

LNO Review Final Report 5 September 2008

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Overview

The proposal, staff presentations, and additional information provided before and during the site visit provided a sound and detailed basis for evaluation of the LTER Network Office's (LNO) impressive record of accomplishment and plans for the future. The Site Review Team (SRT) commends the LNO for its strong response to the Mid-term Review Panel's recommendation to invest effort in advancing the goals of the Decadal Plan. The team notes that some links from the proposal and from the renewal webpage did not work, although the team was very responsive during the site visit. After commenting briefly on the LNO's response to the midterm review, we present our comments here, pertinent to major areas of the proposal and to other issues identified by the review team during our discussions.

Major areas of proposed activity include: Support for Research Synthesis, Development and Implementation of Cyber-infrastructure, Core Services, and Development and Outreach. In addition, our discussions covered Assessment and Evaluation, Budget and Management Planning, and Institutional Support.

LNO Response to the Midterm Review

This SRT reviewed the recommendations of the 2005 mid-term review. Several points are worth reiterating here:

1. Communication plan.

The development of a comprehensive communication plan is part of the renewal activities and is addressed elsewhere in this review.

2. Higher level of evidence of LNO impact on LTER Network.

The SRT suggested that new metrics of performance must be developed to focus on the overarching role of the LNO in the LTER Network, moving away from the detailed fine-grained specific lists of tasks performed toward a more comprehensive and relevant view of broader impacts. It may be that this suggestion inadvertently contributed to the decision by the LNO staff not to include in the proposal stronger supporting materials of metrics compiled and available to the LNO for their own assessment of this impact although the proposal continued to include fine-grained lists.

3. Cross-site working groups – support and assessment.

The LNO was encouraged to support opportunities for groups of sites to self-organize to build Network science, regardless of specific funding scenarios. LNO plays a very active role in the

stimulation and facilitation of such activities drawing on multiple funding sources. Less obvious to this SRT was the establishment of a mechanism for assessing the outcome of the small grants that have been provided for synthesis with the goal to guide the strategic support that would increase the success rate and payoff of small projects. We understand that steps are being taken to develop such processes and data and encourage that these assessment mechanisms be given high priority.

4. Quicker release of data products.

The LNO has worked to shorten the lag between development and implementation of IM technologies that address priority needs of the sites. The challenge is then to continue to deploy resources to further test and finalize these products to achieve a high level of quality.

5. Site-to-network information exchange.

It was suggested that additional LNO staff, such as web and software developers, travel to sites in order to maintain good communication channels and coordination between LNO and site information managers. We understand that this has taken place and planning for more such visits is included in the renewal.

All in all, the site review team acknowledges considerable attention to and progress in meeting the recommendations of the mid-term review of LNO activities.

Support for Research Synthesis

The site review team commends the LNO for its strong response to the Mid-term Review Panel's recommendation to invest effort in advancing the goals of the Decadal Plan. In particular, the LNO has focused on facilitating research synthesis with a four-pronged approach that engages the Science Council, All Scientist Meeting, Research Working Groups, and Planning Meetings. This approach provides fertile ground for developing integrative research designs and integrating research results. As the LNO assumes synthesis responsibility, it is crucial that it articulate a clear vision of its evolving role in promoting synthesis. The LNO has begun to assert stronger leadership in promoting the specific goals of the Decadal Plan, but it is still not clear whether the LNO sees itself facilitating implementation of the recommendations of the Science Council or planning groups. Does the LNO have a role in engaging other related observing networks for the purpose of promoting collaborative campaigns? A clear vision statement, endorsed by the LTER Executive Board (EB), will send important direction to the individual sites concerning LNO services and expectations with respect to research synthesis. To that end, we recommend some elements that might be included in a synthesis vision in the paragraphs below.

