Appendix 1: Survey Findings

March 26, 2014

Task Force on Envisioning the Next-Generation LTER Network Office

Diane McKnight, Chair
Aaron Ellison
Christine Goodale
Margaret Palmer
Lindsey Rustad
Ann Zimmerman

http://lnovision.colorado.edu/

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Executive Summary

This report presents findings from a survey conducted to collect information to inform the structure and functions of a future Long-term Ecological Research (LTER) Network Office. The survey was administered by the Task Force for Envisioning the Next Generation LTER Network Office through support from the National Science Foundation. The survey addressed one of the Task Force's main objectives – to solicit input from a broad range of current and potential constituents of the LTER program, including educators and professionals involved in natural resource management.

The twelve-question survey was administered using SurveyMonkey® and was accessible through the Task Force web site in late 2013 through early 2014. The survey sought information on individuals' familiarity with the LTER Network and the LTER Network Office (LNO); use of LTER products and participation in LTER activities; and ideas about what makes for a successful network office.

A total of 268 usable responses were received. The majority of respondents were employed by a college or university. The most frequent occupations included researcher, faculty member, and graduate student. Almost two-thirds of all respondents were affiliated with an LTER site.

With respect to the level of knowledge of both the LTER Network and the LNO, people who were affiliated with an LTER site were more likely to indicate that they knew a tremendous amount or quite a bit about the LTER Network. Whereas, individuals who were not affiliated with an LTER site were more likely to state they knew a moderate amount or a little about the LTER Network. Responses from both groups showed that people know less about the LNO – slightly more than half of respondents indicated they knew little or nothing at all about the LNO.

Data and publications were the products most commonly used by all respondents. People affiliated with LTER were almost twice as likely to indicate they had used LTER data.

The survey included four open-ended questions. People were asked to describe the LTER Network and its value now and in the future and for their opinions about successful networks and the role of a network office.

The LTER was primarily described as *a collection of sites focused on gaining ecological understanding over the long-term*. Other important features included LTER's informal organizational structure, the diversity of people who are part of the Network, and the importance of different kinds of connections across the Network, particularly common measurements and protocols and collaborations between people. In general, one of the weaknesses noted by both groups was that the Network has yet to fully capitalize on the potential for linkages among sites.

When describing the value of the LTER Network, many of the same themes emerged. In other words, the aspects that form the essence of the LTER Network are also what make it valuable (i.e. long-term focus, data, linkages across sites, people, and stable funding).

For the last two open-ended questions some respondents took a broader perspective addressing networks in general while others focused on the LTER Network.

Both LTER and non-LTER affiliates identified communication and collaboration as two of the most important aspects of a successful network. Another topic mentioned frequently was linkages of one form or another, whether between people, across sites, or between data and ideas. Respondents associated with LTER sites emphasized the value of face-to-face interactions, particularly in the form of meetings, as a way to encourage and strengthen linkages and to support the exchange of ideas. Access to data that are comparable across sites was also viewed as important by both groups as was the infrastructure to support data collection, storage and discovery. People were viewed as important to a successful network, particularly by individuals associated with the LTER. Balance between consensus and diversity of views and between individual projects and network-wide activities, along with support for the network were also seen as critical. Finally, people in both groups wrote about the importance of openness in a network.

The responses to the survey's first three open-ended questions provide a basis for understanding people's ideas concerning the role of a national network office. Responses ranged from broad statements about what a network office should do to lists of very specific activities (e.g., organize meetings, advertise network products and accomplishments). Most responses fell into the former category and began with words such as *coordinate, promote, facilitate, foster, and support*. For individuals affiliated with the LTER Network, the highest priority functions for a network office were 1) collaboration, communication, and coordination across sites and the support of network activities; 2) data and information management; 3) external communication and outreach; and 4) meeting support. The three highest priorities for those who are not affiliated with the Network were 1) data, especially standardization and accessibility; 2) communication and outreach; 3) and coordination across sites.

1. Introduction

This report presents findings from 268 responses to a web-based survey conducted by the Task Force for Envisioning the Next Generation Office of the Long-term Ecological Research Network. The twelve-question survey sought information on individuals' familiarity with the LTER Network and the LTER Network Office (LNO); use of LTER products and participation in LTER activities; and ideas and opinions about what makes for a successful network and coordinating office (both in general and specific to LTER). Demographic information was also collected. A copy of the survey is available in Appendix A.

Information about the survey was advertised on relevant listservs (e.g., all-lter and ecolog-l) and publicized at the American Geophysical Union (AGU) Town Hall meeting. Scott Collins, Chair of the LTER Science Council, also mentioned the Task Force web site and survey in his column in the fall issue of the LTER online newsletter, and he encouraged people to complete the survey.[1]

The survey was administered using SurveyMonkey®, a web-based survey software tool, and was accessible through the Task Force web site.[2] The survey received 274 responses. Six responses were eliminated, leaving 268 responses for analysis.[3] It is not possible to calculate a response rate since the survey was open to anyone and not drawn from a sample population. Nearly all responses to the survey were received between October 2, 2013 and January 31, 2014.[4]

Data were exported to Microsoft Excel® from SurveyMonkey®. The data were analyzed using Microsoft Excel® and analytical functions available through SurveyMonkey®. Descriptive analyses, primarily in the form of frequencies, were completed for multiple choice questions. Open-ended responses were coded using Dedoose, web-based software for analysis of quantitative and qualitative social science data.

