites • Coordination of NEON: LTER NET could play active role in coordinating NEON activities. Needs: Additional personnel, space and equipment • Leadership in NEON information management: LTER sites and NET could play a leadership role in creating the information and knowledge management systems needed to operate NEON. The techniques and systems used for the LTER NIS might be generalized to deal with data from a wider array of instruments and sites. Needs: Personnel, training and equipment to take LTER information management to the next level.

Table 2. Potential Partners and Links of BioInformatics C onsortium (BIC)

Institution	Strengths
San Diego Super Computer Center (SDSC)	Long-term storage data archival, high-performance computational technologies, advanced networking, visualization capabilities
National Center For Ecological Analysis & Synthesis (NCEAS)	Facilitating environment of personnel and resources for further development on intellectual challenges of metadata, standardization, and use of newer, commercially available software tools
Kansas University Natural History Museum – Division of Informatics	Connection to the libraries & collections communities. Opportunity to learn from KU/KDI effort on use of "authority" files for synonymies.
Global Climate Master Directory/NASA (GCMD)	Uses a controlled vocabulary of keywords. GCMD personnel have begun to mesh LTER core datasets into metadata GCMD schema.
Distributed Active Archive Center (DAAC)/Oakridge National Lab/NASA	A specific solution for centralized project specifics data archival & storage.
Northwest Alliance For Computational Science & Engineering (NACSE)/Oregon State University:	A group of computer scientists concerned with software usability issues and development of tools (predominantly web-based) to facilitate and enable interdisciplinary research. LTER community is a prime domain of interest & collaboration.
National Biodiversity Information Infrastructure (NBII): Community. Teamed With USGS.	Agency attempt to approach Biological Informatics needs of broad ecological & environmental
Organization Of Biological Field Stations (OBFS):	Loosely knit network of field stations and marine labs, with field-based needs for computer connectivity, analytical tools, and data storage & archiving.
Ecological Society Of America:	A professional society concerned with long-term future of ecological datasets (FLED Report) often orphaned by neglect, oversight on part of researcher, or lack of infrastructure.
Genomic Community/Macromolecular Structure Database:	This link is subtler than those above. But it is imperative that we keep the lines of communication open with the genomic community. Use of ascension numbers for datasets (i.e. sequences) offers a model to Ecological Informatics community for electronic data publishing.
International Long-Term Ecological Research Network (ILTER):	This is a sibling organization, patterned after our US-LTER efforts. Clearly, accomplishments within LTER and greater BIC

should be shared with ILTER community as well as vice versa. Since we all face similar challenges, nationally and internationally, efforts should be coordinated as much as possible.

Figure 1. Component Model of Bio-Informatics Infrastructure

2.1 ASU proposal to NSF Biological Databases and Informatics (P. McCartney (CAP))

Arizona State University, host institution for the Central Arizona – Phoenix (CAP) LTER, submitted a proposal titled "Networking our Research Legacy" in July 1999 to the NSF Biological Databases and Informatics program. While the status is still undecided, the motivations and goals for this proposal are directly relevant to current activities of the LTER information Management committee and a presentation was made at the August meeting.

Background

Motivations for ASU's proposal came from the recognition that a successful proposal to anticipated initiatives from NSF such as BON/NEON would likely include demonstration of an advanced and capable information infrastructure and goals for this proposal were outlined during ASU's first meeting on BON. In addition, there was a desire to build upon the LTER supplement grants awarded to CAP for upgrading ASU biological collections inventories and publishing them to national search networks. This grant will contribute a robust information management division with CES that will be capable of responding to the ever-expanding scale of information integration demanded by LTER network and future data sharing consortia.

Project Summary

We proposed to address a limited set of needs identified in the LTER whitepaper by creating an infrastructure based on tools, data archives, and applications to deliver ecological data products in more useful ways. We will draw upon the data resources available at Arizona State University (ASU) and the Central Arizona – Phoenix Long-Term Ecological Research (CAP LTER) project. The *Networking our Research Legacy* project will focus on three areas:

- Developing key technological components to better document research datasets and make them more accessible. Using eXtensible Markup Language (XML) as the underlying medium for information exchange, we will develop a series of software tools that: 1) assist in creating and managing metadata; 2) export and exchange metadata (and optionally the primary data themselves) in XML format; and 3) use these metadata to automatically generate data preview and query applications so that a more generic query interface can be maintained to access many datasets from heterogeneous sources.
- Developing data delivery systems that bridge the gap between data archives and users by targeting three classes of user groups: 1) the ecological research community as represented by ASU students, faculty, research scientists, and the broader LTER network; 2) the K-12 educational community; and 3) resource managers and conservation ecologists. These systems will be developed using a modular approach that combines the technical tools developed above to achieve some degree of application specificity without redundant programming effort.
- Enhancing existing ASU data resources for these two tasks by: 1) enabling search access to core databases via national search clearinghouses such as NSDI, NBII and KU-NHM; 2) implementing geographic indexes and software to facilitate spatial query of legacy databases that lack explicit geo-referencing; and 3) applying cross-referencing indices to better integrate the core of referencing and cataloging databases. These steps will leverage the value of each resource through cross-referencing and enable national access through universal search protocols used by library search engines.

Perspectives on site initiatives in information technology

One of the significant issues to work out with a proposal such as this was how to articulate our proposal within the broader context of the other 20 sites, the Network Office and beyond. Many of the goals for our proposals came from the February executive council meeting in which issues regarding the future of bioinformatics were discussed. Considerable overlap is evident with this project and the overall goals of activities currently underway by the KDI grant, NACSE, and the NIS projects. The challenge was to position ourselves to mitigate direct conflict while retaining the vital links these efforts so that we do not wind up working in a vacuum. A reasonable approach seemed to be to write a proposal that a slightly greater emphasis on local application and implementation than the more general, network wide focus of KDI and NET. While there is still room for innovation within the ASU project, we felt that this position allowed us to draw guidance on standards and solutions from NET, NCEAS, and other groups and concentrate on making solutions work within a reasonably bounded context. It is our hope that products of this grant will made of use to the broader LTER network through subsequent collaborations to be coordinated by NET.

2.2 LTER-SDSC Biological Scale Process Modeling (BSPM) Status (T. Fountain (SDSC))

The BSPM project is a collaboration between LTER and SDSC that seeks to bring the computational resources of the SDSC to the LTER efforts towards regionalization of ecological modeling. In December 1998, a workshop was held at SDSC to identify issues of ecological modeling and supercomputing, and to develop a research plan to pursue these issues. Bob Waide and Stuart Gage of the LTER and John Helly of SDSC organized this workshop. The workshop was attended by17 LTER representatives, 9 members of the biodiversity community, 3 NSF members, and 1 representative from NCEAS.

During the workshop the participants made presentations on their research, tutorials on supercomputing were held, and new research experiments were defined. In general the experiments were targeted towards extending the scale of modeling efforts and integrating research areas (e.g., relating biodiversity data from museum collections with LTER modeling results). A draft report of the workshop proceedings is available at www.sdsc.edu/sdsc-lter. A total of 13 new experiments were defined at the workshop. Since then three groups have been most active: Stuart Gage and the Maize group from Michigan State Bill Parton and the Century group from Colorado State Roger Pielke and the RAMS group from Colorado State. Current activities are focused on porting the LTER models and the supporting computational infrastructure to SDSC. Scientific results from these activities will be presented at ESA 2000.

2.3 NCEAS/LTER/SDSC/Texas Tech University KDI Proposal (M. Jones (NCEAS))

Matt Jones summarized the successful collaboration among the National Center for Ecological Analysis and Synthesis (NCEAS), the LTER Network office, San Diego Supercomputer Center (SDSC), and Texas Tech University in obtaining an

NSF grant to improve information management for the general ecological community. The proposal was funded by NSF's Knowledge and Distributed Intelligence program and was titled " A Knowledge Network for Biocomplexity: Building and Evaluating a Metadata-based Framework for Integrating Heterogeneous Scientific Data". The intent of the proposal is to build a tightly-integrated network for data and metadata management and exchange among participating sites from LTER, NCEAS, the Organization of Biological Field Stations (OBFS), the California Natural Reserve System (NRS), and SDSC. The proposed research involves developing uniform mechanisms for discovery of and access to heterogeneous data sets that are distributed throughout the ecological community; interpretation of data via machine-processable metadata; semi-automated integration of heterogeneous data via metadata extensions that describe the semantic content of the data; and synthesis of this resulting information through semi-automated hypothesis modeling (Figure 2). Ecological research on the relationship between biodiversity and ecosystem function is tightly integrated with the informatics research in order to provide important feedback to system development. The proposal is particularly exciting because it will be forging new techniques for data integration and ecological synthesis, and as such is highly complementary to existing LTER projects for the LTER Network Information System (NIS) such as CLIMDB. Consequently, group discussion focused on the multiple ways in which communication between the LTER information managers and the KDI project can be facilitated, and on the need for participation by a number of LTER information managers in the Informatics Working Group of the KDI.

Figure 2. Principal components of a knowledge network prototype: a set of distributed data repositories and their associated metadata catalogs; a centralized metadata search service that allows unified searching across multiple metadata types; a data integration engine that uses high-level metadata to integrate heterogeneous data; and a hypothesis modeling engine that allows for formal evaluation of scientific hypotheses.

2.4 Wireless Technology (B. Benson (NTL))

Several initiatives have occurred within the past year involving LTER sites in exploration of wireless, spread spectrum radio technology to provide high-speed data communication to remote field sites. This technology offers the possibility of real-time data flows from remote sites at speeds from 115 Kbps to faster than T1, low power requirements, the ability to reach up to 25 miles line-of-sight, and interactive control.

The first initiative is a proposal by David Hughes of Old Colorado City Communication to ANRI (Advanced Networking Infrastructure & Research) at NSF entitled "Prototype Testing and Evaluation of Wireless Instrumentation for Ecological Research at Remote Field Locations." Two LTER sites LUQ and NTL will be involved in the applications of wireless technology. Requirements at each site will be determined and ways of interfacing sensors, wireless devices and satellite services will be studied and tested. {As an update on this report, it is noted that this proposal was approved by NSF and funded for $384,830 for the first of three years, September 15, 1999 through August 31, 2000}.

In a complementary initiative, NTL-LTER received funding through the 1999 Connectivity Supplement to deploy instrumented buoys at relatively remote sites in the middle of lakes with high speed communication with field stations provided by wireless, spread spectrum radio transmission. NTL also proposes to develop "roving internet units" based on a ruggedized laptop computer and a spread spectrum radio that will enable researchers in the field to access the internet at high speeds.

Paul Hanson from NTL-LTER has proposed a workshop on Spread Spectrum Radio Communication for the 2000 All Scientists Meeting.

