Report of the National Advisory Board of the US LTER Network

1. Executive Summary

This is an exciting time for the LTER Network, in which the framework is being designed to conduct network-level science and education. The NAB was impressed by the vision and the energy of the individuals involved. We strongly encourage continued and deeper interactions with the social sciences community. Continued interaction with that community will change fundamentally the nature of the questions being asked, which we feel is important for the long-term success of this initiative.

We feel it is important to put this activity in the context of other related national (e.g., other NSF activities such as NEON and Coupled Natural-Human Systems, other agencies such as NASA and NOAA) and international efforts (e.g., International Human Dimensions Program of Global Environmental Change, IHOPE Program of the International Geosphere-Biosphere Program, Millennium Ecosystem Assessment, Earth Systems Science Partnership; ILTER, and activities in other major countries (China, the European Union, Canada, Japan …), the latter in light of the NSB report 2020[1]. Doing so will give greater credibility of the effort, leverage the expertise available outside the LTER network, and better inform NSF of the value of building an initiative on the LTER experience.

Partnerships will be essential to succeed in this initiative, and LTER has formed strong partnerships in the past. In addition to the partnership with the social science community, we feel a clear role for geosciences is important and needs to be better articulated in the planning documents. To succeed in this initiative the cyberinfrastructure plans will be critical. We urge the planners of this initiative (as defined in the Initiative document) to continue to engage computer science and cyberinfrastructure (CI) experts to complement the expertise gained in the LTER network, and to engage these experts as equal partners in the further development of the Initiative. This partnership will provide the best possible insight into technology trends in CI, and will ensure the plans are compatible with trends in the broader CI community.

We were pleased to hear about the multiple foci of the initiative (science, CI, education and outreach, and governance) and actions already taken (e.g. new Bylaws for LTER Network to position the community for the network-level science). We support the effort to ensure that all programs reach a minimum level of technical readiness. This will allow LTER to have a much stronger core. We also believe that LTER must continue to experiment, in particular with its role with respect to users of the science (e.g. conservation managers, policy makers), in order to provide its students and graduate students with the foundations enabling them to choose among many career paths, and to provide leadership internationally.

[1] National Science Board (NSB 05142): 2020 Vision for the National Science Foundation, http://www.nsf.gov/pubs/2006/nsb05142/nsb05142.pdf

As the focus of effort moves from planning to implementation, we strongly recommend both pilot activities and staged implementation. This approach allows the network to see how new activities impact and stress the network before long-term or broad investments are made. Also, this allows for controlled experimentation which will be vital to the success of the initiative.

In particular, the NAB wishes to express our strong support of providing sufficient salary for the Chair of the Science Council and Executive Board to conduct his/her responsibilities.

These themes are expanded upon on the report. We also pose questions relating to the new governance structure and address a rotation plan for the NAB.

Our comments are intended to enhance the extensive work that has already been done, by providing input into the planning activities and the documents and to help clarify what still should be addressed.

2. Background

The LTER Network is slightly more than twenty-five years old. The network has been able to address key long-term studies at the site level and some at the network-level. Both the 10-year and the 20-year reviews have encouraged the LTER network to conduct more cross-site research, to take advantage of the network of sites and programs. In particular, the second comprehensive review (Krishtalka 2002) noted that, "…missing is a clear exposition of what synthesis science LTER should accomplish—what should the scientific focus, niche and priorities of the LTER program be for the next decade? …despite… accomplishments, some of the critical recommendations of the Ten-Year Review for LTER science have yet to be fully realized. The transition from individual site-based research and science projects to a broader, more integrative research platform has not been sufficient to address large-scale, interdisciplinary environmental issues" [from the Planning Proposal to NSF].

In response to this review, a planning activity was launched, with a proposal to the NSF. The Planning activity envisioned three components: Develop a plan for network-level science, technology and training; Explore alternative governance, planning and evaluation structures for managing LTER Network science; Envision and plan for education, training, outreach, and knowledge exchange activities to link LTER science with application needs. Subsequently, a fourth goal was added: Develop a plan for cyberinfrastructure (CI) to facilitate and promote advances in collaborative and synthetic science at multiple temporal and spatial scales by maximizing flows of data, synthesis of information, and generation of knowledge about ecological systems**.**

An award from NSF was made to the network (current PI is Scott Collins). The process designed to address these changes involved meetings with broad representation from the LTER network as well as non-LTER community. These meetings produced many ideas that were then distilled down into documents developed by a smaller group of individuals.