2. Pilot Survey

A pilot, paper-based survey was handed out at the Town Hall Meeting hosted by the Task Force at the Ecological Society of America (ESA) meeting in August, 2013. A copy of the ten-question pilot survey, which received 22 responses, is available in Appendix B.

Minor revisions were made to the pilot questionnaire after the ESA meeting. In the end, half of the items on the pilot survey, including the four open-ended questions, appeared on the final version of the survey that was available through the Task Force web site.

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[1] Collins, Scott. (2013). View from the Chair. *Network News*. 26(3). Retrieved March 25, 2014, from http://news.lternet.edu/Article2891.html.

[2] http://lnovision.colorado.edu/

[3] These were eliminated because responses to question 1 indicated that the respondents knew nothing at all about the LTER Network, and they did not complete the remainder of the survey.

[4] Two responses to the survey were received in mid-March and have been included in the analysis.

Although it was a pilot, the questionnaire handed out at ESA provided valuable input. Below, we present findings from the five multiple choice questions that appeared on the pilot survey. Findings from the open-ended questions were included with results from the final survey and are reported on in Section 3.4 of this report.[5]

2.1. Findings

The first question on the survey asked: *Prior to this session were you aware of an LTER site, the LTER network, or the LTER network office?*[6] More than three-fourths of respondents answered "yes," (n=17; 77%).[7] The remaining 23% indicated that they were not aware of these entities.

Half of all survey respondents were students. Further, most respondents were not affiliated with an LTER site (n=15; 68%). Whereas, the remaining one-third (n=7; 32%) were affiliated with an LTER site. These results may help to explain why half of the people said they had not participated in an LTER site or Network activity. In addition, half of the respondents stated that they had not used LTER data or other products. There was overlap in those who had not participated in Network activities or used LTER products.

Almost all of the individuals who responded to the survey were affiliated with a college or university (n=19; 86%). Of the remaining three respondents, two were employed by a federal agency or non-profit institute, and one worked as a private practitioner scientist.[8]

In summary, the findings from the multiple choice questions on the pilot survey show that almost all respondents were affiliated with a college or university; half were students; and most were not affiliated with an LTER site. A majority of people indicated that they were aware of an LTER site, the LTER Network, or the LTER Network Office. Finally, half of the respondents had not participated in an LTER site or network activity, and half also stated that they had not used LTER data or other products. Results suggest that those who attended the ESA Town Hall and completed the survey were interested in learning more about the LTER Network and how they could become involved.

3. Results from the Task Force Survey

This section reports findings from the web-based survey that was available through the Task Force web site. It begins with a description of the general attributes of the survey respondents. This is followed by results pertaining to the major sections of the survey.

[5] The open-ended questions on the pilot and the final survey were the same.

[6] In the final version of the survey, this question was broken into two questions. One asked people about their level of familiarity with the LTER Network and the other asked about the LTER Network Office.

[7] Throughout this report, percentages have been rounded to whole numbers.

[8] This question was improved in the final version of the survey by offering a more comprehensive list of institution types.

3.1. General Attributes of Respondents

We collected data about the characteristics of individuals in order to get a picture of the types of people who completed the survey and to better understand some of the factors that may have influenced their responses.

Almost two-thirds of survey respondents (n=170; 64%) were affiliated with an LTER site (see Figure 1). Figure 2 shows the category that best reflects the role of the 170 people who indicated they were currently affiliated with the LTER Network.

Q3: Are you currently affiliated with an LTER site?

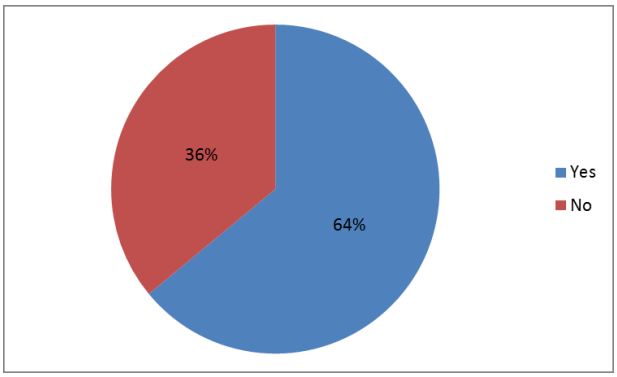

Figure 1: Percent of respondents affiliated with LTER site

Q4: Please select the category that best reflects your role in the LTER Network

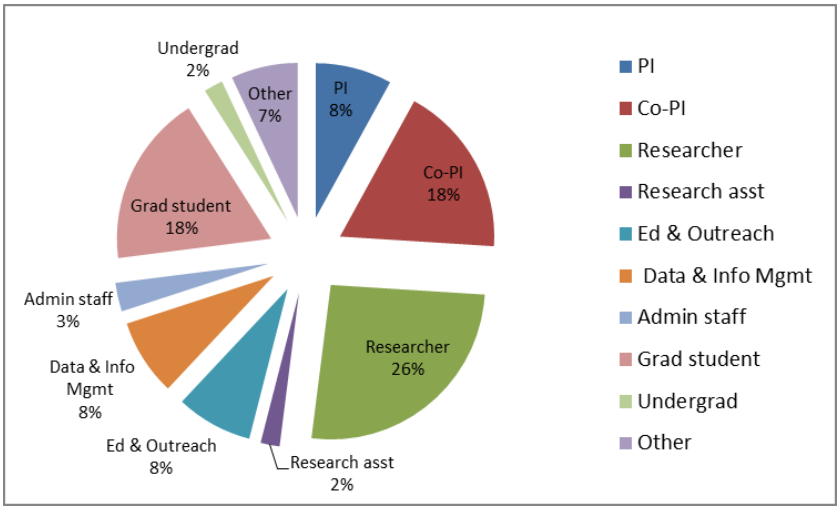

Figure 2: Role in the LTER Network

Presuming that most PIs, Co-PIs, and graduate students can be categorized generally as conducting research, the majority of respondents represent a research perspective. More specifically, 72% of respondents identified themselves as a PI, Co-PI, researcher, research assistant, or graduate student.