3.0 Network Office Report (J. Brunt (NET))

(from John Porter's notes)

1) activities
   a) Richard
      1> CLIMDB
      2> SITEDB
      3> ASBIB
   b) James
      1> connectivity
      2> network conferencing
      3> KDI Consortium
      4> OBSF Outreach/BON
2) vBNS map
   a) 14 primary institutions connected
   b) 4 planned
   c) LUQ and UGA not connected....
   d) questions on vBNS
      1> does not have long term funding...
      2> what does vBNS mean - very broadband network service

3> also commercial networks out there...
3) rethinking the way LTERNET WWW is presented
a) presentation quality WWW
b) parallel intranet WWW that has nitty gritty
1> password controlled
c) LTER Cam network - interest in NET in WWW cams
1> good for SLTER
4) New Network Office positions
a) 3-4 new positions
b) software engineer
1> key KDI person at NET
2> install, configure and test software to support distributed data and metadata access
c) Data/IM specialist
1> OBFS research stations
2> develop data and metadata resources
3> further use and participation of field stations and marine labs
d) database administrator
1> design, implement and maintain integrated databases
e) programmer - generalist
5) IMpact - places where we could have major impact
a) standards development
1> metadata
2> QA/QC
3> data management and access
a> distributed data
4> semantics
b) Integrative Databases
c) EOT (ed. outreach, training)

4.0 Network Information System (NIS) Databases

4.1 Climate Database Project (ClimDB) Update (D. Henshaw (AND))

- Don Henshaw (AND) - Project Leader
- Richard Dahringer (NET) - ClimDB Administrator
- Robin Stubbs (NTL) - Primary Technical Support
- David Greenland (Climate Committee) – Science Leader

Development Team (climdb@lternet.edu
):

- Karen Baker (PAL), Barbara Benson (NTL), Darrell Blodgett (BNZ), John Porter (VCR), Eda Melendez-Colom (LUQ), Emery Boose (HFR), John Anderson (JRN)
- Data providers / Climate specialists: (climdbplus@lternet.edu)

ClimDB Accomplishments (since 1998 IM meeting)

- ClimDB Migration from NTL to NET - Robin Stubbs (NTL) converted ClimDB from Oracle to MS SQL Server and ported the application to NET
- Network Office supports Richard Dahringer (NET) as ClimDB administrator
- NACSE demonstrates a ClimDB interface at SC98 developed by Joe Hanus (NACSE) in HyperSQL

ClimDB Action Plan (3 phases over next 2 years)

- Phase 1 (complete by October 31, 1999)

- ⇨ **Expand ClimDB to include all LTER sites (16 sites included now)**
- ⇨ **Include all years of Level 1 data for one station (8 sites have updated scripts/files)**
- ⇨ **Developer sites add metadata to BNZ prototype (5 sites have added complete or partial metadata)**

- Phase 2 (complete by July 15, 2000) (Prototype --> Production Module)
  - ⇨ **All sites complete Level 1 implementation for primary station (all years of record with metadata)**
  - ⇨ **Optional: add key secondary meteorological stations**
  - ⇨ **Developer sites complete Level 2 implementation (Add relative humidity, solar radiation, wind speed and direction variables and metadata)**
  - ⇨ Optional: prototype selected Level 3 variables (i.e., soil variables, nitrogen deposition)
- Phase 3 (complete by July 15, 2001) (Prototype --> Production Module)
  - ⇨ All sites complete Levels 1 & 2 implementation for one station (all years of record with metadata)
  - ⇨ Optional: add selected Level 3 variables (i.e., soil variables, nitrogen deposition)
  - ⇨ Optional: add key secondary meteorological stations
  - ⇨ Optional: add high temporal resolution data (i.e., hourly)

ClimDB Associated Webpages

- ClimDB prototype:

http://sql.lternet.edu/climdb/climdb.html

- ClimDB participation/exchange format instructions

www.lternet.edu/network/committees/climate/climstan/climfmt.htm

- ClimDB metadata prototype

www.lter.alaska.edu/cgi-bin/w3-msql/climdb/climdb_menu.html

- LTER Climate Standards

www.lternet.edu/network/committees/climate/climstan/standards97.htm

- CLIMDES project

www.lternet.edu/network/committees/climate/climdes/climdes.html

4.2 SiteDB Development Update (K. Baker (PAL) and D. Blodgett (BNZ))

SiteDB is an LTER Network Information System module developed to provide site descriptive information for all the LTER sites in a uniform format. It also provides a mechanism to retrieve this information for comparisons across all or a select group of sites. The SiteDB project leader Karen Baker and technical coordinator Darrell Blodgett originally developed a prototype at the Bonanza Creek site using MiniSQL behind a web forms interface. A visit to the Network Office in March 1999 provided the opportunity to rework the simplified SiteDB schema into a more extensible three table layout which takes into consideration the GTOS and TEMS variables. It also provided the opportunity to confer with newly appointed SiteDB administrator Richard Dahringer. A portal to the SiteDB work exists at http://www.icess.ucsb.edu/lter/dm/projects/sitedb.

Since the Network Office has recently installed miniSQL, the intact BNZ SiteDB module will be copied to lternet.edu in order to have a copy running at the Network Office prior to moving the information from miniSQL into the new schema in MS SQLServer. There are plans to create definitions for table variables and to further coordinate with Dick Olson, Oakridge DAAC, and to crosscheck tables with their developing site catalog.

4.3 NIS Database Discussion (D. Henshaw (AND))

Lessons learned from the ClimDB research module offers feedback and brings attention to important issues to be considered before the development of additional modules.

1) The development of NIS administrative and research database modules must be driven by the need for comparable intersite data. In the case of research modules, science involvement is critical. David Greenland, Doug Goodin, and other members of the climate committee played key leadership roles and were essential in the success of ClimDB.

Additionally, the development of collection standards for site climate data allows for appropriate intersite comparisons.

2) Participation from all of the LTER sites is another measurement of success. Benefits that a module returns to the sites can boost participation. Keeping individual site PI's informed and interested in these intersite efforts will also improve a site's willingness to participate.
3) Commitment on behalf of certain sites in terms of hosting and testing prototypes and in terms of leadership is also essential. ClimDB would likely have been much longer in development without the initiative and dedicated efforts of the North Temperate Lake (NTL) site. NTL devoted time and provided resources to ClimDB. Planned compensation to host sites will be necessary in future development efforts.
4) Research modules need to keep in mind the need for sharing necessary metadata as well as data. Interaction of the science team, data users and modelers, and the database developers will be important in developing and refining theme-specific metadata. Mechanisms for sharing metadata will be essential to future intersite data projects.
5) Network Office involvement from the outset will greatly improve the time and efficiency of module development. A data administrator at the Network Office will be necessary for each intersite database. Planned database migration to the Network Office from a hosting site will also improve the speed to which a prototype module evolves into a production module.

5.0 Education, Outreach, and Training

5.1 All-Scientist Meeting 2000 (B. Benson (NTL) and C.Wasser (SGS))

Barbara Benson and Chris Wasser reported on preliminary plans for workshops organized by information managers at the 2000 All Scientists Meeting. Three workshop proposals had already been submitted to the meeting organizers on behalf of the information managers. Information managers outside of the LTER network had also expressed interest in conducting workshops and all agreed these efforts should be coordinated.

Discussion at this meeting resulted in revisions to these plans. The current plans now include

1) A request for a plenary speaker on the projected impact of new advances in information management on how science is conducted
2) A workshop also involving researchers as speakers and panelists to examine the role of information management in synthetic intersite research. Barbara Benson and Dick Olson will coordinate this workshop. The working group generated a list of possible speakers.
3) A workshop focused on technological developments in information management. This workshop would include speakers, discussion, and hands-on demonstrations. A portion of the demonstrations would occur outside as a "Techno Trail" (e.g., GPS, wireless technology). Chris Wasser, John Porter, and Hap Garritt will coordinate this workshop.

5.2 Information Sharing and Inreach (M. Hartman (NWT) and P. McCartney (CAP))

5.3 LTER Education Outreach Update (K. Baker (PAL))

NSF's support of a variety of Education Initiatives is evidence of the importance placed on addressing education issues such as innovative programs and school classroom-field researcher partnerships. Education reform has culminated nationally in Project 2061 (1986), the Benchmarks for Science Literacy (1993), and the National Science Education Standards (1996). NSF's focus includes training future scientists, educating the public about science and earth systems as a whole as well as educating cross scientific disciplines.

NSF LTER Schoolyard Supplements for 1998 and for 1999 have been instrumental in addressing education outreach across the LTER network. The first LTER Education Workshop, organized by the LTER Education Standing Committee on Education chaired by Diane Ebert-May, was held at the Biosphere in October of 1998. Ten LTER sites participated with site representation by a team of three (a classroom teacher, an educator, and a scientist). The workshop addressed current and future site education outreach approaches. Specific topics such as inquiry-based learning, assessment-evaluation, as well as

program co-ordination and support were discussed. The workshop provided the opportunity to consider aspects of the four-cornered partnership between Teachers, Information Managers/technologists, informal and formal Educators, as well as Scientists. The two information managers present were able to highlight the role that information managers play in facilitating communications, exchanges and technology for education outreach. A workshop final report is online [http://lternet.edu/oppts/education/98workshop].

An LTER site's home web page is an outreach activity. In addition the LTER workshop provided the stimulus to the Palmer LTER team to develop a site Education Webpage summarizing the multi-faceted group of opportunities to which Palmer LTER scientists have responded from 1991 to the present.
Despite limited funding, the value of creating a sustained site initiated outreach was recognized. Efforts were made to identify local ongoing and potential outreach programs with which to co-ordinate. Researchers were canvassed so that a Palmer LTER Education Contacts list could be established.

Palmer LTER ties were reestablished with a past Teacher Experiencing Antarctica (TEA) program participant. A working meeting held in March of this year permitted a follow-up Antarctic Journal article on Besse Dawson's research experience with the Palmer LTER in January 1998 to be written and a small summer meeting to explore outreach in a meeting modeled after the Biosphere Workshop. The Palmer LTER Education Forum was held July 1999 in order to discuss educational outreach interfaces, to consider elements of successful outreach, to formulate steps toward joint programs and to develop guidelines for the Palmer LTER Schoolyard efforts. The meeting was held in Santa Barbara in collaboration with the National Center for Ecosystem Analysis and Synthesis with members of TEA, NCEAS, SB Sea Center, SB Natural History Museum, SB teachers, UCSB education department researchers and Palmer LTER scientists attending. Outreach topics included outreach paradigms, guidelines for long-term outreach, successful program elements and collection options for weather data. A proceedings is in preparation (UCSD/SIO Report 99-14).

5.4 LTER DataBits Newsletter Redesign and Publication (K. Baker (PAL))

The first issue of the redesigned newsletter for the LTER Information Managers was published in time for distribution at the April LTER Scientist Central Committee (CC) Meeting this year. An internship visit to the Network Office by Karen Baker provided the opportunity to work with Marshall White and to develop design criteria for the newsletter and produce a prototype issue for consideration at the February 1999 DataTask Meeting. Design concepts include online publication and modular organization with three sections including feature articles, news Bits and the Calendar.

Establishment of a rotating editorship was considered important in that it promotes "Inreach" with cross-site and site-network responsibilities as well as provides site managers with editorship recognition, a publishing forum for individual viewpoints and investigative/synthesis opportunities. As a result, remote edit methods and simplified design were important constraints.

The initial Spring99 issue was co-edited by Karen Baker (PAL) and James Brunt (NET), while the Fall99 issue will be co-edited by Karen Baker (PAL) and Denise Steigerwald (MCM), and followed by a Spring00 issue edited by Denise Steigerwald (MCM) and Ned Gardiner (CWT). Initial plans are to have two issues a year published prior to the annual April and October CC Meetings in order to augment information manager-scientist communications. The first issue is online at http://lternet.edu/documents/newsletters/databits/99spring. An email address (databits-ed@lternet.edu) has been established for communication with DataBits editors. A subscribable mailing list (databits@lternet.edu) was created so that the first page summary header box can be sent out to announce each new issue.

5.5 One LTER Communication Paradigm: Site Information Manager-Network Office Exchanges (K. Baker (PAL))

A mechanism for short-term support of exchanges has been identified within the framework of the LTER Network Office in recognition of the benefits derived from having individual LTER site information managers (IM) directly involved with network activities. An initial Network Internship by Karen Baker helped to define the internship process, address the lternet.edu web structure, initiate network office online meeting elements, redesign DataBits and discuss relational database alternatives. The focus on web structure resulted in creation of an IM presence on the home page sidebar, consolidation and completion of education pages, migration of the IM meeting page to http://lternet.edu, update of report links and initiation of

category definitions. The online meetings elements included centralization of meeting registration process, registration notification, and posting of reimbursement forms.

The Network Internships to date include:

- Karen Baker (10-18 Jan 1999) as noted above
- Robin Stubbs (Feb 1999) to port ClimDB to the Network Office
- Darrell Blodgett/Karen Baker (24-25 Mar 1999) to port SiteDB to the Net Office
- John Porter (09-14 Jun 1999) to plan development for DTOC, metadata, proposals
- Karen Baker (10 Jun 1999) to discuss proposals and demo the software survey

A part of the goal to improve connectivity and communication is addressed by the ongoing collaboration with the National Partnership for Advanced Computational Infrastructure (NPACI). NPACI funds have been available for these initial internship projects. The Network Office will strive to identify and make available funds for these kinds of activities in the future.