The inclusion of social scientists into the LTER model poses challenges that the LNO must resolve. The social science community is less experienced with coordinated field observation. The LNO has an opportunity to provide leadership by engaging carefully chosen pilot teams, in some cases leveraging faculty and expertise from the University of New Mexico, to develop operational social-ecological observing templates to be used by research working groups. Progress in this area is an important part of the network's Decadal Plan, and should be tracked

closely by the LNO and both successes and challenges should be frequently reported (18-month time-frame) to both the Executive Board and NSF.

The 2007 LNO survey reported that the network highly valued the use of working groups to facilitate synthesis and to promote the goals of the Decadal Plan. For this reason, it is important for the LNO to have a clear and consistent mode of communicating the aims of the working groups and a common format for reporting their results. First, to help LTER scientists to make the most of working group opportunities (whether at the ASM, Science Council (SC) or planning meetings, or annual funded competitions), prior to their announcement the LNO should make available a document to the community that includes:

- topical guidance as discussed with EB, and links to the Decadal Plan
- availability of supporting funds for mini-sabbaticals
- availability of the training room at the LNO
- availability of data resources to guide topic choice and pre-meeting synthesis
- VTC capabilities
- links to possible funding sources for proposals that may be generated from working groups (NCEAS, NSF RCN...)
- links to products from prior working groups
- links to a reporting page with tractable product expectations

While availability of all of these resources may be provided in different links on the current webpage, they are not together in a single document and often difficult to find.

Second, the LNO is tasked with recording the efforts of these working groups, but staff conveyed that it is challenging to link products to specific working groups (not an easy task, with ~40 per year). As a result, the SRT had difficulty finding the products cataloged in a way that would promote their efficient use and assume it is similarly difficult for site scientists who need to use these documents. This catalog of products is not only important to driving more efficient synthesis, but also in communicating the strengths of the LNO in facilitating scientific advancements. The SRT suggests that the LNO provide a web link to a reporting page that would have a common format for working groups of ALL types, that would require the group to report their topic, members and leaders, abstract of goals, summary of workshop results and a dynamic link to products (proposals, publications, etc...) that could be regularly updated by the working group leads as products are generated, and then directly imported to a common product database. In their web activity report, the LNO reported that the most common hits are to the document archives, indicating a real need by the community to have these products more easily accessible. [Notably, the team found it difficult to find ASM and working group reports outside the intranet and strongly urges making this information open and easy to find by any user.]

The SRT was supportive of the additional funds allocated toward competitive, funded working groups during the next funding cycle. They wondered whether the LNO should consider annually allocating one of these opportunities to the graduate student community. The LNO director acknowledged in conversation from previous experience that this process could benefit from

faculty mentoring. The SRT thought this was a good idea and that the LNO should discuss it with the EB, to activate a response from the SC or broader community to engage in faculty mentoring. It was questioned whether this could be a role for the Associate Director of Synthesis? The graduate students have communicated a need to feel more engaged with network activities, which needs to be addressed since equipping these early career scientists with knowledge and tools to advance LTER science is crucial to its long-term viability.

The SRT also noted that the same LNO survey indicated that, second to working groups, the LTER community advocated the use of post-docs to drive network synthesis. While the SRT did not find a place where funds could be reallocated in the current proposal toward this endeavor, they felt that the LNO should be pro-active in stimulating working groups that have a goal of writing leveraged proposals to support an LNO-centered post-doc. By being a central archive of data and products, the LNO has the opportunity to “see the forest through the trees” in a way that may be more difficult for site scientists and is, therefore, in a unique position to suggest to the community (with help from the EB and SC) directions for specific synthesis endeavors. By promoting proposals to support post-docs for meta-analytic tasks, the LNO would not only be facilitating the advancement of science but also be directly participating in that advancement on site. In this same vein, the LNO is encouraged to continue conversations with NCEAS as a possible route to achieve this goal.