The most recent meeting of latter group took place in Madison Wisconsin on 21-23 June 2006. The next meeting will take place in August. Finally, there will be a significant amount of time to discuss this plan at the All Scientist Meeting (ASM) 19 -22 September 2006 in Estes Park Colorado.

Four documents are in various stages of completion and a fifth is planned but not in draft form. These documents include:

- Integrative Science for Society and Environment: A Strategic Research Plan (ISSE – Initiative, or simply Initiative)
- Integrative Science for Society and Environment: An LTER Network Science Initiative to Understand Long-Term Change in Integrated Social-Ecological Systems, Scientific Framework Proposal (Proposal)
- LTER Cyberinfrastructure Strategic Plan (CI Plan)
- LTER Long-Term Ecological Research Network Bylaws Version 2.0 (Bylaws)

These are available at http://intranet.lternet.edu/meetings/meeting.php?id=482. The Education and Outreach plan is missing.

The current plan calls for finalization of the "Initiative" document by the end of September. The "Proposal" is slated to be submitted to NSF in July 2007. We are pleased to note that the new Bylaws were accepted on 18 May 2006.

3. Goals and Objectives of Meeting

The role of the National Advisory Board (NAB) is to provide independent review and advice to the LTER Network, the Office, and appropriate funding agencies (Bylaws). In addition, the NAB can play a role of advocacy for the network and will act to hold the LTER network accountable to its mission.

Since much of the energy of the network has been spent on the planning process, the NAB focused on the four components of this process (network level science, CI to support network-level science, education and outreach, governance), in order to provide input to the process prior to the ASM in September 2006. In addition, the NAB was to make

- Suggestions to improve the Proposal and Initiative documents;
- Recommendations for the transition to a Science Council;
- Recommendations for alternative funding strategies for components of the Initiative;
- Recommendations for other elements of strategic plan, which do not figure in the Proposal and Initiative documents.

Below we give comments on the overall plans. In addition, in the case of the ISSE - Initiatives document, we make some specific comments on the document because of the stage of completion it is at. Comments on the Initiative document are to also help clarify some points in the document.

4. ISSE: Initiative and Proposal

Most of the discussion at the meeting was on this "Integrative Science for Society and Environment Initiative" and "Proposal to NSF", with the bulk of the time spent on the Initiatives document, given the fact that the delivery date of the Initiative document is near, and that of the proposal is much further in the future. Furthermore, much of the work for the Proposal document is yet to be done; in fact, a meeting will be held in August that includes members of almost all programs of the LTER to help shape that document.

The "Initiatives" document aims to submit a broad environmental initiative to NSF, thus supporting the research activities of both the LTER community as well as external researchers who are interested in the goals of the initiative.

Overall, we applaud the LTER Planning committee for the vision that they have presented and the energy they have demonstrated in their efforts to move this process along. The overarching question is "How do changing climate, biogeochemical cycles, and biotic structure affect ecosystem services and dynamics with feedbacks to human behavior?" We strongly endorse the concept, and encourage continued in-depth interaction with the social science community.

That said, we feel that there are several ways in which the initiative could be strengthened and the document could be improved.

Context of the Initiative with Other Activities

The issues raised in the Initiative are broad and of interest to many groups in this country and around the world. This Initiative activity should be put in a broader context, nationally and internationally, in particular with respect to engagement of the social sciences. This would allow researchers to see how this activity relates to other existing activities and requires the authors to articulate the uniqueness of the initiative (Why now? Why us?). For example, this initiative should be related to the Millennium Ecosystem Assessment, the work of the Intergovernmental Panel on Climate Change, the Earth Systems Science Partnership (ESSP), the International Geosphere – Biosphere Project (IGBP), and the International Human Dimensions Program on Global Environmental Change (IHDP). But it should also be related to the activities of other U.S. agencies and programs (NOAA, NASA, various Federal and State departments, etc); and of course to ILTER, NEON and WATERS, as well as to the international Arctic and Antarctic programs. Equally, it may be useful to relate it to some regional or national research programs abroad (European Union, China, Japan, Australia, etc.).