5.6 LTER Software Survey (K. Baker (PAL))

The first annual LTER software survey was conducted in 1992. The next year the survey results were migrated to the Network Office. In 1996 the survey was changed from a standardized list to a tabular format. Annual results have been presented in the Data Manager meeting reports while summaries appeared in 1996 at EcoInforma and in 1998 as part of the LTER outreach resource guide: Software, Data and Information Management in Ecological Sciences edited by Michener, Brunt and Stafford.

This year, the LTER Software Survey has been used as a development project by the Palmer LTER information management design team in order to investigate development of relational modules. As such, a four-option online survey presentation includes list, package search, category search and maintenance. The prototype project tests using a non-dedicated unix server, considers normalization issues, explore a variety of relational database management systems including miniSQL and access, explore a variety of web interface script models including Lite and Perl, and to consider security issues. Although site survey updates were collected at the meeting, the option now exists to make these updates through online forms.

5.7 Standards (J. Porter (VCR))

6.0 Working Group Reports – Day 1

6.1 Big Picture / White Paper Discussion (N. Gardiner (CWT))

The “big picture” working group met to discuss some familiar themes. In many cases, scientists in the LTER program could well be more familiar and supportive of the process of storing and retrieving data. Science rewards publishing, and I don’t mean on the web. If we are a bit frustrated, perhaps we are not alone. Other agencies may be interested in sharing data and/or experiences. We should collaborate. All parties stand to benefit from the shared technical expertise. A consortium, perhaps organized around specific themes, could be a proactive way of working across agency lines for common interests.

Oak Ridge National Labs have demonstrated some success in moving beyond the barriers between researchers and data managers. In their case, it took the commitment of one committed individual who was active on national and international committees to push data management to the forefront of investigators’ priorities. Another success story was a recent National Resource Council book, Finding the Forest in the Trees (Chapter 3), which integrated diverse data from the National Lake Survey.

ClimDB and SiteDB would be useful case studies to discuss with a larger community of environmental IT’ers. The developers of these databases could provide crucial leadership to modeling efforts of broader interest. For example, the consortium might organize around implementing the century or another process-based model across broad scales, including validation. Another possible example is Net Primary Productivity (NPP). These LTER databases (ClimDB, SiteDB) have

some downsides, however. First, they took too long to implement. Second, they may not be implemented in the most scalable way. Last, they may not be efficient for on the fly, i.e., open, connection requests.

Solutions? As many working groups recognize, we need leadership from our scientific investigators before implementing additional projects. Publication and promotion could be powerful incentives driving future efforts. The network office could broker memoranda of understanding with NASA, DoD, DoE, USGS, NOAA, etc. The most important key is the commitment of people power - committed programmers and project managers.

The problems faced by the LTER and other agencies may be larger than any individual group can solve. We can seek solidarity, recognizing common issues. For example, we all share the difficulty of retaining highly qualified personnel. The most effective relationships with other agencies will organize around solving problems, scientific, sociological, and technical. We must move beyond the mindset that has inhibited advances in ecological data management.

What will things be like in 3 years? My own opinion is that the current trajectory will not change until science identifies the need for new database management systems. We should ask ourselves tough questions in finding such areas of inquiry. After 20 years, how successful has LTER been in conducting biome-wide syntheses, for example? What important scientific questions are not being addressed because of a lack of adequate networking and/or information management?

Action items. NET should obtain the MOU's described above. We must remain vigilant for BON, NEON, and other upcoming RFPs. We should respond to calls for information. We should compile a list of suggestions, pertinent to data management, for sites preparing for BON, NEON, and other opportunities.

6.2 NIS Modules (D. Henshaw (AND) and J. Campbell (HBR))

Working Group members: Darrell Blodgett, Karen Baker, Richard Dahringer, Eda Melendez-Colom, Jim Laundre, Mike Hartman, John Campbell, Don Henshaw

Goals: Examine current NIS modules, determine the next steps, and what is left to do.

In general, we need to build on lessons learned as we complete current modules and begin to build new ones. Funding from the Network Office will likely be necessary for module development to proceed. An administrator at the Network Office will also be necessary for most modules. Research modules need to be guided by an appropriate PI to help make science-based decisions. Besides a leading investigator, each module needs a project leader, a technical advisor, and an LTER Network Office contact/administrator.

ClimDB: Robin Stubbs (NTL) (see section 4.1) has successfully ported ClimDB into SQLServer at the Network Office from the Oracle prototype at NTL. The ClimDB metadata prototype is at the Bonanza Creek site (BNZ) in MiniSQL and maintained by Darrell Blodgett. For best integration of the climate data with the metadata, it was decided that the metadata prototype would also be ported into SQLServer.

Action Items:

- Transfer metadata database to the Network Office by October 1999 - Darrell and Richard
- Create a web form for metadata entry (probably using Perl) – Richard
- Develop project web page to document project information and coordinate communications regarding project developments
- Possibly allow sites to trigger automatic harvests of climate data

SiteDB: The SiteDB (see section 4.2) prototype has been developed at the Bonanza Creek site using MiniSQL behind a web forms interface. The project leader is Karen Baker; technical coordinator is Darrell Blodgett; and the network office administrator is Richard Dahringer. For the most efficient integration of this module with other administrative and research modules, it will be ported to MS SQLServer at the Network Office. This may necessitate a complete rewrite because of differences between the database systems.

Action Items:

- Transfer SiteDB database to the Network Office - Darrell and Richard

- Develop new SiteDB entry forms in SQLServer by February, 2000 – Richard
- Develop attribute definitions - Karen and Darrell
- Investigate and maintain compatibility with international site catalogs - Karen, Darrell, James
  - TEMS, the pilot project of GTOS Terrestrial Ecological Monitoring Stations
  - NSF GFS, Global Fiducial Site Survey
- Develop project web page to document project information and coordinate communications regarding project developments

Personnel: James Brunt (NET) is the project leader for this database. This database allows every individual in LTER to update his or her own information. This can create problems for the individual site information manager, as site personnel information can become out of synchronization with the Network Office personnel directory. Mechanisms for automatically transferring site personnel information to the Network Office directory are needed.

All-Site Bibliography: James Brunt (NET) and Peter McCartney are leading the efforts for this module. Richard Dahringer is converting the original gopher WAIS index to SQLServer for querying this database. Future updates of the bibliography will likely be handled with XML structures rather than the original individual site transfer scripts. Peter McCartney (CAP) and James have developed a prototype.

Action Items:

- Share XML prototype with the IM committee through an email or web posting – Richard or Peter

6.3 NIS and KDI Interaction (??)

(from John Porter's notes)

1) action items
  a) opening channels of communication
    1> how can sites participate
      þ> characterize involvement
    2> informatics working group
      þ> process by which LTER working groups can participate through representation
    3> put proposal up for viewing on WWW
    4> articulate how KDI will enable NIS development
    5> keep Databits updated until project is complete
  b) Future NIS/KDI Interaction
    1> Hardware/Software/Procedures survey
      þ> access and management of data
      þ> discussion
        a: could come out of KDI group so they can identify what will be needed to interface with individual sites
    2> Evaluation of site CLIMDB semantics
    3> form Metadata working group
      þ> interface with NBII and other metadata working groups
2) afternoon session
  a) coordinated with other NIS group
  b) focus on funding mechanisms
  c) how will LTER decide what new modules to develop for NIS?
3) questions and discussion
  a) new integrated databases (like CLIMDB)?
    1> CC efforts may generate some
  b) what would be good for sites and NET to do relative to KDI
  c) new initiatives
    1> KDI has some test sites
    2> BON and NEON will require metadata formalization

7.0 Metadata Data Standards Presentations

7.1 Metadata Challenge (J. Brunt (NET))

7.2 Metadata for Ecology (M. Jones (NCEAS))

Because of the resources required to generate metadata for ecology, the ecological community should evaluate the major functional uses that metadata is designed to facilitate. Some of the major uses of metadata include data discovery, access control, data interpretation, data integration, and data presentation. Each of these functions requires varying degrees of machine processing of metadata, but it is particularly important for the integration of heterogeneously structured ecological data, which is commonly needed for cross-site research, synthetic and long-term analysis, and integrated modeling.

The extensive use of metadata in the LTER system, currently highly useful for data discovery and interpretation, has evolved through standardization efforts into several suggested metadata content standards relevant to ecological information. The ESA committee on the Future of Long Term Ecological Data (FLED) made recommendations for metadata content that have been implemented at the National Center for Ecological Analysis and Synthesis (NCEAS). This metadata implementation, Ecological Metadata Language (EML), is implemented in eXtensible Markup Language as a standards-based format for metadata exchange. In addition, NCEAS is developing a Java-based metadata editor that utilizes EML and can adapt to changes in metadata content standards and in version updates. This approach – making sure that content standards are dynamic and not hard-coded into software applications—is an important feature of extensible and adaptable processing tools that are relevant to ecology. This is because many content standards are relevant to ecology. These include FLED/EML, the FGDC Content Standard for Geospatial Metadata (CSDGM), the NBII Biological Profile of the CSDGM, the NBII Taxonomy and Nomenclature proposal, ISO 15046-15 Geospatial information metadata, Dublin Core metadata, and others. In addition to having multiple content standards relevant to ecology, each of these standards has been released and revised multiple times and is continuing to evolve.

Information managers should not expect this evolution to halt, but rather should develop tools that can adapt to the multiple evolving standards useful to ecology. Three approaches are being explored at NCEAS to address these barriers to standardization: 1) adopt a modular approach to metadata implementations that permits individuals to only utilize those components of metadata content standards that are relevant to their data; 2) develop software tools that can adapt to dynamic changes in content standards without having to revise the software substantially; and, 3) provide transformation tools that use cross-walks among content standards to translate from one standard or version to another and can output standards compliant metadata documents from existing metadata databases.

7.3 LTER Metadata (J. Porter (VCR))

8.0 Metadata Working Group Reports

8.1 Metadata Working Group #1 (J. Campbell (HBR))

Friday, August 8 11:00 am - 12:00 pm
Team members include: Dick Olson (ORNL), Emery Boose (HFR), John Campbell (HBR), Richard Dahringer (NET), Hap Garritt (PIE), Mike Hartman (NWT), and Susan Stafford (CHAIR)

The metadata working group opened with a general discussion about metadata and there was an agreement among members that we should move toward using a more structured format for LTER metadata. We also agreed that it would be a good idea to include LTERNET as a node on existing systems such as NBII and that standardizing LTER metadata would facilitate this process. This could possibly be accomplished through the existing Data Table of Contents (DTOC) that John Porter developed. We felt it would be helpful to either find or create an overview outlining data/metadata schemas before we begin developing or implementing standards.

It was suggested that it might be a good idea to have people formally review LTER data and metadata. This review could be accomplished by publishing the data in journals although it was recognized that it would not be possible to have all the LTER data peer reviewed. Several working group members identified differences between metadata that current principle investigators like to see versus what is necessary to ensure that metadata are adequate for future scientists and for archival purposes. We also discussed metadata that is "human readable" versus metadata that is "machine readable" and determined that attributes of both are important.

Differences between the LTER metadata standards presented in the 1994 Data Management Report and the standards that are being developed as part of the NSF Knowledge and Distributed Intelligence (KDI) program were discussed. It was proposed that we revisit the standards in the 1994 Report and possibly use those standards initially and then work toward implementing more detailed standards as the KDI work develops. Developing LTER metadata standards listed in the 1994 report seemed like a goal most information managers could accomplish fairly easily, but it did not seem realistic to work on something more complex at this point, particularly since XML and some of the other tools are still in development.

Questions were raised about how difficult it would be to convert LTER standards into KDI standards. We thought that it would be a good idea to look at current metadata for each site and to use that information to decide if developing standards is a priority. If the current metadata are adequate it may be beneficial to wait until the KDI group develops tools for metadata entry. Most of the information managers in the working group felt that they did not have time to work on an independent effort and that the standards proposed in the KDI program will work well for LTER data. It was unclear to the group whether LTER sites were included in the KDI proposal, but the group was in agreement that it would be beneficial to work closely with the KDI investigators. It was also suggested that a few or all LTER sites could be used as a test group for KDI, which could be accomplished as part of the KDI program or as a separate endeavor.