Core Services

The LNO has a formal relationship with CREST, a research center that reports to the Dean of Arts & Sciences. Research administration, office management, financial services, and logistical support for the LNO are the responsibility of Marjorie McConnell, who has a university appointment within CREST and LNO, and a small office management and administrative support staff. Workshop support, logistics, travel, and accounting activities represent a significant portion of their responsibilities. This unit appears to be professional, efficient, and talented and quite able to provide the services necessary to perform the administrative functions of the LNO. The SRT is confident that the LNO is being well served in this area; we consider that the delivery of high-quality core services is a significant component of the Network Office and we recognize the responsible program manager as a key part of the senior management team.

Cyber-infrastructure Development

a) NIS Development

Strengths: The proposed system promises to be a significant step forward towards making the LTER data holdings accessible through a common data access interface. The envisioned system, a derivative of the EcoTrend testbed project, nicely leverages prior development and should be a good start off point for a functional data search, access, and retrieval environment.

The development plan is reasonable and the associated FTE allotment appears to be reasonable in view of the expanded scope. The SRT has no issue with the allotted FTE number to handle the CI development.

The data integration effort using ClimDB and HydroDB is a good step to test their ability to actually execute the data integration services. There also seems to be the desire to integrate other data sets, be they time-series data or GIS type geospatial data sets, in addition to remote sensing data in order to meet the diverse data expectations of the user community.

Concerns: When asked, there seemed to be no real plan in place that would help prioritize the inclusion of additional external data sets (i.e., time-series or GIS-type data) in order to expand the data coverage on a specific site. Six years is a long time and should contain some trajectory that expands coverage. There was also some vagueness on the issue of making use of already established metadata catalogues, and how they could be harvested to expand the data coverage of Metacat. There are a lot more data out there than collected just by the LTER sites.

Recommendations: The review team recommends that the CI team develop an approach that would help them prioritize data coverage expansion (beyond ClimDB and HydroDB) throughout the next 6 years of the project duration. The CI team could look for some low hanging fruits in utilizing other already compiled metadata catalogues like CUAHSI HIS or NASA's ECHO.

b) Technical Development

Strengths: The LNO and the LTER Network have invested considerable time and energy into developing an integrated technology plan that describes the cyberinfrastructure components needed to promote the synthetic research activities of the LTER Network. This has been an evolutionary process, and many portions of the plan are very well conceived. For instance, the PASTA framework provides an excellent software template that is designed to enable data integration activities for specific analysis and presentation efforts, with the EcoTrends project as its main testbed implementation. The modularity of the software system is commendable, and the staged development of the implementation also provides quick feedback for those involved in the end product (like the EcoTrends investigators). This component of the Network Information System (NIS) builds upon existing open-source software, and is designed with an eye toward flexibility and interoperability. Likewise, the framework can be applied to other cross-site efforts such as the ClimDB and HydroDB database initiatives.

As part of the PASTA framework, the team is looking for the integration of workflow engines (developed under the SEEK project) in deriving data products. This is an innovative component of the system that deserves recognition. This is unique, challenging, and would constitute a first in an integrated NIS. The fact that the system promises flexibility in terms of what workflow engine could be employed (such as straight R scripts), is a testament to the design forethought.

The PASTA system builds on existing components (Metacat, harvester, EML) which is a sound and efficient approach. The use of technologies like JAVA and XML promises a high degree of adaptability by different OS systems and uses components that are open source, all of which are positive aspects of the proposed system.

The system seeks to move its metadata harvesting capability to the next level to include data harvesting that is to be registered in a data registry. This would enable the system to actually offer added-value data products, representing a step up from just delivering metadata and a URL pointer to get it.

The system back end is supposed to adhere to an interface that would allow exposure of the Metacat metadata contents to the outside world through web services. This is very much in tune with how other NIS and data repositories seek to publish their data.