Question 11 asked individuals about their occupation. An analysis of all respondents (i.e. both LTER and non-LTER affiliates) shows that among those who responded (n=207),[9] the most common occupations were researcher (30%), faculty member (28%), and graduate student (14%). Together, these three categories accounted for 72% of the responses. Figure 3 shows the frequencies for these and the other most common categories. Twenty-two people (10%) identified themselves as having other occupations. This included a variety of situations (e.g., retired) and titles (e.g., historian, postdoc). Of the 22 responses in the "other" category, seven identified themselves as information managers. The other category shown in figure 3 also includes response frequencies for K-12 teachers (n=1) and undergraduate students (n=4). No respondents identified themselves as clerical staff.

Q11: Please select the response that best reflects your current occupation

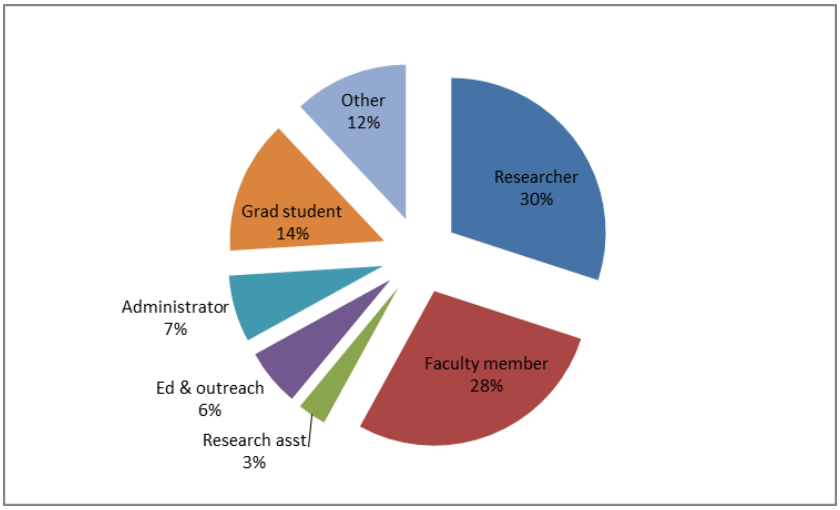

Figure 3: Occupations of both LTER & non-LTER respondents

Question 12 sought information about the type of institution that individuals were associated with. Findings show that both LTER and non-LTER respondents were overwhelming affiliated with a college or university (n=170; 82%). The next largest categories in terms of institution type were federal agency and nonprofit organization, with each accounting for 6% (n=14) of the responses. Only one person noted being affiliated with an elementary or secondary school.

[9] Questions 11 and 12 on the survey appeared after the four open-ended questions. We speculate that *survey fatigue* – a phrase that refers to the fact that respondent attention and motivation drop off toward later sections of a questionnaire – led to a lower rate of response compared to earlier multiple choice questions. Specifically, items 11 and 12 were completed by about two-thirds of the 268 respondents.

3.2. Knowledge of the LTER Network and the LNO

The first two items on the survey sought information about individuals' knowledge of the LTER Network and the LTER Network Office. Figure 4 shows responses to Q1 based on whether a person was affiliated with an LTER site or not.[10] As might be expected, those affiliated with an LTER site were more likely to indicate that they knew a tremendous amount (n=31; 18%) or quite a bit (n=83; 49%) about the LTER Network. Whereas, those who were not affiliated with an LTER site where more likely to state they knew a moderate amount (n=47; 48%) or a little (n=19; 20%) about the LTER Network. None of the respondents stated that they knew nothing at all about the Network.[11]

Q1: How much do you know about the LTER Network?

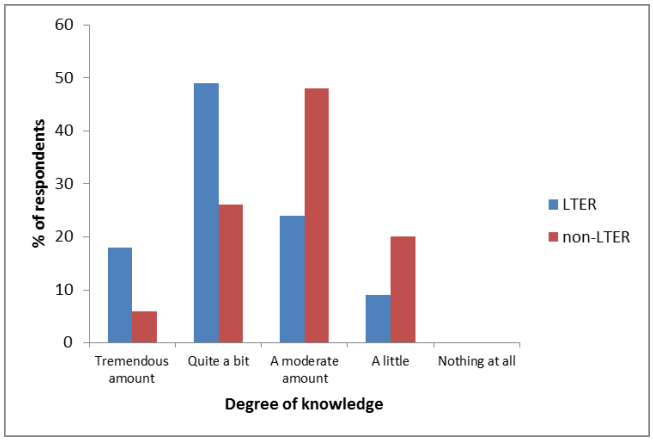

Figure 4: Degree of knowledge about the LTER Network

In regard to their knowledge of the LNO, slightly more than half of the 267 individuals[12] who answered this question indicated that they knew a little (n=72; 27%) or nothing at all (n=71; 27%) about this office. In addition, almost another quarter of respondents (n=61; 23%) stated that they knew a moderate amount about the LNO.