The working group identified the following goals:

1. Create a committee to begin investigating the development of metadata standards for LTER data.
2. Create an outline of existing data/metadata schemas used by other organizations.
3. Review current metadata on the web for each LTER site.

8.2 Metadata Working Group #2 (S. Walker (BES))

Team members include: Matt Jones (NCEAS), Tony Fountain (SDSC), Peter McCartney (CAP), Chris Wasser (SGS), Sam Walker (BES), Darrell Blodgett (BNZ), Don Henshaw (AND)

LTER Metadata: Next Steps

1. Identify specific capabilities that the sites will need to drive metadata updates
2. Identify baseline data sets that will most likely be exchanged
3. Develop a metadata user needs / status assessment (survey) to serve as a “status report” for the LTER Network and to help new LTER sites develop appropriate metadata protocols
    a. Augment the data survey (add data mechanisms, protocols, ER diagrams, etc.)
    b. Post results to NET web site for review

Internally at each site:

1. Communication of the data manager with the PI needs to improve. The site’s representative to the CC should be in contact to discuss possible pilot cross-site metadata/data exchange opportunities.
2. Consider responsibility for metadata. Who enters the metadata? What level of metadata is acceptable?
3. Who is trained to enter/create metadata? What level of training is required/possible?
4. *Required* fields need to be identified (each site will need to review existing fields)
5. Consider using metadata to perform automated quality assurance (e.g., referential checks)

Other metadata issues:

1. Need to identify ways to classify the “ecological intent” of data values (semantic issues)
2. Need to identify procedures to that describe “where a data set ends” (level)

3. Use existing tools that act as “parent identifiers” to minimize redundant entry for related or adjacent data sets
4. Identify statistical functions that are key for inter-site comparison
5. Improve ability to locate data sets within the LTER Network easily and quickly
6. Nomenclature could be more clearly defined through “modular approach”
    a. Develop identifiers between data files and the corresponding metadata
    b. Limitation is that you need to assign a discrete ID to each object
    c. Be careful not to hard code values into your software
7. Consider maintenance and follow-up metadata entry (assuming lower level entry initially)

Action Items:

1. Identify steps the Data Managers can take to “sell the concept of metadata” at a site?
2. Identify more functional benefits to developing structured metadata
    a. Positions sites for additional funding
    b. Facilitates cross-site collaboration (incentives)
    c. Facilitates modeling development driven by metadata-based information
    d. Enhances network-wide search capabilities
    e. Provides benefit to new data managers by setting a benchmark
    f. Allows metadata-based quality assurance checking
3. Improve Network-wide search capabilities
4. Create a matrix-based report that compares content Standards and Exchange Format/Function (present this to all the Data Managers with support from NET)
5. Develop a wizard-style entry tool that is very user friendly
6. Quantify the resources that are required to create metadata
7. Expand Baker’s survey for current site metadata status (content and function)

8.3 Metadata Working Group #3 (N. Gardiner (CWT)

Team members include:
Don Catanzaro, chair, Barbara Benson, Ned Gardiner, Brent Brock, John Briggs, Jim Laundre

Our group convened with a brief review of the Park Service, an agency whose centralized control differs from LTER. The same issues that led to their adoption of metadata standards for internal exchange could facilitate interacting with LTER. Conversely, they may be interested in using LTER data to augment their science-based management decisions. Don reminded us that individual parks have had their funding threatened by lack of compliance with agency mandates.

Some problems we focused on… (1) Metadata are either too general or too specific. It is desirable to have alternative representations of metadata content. Content should be modular so that one can use the appropriate subset suited to a given task. For example, metadata could be useful in QA/QC. We discussed “lite” vs. full representations. (2) We should identify the concerns of researchers where they conflict with data management priorities. (3) We don’t want to commit to the wrong standards. What standard should we conform to? What software is most appropriate for those goals? Things have worked to this point. Now that we are considering a larger effort, e.g. distributed databases, what do we need to do?

We discussed common tools for parsing or converting metadata. The consensus was that stability of tools could stimulate advances in network-wide activities. We discussed: metaparser, metamaker, a word perfect add-on that allows one to tag highlighted text, XML, NACSE collaborations, the arc/info data catalog (an example of GUI-based views of data structure and content that facilitates metadata collection as data are compiled). Some conclusions - it would be nice to have a GUI for entering data and looking at metadata. What tools out there should we adopt and when?

We need to identify proactive methods to get co-investigators involved in any network-wide efforts to implement metadata standards. A Carrot-Carrot solution without a stick (e.g. infrastructure building to get to BON/NEON) was discussed. Such a proposal would require clear demonstrations of good applications that required standard metadata. For example, are there scientific or management questions that are not being pursued due to a lack of adequate metadata? If we do establish such a need, perhaps NET and some sites could get money from FGDC or NBII to do a project.

Next steps

1. We need to get investigators to buy in if we are going to do anything substantial.
    A. When ClimDB was demonstrated, it became clear which sites were participating, and that generated interest by sites in being more active.
    B. Maybe ClimDB would be worth migrating to FGDC compliance.
2. It might be worthwhile to identify levels of compliance by sites to metadata standards. It might be worth discussing how valuable metadata have been (have they been?) in synthesis volumes. For example, has a lack of information on treatments or study designs hampered long-term analyses?
3. What data sets are most wanted or used in meta analyses by LTER and investigators outside the network?
4. Articulate how information management can facilitate large efforts such as BON and NEON. What do sites need to do to improve their ability to participate in such efforts?
5. Should we encourage a demo project focused on weather or hydrology data? These would be pan-agency efforts.

The LTER Coordinating Committee (CC) should present minimum requirements to sites for data archiving and sharing. They should indicate requirements for various collaborative efforts. CC should present clear incentives and consequences for a given level of commitment. They might consider establishing conditions for compliance with a given level of compliance. For example, CC could establish a timeline to achieve targeted benefits on a site-by-site basis, keeping in mind site-specific logistic challenges. Subsequent requests for data supplements might hinge on meeting those targets. This is a means of establishing accountability for sites.

NET could clearly present requirements for sites coming into the network, perhaps highlighting the notable efforts of sites that are doing a particularly good job. Different levels of effort at sites are due to differences in where they are now. The tools are now available to move to the next step in metadata.

Data Managers should determine what we want to do with metadata, whether it is discovery, information, etc. From this exercise, we could determine the fields required to meet FGDC and ecological research requirements. We should take baby steps. What are the minimum requirements, project by project? We should identify priority data sets for meeting metadata standards. Begin with new data, prioritize data sets critical to current ecological research, and determine which data sets are under the most demand.

8.4 Metadata Working Group #4 (J. Porter (VCR))

Frondorf Working Group:
Participants include Anne Frondorf (USGS/NBII), Denise Steigerwald (MCM), Garrett Ponciroli (KBS), John Briggs (NSF), Eda Melendez (LUQ), PAL: Karen Baker (PAL), John Porter (VCR)

Discussion:

a) legacy datasets vs new data
  1> most data is current
  2> interest leads to incorporation of legacy data
  3> why free text?
    þ> has a lot to do with age of site
    þ> newer sites started off with network perspective
      a: often at cutting edge of technology
b) what do you do at BRD centers?
  1> get full inventory
  2> get prioritization
    þ> some not documentable
  3> once you have priorities, you can leverage
c) we have seen some loses of grad student data - too many to manage
  1> sites vary in how they handle
  2> some archive student theses and dissertations with data in appendices
d) do you have projects?

1> we have them at whole LTER level
2> some sites do projects at level above datasets
e) does NBII have something similar to EML?
1> FGDC and NSDI have some parsing tools etc.
f) NBII is more interested in getting output rather than tools
g) what types of media
h) coming from unstructured metadata site.... how do you get PI to see that as reasonable request for my time
1> what is motivation?
þ> need to see immediate benefits
2> would be useful to have some product attractive to PIs
3> variability in commitment to IM within sites
i) NBII - focusing on having someone help with metadata development
j) one concern is that data may be too accessible and put major load on system
1> we have massive amounts of data that are stressing system
k) would only be METADATA not data
1> NBII nodes could even provide all the searching etc.
l) what can we offer to bring PIs around
1> provide tools to go to FGDC - valuable for Federal Researchers
2> access to more data types
3> talk to PIs one-on-one
þ> for some, just not a priority
m) focus in proposals
1> data availability was focus, not metadata form
n) would be good to have supplement focused on providing structured metadata
o) how long does it take to add structure to unstructured metadata?
1> get some specialists focusing on translating data
þ> have specialist at GCMD
p) could do joint training session
1> provide tool customized to LTER
q) tools
1> could provide markup tool
þ> perhaps modify HTML editor
r) bulk of time of doing metadata record is in compiling the needed information - you already have that
1> then function of level of training - someone who knows real standard, you can work really quickly

3) action items
a) survey (Karen)
1> what sites are already node on NSDI/NBII clearinghouse?
b) need to identify objectives relative to other standards
1> develop cross site exchange standard
2> develop one set of mappers to each of
þ> FGDC
þ> GCMD
c) see if GCMD would focus on sites with unstructured metadata to create structured, directory-level metadata
1> we could then download
2> or have person at NET to do.....
d) training on metadata preparation
e) recommend supplement for structuring metadata
1> either to NET or to sites

f) can we amend data availability policy to dictate structured metadata

4) discussion
a) availability of MetaMaker Templates - helps make it easier
1> would make it possible for student hourly to do
b) tool for marking up older documents
1> have done using WORD to use glossaries for sticking in tags from list
2> would be good to have tool based on DTD
3> talked to Sherry Pancake interested in doing, but wants specs
þ> Peter McCartney will write up 1 pager
4> would be good portable tool
c) MDE metadata editor - tree-based
1> now want to layer on top dynamic forms interfaces
2> KU has built adaptable forms-based entry tools that allows customization
þ> allows data manager to exclude some areas of metadata
3> might be consolidated in phase II

8.5 Metadata Working Group Synthesis (P. McCartney (CAP), D. Henshaw (AND), and J. Porter (VCR))

Discussion
A metadata working group will need to be established. The group will produce products within the next 4-6 months about metadata use, structure, and standards. The working group will need to do an in depth review of existing metadata standards and available options for structuring and sharing metadata. Work will need to proceed on a short time scale and tie closely with ongoing KDI efforts. Earlier IM Committee metadata working group results should be built on. Some compelling cross-site metadata exchange demos should be suggested and prepared for the All-Scientist 2000 meeting. A peer-reviewed journal article should be considered.

Is there formal expectation that metadata will be available? There is an implicit expectation that LTER metadata will be available. While structured metadata is not mandated, sites should be "encouraged" to create structured metadata. The new metadata working group will send a recommendation through CC that supplements be made available for structuring metadata.

The information managers need to remarket ourselves as being willing to participate in CC meeting themes; we want to work as collaborators and not just handle requests for data. CC themes could be linked to data products and standards development. These theme meetings could be one way to pull in scientists and organize dataset priorities. We also need to educate our PIs about how metadata will prepare sites for BON and NEON.

What role can data managers play in the data integration process? The NCEAS model takes a long time and is difficult, but is the only show in town given current state of affairs. We might look at what CLIMDB has taught us about what semantic information is needed to synthesize data sets. The CLIMSTAN meeting brought together scientists, modelers-data users, and information managers and focused on 1) what metadata is needed and 2) data collection standards.

LTER Metadata Standards Committee (from Databits Fall 1999)

LTER has long recognized the importance of metadata to data survival. The recent NSF KDI award to NCEAS, LTER-NET, and SDSC will usher in changes in the role of metadata from textual documentation to more structured information that can support future applications that automate much of the data management and access process. To prepare the LTER network for these new developments, a Metadata Standards committee was formed at the 1999 IM meeting to review existing content standards for ecological metadata and to make recommendations for upgrading site metadata to meet the structure and machine-accessibility requirements of the KDI project, NIS expansion, and other cross-cutting data access developments.

Members of the committee are P. McCartney - CAP (leader), J. Brunt - NET, J. Campbell- HBR, D. Henshaw - AND, J. Porter - VCR, D. Steigerwald - MCM, M. Jones - NCEAS.