Doing so will give greater credibility to the effort, leverage the expertise available outside the LTER network, and better inform NSF of the value of building an initiative on the LTER experience. Moreover, it would be an occasion to underline the fact that the early start of LTER has resulted in the fact that many other national and international programs see LTER as an example.

With respect to NEON, in our last report (September 2005) we wrote:

> The LTER community is well poised to take advantage of the potential complementarities between LTER and NEON. Furthermore the LTER network is positioned not only to take advantage of the NEON infrastructure, but also to help shape some of NEON's research agenda. We support such positioning, but we believe that the research program being developed in the planning grant is of great value on its own.

This year we heard that this effort is moving along a path that can take advantage of NEON should that infrastructure project be funded, but is a valid activity on its own. It was pointed out that there is some risk that LTER's effort at $30M/year could undermine the NEON activity because of the possibly subtle difference (research (LTER) versus infrastructure (NEON)) to some decision makers. LTER would not want to undercut the larger activity. It is thus very important to clearly outline the differences and the complementarities as well as how they leverage each other; it needs to be clear that the two initiatives will not duplicate efforts.

Partnerships

Social Sciences: In order to achieve the goals of this initiative, true interdisciplinary partnerships will need to be formed. We are very supportive of the active engagement of the social science community in this initiative. However, the document seems to be written as if the ecological questions were defined first, and then social scientists were asked to add a social science perspective. [In fact this was confirmed at our meeting.] Indeed, the central question, "How do changing climate, biogeochemical cycles, and biotic structure affect ecosystem services and dynamics with feedbacks to human behavior?" leaves the social dimensions to last, and could be rewritten in reverse order [we suggest serious consideration be given to reversing the order of the central question]. We understand that a meeting of the social scientists already engaged with LTER research was convened in Georgia in 2005 as part of the planning process, but encourage the team to cast the net wider, and to engage with social scientists whose thinking is not already strongly coupled with LTER. Both the LTER and NEON networks were designed to sample environmental spaces and to answer environmental questions. Thus it will clearly be difficult for social scientists to see how either network could help them to answer the kinds of questions they consider important, and it is essential therefore that the social scientists be engaged to help define some of the research issues LTER and NEON plan to address. Over the course of the initiative the discussion needs to move to mutual research and collaboration. First of all, this will require that LTER formulates its questions in a language that is familiar to Social Scientists, and in ways that enable the latter to see the interest of the questions, but also how social scientists can help answer them. As the collaboration broadens and deepens, the nature of the questions will change and that should be seen as a positive outcome of the activity and a natural expansion of the LTER community. We note that other social scientists have had a chance to review this document. We recommend engaging a few other members of the NAB committee to

comment in some depth on the document and engagement with the Social Science community.

Geosciences: While a great deal of space was devoted to the role of social sciences, the role of the geosciences, mentioned as one of the three key players, should be clarified and expanded upon. It would be interesting, for example, to see how, in other programs, the geosciences have made their important contribution to the overall picture, and to profit, if necessary and possible, from the lessons learned in that process.

Cyberinfrastructure and Information Technology: For this initiative (as described in the "Initiatives" document) to be successful, it must involve continued and expanded expertise in information technology (IT). While the LTER network has a great wealth of expertise on some aspects of IT in particular in information management, the IT field is broad and the initiative needs input from several sectors. One required expertise is that of an architect for the cyberinfrastructure, basing the design on technology trends as well as current capabilities. This activity would be conducted in conjunction with the scientists who are articulating the needs. This requires knowledge of the hardware systems, the middleware, and demands to be made on the system and networks. To utilize this expertise fully requires that IT researchers need to be engaged as equal partners in this initiative, and not as afterthought, servants (which makes it difficult to get strategic input), or consultants, as is currently the case. We note that current text calls for interacting with "information systems"; we believe it should be with the IT people. While we are not suggesting IT people lead the network-level science efforts, they can provide input on the trends in IT to allow this effort to build to where the technology is going and not be wedded to today's technology. There are some comments relevant to this point.