Concerns: The PASTA architecture is an excellent conceptual framework, but some of the implementation details remain vague, and portions of the framework that provide optimizations may need to be revisited from a design perspective. For instance, the plan will rely on the EML Data Library software to structurally interpret the data via the detailed metadata descriptions, but the plan does not outline how issues such as sampling scale will be handled. Likewise, the search optimization component of the 'Extracat' module of the framework may provide stopgap functionality that may be better addressed in the search functionality of the Metacat component. The use of a workflow engine such as the Kepler system, while commendable, may present challenges in the implementation. The vision of the CI development team regarding how to install these workflow sequences, how to manage them, how users are supposed to suggest and install new ones, and what the management of potentially thousands of these workflow sequences remains unclear. Are the users supposed to create their own Kepler, R, Java script sequences? Are they supposed to submit a request outlining what they want?

Programmatic access to data typically requires the formulation of a data model in which all different data types and variables can reside. There is no indication that the team has developed a data model, a means to transmit the data in standardized format, and what it should be encoded in. Also, there was no indication that the team had looked into what other initiatives may have developed to this date.

Recommendations:

- The workflow engine component needs to be worked out in more detail. The current installation of a simple R-script is helpful, but does not constitute a real stringent test let alone how the CI team plans on integrating and managing the workflow environment and its use.
- The CI team develops a plan or a concept for transmitting data from the system into end user systems other than the EcoTrends-based new access system. There should be a standard (XML schema) that would define the contents of a data record retrieved from the NIS via web services. There should be review of what is available and, in case there is nothing suitable, a plan to develop a data model. Attention should be paid to the fact that there are

times-series data, remote-sensing (raster) data, grab (and core) samples, GIS type data, and perhaps even modeled data - all of which require a different representation.

c) Network Integration

Strengths: It is clear that the LNO has seen a dramatic infusion of responsibility to handle network wide tasks, particularly on the CI development side. The office has come a long way from being a pure service institution to an office that takes on a leadership role in the entire LTER. The transition has happened over the years and the introduction of EML as a data annotation tool across all sites (at least at a minimum level, and even better at the “rich” level) is a real success towards a federated system with a central leadership in some aspects. The CI expansion in the Decadal Plan, namely the establishment of a true network with common access means and a common data description, is a real step forward that carries a lot of promise. The planned activities to draw the various sites (with varying degree of “readiness” levels) into the fold with active site support, visitation, and training is a remarkable service the LNO is offering to bring the sites up to speed with network developments. It leaves the review team with the impression that the LNO is truly committed to the success of this effort by dedicating a substantial degree of resources to it.

The creation of the NISAC is a fine step forward to ensure continued input from the sites to CI development, a necessity that has been recognized by other network development efforts as well. It is crucial that domain scientists define the CI needs and communicate them to the IT specialists and not the other way around.

Concerns: While the CI plan and its scope reflects what needs to be done, the review team somehow senses that the complexity of what needs to be done has not been fully realized. The fact that the sites are at different readiness levels will require various degrees of support and effort. The SRT would feel more comfortable if the CI development and implementation team would actually have a documented current site status, defined levels of where they need to be, and the allocation of effort. There is the impression that the LNO CI team is not fully aware of what they could expect the sites to provide vs. what the sites can commit (IM FTEs for example) on the road ahead. This could potentially be a substantial obstacle to implementing the full functionality of the proposed vision.

Recommendations:

- The review team believes that it would help if the LNO CI team documents the current status of each site so they (and others) are aware of what the required effort to bring all sites up to a minimum level to actually being able to implement network-wide cyberinfrastructure components. They need to articulate what this minimum level is and how they plan on getting the sites to this level.

d) Interoperability

Strengths: Interoperability is an important goal for NIS and the LNO recognizes the importance.

Concerns: It remains a concern how the LNO CI team plans to overcome the syntactic and semantic heterogeneity imposed on them based on the history of the 26 sites and their CI deployments. The fact that 26 sites use 26 different ways of storing and encoding their data seems to be daunting, particularly in view of the PASTA system trying to interpret and re-code them in unified format. In addition, EML elements alone do not constitute a full description of data; one needs controlled vocabularies as well (e.g. to label a variable). While there are some workgroups working on this it remains unclear how exactly PASTA would address this. There is little evidence that the NIS is identifying means of overcoming heterogeneities with other data repositories or metadata catalogues. The exposure of the Metacat holdings via web services is a first step into the right direction, but the reverse, i.e. harvesting other catalogues for inclusion into Metacat will not be achieved if there is not a semantic mediation step involved.