Figure 5 shows responses to Q2 broken down by those who were affiliated with an LTER site and those who were not. As might be expected, respondents who were not affiliated with an LTER site were more likely to indicate that they knew nothing at all about the LNO (n=47; 48%), compared to those who were affiliated with an LTER site (n=29; 14%). Both LTER and non-LTER affiliates were similarly likely to say that they knew a little about the LNO with 26% (n=45) of the former and 28% (n=27) of the latter selecting this answer. Finally, just under one-third of individuals affiliated with an LTER site stated that they knew a tremendous amount (n=15; 9%) or quite a bit (n=34; 20%) about the LNO.

[10] All individuals answered this question. LTER affiliates made up 64% (170) of the 268 respondents. Non-LTER affiliates comprised 36% (n=98) of the total respondents.

[11] As noted earlier in this report, we eliminated survey responses wherein people only responded to question 1.

[12] One person did not answer this question.

Q2: How much do you know about the LTER Network Office?

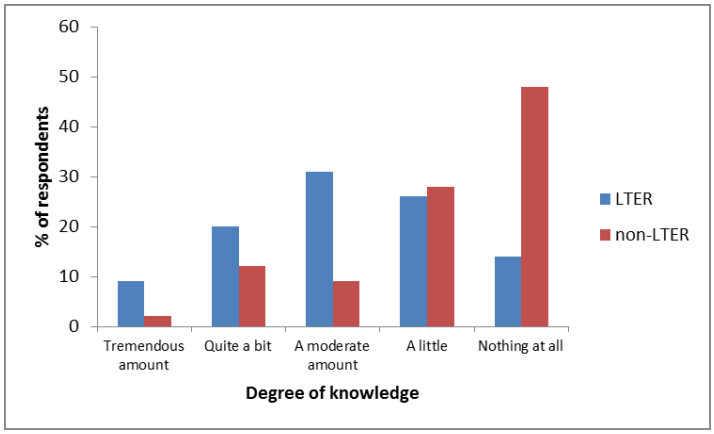

Figure 5: Degree of knowledge about the LTER Network Office

Among LTER affiliates, 64% of graduate students, who represented 18% of the LTER affiliated respondents, indicated that they knew a little or nothing at all about the LNO. Three-quarters of PIs said they knew a tremendous amount or quite a bit about the LNO. This finding makes sense as PIs are likely to have more contact and interaction with the LNO. However, two PIs (17%) indicated that they knew only a little about the LNO. Co-PIs were not quite as knowledgeable about the LNO as PIs: 10% (n=3) said they knew a tremendous amount and 26% (n=8) knew quite a bit. No PIs or CO-PIs stated that they knew nothing at all about the LNO.

3.3. Participation in LTER and Use of LTER Products

Items five and six on the survey attempted to better understand people's use of LTER products (e.g., data, information) or participation in LTER-sponsored activities (e.g., workshops, teacher experiences).

Most people (n=262) answered the question that asked them to select the LTER products they had used. Figure 6 compares responses from LTER and non-LTER affiliates.[13] Data and publications were the products most commonly used by all respondents, although people affiliated with an LTER site were almost twice as likely to have used LTER data (i.e. 78% versus 42%). In addition, twenty percent (n=34) of LTER respondents indicated they had used one or more books in the LTER Schoolyard Book series compared to four percent (n=4) of people not affiliated with an LTER site. Finally, about one-fourth of non-LTER respondents (n=24; 26%) noted that they had not used any LTER products. Although it is not possible to know for sure, this could be a sign that it can be difficult to know when one is using a resource that was produced by LTER.

[13] Percentages equal more than 100% because individuals were asked to select all responses that apply. The same is true for question 6.

Q5: Please indicate which of the following LTER products you have used.

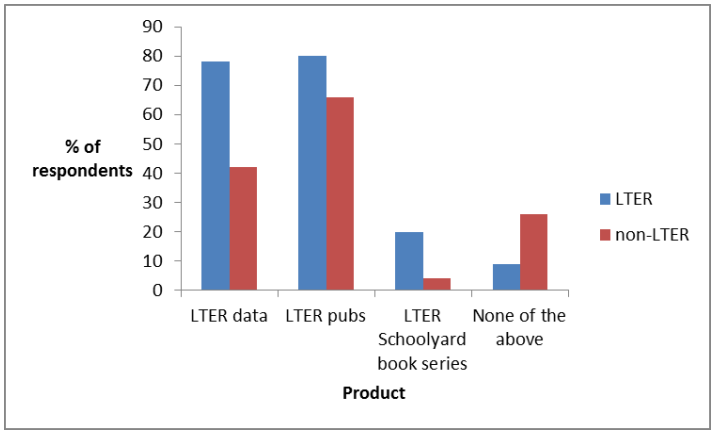

Figure 6: LTER products used

People were also given the option to note other products they had used and 22 individuals did so. Two of resources mentioned by more than one person included the LTER web site and the LTER personnel directory.

The sixth item on the survey asked respondents to select the LTER Network activities they had participated in. Again, nearly all respondents (n=260) completed this question. Figure 7 shows responses categorized by whether or not an individual is affiliated with an LTER site.

Q6: Which of the following LTER Network activities have you participated in?