In addition to reviewing content standards, the committee will review software options available to sites for preparing structured metadata. XML-based solutions will be examined closely and the committee will develop some demonstration applications of this technology to enhance awareness of this technology. It is anticipated that conversion of existing metadata to structured formats will represent a significant workload for some sites. The committee will draft a proposal for future technology supplements to mitigate these costs, which will be forwarded by the LTER IM Committee to the CC Committee.

9.0 Guest Presentations and Collaborations

9.1 NPS-LTEM Project Overview (D. Catanzaro (NPS))

I wanted to discuss how communication between our two programs would be mutually beneficial. First a little background (more information can be found at http://www.nature.nps.gov/im/index.html

In 1992 the National Park Service initiated the Natural Resource Inventory and Monitoring Program to gather information and develop techniques for maintaining the integrity of the ecological communities in the approximately 250 National Park System units with significant resources. In addition to this basic inventory and monitoring, NPS has set up one prototype Long Term Ecological Monitoring Program in each of the ten major biomes that are represented in the National Park System. Working in conjunction with USGS-Biological Resources division, these prototype LTEM programs are tasked with developing protocols to comprehensively monitor important biological resources and make these protocols accessible to other NPS units. These programs are designed to bring all the monitoring activities of the NPS under one comprehensive umbrella.

As you are well aware, data management is a very important aspect of collecting biological data on a long-term basis, and both of our organizations have formed subcommittees to deal with it. I believe that our organizations can learn from each other's experiences, and by strengthening institutional ties between our two programs, to increase understanding of these complex ecosystems. The close proximity of many NPS-LTEM and NSF-LTER sites make it possible to share data and findings in an exciting way.

9.2 ORNL DACC Experience (D. Olson (ORNL))

Dick Olson, ORNL, summarized activities at the Oak Ridge National Laboratory Distributed Active Archive Center for Biogeochemical Dynamics (ORNL DAAC – http://www-eosdis.ornl.gov/) that related to discussions by the LTER data managers. The ORNL DAAC has been funded since 1994 by NAAS as one of the eight DAACs to distribute and archive data associated with the Earth Observing System. The ORNL DAAC currently has over 400 datasets with over 1600 unique users. In 1998 they distributed over 7000 products including 1000 CDROMS, 4000 ftp deliveries, and 2500 Web deliveries, the NPP datasets represented one of the most dominant requests. The DAAC has invested a significant effort to capture user statistics to document the use of the system to our sponsor and advisory group.

NASA is developing a federation of data providers that includes the DAACs, a set of Earth Science Information Partners (ESIPs), and a set of commercial partnerships. This effort will provide additional access to remote sensing data and may provide access to developments in distributing ecological data, such as Web-based GIS functionality. The Federation Web page (http://www.esipfed.org/) is currently under development.

An update on the Mercury system was presented. . Mercury is a Web-based, distributed system designed to allow the searching of metadata to identify datasets of interest and to deliver those datasets to the user. The system is being used for several projects with continued development. The goals of the system are to facilitate early exchange of data between PIs, provide PIs complete control of data visibility in the system, achieve rapid and economical deployment, and incorporate automation and scalability to reduce maintenance costs. The system software is centralized, using specially modified commercial-off-the-shelf software components. The metadata files and data files reside on data-provider machines distributed anywhere and connected by the Internet. Data providers make their metadata and data available to the system by simply placing them in a 'visible' area on their machines, and periodically the Mercury crawler harvests the metadata and

automatically builds both an index and a relational database with the information, which resides at the central facility. Preliminary data associated with NASA validation projects can be viewed at http://mercury.ornl.gov/servlet/landval. A Metadata Editor has been developed (http://www-eosdis.ornl.gov/cgi-bin/MDE/MERCURY/access.pl) and an on-line tutorial is available (http://mercury.ornl.gov/pk/Mercury/mercurytutorial1.4.ppt).

9.3 NACSE Status and Development (Sherry Pittam and Joe Hanus (NACSE))

Sorry, we can't be there. I was anxious to talk with folks there to see if we could get something a little more concrete working between the LTER's and us via the OCID project. For right now, I will summarize a couple projects so that if you wish you could let the people at the meeting know about them. More information on NACSE projects can be found at http://www.nacse.org/.

1. Web form based data entry to the unix database that Robin Stubbs had suggested. We let her know of an effort here to do that. Joe and I have written an interface to one of the databases here that I have to update on a regular basis, and we are modifying the tables now on the web. The biggest problem is to be able to update related tables at the same data entry stage. We know the solution lies somewhere between control in the database itself and in the way the form is laid out, but haven't made the leap yet. Ken Forschwiler is also tackling this problem on the other side by developing some software to automatically generate the forms and cgi-scripts to make them work. As soon as we get something functioning well enough to test, we will let you know.

2. There was mention of the development of a centralized LTER resources database - I believe Peter McCartney was interested. The part of this that fits well with the OCID grant is the "harvesting from different sites and platforms" to a centralized location for web serving. Mark Newsome has enhanced Query Designer and it is being rewritten in JAVA. It, combined with a metadata browser we are developing with the MEL folks, will be able to begin to provide us with a means to talk across platforms, databases, plus select data we want and eliminate data we don't want for downloading.

3. Arc View data to the web. We have only begun to look at that; both Mark and Joe have been studying different approaches to the problem. Joe took the weeklong ESRI course so we could generate files in-house. Since this is not part of the OCID grant, it is currently unfunded.

9.4 Proposal to NACSE: XML Editor (P. McCartney (CAP))

An editing tool for converting unstructured documents to XML

As is often the case in science, concepts often predate the nomenclature by which we eventually come to know them by. This is true of metadata – that class of information that identifies and describes data. Valuable metadata describing “legacy” datasets has been accumulated in unstructured text format either as research protocol descriptions, research proposals, or end-of-project reports. Even after the term metadata became widely recognized, such information remained in unstructured documents meant for reading only. Today we recognize much more powerful applications of metadata such as Boolean search, online publication, and automated data integration. These applications require metadata to be highly structured following strict rules of content and organization. Within the LTER network, a recent survey revealed that at least 6 of the 21 sites had metadata exclusively in unstructured formats; and the majority had at least some metadata in that unstructured format. The tool proposed here would assist the conversion of unstructured metadata to modern formats based on eXtensible Markup Language (XML). XML is chosen as a file format because of its universal software support and ability to validate data against a predefined schema.

The basic functionality of the editor would be to open an existing text document and present it in a scrolling editing window. Basic editing functions such as insert, delete, copy, paste, etc would be present. The user would be able to select, via a file picker window or URL, an existing XML Document Type Description (DTD) or optionally be able to reverse engineer a DTD (into a readable text file) based on an existing XML document. The user would work through the document selecting data belonging to discrete metadata and then identifying that element from a list. The editor would then automatically insert the appropriate bracketing tags. The popup lists of tags would ideally be context-sensitive, so that the user would be able to select only from allowable tags based on the parent tag. It should also be intelligent so that tags are automatically nested and closed to keep the document well formed and valid. Use of color to identify invalid or untagged material would help cleaning up

unwanted text. The output of the program would be a well-formed and valid XML file that could be further edited with a simple XML editor such as MS XML Notepad or NCEAS's Java-based editor.

Choice of development platform could be open, although any solution should minimally work on Windows NT/95/98 given the popularity of that platform. NCEAS's editor configures itself to a user-selected DTD; if Java were chosen, source code from that application might be relevant to the one proposed here. MS provides an object model for XML that can be accessed from any development language supporting ActiveX, such as Visual Basic, J++, or C. The entire editor might also be developed as a Visual Basic script within Microsoft word, using the built-in editing and XML support in MS Word, although this approach would be less portable.

10.0 Internal LTER Business Meeting (D. Henshaw (AND))

10.1 Election of New DataTask Members

A closed LTER Data Manager session was conducted to conduct DataTask elections. Chris Wasser and John Porter were rotating off three-year DataTask terms. Peter McCartney and Ned Gardiner were elected to new three-year terms. The current DataTask membership is as follows with year of election:

Susan Stafford (Chairperson, ex officio) - 1998
Peter McCartney (CAP), Ned Gardiner (CWT) - 1999
Karen Baker (PAL), Don Henshaw (AND) - 1998
Darrell Blodgett (BNZ), Michael Hartman (NWT) - 1997
James Brunt (NET, ex officio)

10.2 Guest Invitations to the Annual IM Meeting

Our policy of inviting visitors to participate at the annual LTER IM meeting was reviewed. It was widely agreed that this year's invited guests were a great addition to the meeting and were strong participants in our discussions. We agreed that all future invited guests would come as "participants" and not just as "observers".

Requests for additional participants should be sent to IM Chairperson. Visitors will generally be limited to 6 persons, and decisions on who to invite will be made on a case-by-case basis. Decisions on invitees will likely wait until the meeting is close at hand, but also be balanced against the time a visitor will need to schedule and plan for attending (approximately 2 months before the meeting). This leaves flexibility for adding key visitors that might be critical for the planned meeting agenda. We will also consider funding for certain invited guests.

We will also encourage Bob Waide to attend, as well as any PI's. We might also consider targeting specific PI's that might provide key contributions to the meeting agenda.

APPENDICES

A. List of Participants

(Note: For e-mail, use the usual LTERnet naming scheme, e.g. dhenshaw@LTERnet.edu.)

CHAIR: Susan Stafford
AND: Don Henshaw
ARC: James Laundre
BES: Sam Walker
BNZ: Darrell Blodgett
CAP: Peter McCartney
CDR: NONE
CWT: Ned Gardiner

HBR: John Campbell
HFR: Emery Boose
JRN: John Anderson
KBS: Garrett Ponciroli
KNZ: Brent Brock
LUQ: Eda Melendez-Colom
MCM: Denise Steigerwald
NET: James Brunt
NET: Richard Dahringer
NTL: Barbara Benson
NWT: Michael Hartman
PAL: Karen Baker
PIE: Hap Garritt
SEV: James Brunt
SGS: Chris Wasser
VCR: John Porter

GUESTS:
John Briggs (NSF)
Dick Olson (Oak Ridge National Laboratory, DAAC project)
Matt Jones (NCEAS)
Tony Fountain (SDSC)
Anne Frondorf (USGS/NBII)
Don Catanzaro (NPS)

B. 1999 LTER Site Flashes

Andrews Experimental Forest (AND): Don Henshaw

The Andrews Forest LTER has had an incredibly busy and productive year. The departure of Susan Stafford to Colorado State University also dramatically increased the workload for Don Henshaw, Gody Spycher, Hazel Hammond, and others. Most of the year's information management efforts were geared toward preparing for our site review, which was held in mid-July. Matt Jones (NCEAS) led the review of our information management efforts, and we benefited from his positive, constructive comments. Overall, our site fared well during the review process, and we hope to maintain momentum as we discuss the review team's report and implement suggested recommendations.

In particular, we worked overtime to enhance our webpages for the review (http://www.fsl.orst.edu/lter). Much of our "Research" webpage describing our major science component plans and synthesis areas was expanded and updated. An additional 18 databases have been made available online since January 1. We have also updated our projects, publications, personnel, and mailing lists. An Andrews LTER graduate student mailing list and webpage was created in this process.

Using supplemental grant dollars, we have contracted with James Tucker (The Evergreen State College) in developing our redesigned metadata system for the Forest Science Data Bank using MS SQLServer. The metadata database has been designed in compliance with the existing FGDC/NBII metadata standard. The system will feature interactive web pages for searching for publications and spatial and nongeospatial databases. Queries by theme keyword, location, species, and person will be possible.

Hardware necessary to support T-1 connectivity to the Andrews Forest Headquarters has been bought with money from our NSF Connectivity supplement grant. New hardware includes a Dell LAN Server, Sun Ultra 10 mail server, two UPS systems, 5 Windows NT systems, and Legato backup capability from Oregon State. The T-1 service is currently being ordered from U. S. West, as well as the T-1 multiplexor (junction box). The physical line to the Andrews is already in place, and we hope to be connected by later this year.

Don was an invited speaker at the North American Symposium on Monitoring Forest Ecosystem Resources in Guadalajara, Mexico (Nov. 1998); an instructor at a Western Forestry and Conservation seminar on Monitoring for Land Managers (Dec.

1998); and attended an LTER DATATASK meeting at NCEAS (Feb. 1999).