Recommendations:

- The CI team needs to work out a more detailed strategic plan that outlines the challenges and an approach to address these challenges. There may be the need to alleviate some of the heterogeneities at the sites themselves so as to help the LNO to achieve their goals.
- There should be a plan on addressing the semantic mediation between the sites as well as a plan to do this for outside data repositories. There may be projects like INTEROP and DataNet that would address some of these issues, but these are different projects and are not part of the proposed scope of the CI developments.

e) Web site public access and usability

Concerns: The LTER LNO website provides access to information about the LTER Network activities, to reports and publications, to information about educational outreach, and to the LTER site data and metadata via the LTER Data Catalog. In evaluating the proposal, the reviewers were sent to a number of links to gain access to supplementary information and documents in the website. Some links failed to provide the intended information. In other cases, the interface was not user-friendly. For example the data catalog interface was cumbersome. One could not access the catalog without having to enter some searchable word or phrase. For a novice not knowing what was in the catalog, but wanting to gain an overview of what the catalog holdings looked like, this presents a tremendous impediment to information discovery. In addition, some searches produced information that was not directly related to the information being sought.

Access to most of the LTER data via the website also has a structural impediment in the form of a log-on requirement. Clearly this requirement is mandated by the LTER data policy in the section “LTER Network Data Access Requirements”. However, such a policy element is not

mandated by NSF, which in fact specifies that data be made freely available after an appropriate period of time without restrictions. Tracking information about site utilization and which data are being examined and/or downloaded can be obtained without the need for a log-on. A fraction of individuals who might like to explore the data holdings (as opposed to the metadata), will turn away from the site rather than go through the log-on process, thus leading to an under exploration and utilization of the site data. Clearly, there is need for individuals who download data and intend to use them scientifically or otherwise to communicate with the data owners. This etiquette needs to be instilled in the data users at the time of the downloads.

Recommendations:

- Organization of the website needs an overhaul. The SRT recognizes the magnitude of information available through the website, but it is only useful if it is easy to find – could a web-review team be established to help guide a more user-friendly tracking system, and one that requires less maintenance by the web team?
- The data policy should recognize a more open access to the LTER data by dropping the need for a log-on procedure.

Development and outreach

The proposal and site visit presentation outlined four major focal areas - the strategic communication plan, communication and outreach, development, and training.

a) Strategic Communication Plan

Strengths: The LNO has delayed the preparation of the Strategic Plan for Communication (mentioned in the 2005 mid term review) because they identified a need to first define and prioritize the goals. We commend the care invested in establishing a planning group, carrying out pre-planning, and then outlining a process to ensure that the network contributes to the prioritization and execution of the plan.

Concerns: While the contextual scan will be invaluable to help identify needs and stakeholders, the SRT recommends keeping in mind that different targets/audiences not only have different requirements, but that the communication to them can, and should, address different goals: raising scientific literacy is distinct from training the future workforce of scientists and information experts, while both may be aimed at young people or the general public.

Recommendations:

- The LNO, together with the EB and SC, and with communication to NSF, should identify not just the targets, but also the primary goals and needs, which obviously will change with time.

- As an example of needs changing with time, the SRT felt that communication during the development of the Decadal Plan will involve considerable communication with social scientists and that effort should be made to ensure that the results of the LTER be placed, when possible, into a context that is relevant to decision-makers and in the context of policy.

b) Communication and outreach

Strengths: The SRT commends the hiring of McOwity Thomas and notes that his news releases are among the most frequent hits in the LNO website. Maintaining the newsletter and progress in written brochures and other promotional material are appropriate, as is the upgrading of the display panels for meetings. Likewise the participation with and contributions to LNO publications and the Oxford LTER volumes are valuable.