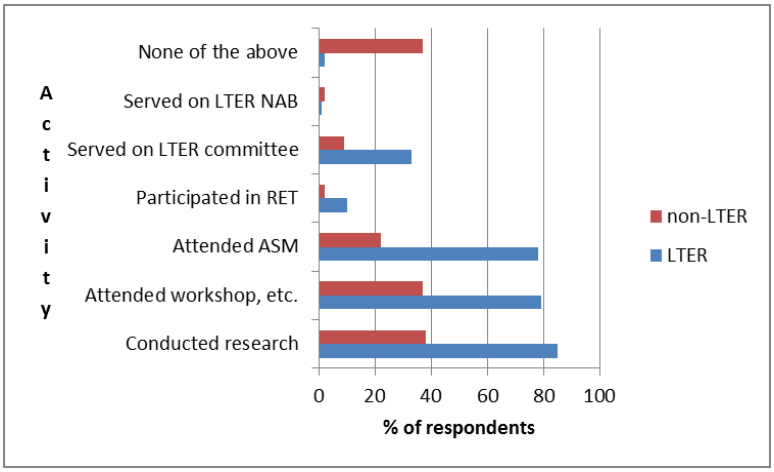

Figure 7: Participation in LTER activities

While more than a third (n=34; 37%) of non-LTER respondents indicated that they had not participated in any of the listed activities, there were many who had, including 22% (n=20), who noted that they had participated in one or more ASMs.

3.4. Open-Ended Questions

Four of the twelve items on the survey were open-ended questions (i.e. Q7-10). Two of the advantages of open-ended questions are that they allow people to answer in their own words, and they provide richer and more in-depth data. Both of these were important in the context of the Task Force's goals.

Open-ended questions also require more time for people to answer, and this can contribute to incomplete survey responses. As expected, response rates dropped off starting with Q7 in comparison to the first six questions on the survey. In spite of this, responses to these questions remained strong, including among non-LTER respondents. Figure 7 shows the percentage of LTER and non-LTER affiliates who completed each of the open-ended questions. An average of 66% of the total number of respondents affiliated with an LTER site answered the open-ended questions, and an average of 58% of non-LTER affiliated people did so. Further, many responses were comprised of multiple sentences. While we cannot be certain, we attribute the strong response to the interest that all types of people have in the LTER Network. A clear finding from the survey is that the Network is widely viewed as unique and valuable.

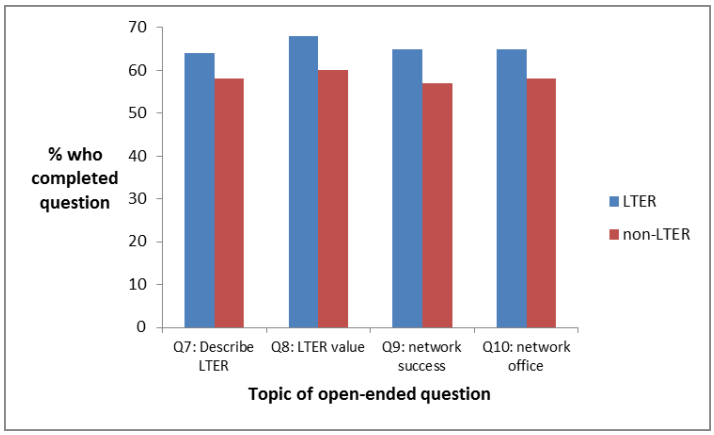

Figure 8: Response rates for open-ended questions

Open-ended responses from the pilot survey have also been included in the findings presented below. A majority of the 22 individuals who completed the pilot survey provided response rates to the open-ended questions. Specifically, 90% of respondents (n=20) answered the items that asked them to describe the LTER Network and the value of the LTER Network; 77% (n=17) provided answers to the question of what makes for a successful network; and 82% (n=18) completed the question about the role of a national network office.

Responses to each of the open-ended questions were analyzed in order to identify major themes that emerged. Each response was then coded and analyzed using Dedoose software. Dedoose is a web-based program for analyzing qualitative and quantitative social science data.[14] Many responses were categorized according to multiple codes,

[14] http://dedoose.webvanta.com/

where each code represents a concept or idea (i.e. theme) expressed in answers to the open-ended questions. The assignment of more than one code to many of the answers was necessary because these responses contained multiple ideas. For example, below is an answer to Q9 (i.e. What makes for a successful network?) that illustrates the richness of some of the responses.

> Successful networks can take many forms - corporate and military networks can be very successful although obviously very different than the LTER Network. I believe the particular strength of the LTER Network is that it emerges and federates the constellation of research interests, activities, collaborations, partnerships, etc. at sites across the network. That necessitates a) very good internal and external communication; b) mechanisms and procedures for coordinating and agreeing on commonalities; c) constitutional processes for ensuring the Network is representative of the membership; and d) expertise and means to project the identity and objectives of the Network beyond the confines of the membership.

This respondent, an LTER PI who knew a tremendous amount about both the LTER Network and the LNO, described several roles for a national network office. Each of these roles – some of which were also mentioned by other respondents – was assigned a unique code.

Responses from LTER and non-LTER affiliates were analyzed separately in order to understand similarities and differences among these two groups. While responses from non-LTER affiliates appeared somewhat shorter in length overall, the general trend was toward one or more sentence answers to questions. Only a few people (n=<5) expressed frustration with the open-ended and broad nature of the questions or felt unable to answer them.

Description of the LTER Network

The first open-ended question on the survey (i.e. Q7) asked respondents how they would describe the LTER Network. Both groups of people (i.e. LTER and non-LTER) were overwhelmingly alike in describing the LTER Network as a **collection of sites** focused on gaining **ecological understanding** over the **long-term**. Some people in both groups also noted that the LTER is supported by NSF. The survey response below captures the multiple facets of the Network that people highlighted.

> The LTER Network is a set of sites and associated investigators dedicated to long-term research and experimentation about ecosystems and ecological phenomena, with core support from the National Science Foundation.