1. One of the strategic priorities in the NSB report 2020 calls for critical investments in infrastructure, specifically calling out cyberinfrastructure (CI). However, CI is still hard to use on a routine basis, and will require partnerships to take full advantage of this infrastructure.
2. Furthermore, there is an opportunity to engage the Office of Cyberinfrastructure, which is now led by Dan Atkins, lead author of the Atkins report on Cyberinfrastructure[2], who has had a long history of interaction with the social science community.[3]

As the initiative is put in place, other communities will need to be included in order to bring the initiative to fruition, for example engineers for building sensors and mathematicians for improving models. By the time it is all in place, new applications in Nanotechnology may also come to play a role in this.

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[2] Atkins, D.E., K.K Droegemeier, S.I. Feldman, H. Garcia-Molina, M.L. Klein, D.G. Messerschmitt, P. Messina, J.P. Ostriker, M.H. Wright. 2003. Revolutionizing Science and Engineering Through Cyberinfrastructure: Report of the National Science Foundation Blue-Ribbon Advisory Panel on Cyberinfrastructure (National Science Foundation, Arlington, VA, January 2003); http://www.communitytechnology.org/nsf_ci_report/, and http://www.nsf.gov/od/oci/reports/toc.jsp

[3] We note that a strategic level meeting was held in Munich in July2006, between the NSF and the European Research Directorate. It was intended to recognize the urgent need for major social science cyberinfrastructure, and the advantages of collaboration between the two continents.

International Leadership
The issues faced in this initiative are not unique to the United States, rather they are universal. As such, this initiative needs to be informed by activities elsewhere in the world, to enlist the global talent to address these issues, and to leverage and help create similar activities to gain a better understanding of similar systems. We note that once again the NSB 2020 report is very clear about the global frontiers of science. This is an opportunity for the LTER community to show its international leadership.

Enhancement to the Presentation of the Initiatives Document
We recommend the writers of the document consider some of the following specific points that will improve the impact of the document.

- Include some background section to the document that explains the origins of the document and puts the initiative in a context.
- Use concrete examples that illustrate the use of data, give graphs, show the value of network-level science and that of the initiative.
- Have an editor move the text from a "committee" style report to a single authored document, allowing more enthusiasm to be reflected in the presentation.
- In the introduction, make a strong argument for the relevance to our societies of the work being done in the LTER and similar programs elsewhere. See, for example, the introduction to the IHDP's "Global Land Program" (2005).

5. Cyberinfrastructure

We were impressed by the thoughtfulness and extent of the Cyberinfrastructure (CI) Plan and the level of outreach that this group has done to consult with other community experts. However, we have several comments that we hope will be used to improve the plan and the document. We would be happy to discuss these ideas further with the Cyberinfrastructure group.

Pilot Projects
We strongly recommend looking at the implementation issues, and beginning with pilot projects and test cases over a 2 to 3 year horizon. For example, appropriately designed test cases can ensure that components work together across all the sites, namely you don't have wait for an application to make it happen. A test case can be narrowly defined to just test specific resources or capabilities. Perhaps also include some stretch goals and objectives to help reviewers understand what can be done and when (as well as give LTER members a better handle on how CI functions).

Priorities
The cost of the CI plan (based on the budget on the website) is very large. What are the relative priorities of each of these investments? What is the true payoff for each investment? Who needs to be involved in the implementation of any of these activities? Are those groups ready? How will these investments achieve the goal of network science and education? We recommend that the team do an assessment of each of these

investment areas, from a user's perspective, and try to quantify the output, the outcomes, and the impact of the CI investments. We note that conducting some pilot projects will help in this very important exercise. Furthermore, the exercise of setting priorities will focus the LTER needs and clarify the initial steps leading to implementation.