Concerns: The website, while uncluttered and attractive, does not provide a clear link to many useful and relevant locations. For example, the webpages corresponding to past ASM meetings hold a wealth of information regarding the working groups that is scientifically invaluable. (see recommendations and comments above)

Recommendations:

- The webpage should be kept more up to date and there should be clear links to key elements of the LNO activities, such as past ASM meeting results.
- Keep up the good work in high quality written, web, and other communications.
- Consider alternative approaches for communication such as podcasts and weblogs.

c) Training

Strengths: While the LNO has no specific mandate for training, the training laboratory developed with SEEK funds is very impressive.

Recommendations:

- The SRT feels that the potential for using the training laboratory to train IM managers from the sites, for working group meetings, and for other non-LTER but relevant training efforts at UNM should be considered. The laboratory has great potential to facilitate effective synthesis by allowing working groups to plan research in a collaborative setting. The Network needs to be more aware of its existence and utility for working groups and synthesis.

e) CI Development and National and International Outreach

Strengths: The LNO has been extraordinarily active in establishing successful relationships and working relationships with a number of institutions and initiatives. The national and international partnerships in which the LNO staff is engaged represent an important aspect of LTER's leadership in the ecological and environmental science community.

The involvements range from project participation (other than the LNO), for example NBII, INTEROP, SEEK, to participation in advisory committees (Servilla in CUAHSI HIS and Brunt in FEON). Even though the involvements occur at different levels (some of which are not necessarily funded), it demonstrates the commitment of the LNO to be "involved," keep abreast and informed, and at the same time keep others informed about the LNO developments, as well as representing their leadership.

LNO is also expending considerable effort to link up with other national eco-biological initiatives like the OBFS, NEON, ESA, as well as leading entities like NCEAS. This is a very positive aspect that deserves high praise as it demonstrates LNO's commitment and realization that they cannot operate in a vacuum and are actively aimed at taking a leadership role to help move the eco-biological CI developments to the next level.

Concerns: Many of the involvements (both international and national) are based on collaborations on separate projects like INTEROP, DataNet, and SEEK. While this raises concern as to the time allotment of the personnel to LNO and then other projects (over commitment?), it also remains unclear how these projects tie into the LNO project scope. These projects are chance projects and in the case of unfunded projects do not clearly demonstrate how well LNO is linked into other activities. For example, if DataNet is not funded, LNO's international activity is less, although we recognize the attempt to be involved and the partnerships implied in proposal preparation.

While the list of links to national efforts is quite impressive, it reads like a laundry list leaving some uncertainty about what exactly is being achieved and what are the expected impacts for the LNO and for the development of the LNO cyberinfrastructure. For example, although Servilla's involvement in the advisory committee of CUAHSI HIS is valuable to HIS (and possibly for him and also the LNO as they see what happens elsewhere), the connection proposed by the DSS for collaboration and synthesis with CUAHSI is vague and undefined. Hence, the reviewers are left with the impression that there is plenty to look at, but with undefined scope, activity, commitment (budget wise also), and real expected benefit to LNO and ultimately the network.

Recommendations:

- There should be a clear delineation of what LNO is planning to do, what the staff commitments are, and what the outreach involvements require in terms of time and development. For example, who is going to work on the INTEROP project if all FTEs are committed elsewhere? The leveraging by LNO with and towards other projects in the CI area

while apparently very successful also muddles the view of what LNO is actually planning on doing.

- There should be a focus on defining what to involve themselves in, and what they expect to get out of it. The current list of activities is long, diverse, and hence somewhat confusing. It should be clarified, for the benefit of the LNO team as well as NSF and future review teams. For example, the commitment of installing CUAHSI HIS web services and also working on appropriate sniffers for the CUAHSI HIS network would constitute a real and concrete task in the national collaboration/involvement category. While not all activities need to have such a concrete outcome, it would help to have a clearer plan for these activities, defining the foci and the anticipated impacts.
- While the LNO appears to be making excellent use of partnerships, there is a risk of responding so opportunistically as to detract from making progress in areas most important to LTER. The recommended outline and focus would help ensure that responses to opportunities are strategic and in parallel with the highest priorities of the network.
- The above concerns notwithstanding, we recognize the need to be both opportunistic and proactive and recommend that the LNO take great care in maintaining the tension between the two strategies.