Arctic Toolik Lake (ARC): Jim Laundre

At the ARC LTER we continue to add new experimental and monitoring data to our on-line database. Other projects based at Toolik Field Station have also made use of current and long-term databases.

We replaced our Unix server with a new NT server this past winter. The move went well with only a few problems. We plan to move the web pages to the new server in the near future. This will facilitate keeping web pages up to date.

NSF is continuing to fund major improvements to the Toolik Filed Station. The UNL Polar Ice Coring Office is tasked from NSF for the following upgrades to Toolik Field station:

- Upgrade site drainage/gravel
- 4 new laboratories -- bids are in and contract should be issued this week
- 1 new generator module plus sound-attenuated enclosure -- generators have been delivered and module has been constructed. We are assembling the plant Upgrade site electrical distribution system -- bid spec document is in progress
- Install 2 T-1 lines -- bids are in.
- Install Potable Water System and grey water handling system --- Potable water plant has been purchased, bids are in for trailers.

These projects should be completed by Oct 31, 1999.

A proposal to fund an Arctic Observatory at Toolik Filed Station was submitted to the NFS Office of Polar Programs. Below is summary of the proposed observatory:

> The Toolik Lake Arctic Observatory will have five main components including (1) climate, microclimate, and radiation monitoring; (2) monitoring of fluxes of energy, carbon, nutrients, and water in relation to climatic variability; (3) description and monitoring of long-term change in vegetation structure, plant community composition, and population dynamics of selected plant species; (4) description and monitoring of the distribution and abundance of animal populations, their health and reproduction; and (5) a central data management and communications facility. Components (3) and (4) will also be linked to the University of Alaska Museum for archiving of plant and animal samples. Working with existing long-term, experimental research projects also based at Toolik, we will develop an integrated, long-term database that is outstanding in its usefulness and relevance to promoting our understanding of current conditions, spatial and temporal variability, and long-term change in arctic ecosystems.

Baltimore Ecosystem Study (BES):
<none>

Bonanza Creek (BNZ): Darrell Blodgett

Marilyn Walker, the Co-Pi of our LTER project has now moved to Fairbanks and she is very supportive of data management.

Our request for supplemental funding for improved data management was approved and will be used to augment both data management staff and equipment. The goal is to become more proactive in obtaining data and information from the PI's as well as being more supportive by providing data entry and qa/qc services from within data management.

We are still using MiniSQL extensively behind Netscape's Enterprise server to store and access our site bibliography, personnel directory, project and data catalogs, and information on individual research plots/stations. This information is also maintained and updated via the web. All data is still stored as ASCII files, which are linked to data description forms (metadata).

During the year we have added a news posting system, as well as an image archiving system both implemented in MiniSQL. Hopefully these two systems can be used to their full potential. We are in the process of reviewing data entry and qa/qc software. We may choose to develop our own web-based system, depending on the features, limitations, and cost of commercial data entry software.

Currently much of the codebase involved in our Mini-SQL implementation is written in Mini-SQL's Lite scripting language. We hope port this code over to a Perl and Java implementation for its portability, it's more efficient data base connections, and more efficient forms error checking (Java).

The Frostfire burn in the Caribou Poker Creek Research Watershed was accomplished July 8-15 1999: Frostfire

Darrell Blodgett attended the Datatask meeting at NCEAS, and spent two days afterwards at the network office in Albuquerque. During the two days, a new schema for SiteDB was drafted with Karen Baker, and James Brunt.

Cedar Creek (CDR): Clarence Lehman, Louise Johnson

It has not been a quiet year at Cedar Creek. Our statistician Charles Bristow, who spent much of his time on data management, moved on to Illinois when his wife got a new faculty position there, and Louise Johnson arrived from England late last summer to assume his statistical and data management responsibilities. Clarence Lehman completed his doctorate in ecology and assumed a new position as associate director of Cedar Creek in mid-July. There he continues to work on data issues, along with many other things, but now encompassing data for other projects as well as LTER. Nicolas Spilman, an experienced computer science student at the University, started working for us this summer and is starting to make our computer tasks look easy.

The number of soil and biomass samples we weigh now amounts to many thousands each time we sample, and keeping all those sample vials matched with the appropriate projects and experimental plots with over twenty persons working on a single activity has generated occasional problems. Accordingly, this year we purchased bar-code readers for all our weighing computers, and now process samples faster and with near-perfect accuracy. We have a multi-step computerized procedure that allows workers from the various projects to print bar-code labels, create sample sheets, weigh the samples, and compute nitrogen contents without much help from computer personnel. Now that we have the bar-code readers, it is hard to imagine how we ever kept the process straight before.

We finally have, as of early June, a reliable internet connection for our field site at Cedar Creek (T1 level) and a powerful new Sun server for local data storage and analysis. A new automated weather station, now under our control rather than the control of a separate university department, is installed and working, and its data are being readied for direct deposit to the web. The Ethernet within our main laboratory building has been outfitted with about two dozen personal computers (W95/98 level) and individual printers, most with direct internet access. One of the computers is permanently dedicated to scanning of field specimens, including plants and insects. For the first time we do not seem to be particularly short of computers.

Our web site has been expanded, among other things, with a substantial subsection on the insects of Cedar Creek (about 700 web pages covering 3000 species of insects), created and overseen by entomologist John Haarstad, with the help of software person Erin Bartlett. It has data on what species have been found here over the last 20 years, when they emerge, which ones overwinter, and so forth.

Central Arizona / Phoenix (CAP): Peter McCartney

Resources

One of the most significant changes at CAP is the decision in late spring to separate LTER data management activities from the joint lab shared with the Archaeological Research Institute and establish a new lab for data management and GIS within the Center for Environmental Studies. The changes are more in spirit than in body at this point, as we really don't have a new space to house such a lab. Nevertheless, computers are being shuffled around, a new network domain created, and new resources are being bought (the biggest being an HP 1055CM plotter - we're tired of BES having sexier posters than us). This reaffirmation of CAP's emphasis on data management is also reflected in a shift in the data manager and the system administrator positions from 50% to 100% CES. This means an effective increase of one FTE for LTER or LTER-related data activities. Ted Oliver left ASU in spring to join a private consulting company in Tucson and Steven Rosales (srosales@asu.edu) was hired as his replacement. Steve has a master’s degree in environmental engineering and was employed by a geo-technical consulting firm in Seattle prior to coming to ASU. In addition to managing workstation and server resources, Steve participates in database design, application development, and data archiving and can tell you where every Starbucks in the east valley is located.

We expanded our server resources by adding a second dual-pentium server with another 27 gig of raid storage. This machine hosts all our SQL data, Spatial Database Engine (SDE) service, and archived data files, leaving the other server for active user and project files. The new machine was purchased by the state archaeology database project, which remains within the CES lab and shares with LTER the use of many of the basic infrastructural GIS themes that we have been loading into SDE.

And oh, yeah…just one more little thing…..John Briggs is joining the ASU faculty. Seriously, we look forward to John's contributions to CAP because of his sensitivity to IM issues and the way his research applications of remote sensing and GIS will stimulate the activities of the lab.

Activities and products

Core catalog databases used for general project management were maintained and expanded. Features were added to the bibliographic database that allows users to make and store selections of references for output as bibliographies. An online, searchable metadata catalog for LTER data was added to the website in the fall and continues to be enhanced (http://caplter.asu.edu/data). This application is the main search, documentation and delivery system for making LTER data available over the web for both CAP and external use. Although file security is in place for restricted items, we have yet to implement the planned mandatory user registration system, which will be used to use to track access and usage for all LTER datasets.

An interactive, map oriented web application was created to provide search and display access to the CAP LTER bird survey project (http://caplter.asu.edu/po12). This tool developed the lab's expertise in several core technologies such as web-based mapping that will be reused in many similar applications for LTER projects.

Text and graphics from posters from the first CAP LTER poster conference held January 1999 were collected and formatted for web presentation. These will go online soon pending a few late submissions.

The Ecology Explorers educational project was launched with a website (http://caplter.asu.edu/explorers) that introduces students to ecology and provides them with instructions and support to carry out field research following protocols based on CAP monitoring projects. Databases and web entry forms were developed for four protocols (arthropods, birds, vegetation, and seeds).

With supplemental funding, four legacy collections catalogs for the Biology Department were harvested into an upgraded relational database designed and hosted in the LTER lab. Basic entry and query tools were developed for use by Biology staff; a web query page is in development and will be completed soon.

We continued our efforts to compile existing data relevant to CAP research. Data from Maricopa Associated Governments, Maricopa Flood Control District, USGS and ADEQ were acquired and converted to formats and/or projections compatible for use in LTER Research. The initial phase of an historic land use project was completed producing a series of GIS covers summarizing land use for five discrete points in time, beginning in 1905. Phase II focusing on detailed histories of selected areas was initiated.

The CAP site manager (McCartney) and one of the CAP lead PIs (Grimm) served as site reviewers this summer. In addition, McCartney served as panel reviewer for the NSF Postdoctoral Awards competition in Bioinformatics.

Grants

We were again active in grant writing this year. Supplement grants for connectivity and collections curation were submitted and funded. The focus of the connectivity grant was on K-12 connectivity and on wireless data communications. Connectivity for three target schools is being enhanced and roaming resources (laptops, projection monitors, modems) have been purchased. Over the next year, we will be enhancing the ecology explores website and investing in more server resources to support K-12 access to the lab. The collections award will pickup where the last one left off, and enable us to open search access to ASU collections catalogs to the Z39.50 based search protocol currently being developed by KU and SDSC for biological collections data.

A proposal to the NSF Biological Databases and Informatics program was submitted in July. This grant (described in more detail in the IM annual report) seeks to expand ASU's infrastructure for managing biological data by developing a series of tools for acquiring, processing and reporting metadata and then using them to build delivery solutions that interconnect the search, acquisition and application process associated with using archived data. Another grant effort, this time collaboration

with several Arizona museums and libraries, was submitted to IMLS. This project would expand the bibliographic database format used by CAP LTER to establish a statewide database covering environmental and cultural research. It would both inventory materials in participating libraries and provide a data resource that could be integrated with other research and educational data products. Finally, McCartney participated as a co-PI on a successful KDI proposal on the use of 3 dimensional visualization in scientific applications. Although the proposed research is archaeological and does not directly involve LTER, the fact that ASU is doing 3D work was of great interest to Mark Schildauer at NCEAS and might open another area of collaboration with that group in the area of complex data visualization models.

Directions
In addition to the goals set by our grant activities, CAP has some major goals to achieve with respect to its core data management mission. CAP is now almost two years old and we are rapidly approaching the timeline at which some of our first datasets produced with LTER money are due to come on line. Steve and I have begun dealing with the data submission process with some projects, and are striving to define a reasonable protocol for streamlining the process. Web based applications for delivering archived datasets stored in SQL Server will be developed. Another goal is to continue refining the online data catalog application and to set up a procedure for getting metadata for remote sensing data archived by the Mars Explorer project into the LTER data catalog. Finally, we hope to follow the step taken with the bird survey web page and attempt some for sophisticated web and map- based presentations of LTER research. This sort of presentation will become a major part of the schoolyard project.

Coweeta (CWT):
<none>

Harvard Forest (HFR): Emery R. Boose and John S. Burk

Computers and Telecommunications
Major renovations in computer and telecommunication facilities at the Harvard Forest were begun during the past year with support from NSF, Harvard University, and the Forest. NSF support included a grant from the FSML (Field Station and Marine Lab) program and an LTER supplement to improve network connectivity. Improvements to date include physical renovation of the Computer Lab and the Shaler Hall Vault. The Computer Lab now contains five new Dell computers and two new HP LaserJet printers (one in color) accessible over the network. The Lab has been designed especially for GIS and graphics applications, is available to all staff and visiting scientists, and is used intensively by students in the Summer REU Program. Fourteen new computers were also installed for individual staff. All new computers run Windows NT.