Users Perspective

Ultimately, the success of the CI investment will be measured by the extent to which researchers use the system to conduct research or education, ideally in ways not currently feasible now. Thus, user input and perspective is important in developing the infrastructure. The importance of this perspective will be critical in its implementation. Again, working on a few pilot projects would ensure that some targeted users can use the system. In the end, the payoff from a CI investment to the users depends on the details of how data handling, access, etc improve use for the target group of users.

Data

What data sets will be needed? Which will be made available? Will these be significantly different from what is now available? Success of the entire network-level science and education effort will be the broad availability of new or enhanced data set. Which sets will depend on the questions – and should be addressed early in the process.

Rationale for Embedding CI in LTER

A better case needs to be made on how CI will be integrated and will be embedded in LTER and will fundamentally change the protocol and processes of how LTER does science. At this point, CI seems to be portrayed as just another tool or capability.

- *Workflow:* One area to consider is that of workflow, as that will greatly simplify and encourage scientists to use the CI infrastructure.
- *Incentives:* The report should address incentives and motivation if CI is going to succeed.

Collaborative Tools

The value of cyberinfrastructure is in enabling collaboration. The CI Working Groups should add and incorporate collaboration to their description and understanding of CI. The current primary focus is on traditional infrastructure components (hardware, software, data), which flows out of their informatics experience. Collaboration in turn means collaborative tools, collaboration support including development and support of Virtual Organizations.

Visualization

Another component to consider adding is visualization; the CI is too IT centric, and in view of the larger LTER scope and mission, visualization may be one of the most important capabilities if CI as it is incredibly useful for science as well as educating the public.

Other CI Projects

The group might want to talk to some existing CI projects which have experience in dealing with a centralized or distributed approach to CI. There are advantages and

disadvantages to both and the discussions would help position an appropriate role for the Network Office. There is a balance and too much centralization is often detrimental to buy-in and use by sites. The CI group may want to look at BIRN, NEES and PRAGMA for ideas and insight.

6. Education and Outreach

While we heard a brief overview of the thinking to date by one of the leads of the Planning Committee of Education and Outreach, we did not have a document to review. This situation is in contrast to the other areas that had such documents. We regret not seeing this groups thoughts articulated.

We strongly recommend that the PI of the Planning Activity, the Executive Director, and the interim Chair of the Science Council inform the members of the Education and Outreach Committee that it is extremely important that their ideas are captured in a written document. The reactions below are few, and based on the text in the ISSE document.

We hope that the final Education and Outreach plan will have a more appropriate balance of activities at all levels of Education (the current draft is very loaded towards k-12 education – important but far from the full extent of the activities).

Second, we hope to see more on Outreach, which we feel is important, as we urgently need to build bridges to policy makers and to establish the LTER as the "go-to science people" for applications of ecological theory (e.g. conservation management), among local community groups and industry. With respect to industry, we insist that for our world to develop sustainable initiatives, industry will need to be involved (comment by Ed Friedman, author of the NAS study Our Common Journey: A transition towards Sustainability). We note in particular that little is done to prepare students for these interfaces. As part of a broader training policy, we should include them so that students understand that there are many career paths to support network-level activities.

Third, these days any education plan is incomplete today without the inclusion of substantive opportunities for an international experience. As is stated in the Lincoln report "*What nations don't know can hurt them." The stakes involved in study abroad are that simple, that straightforward, and that important. For their own future and that of the nation, college graduates today must be internationally competent* [Lincoln Report 2005]. We note that the NSB 2020 report also emphasizes the need for sustaining a world-class S&E workforce and for fostering the scientific literacy of all our citizens.

7. Governance

We strongly support that sufficient salary be provided for the Chair of the Science Council. This will help attract strong candidates and buy for the Chair the time needed for

providing strategic and scientific guidance to the network. The NAB was unanimous in its support of this position, given that the LTER consists of 1200 scientists. We could not think of a comparable example of an organization of that size and scope that did not compensate its leader.