The data that are produced through the efforts of the LTER Network were also included in many descriptions provided by both LTER and non-LTER respondents. While many of the respondents, including the person quoted above, described both the long-term nature and eco- focus of LTER, a number mentioned only the latter. For example, as one individual said, LTER is "a set of sites around the country conducting ecological research to understand dynamics in different biomes/ecosystems." Other facets of the LTER

Network that individuals noted included its "place-based" nature, its diversity in terms of types of studies, and its coverage in terms of being national or international, although the latter was mentioned by only a few people. The response below by a Co-PI at an LTER site illustrates these aspects of the Network.

> A network of sites representing a variety of habitats/ecosystems across the US and abroad (ILTER)

.

A somewhat interesting finding is the number of people who mentioned the organizational nature of the LTER Network in their descriptions. While this aspect came up more frequently in the responses of individuals affiliated with an LTER site, it was also mentioned by some who were not part of an LTER site. Most commonly, people used the words "loose" and "informal" to describe the organizational structure. The vast majority saw this approach as appropriate and beneficial, even though some noted – such as the LTER data manager quoted below – the challenges of operating this way.

> I'd describe LTER as a network-of-networks, rather than a single network. Each site has individual partnerships that both add to and complicate the ways in which it interacts with LTER.

Individuals, particularly those affiliated with LTER, also described the Network as "people" in addition to or instead of being comprised of sites. Some of these descriptions noted the diversity of people in the LTER Network. In general, these responses highlighted the variety of disciplines and types of people and roles played by people in the Network. The response below from an LTER education and outreach professional summarizes the kind of statements made in regard to diversity of people.

> An interdisciplinary group of scientists, educators, social scientists, and artists collaborating through long term ecological research and communicating their findings to the broader community

A theme that came up in answers from both LTER and non-LTER respondents concerned connections across sites in the Network. There were two main ways of describing the general notion of integration or linkages. Some people stressed the collection of common measurements across sites which helped to facilitate synthesis or comparisons while others highlighted collaboration between people at different sites. Both groups of respondents (i.e. LTER and non-LTER) viewed cross site connections as being an important part of the value of the Network. In general, one of the weaknesses of the LTER Network that both LTER and non-LTER affiliates noted was that the Network has yet to fully capitalize on the potential for intersite work. As an LTER Co-PI said:

> There are a few people trying hard to do cross-site, network level science, but there are significant obstacles to this kind of research.

Or, as non-profit administrator stated:

> Great series of research sites and projects, functioning well as a collegiate network, some synthesis but still siloed and not yet reaching fruition on cross site integrative approaches.

Finally, many of the descriptions of the LTER Network provided by both LTER and non-LTER affiliates included information about the Network's value. The next open-ended question on the survey (Q8) addressed this topic and is the subject of the analyses presented below.

Value of the LTER Network

When describing the value of the LTER Network now and into the future, many of the same themes that emerged in response to descriptions of the LTER Network arose here, too. In other words, the aspects that form the essence of the LTER Network are also what make it valuable.

Both LTER and non-LTER affiliates mentioned data when they wrote about the value of the LTER Network. The long-term research and associated long-term data collection were widely recognized as being rare, extremely important, and irreplaceable in a world where grants of 2-3 years are the norm. A response from a graduate student affiliated with an LTER site summarizes what others also described as the value of the "long-term" both now and in the future.

> There is great value in long-term data to help understand past, current and future ecological conditions. As the climate and global population change, long-term data will become increasingly important to understand consequences of said change. Additionally, the diverse array of ecosystems represented in the network allow for an even boarder understanding of ecology. As datasets become longer and the planet continues to change, the LTER Network will become increasingly more important as well.

In the context of the Network's value, people spoke of the importance of data in a couple of ways. One advantage they wrote about was simply the opportunity the LTER program provides for the collection of long-term data. The second strength that some mentioned was the value the data had beyond the Network once – or if – they became available to others. The data could then be used by a much larger group of people; be combined with other data to look at questions at larger scales; and could serve as baseline data now and in the future. As was the case throughout the survey, non-LTER affiliates mentioned access to data slightly more than those affiliated with LTER. A faculty member who was not located at an LTER site and who knew a moderate amount about the LTER Network and the LNO captured the ideas shared by other respondents both within and outside LTER.

> Long term research is invaluable. As we change the environment having long term monitoring and long term empirical studies is crucial. Long term datasets are almost impossible to generate off short term grants. We need to record and publish the natural history of today so that, as has been done with Aldo Leopold's,

> H.D. Thoreau's and Joseph Grinnell's work, we can make comparisons of organisms, phenology and behaviors decades and centuries later.

Integration, connections, and coordination across sites were also seen as a merit of the LTER Network. Like research and monitoring that spans time, investigations that cross space are also necessary and valuable. As an LTER researcher wrote:

> The network facilitates cross-site and cross-ecosystem research, which, I think, will be the main focus of the future ecological research.

As in the responses to Q7, the LTER Network was not seen by all as having fully capitalized on the cross-site potential nor was the data perceived to be easily available. There was no doubt, though, that in the eyes of many these benefits were real and had been met – even if they could be improved upon.

Another important benefit of the LTER Network is the production of fundamental knowledge about the natural and social worlds. A research assistant at a university who also volunteers at an LTER site stated.

> Long term ecological research is incredibly important in order to understand an ecosystem and its functions as it adapts and changes based on many different effects over time. We cannot fully understand an ecosystem in a short period of time, just as you cannot fully understand a person by following them for one week. Long term ecological research allows us to better understand ecosystems over time, and in the future to predict how they might react to other changes, and how we can better conserve them.