Assessment and Evaluation

Strengths: The SRT noted that the LNO has made a large and careful effort in responding to the request for improved metrics and evaluation. The importance of a careful process for assessment and evaluation cannot be overestimated, given the strong mission of “support” of the LNO in addition to its undeniable leadership. There are multiple elements that need to be assessed on a regular or ongoing basis: user needs, meeting and logistical support, IT and IM needs and satisfaction, and communications (VTC, email servers, etc). It was noted that surveys of needs of the users should be and can be linked to the assessments of satisfaction (for example, in documenting that LNO activities have resolved and eliminated particular challenges).

The SRT was pleased to see the ongoing evaluation processes in the last period, which include the evaluation of the EB and the university and surveys, as well as the efforts to engage professional assistance in the surveys. Likewise the SRT acknowledges the effort invested in improving the surveys and increasing the responses. While the desire to hear from all sites is a priority, feedback from participating scientists, and students, in addition to site representatives is also important. The LNO team appears to be very proactive and responsive in addressing concerns of the LTER network when they are identified.

Concerns: While evaluation and assessments have occurred at the LNO, the proposal failed to include sufficient information on the results of these metrics. There was some information available on the ancillary information website and additional information was provided on request at the site visit. Once seen, the overall assessment results are impressive.

The interpretation of the evaluations seems to be slow (references in the 2008 strategic plan to preliminary analysis of the 2003 survey) even though the opportunities to use these surveys as demonstration of success and to help guide efforts should be helpful.

The section proposing future assessment and evaluation approaches was vague.

Recommendations:

- The SRT suggests that future proposals provide summarized information on survey results; if this is as ancillary material on a website, there should be references to it in the proposal.
- Compiling information in a timely fashion from the surveys and assessments is very important.
- Furthermore we suggest that integrating the different kinds of assessment (e.g. CI needs, user statistics and satisfaction, needs assessments) would provide much insight and should be attempted. Obviously there are limits to time and effort to be expended in analyzing these assessments, but there is also great value in knowing the range of, and use of, the evaluations being made.

Budget and Management/Staffing Plan

Initially the SRT members found it challenging to understand how the budgetary request could be parsed across specific activities and investments; in the budget justification, specific staff positions (personnel investments) and operations expenditures were explained in some detail, but not necessarily mapped to the four major areas of continuing operations. The additional budgetary detail provided to us was greatly appreciated and was helpful in understanding the relative magnitude of investment in different activities.

The small number of senior staff positions, the unique histories and qualifications of existing personnel, and the exceptional stability of senior-level leadership within the LNO undoubtedly help to explain the apparent absence of any explicit staffing plan or description of hiring processes. We appreciated Dr. Waide's willingness to discuss both general approaches and the specifics of particular personnel challenges or opportunities.

We recommend that NSF ask the LNO to develop a brief statement of the process to be followed in cases of new senior-level hires: review within the LNO of current perceived priorities and existing skills in the office, consultation with the appropriate entities within the LTER Network to decide upon the level of hire and the main elements of a position description, work within the university system to craft the final description and to administer the search and hire process. This general description of a staff recruitment plan could and should be incorporated into the LNO's "critical procedures" operating document, in order to provide confidence in the long-term vigor of the LNO in the face of eventual need to expand or to deal with turnover. A well-reasoned management plan would strengthen future proposals with regards to understanding how

the team works together and how that team integration might be protected and maintained even through long-term evolution of personnel.