There has also been discussion of having the Chair of the LTER Science Council obtain some of his/her funding from a cross-site proposal. While this is an interesting approach to fund the Chair, we feel that this approach to funding will be detrimental to the position:

- First, the NAB feels that the Chair's position should be focused on the LTER program overall. If the Chair is raising part of this LTER Chair salary, his/her ability to provide unbiased leadership will be seen to decline.
- Second, we feel there is a potential conflict between what is best for the cross-site project versus what is best for the network. Network science will better inform the community of what is possible.

We recommend that LTER Executive Board to develop resources to make it possible for an individual to serve as chair and focus fully on those responsibilities.

We recommend that the LTER Executive Board consider carefully the roles of the Science Committee as the generators of science ideas, possible leaders of proposals, and internal overseers of progress. We are concerned about possible conflicts between these activities. The LTER Executive Board may consider posing this question to members of the Governance Committee or the LTER NAB.

Looking at other organizations for the balance between leading and oversight could be beneficial (e.g. CUAHSI).

8. Communication and Socialization of the Plan

Communication with LTER scientists should be initiated in the earliest stages of any initiative, and should be frequent, both via representative as well as by means of a direct note from the Planning Group. This will be very important to bring the community into this new era.

9. Other Business

Report of Progress since the Last Meeting

Progress on the recommendations from the last meeting was reviewed.

- Governance: New Bylaws were adopted, reflecting input from the NAB
- CI: We did not have an interim meeting on CI. However, this meeting provided us with the status.

Next Meeting

- Date: Thursday March 8 2007 and possibly Friday morning March 9 2007
- Location: Washington DC
- Circumstances/Rational for that time:
    - This meeting would coincide with other outreach activities of LTER, including a Mini-symposium about the overall network-level plans for the LTER, that would have talks by individuals who could address the various issues in the proposal and initiative activities.
    - In addition, the Executive Board would be present
    - Finally, we hope to be able to have NSF staff, including new ADs for Bio (Jim Collins) and Social, Behavioral and Economic Sciences (David Lightfoot).

NAB and NAB Rotation

We re-endorsed the move to continue towards more diversity on the NAB. We reviewed the names of several individuals.

With the new By-Laws of the LTER, and the attempt to formalize the structure of rotation of the Chair of the Science Committee / Executive Board, we felt it important to institute a clearer form of rotation. The next meeting will be the last meeting of several individuals (about one third). We will plan to rotate (or put up for continuation) a third of the members at each annual meeting. A proposed schedule will be circulated separately.

NAB and the LTER Community: Making ourselves known

The issue of communication is important for any large and distributed organization. The NAB members felt that in addition to interacting with the Chair, Executive Director of the Network Office, the PI of the Planning process, and other key members of the planning process and LTER Network office, interaction with the broader LTER community would improve our understanding of and appreciation for the LTER network.

Several options were discussed: Attending the ASM (at least two members will be present – and were invited to participate actively in the meeting and the planning components); Having other members of the Science Council or Executive Board attend the meeting (for example next year); Announcing our interest to interact with the broader community via the LTER Newsletter or other means.

We (the NAB members present) agreed that using the newsletter for this purpose is something that we should pursue. The content of the article is to introduce the members of the NAB (perhaps by pointing to the web site (http://intranet.lternet.edu/NAB/), indicate that we are formalizing the structure of the NAB, we are delighted to serve in these every exciting times; and that we would look forward to hearing from them directly.

10. Present

NAB
Peter Arzberger, UCSD, Chair
Roger Bales, UC Merced
Alan Blatecky, Renaissance Institute
Robert Dickenson, Georgia Tech
Michael Goodchild, UCSB
James Levitt, Kennedy School of Management
Sander van der Leeuw, Arizona State University

LTER
John Magnuson, UWI, Interim Chair, Science Council and Executive Board, LTER
Robert Waide, UNM, Executive Director, LTER Network Office
Scott Collins, UNM, PI, Planning Grant Activities
Barbara Benson, U Wisconsin, Lead CI Planning
Ali Whitmore, UCSB, Lead, Education and Outreach Planning
James Brunt, UNM
John Vande Castle, UNM

More about the NAB is at http://intranet.lternet.edu/NAB/
Many of the materials that were circulated at the NAB or were presented at the NAB are at http://intranet.lternet.edu/meetings/meeting.php?id=482