Further, some respondents noted that the knowledge and data produced by the LTER Network can be used to inform non-scientists (e.g., policy makers, general public) and to educate students at all levels.

Given the many valuable aspects of the Network that people identified it is not surprising that some responses to this question stated that the stability of the funding that LTER receives is important and necessary. Finally, as in Q7, LTER affiliates mentioned people as one of the most important components of the LTER Network.

Successful networks

The last two open-ended questions were intentionally worded to address networks more generally. Some respondents took this broader perspective in their answers while others remained focused on the LTER Network. Both types of answers provided valuable input. In this section, we analyze responses to Q9: What makes for a successful network?

Both LTER and non-LTER affiliates identified communication and collaboration as two of the most important aspects of a successful network. Each of these is a broad concept, and many respondents did not elaborate in their answers in terms of providing specific information about what they meant by communication or collaboration. With regard to communication, people wrote about communication between network locations, between

the network and the general public, among researchers and administrators, among participants and "outsiders," and between members and their stakeholders. In regard to collaboration, the focus was primarily on "collaboration within and across sites."

Another topic mentioned frequently emphasized linkages of one form or another whether they were between people, across sites, or between data and ideas. Respondents associated with LTER sites emphasized the value of face-to-face interactions, particularly in the form of meetings, as a way to encourage and strengthen linkages and to support the exchange of ideas. Another subject discussed by both groups was the importance of holding certain things in common, including shared goals, visions, objectives, or values.

Both LTER and non-LTER affiliates mentioned data in terms of them being easily and openly accessible, comparable across sites, and having the infrastructure within the network to support data collection, storage, and discovery. Once again, support for the network, particularly in terms of stable funding, was also seen as critical. Finally, people in both groups wrote about the importance of openness in a network. People who were not associated with an LTER site spoke more about the need for a network to be open to outsiders, which one person described as "people and groups not already associated with it." For individuals at LTER sites, openness was described in terms of sharing ideas and treating people with respect.

People were also viewed as important to a successful network. As in responses to the two previous questions, people were mentioned more by LTER affiliates. This was the case here, too, with the exception that both LTER and non-LTER affiliates discussed leadership at about the same frequency. Overall, though, leadership was not a large theme in the responses. Individuals associated with the LTER Network also talked more about the need for balance – of various kinds—in a network. For example, an administrative staff person as one of the sites identified the following as important:

> Common goals and a coordinated strategy, but the flexibility to accommodate (site) individuality

Others wrote about the need for balance between "consensus and diversity of views" and "between individual projects and network-wide activities."

Responses to the question of what makes for a successful network also generated a number of other ideas. While many of these were only mentioned by a few people, they illustrate the many dimensions that make a network exceptional. These factors include the kind of people who are involved such as passionate, active participants who are willing to compromise and who have incentives to participate. They also include an organization that is transparent, accountable, has mechanisms and procedures for coordination, is representative of the membership, and has the support of the membership.

Role of a national network office

The responses to the first three open-ended questions on the survey provide a basis for understanding people's ideas concerning the role for a national network office. The

priorities of each group of respondents (i.e. LTER and non-LTER) are presented in the tables below. Each priority area is also described briefly in the table. Priorities are listed in order by the frequency with which they were mentioned, with the most commonly discussed roles lised first. Areas mentioned with a similar level of frequency are noted with the same color font.

Overall, responses ranged from broad statements about what a network office should do to lists of very specific activities (e.g., organize the ASM, advertise network products and accomplishments). Most responses by both LTER and non-LTER affiliates fell into the former category and began with words such as *coordinate, promote, facilitate, foster, and support*. These broader ideas tended to refer back to notions discussed in Q9 regarding the factors that make for a successful network such as collaboration, communication, and linkages of various kinds. The vagueness of the language used sometimes made it difficult to identify concrete and unique categories or to discern where particular suggestion fit best.

Roles of a national network office	**Description**
Facilitate collaboration, communication, & coordination across sites; support network activities	• The roles mentioned in this "category" were overwhelmingly viewed as most important for a network office. The most frequently mentioned roles included fostering, facilitating, supporting, etc. linkages across sites whether they are among people, research, ideas, or other aspects. Fostering synthesis was a small part of what was mentioned in this category. A few people also noted that a network office should fund some of the cross site activities. • Another aspect of this category related to responsibilities of a network office to help the "sites function as a network." This was described in broad terms. For example, one person said a network office "should work for all…sites and their members." Another said, "coordinate the big picture items for the network." Finally, a couple of people stated that a network office should address common problems faced by every site.
Data & information management	The three main topics mentioned in this category included: • provide access to data • provide guidance and support for standardization of data and information • provide technical support, infrastructure, and

	tools
External communication & outreach	External communication consisted of sharing and disseminating information to a wide variety of people and groups (e.g., NSF, policy makers, public). The goals of external communication were many and included things such as "keeping the profile high," advocating for the network, advertising products, and sharing best practices and lessons learned. Outreach spoke to reaching out to other organizations or researchers in order to foster collaborations, bring in new people and ideas, etc.
Meeting support	This category highlighted the role of a network office in bringing people together physically or virtually. It also included providing the infrastructure to support these interactions or events (e.g., software, meeting space, facilitation). Training was mentioned by only a few people.

Table 1: Priorities for a national network office – LTER respondents

Roles of a national network office	Description
Data	The main roles for a national network office were seen as: • ensure standardization of data to enhance use • bring data together and make them easily accessible through a repository
Communication and outreach	• Responses included both the need for a national office to facilitate communication across sites in a network as well as to share information about the network to external audiences. • Outreach was concerned with reaching out to others, particularly other researchers in order to foster collaborations, bring in new people and ideas, etc.
Coordinate research across sites	This category was primarily concerned with promoting cross site science by fostering collaboration between people and sites in the network. Supporting synthesis was a small part of

	what was mentioned in this category.