Improvements scheduled for the coming year include: (1) We are currently negotiating with Bell Atlantic to upgrade the speed of our network connection to the University campus in Cambridge from 56 kbps to T1 for a period of six years. (2) The recently renovated Fisher and Raup Houses, which serve as conference and residential facilities, will be wired for data and connected via optical fiber to our local network based in Shaler Hall. (3) A high speed network connection will be established between Shaler Hall and the
Environmental Measurement Site (EMS) Tower located in the forest at a distance of 1.5 km. (4) Windows NT servers will be installed in the Shaler Hall Vault to enhance local connectivity and to host the Harvard Forest web page, which currently resides at the LTER Network Office in Albuquerque.

Harvard Forest Archives
In its second year of operation, over 500 visitors used the Harvard Forest Archives over the past year. In addition to its value for LTER researchers, the facility continued to be an important resource for the local community, as area scholars, farmers, foresters, surveyors, and planners used archival items for various projects. Significant additions to the Document Archive included maps and notes from recent projects, the Central Massachusetts vegetation survey, roughly 100 copies of maps from the Massachusetts 1830s series, a library of over 160 old and rare books, and a Massachusetts state information section consisting of historical forest and soil surveys, census and tax data, and archaeological information. The adjacent Soil and Sample Archive was completed this year and now holds over 200 boxes of soil, litter, and tree core specimens, all of which were inventoried and entered into a database. And the Harvard Forest scientific reprint collection of over 8,000 holdings was inventoried and the accompanying database updated.

Hubbard Brook (HBR): John Campbell

Over the past year much of the focus of the data management group at Hubbard Brook has been on issues surrounding the physical sample archive. As investigators realize the value of the samples (some are now over 40 years old) we are faced with many questions regarding use, storage, and preservation. With new funds provided by LTER we will soon begin cataloging and bar-coding a backlog of 10,000 stream, lake, and precipitation samples that date back to 1970.

On other fronts, we have continued to improve the Hubbard Brook web site and have added web-based forms for submitting proposals to conduct research at Hubbard Brook and for registering for the annual Hubbard Brook Cooperators' Meeting. Guidelines outlining procedures for using data posted on the web were revised and standardized for all data sets. In addition, a "Current Research" section was added to the web site that provides a brief synopsis of each of the latest research projects being conducted at Hubbard Brook. In the Fall Hubbard Brook will be hosting the LTER Coordinating Committee meeting and we are currently in the process of developing a web page that will provide information about the meeting (http://www.hbrook.sr.unh.edu/ltercc/ltercc.htm). Future goals for the web site include improving methods for downloading data, developing an interactive form for querying the physical sample archive database, and making the Hubbard Brook bibliography searchable using keywords.

Jornada (JRN): Ken Ramsey, Barbara Nolen, and John Anderson

The Jornada LTER has begun building a relational database management system using Visual FoxPro and other components of Visual Studio. The Information Management System (IMS) will be a combination of a 3-tier web application (Internet) and client-server application (Intranet). Data set availability on the Web continues to be expanded. The number of visitors to the Jornada LTER web site has increased from 2350 to 3360 in the past year. The pages showing the greatest number of hits continue to be species lists for the Jornada Basin as well as climate and soil water data.

The 1998 LTER Site Supplement has allowed the Jornada LTER to update site office computers, servers, and software applications in support of an expanded IMS. A new web server has been purchased and will be implemented within the next few weeks in conjunction with ESRI Internet Map Server. A new laptop computer was also purchased and the LAN cabling upgraded. Extended support for a GIS assistant has resulted in digitization and development of numerous projects that were backlogged.

Geographic Information Systems (GIS)
Tasks accomplished this year include digitization of the new (1998) USDA Jornada Experimental Range (JER) and the NMSU Chihuahuan Desert Rangeland Research Center vegetation maps and building related databases, digitization of the historic (1858, 1915, 1923) vegetation maps, collection of existing metadata for the Digital Elevation Models covering the Jornada Basin, and miscellaneous smaller mapping projects. The vegetation maps in particular are crucial both as general context for any new or ongoing studies, and as the essential foundation for our current emphasis on linking vegetation change with geomorphological and soil features.

LAN Improvements
The Jornada LTER LAN was converted from thin net (Coax) to Universal Twisted Pair (UTP). This has dramatically improved network performance. Migrating to UTP also allows the LAN to be segmented and tuned for optimal performance.

File Server
A RAID controller and hard drive were added to the Compaq ProLiant 1500 file server to allow the use of RAID level 5. This has resulted in higher data read/write throughput to the hard drives and a higher level of protection from hard drive failures. The operating system on the file server was upgraded to NetWare 5. Novell's ZENworks and ManageWise server software applications were added to the file server to facilitate remote software and hardware configuration, monitoring, and updating from one central LAN workstation. The backup software has been upgraded in order to run on the new operating system using the old 8-mm tape library. A new tape drive was purchased for the tape library to reduce network backup times. A dual 10/100 Mb network card was installed to improve network performance.

Web Server
A new Gateway ALR-7200 server was purchased to act as our new web/application server. The server has dual PII-350 processors with 256 Mb of RAM and storage capacity of 18 Gb. A dual 10/100 Mb network card was installed to improve network performance for the web/application server.

GIS Computer
A new Gateway E-4200 computer was purchased to replace an older GIS computer that will be used as an Internet Map Server to provide spatial data and associated metadata over the Web. The computer has a PII-400 processor with 128 Mb of RAM and 19 Gb of capacity (9 Gb from the old GIS PC). The old 8-mm tape drive from the tape library was installed to allow transferring large datasets from 100Mb to 14 Gb in size. A CD Rewriter was acquired to allow for archiving datasets and images (up to 640 Mb) on CD media. These improvements allow the GIS/Remote Sensing person, Barbara Nolen, to work with larger datasets more easily and with greater efficiency.

Year 2000 Compliance Testing
All mission critical Jornada LTER computers (servers and workstations) have been tested and are hardware Year 2000 compliance. A site software inventory is underway to determine Year 2000 compliance and the need to upgrade to a compliant version. All data and metadata are archived in flat ASCII format; Year 2000 concerns are not applicable.

Kellogg Biological Station (KBS): Garrett Ponciroli

The Kellogg Biological Station (KBS) LTER is in the process of moving from a VAX system to a Microsoft NT server. Several data sets have been moved from an INGRES database to an Access 8.0 system in the past year. The data entry and storage process is currently being moved from spreadsheets to Access databases for more efficient data management and Internet publication. We are migrating the weather and biocollections databases from Access to SQLServer due to database size and potential multiple user limitations.

The connectivity supplement has been used to install a T1 connection from KBS to Western Michigan University. It also allows for a T1 connection to 2 K-12 project schools, Gull Lake Middle School (GLMS) and Plainwell Middle School. GLMS will be connected directly to KBS with a wireless bridge due to its close proximity.

One of the major projects for the KBS LTER computing staff has been and continues to be the Biocollections project funded by the NSF. The following is an abstract describing the project.

KBS LTER Biocollection Project
Last year, the LTER project obtained a supplemental grant for improving the biological collections stored at KBS. The KBS Herbarium was the logical starting place for improvements in both the content and accessibility of the collection.

Much of the herbarium data was already in electronic format, allowing for timely development of a database and web site. The new herbarium database is searchable and will allow future additions to be correctly cataloged into the collection. Under the guidance of Dr. Kay Gross, we have transferred information from the KBS Herbarium database to a web-based format accessible from the Internet.

The herbarium web site consists of two main parts: the collections database and an image gallery. These two components are linked to increase the user's experience. Both the database and the image gallery are searchable by botanical family, keyword or plant species. The database currently contains data for 6700 herbarium specimens describing over 2300 species. The image gallery contains more than 270 images showing 92 species and is being updated continually. The herbarium web page is linked to the KBS LTER web page and is at: http://lter.kbs.msu.edu/herbarium/.

The Biocollections project has recently obtained further funding to enlarge the scope of the work. The next step will be to create a KBS insect collection and place the information and images about this collection on the Internet. We will also continue the development of the KBS Herbarium and will expand it to include collections and images of plant species from unmanaged areas. Personnel for this project are Barb Fox, Karen Tindall, Melissa McCormick and Garrett Ponciroli.

Konza Prairie (KNZ): Brent L. Brock

This has been a busy year for Konza data management. John Briggs, the data manager at Konza since 1984 was on leave from KSU this past year and Brent Brock was hired as interim data manager for the project. Brent had worked 1/2 time for the Konza LTER program the previous year in which he was responsible for creating and documenting the GIS coverages will soon be on-line. With Briggs departure to Arizona State University 01 September 1999, Brent will assume the job of data manager for the Konza Prairie LTER project. Briggs will stay involved with the Konza Prairie LTER program, will be

available as a consultant, and assist Brent Brock in any questions that arise concerning the data management system at Konza.

T1 connectivity to Konza was completed during fall 1998 providing researchers, employees, and visiting scientists with fast computer networking capability. At this same time, network wiring was upgraded to CAT5 throughout the ecology building on the KSU campus providing 100 mps connections to the Konza LTER Web server, LAN, and several workstations.

Konza networking capacity was further enhanced through the NSF Connectivity Supplement. This money was used to purchase new PC workstations for the new computer lab and the visiting scientist's quarters at Konza, as well as a high performance NT workstation for GIS/Remote Sensing use. Supplement funds were also used to help purchase a new HP LH3 LAN server. The server features 36 Gb of useable storage in RAID5 configuration with a DAT 24X6 tape autoloader. This will greatly enhance our data storage and safeguarding capacity. Additional plans for supplement funding are to purchase a networked large format plotter and connect our Met station to T1 to provide real-time weather data. These last items should be implemented this fall.

Finally, Konza continues to prepare for our upcoming site review. Part of this preparation has been to update the Konza-LTER web site with a new frames-based GUI. Much of the information at the site has been updated and the site now offers more than 53 downloadable data sets. In addition to these data sets, we hope to provide many of our core GIS layers as downloadable exchange files by the end of August.

Luquillo (LUQ): Eda C. Meléndez-Colom

Connectivity

We finally obtained a proposal from one of the local carriers to establish connectivity at El Verde Field Station (EVFS), located at about 16 miles from our administrative office. After three years of contacting the telecommunications companies in Puerto Rico there was one, already holding a contract with the University of Puerto Rico, which submitted a plan to us. The only drawback was the recurring cost of up to 24K a year for maintenance and service, which adds up to 144K in six years.

Last year, David Hughes from a company located at Colorado Spring, visited us to examine the possibility of establishing monitoring devices throughout the forest that allow us to perform real-time monitoring, including video, using no wires. His effort was part of a proposal to NSF to establish wireless technology applied to research in two of the LTER sites: Luquillo Experimental Forest and North Template Lakes. The technology is known as spread spectrum and once is established requires no recurrent cost.

We immediately invited David Hughe's partner, Mike Willet, to do the engineering tests to establish telecommunication facilities at the EVFS. His proposed plan requires similar investment to what has been already proposed by the local company. Initial costs include materials, installation, labor, and the incorporation of a house located about 2 miles from the station in the plan. This residence has been recently purchased by the University for the use of the IEET (the Institute for Tropical Ecosystem Studies, LUQ LTER program's host at the University of Puerto Rico) to shelter our frequent and numerous visiting researchers. Mike Willet's proposal includes no recurrent costs. We have started the paper work in the University to contract this company. The connectivity supplement money approved this year has been allocated to cover these costs.

At the same time, we placed the request for the materials for the installation of a 10BaseT-based Local Area Network at the EVFS. Installation costs will be minimal since we have hired an E.E. with the expertise and knowledge to install and give service to this LAN and the other one located at our administrative offices.

The projections are to have a LAN at the EVFS connected to San Juan through a T1 using wireless technology, and the monitoring of weather at several locations up and down the mountain by the year 2001. We also expect to enhance our 56K connection to the University's Wide Area Network, to a fiber optic connection. The later is facilitated by the plan of the University to upgrade all its buildings connections.

Data Management

We obtained the supplement for Data Management, and we are in the process of buying one public machine and a new Novell File Server. The data entry technician's computers as well as the data manager's will have cameras and multimedia to establish communication with other machines. This kind of communication has already been established between the Data Managers' computer and John Porter's at the Virginia Coast.