Institutional Support

The UNM provides personnel and administrative infrastructure support to the LNO. It was clear through the participation of members of the higher administration of the University in the site visit, and remarks and conversations with the President, the Interim Research VP, and the chair of the Biology Department, that the LNO is considered a significant university asset. In fact, the President specifically asked the SRT members if there was anything that the University could do in further support of the LNO. This level of positive feedback attests to the success of the LNO staff in their relationships with other units within the university. We look forward to seeing some of the suggested ways UNM might facilitate interdisciplinary goals of the Decadal Plan, especially the facilitation of social ecological research, come to fruition.

We recommend that the LNO solicit a letter from a University official, especially the President, that documents the level of current support, states the nature of future support, and recognizes the qualifications and backing of the LNO team. Such a letter would document the current commitments and enhance any future proposals from the Network Office.

Review Process

The SRT applauds the LNO's extensive and effective preparations for this site review. The provision of supplementary material to the proposal allowed the team to gain extraordinary depth and breadth of understanding of the LNO's accomplishments and plans. While the supplementary material was very helpful, there were some problems: the website with the material had elements in construction two weeks prior to the review due date, some of the links did not work, and some of the links in the website did not connect appropriately. Also direct references in the proposal to material in the renewal website (not links per se, but references) would have given that material context and made it value-added. We suggest that, for pre-meeting preparations, the LNO provide a roster of staff members and their responsibilities ahead of the meeting. This would have facilitated the matching of people with the proposed activities. We valued the enthusiastic involvement of every member of the LNO staff in the site review. In fact, we suggest that an even larger venue might have permitted all of the LNO staff to sit simultaneously with the SRT and NSF staff, allowing the entire organization to learn from the review. The presentations by LNO staff were clear and well-organized. However, we would have benefited from shorter, more succinct presentations with more time for questions and discussion. All in all, the LNO was superb in facilitating the needs of the SRT.

Panel Summary

The LNO has played a critical role in the historical success of LTER site research and an increasingly important role in advancing complex science across the LTER network. The proposal presents a framework for facilitating LTER science within the context of the Decadal Plan for LTER. The transformative nature of the Plan necessitates transformation within the

LNO, and budgetary requests are consummate with that need. First, the LNO proposes to continue existing operations through a base budget of \$10,350,000 (accounting for inflationary increases), supporting the management of site information, facilitating network meetings, archiving and recording site and network activities and communicating science to the network and public. The LNO has functioned commendably in these areas in the past and has a clear plan for building on their strengths and continuity in staffing for efficiently meeting these objectives in this renewal. Second, the LNO requests an additional \$2,106,540 to support science and governance goals of the Decadal Plan. The science activities are well justified: through increased funding for working groups and network meetings, the LNO can build on the intellectual momentum of LTER scientists toward implementing the transformational science in the Plan. Third, the LNO outlines a plan for implementing preliminary cyberinfrastructure needs for the Decadal Plan at a cost of \$3,205,639. This includes completion of the Network Information System, stewardship and development of databases and training LTER information managers and scientists on how to use new IM tools. One recognized challenge to the LNO and network is increasing the involvement of social scientists in advancing new trans-disciplinary science as well as the tools for carrying out that science. The LNO will need to closely track progress in social-ecological research efforts, and will need to frequently report successes, as well as potential impediments, including limitations in cyberinfrastructure that prove to be barriers. As the LNO has been instrumental in developing, refining and communicating the tools of science, the panel views the request for increased funding as fundamental and necessary to achieving the transformative mission of the Decadal Plan. The LNO recognizes the significance of intentional and considerable support of the UNM, and should capitalize on the opportunities afforded by that relationship in facing the complex challenges of evolving LTER science. **The panel recommends that NSF support (1) the base budget for continued operations, and contingent on funding availability: (2) additional activities to facilitate new science of the Decadal Plan, and (3) enhanced funding required to accommodate cyberinfrastructure needs to support this new science. The panel also recommends that NSF requests an 18-month report detailing the progress made toward integrating social and ecological research.**