Also, Data Management will obtain a CD-RW to archive the long-term data sets that have gone through a long process of quality control. The idea is to be able to have copies of these data sets at the EVFS, and at the International Institute for Tropical Forestry (IITF), which is the Institution of three of our principal investigators. Previous attempts to accomplish this were unsuccessful primary due to the limitations of the CD-R technology or to a lack of understanding on how it works.

The Data Manager is proceeding with her plans to continue her studies on Environmental Modeling. Eda has already started to take leveling courses and will take as many as she can at the University of Puerto Rico, with the idea of transferring her course work to the University of North Texas (UNT). She has already started working toward her dissertation with Dr. Miguel Acevedo, from the UNT, in his version of the Zelig model. LUQ LTER is contemplating to have Dr. Acevedo become one of our collaborators, and will work closely with the Data Manager in this project.

McMurdo Dry Valley (MCM): Denise Steigerwald

During the past year the McMurdo Dry Valleys LTER data manager has:

1. Gotten Oracle up & running:
    a. Installed Oracle on a unix server & Windows NT client;
    b. Created the database for MCM-LTER & decided on the way it would be layed out/designed for the variety of information collected in the McMurdo Dry Valleys;
    c. Worked with the investigators to get their datasets into desirable layouts so they will be useful in the Oracle relational database;
    d. Has been stressing how important date & location (latitude/longitude) are for every dataset;
    e. Started populating the database, first with large datasets associated with the 11 meteorology stations
2. Added a "photo album" to the web site. It's divided into categories such as general, scenic, streams, lakes, glaciers, soils & meteorology, so the user can either get an overall view, or look at very detailed photos such as diatoms found in Lake Hoare.
3. Continued to keep data found on the web up-to-date so that we're compliant with the National Science Foundation's requirements /recommendations. This involves appending data to established sets as well as creating new files / web pages for data that falls in a new category.
4. Obtained copies of environmental assessments required to perform our studies from Antarctic Support Associates & posted them on the web.
5. Kept the MCM LTER bibliography up-to-date; added abstracts for most, & the full article for non-copyrighted publications. This is being formatted to use in Oracle, where it will be linked to specific datasets and/or associated with specific keywords.
6. Kept the MCM LTER personnel portion up-to-date.

The data manager is currently:

1. Working on using Oracle's application tools to develop dynamic web pages based on the data being entered into Oracle; must include the metadata in this process & will also provide links to the bibliography / articles generated from the data the user is accessing.
2. Reorganizing the storage of data files to become more efficient & allow dynamic html documents to be generated rather quickly using Oracle.
3. Investing in more RAM & disk space on the unix server.
4. Figuring out a long-term plan to allow for expansion as the database grows each year. Due to funding limitations for the Office of Polar Programs sites, many of the options available to U.S. LTER data managers are not available to McMurdo LTER. Alternative solutions must therefore be found.

Network Office (NET): James Brunt

See Section 3.0

Niwot Ridge (NWT): Michael Hartman

<none>

North Temperate Lakes (NTL): Barbara Benson, Paul Hanson and Robin Stubbs

Connectivity Supplement
Through the connectivity supplement this year we implemented a T-1 connection of the Trout Lake Station, our field station in northern Wisconsin. With this higher speed internet access, we introduced videoconference capability. We used supplement funds to purchase two videoconference stations, one at Trout Lake Station and one at the Laboratory of Limnology in Madison. Each station is equipped with a computer, video camera, computer video projector, a touch pad drawing tablet that serves as an electronic "white board", and a document camera. We have been using Microsoft Netmeeting. The initial uses of the videoconference capability have been enthusiastically received. Barbara was able to present a training session to the fish crew in northern Wisconsin without spending 8 hours travel time. We have shared applications and collaborated in producing documents.

We had a vision of internet access at high speeds from anywhere at the field sites. The supplement funding is permitting us to develop two types of remote instrument packages using wireless, spread spectrum radio technology: instrumented buoys on lakes and mobile internet units consisting of a ruggedized laptop computer and a spread spectrum radio.

Transfer of ClimDB to Network Office
Robin ported the ClimDB database from Oracle to SQL server. She then spent a week at the Network Office installing ClimDB.

Database Development
We made substantial progress incorporating additional data sets into the Oracle database. We have expanded the use of web-to-Oracle data entry controlled by information placed in a “data entry control” table. We have been fine-tuning this Web interface in response to technicians' feedback after using the new system for data entry.

Palmer Station (PAL): Karen Baker

Field support for the traditional field season (annual January cruise and seasonal October through March station work) included involvement with personnel and equipment logistics, real-time field data review and data archive in addition to year round weather data collection, biomass monitoring and field updates. The past January cruise and season were synthesized and submitted to the Antarctic Journal for publication. A June process cruise crowded the already full year's events but fired everyone's enthusiasm. Since the Palmer LTER time-series of summer-spring water column sampling data is affected significantly by the previous year's ice, this was a unique opportunity to explore the winter Antarctic ice "hands on". This ice cruise also included data distribution via CD at cruise end, new methods investigations with Beta Testing Turner Design fluorometric solid standards, and education outreach through web communications.

Partnership of information management and education outreach continued with a March Education Working Meeting at UCSD/SIO and a 'Teacher Experiencing Antarctica' (TEA) interning at UCSD/SIO with information management in July. A Palmer LTER Education Outreach Forum held in conjunction with the National Center for Ecosystem Analysis and Synthesis (NCEAS) was the first education meeting held at NCEAS giving Palmer the opportunity to bring together national and local representatives (scientists, educators, teachers and information manager/technologists) to begin exploration of potential directions for a sustainable long-term educational program. A proceedings is in preparation.

Funded through OPP, the Palmer site has been ineligible for the LTER technology supplements through DEB over the past years so continues to depend on the Institute for Computational Earth System Science (ICESS) infrastructure. A few weeks internship for K. Baker with the LTER network office provided valuable training and an opportunity for interface with network projects such as SiteDB development, registration form centralization, web structure design and accessibility, creation of a network home page 'Information Management' link in addition to the 'data' link, migration of meeting pages to the network /www directories, preparation for passing the IM meeting page to another site data manager, proposal discussions and lead on a multi-authored manuscript submitted to BioScience presenting an overview of the current LTER IM paradigm. The LTER Information Manager Newsletter, DataBits, was redesigned, edited by Karen Baker and James Brunt, with publication of a Spring 1999 issue.

Continued efforts were focused on development of at-a-distance communications using electronic coordination (i.e. MS Netmeeting, shared ppt), electronic archives, web page synthesis and portals, and increased field support including digital photographs for both technical and outreach situations). The co-ordination through information management of a new part-time programming position (Oct98) and staff research associate (Mar99) broadens and stabilizes planning opportunities. Investigations with a variety of relational database software (i.e. MiniSQL, mySQL, access) have begun using the LTER Software Survey as a dataset with which to gain experience. The goal is to develop selected prototype elements prior to addressing relationally the Palmer Information System design with LTER metadata, data, bibliography and personnel directory.

Karen Baker began preparations for this year's upcoming August site review with an NSF Palmer 2 year review in Washington (May98), prepared materials for the LTER/SCAR Scientific Committee for Antarctic Research meeting (Aug98), attended the LTER Education Committee meeting at the Biosphere (Oct98), presented at an LTER PI meeting at ICESS/UCSB (Dec98), participated in the LTER Network Internships (10-18Jan99, 24-25Mar99, 10Jun99), provided logistics for and attended the LTER DataTask meeting at NCEAS (Feb99), held an initial Education Outreach Workshop with past TEA participant (Mar99), attended an LTER Technology Committee meeting at SDSC (Mar99), conducted an OPP "Teacher Experiencing Antarctica' internship (19-30Jul99), and co-authored as well as facilitated through web communications two LTER multi-author joint publications.

Plum Island Sound (PIE): Hap Garritt

We are in the midst of a typically busy summer field season with many new college undergraduates, high school students and new researchers participating in LTER research at the Plum Island Ecosystems (PIE) LTER. Summer projects include: sediment benthic flux measurements, sediment desorption/adsorption of ammonium as a function of salinity, researching historical water withdrawal records for the Ipswich River, physical, chemical and biological characterizations of several tidal creeks, green crab population size and home range, mummichog growth rates as a function of marsh access and ribbed mussel and snail population surveys. With the help of our University of South Carolina colleagues we installed our first group of sediment elevation table (SET) pipes in the marsh. SET measurements in the marsh will help us evaluate sea level rise impacts in our marshes.

The PIE field station in Rowley, MA has been very busy as a result of the summer field season and we are still awaiting our T1 connection as funded by the connectivity supplement. We hope to have the T1 installed by fall 1999. Currently, we have no connectivity connection to the outside world other than lap top modems. We are also in the midst of evaluating various data acquisition systems for collecting data from field monitoring stations (weather, tidal water quality, stream gages) and transmitting it to our server at the field station.

Sevilleta (SEV):
<none>

Short Grass Steppe (SGS): Chris Wasser

Quite a bit has happened in the last year here at the SGS LTER. First of all we purchased a Dell PowerEdge 2300 server for database, web, and email services. In addition, we have completed a move from Oracle to Access and the Microsoft line of Internet software – NT server, IIS, and Visual InterDev. This has greatly reduced the development time for applications linking our database to our website and has greatly reduced the overhead required to manage and administer our database and website. Having an integrated suite of products is definitely the way to go, even though it means we are locked into the Microsoft empire ☺

As some of you have undoubtedly noticed we have also completed a complete redesign of the SGS LTER website to incorporate consistent design elements throughout the entire site and to provide better navigation tools. Please let me know what you think, as all websites are works-in-progress. We are now looking to expand the content of our website to include more dynamically generated information.

Progress continues on adding datasets to our RDBMS and posting them on the web and we just purchased a Trimble GPS unit, which we hope to use extensively next field season.

Virginia Coastal Reserve (VCR): John H. Porter

This has been a busy year for information management at the VCR/LTER site. It started by greatly expanding the number of computers available at the VCR/LTER field laboratory in Oyster VA. In the past, a single, high-end, windows-based computer was available for network access via modem. However, the demands of researchers at the site for electronic mail and WWW access were seriously outstripping the number of network "seats" available at the site. To remedy this we installed a LAN in the central office of the laboratory with 5 computers (varying from Pentium II/350 to 486-66s) along with WINGATE software. The WINGATE software allowed simultaneous sharing of a single 56KB modem by all computers connected to the LAN and proved to be a great success for email and limited WWW browsing. The network enhancement supplement we received will allow us to improve our connection to 1.5MBS via Network Virginia and add an additional server.

We have been able to substantially upgrade our UNIX computing power by replacing venerable SUN SPARCstation 1's with venerable, but more powerful, SPARCstation 10's. This upgrade became possible when the state donated over 200 SPARC 10's to UVA when the state highway department converted to NT-based systems. This upgrade has eased the transformation from SUNOS to Solaris operating systems. Security has been a problem this year with 3 documented break-ins to computers on our departmental network. We are working with departmental and university groups on improving computer security.

We continue to make extensive use of WWW forms for collecting information from our researchers. Our database continues to be Mini-SQL running on a UNIX platform. I've completed the migration of our databases from MSQL-1 to MSQL-2 and celebrated by adding links to projects and datasets to personnel directory entries. At Eda Melendez's suggestion, I've added electronic mail capabilities to the process_doc program (used to create this WWW document from an online form).

Meetings and talks included an invited talk on LTER Information Management at Evergreen State University (April 1999), participation in an NSF panel evaluating KDI pre-proposals (April 1999), a DATATASK meeting at NCEAS (Feb. 1999), the User Working Group for the Global Change Master Directory (Mar. 1999), Biodiversity Observing Network workshops in Sep. 1998 and Jan. 1999, an AIBS panel on the Biological Data Profile for the FGDC metadata standard (Jan. 1999), a presentation on "many small data files" at a NASA-organized conference on mass storage (Nov. 1998), and attendance at a "metadiversity" conference that focused on "the grand challenge for biodiversity information management through metadata" (Nov. 1998). Finally, I have been representing the LTER on an interim basis at the Biological Data Working Group of the FGDC (Jun. 1999).

Plans for the next year include continuing work on developing XML versions of metadata and improving systems for accessing images. I will be working with the LTER Network Office on developing or enhancing some systems associated with the LTER NIS.