Table 2: Priorities for a national network office – non-LTER respondents

Other comments

At the end of the survey, we provided individuals with the opportunity to make additional comments. Ten percent of people (n=10) who were not affiliated with an LTER site submitted other comments, and 19% (n=33) of those associated with an LTER site did so. Two respondents to the pilot survey, both of whom were affiliated with LTER sites, offered additional comments. Many of the comments fit appropriately with one of the other open-ended questions, and so they were included in the analysis of those questions. For example, some people expanded on ideas they had mentioned elsewhere, whereas others emphasized a topic that they viewed as especially important.

Thirteen people (10 LTER and 3 non-LTER) provided comments specifically related to the LNO. A couple respondents recommended that the LNO be eliminated. However, several others took the opportunity to state that the LNO was important and necessary..

4. Summary

In summary, findings from the survey clearly show that the LTER Network is highly valued for its long-term focus and data, scientific contributions, people, and integration across sites. While more funding would always be desirable, the ongoing support that the Network receives from NSF and through other sources has been and will continue to be crucial. Still, those who responded to the survey see areas where the Network could contribute even more. Going forward, both LTER and non-LTER affiliates view more linkages across sites as particularly important, and they see facilitation of these linkages as an important role for a network office. Other important roles for a network office include data and information management and external communications and outreach. Finally, those at LTER sites see meeting support as a key role for a network office.

Acknowledgments

The Task Force extends its thanks to all the people who took the time to share their ideas, opinions, and concerns through the survey. We also acknowledge Eric Parrish, Professional Research Assistant at the University of Colorado Boulder Institute of Arctic and Alpine Research (INSTAAR), who developed the LNO Task Force web site and facilitated the dissemination of the survey. Jessica Ebert, INSTAAR doctoral student, provided invaluable support to the Task Force.

This report is based upon work supported by the National Science Foundation through grant to the University of Colorado Boulder. Any opinions, findings, conclusions, or recommendations expressed in this report are those of the authors and do not necessarily reflect the views of the National Science Foundation.

Envisioning the Next Generation LTER Network Office

The Task Force for Envisioning the Next Generation Long Term Ecological Research (LTER) Network Office seeks your ideas on the future functions and structure of the LTER Network Office. This short survey is one of the primary methods we are using to collect information. We welcome your insights even if you are not familiar with the LTER.

Findings from the survey will provide important input to the Task Force and will be presented in the final report to be delivered to the National Science Foundation in spring 2014.

Further information on the Task Force's goals and activities, including other ways to share your ideas, is available at http://lnovision.colorado.edu/.

If you have questions about the survey, please contact Task Force member Ann Zimmerman at annszimmerman@gmail.com. We appreciate your participation in the survey!

Familiarity with the LTER

1. How much do you know about the LTER Network?

- ◯ A tremendous amount
- ◯ Quite a bit
- ◯ A moderate amount
- ◯ A little
- ◯ Nothing at all

2. How much do you know about the LTER Network Office?

- ◯ A tremendous amount
- ◯ Quite a bit
- ◯ A moderate amount
- ◯ A little
- ◯ Nothing at all

3. Are you currently affiliated with an LTER site?

- ◯ No
- ◯ Yes

Envisioning the Next Generation LTER Network Office

4. Please select the category below that best reflects the your role in the LTER Network.

- ◯ Principal Investigator
- ◯ Co-Principal Investigator
- ◯ Researcher
- ◯ Education and Outreach
- ◯ Data and Information Management
- ◯ Research Assistant
- ◯ Administrative Staff
- ◯ Undergraduate Student
- ◯ Graduate Student

Other (please specify)

The Long Term Ecological Research Network

The questions below ask about your experiences with the LTER Network.

5. Please indicate which of the following LTER products you have used. Check all that apply.

- ☐ LTER data
- ☐ LTER publications
- ☐ One or more books from the LTER Schoolyard Book Series
- ☐ None of the above

Other (please specify)

Envisioning the Next Generation LTER Network Office

6. Which of the following LTER Network activities have you participated in? Please check all that apply.

- [ ] Conducted research at one or more LTER sites
- [ ] Attended one or more LTER-sponsored workshops, symposiums, or seminars
- [ ] Attended one or more LTER All Scientists' Meetings
- [ ] Participated in the LTER Research Experience for Teachers Program
- [ ] Served on an LTER Committee
- [ ] Served on the National Advisory Board for the LTER
- [ ] None of the above

Other (please specify)

The LTER and its Future

7. How would you describe the LTER Network?

8. In your opinion, what is the value of the LTER Network now and into the future?

Network Organizations

The two questions in this section seek your opinions about network organizations in general. We welcome your thoughts and suggestions whether or not you have experience with the LTER Network.

9. What makes for a successful network?

10. What role should a national network office play?

Demographic Information

Please provide information about yourself that will help us to understand how responses to the survey vary among different kinds of people.

Envisioning the Next Generation LTER Network Office

11. Please select the response that best reflects your current occupation.

- ◯ Researcher
- ◯ Faculty member
- ◯ K-12 teacher
- ◯ Education and outreach professional
- ◯ Administrator
- ◯ Clerical staff
- ◯ Research assistant
- ◯ Undergraduate student
- ◯ Graduate student

Other (please specify)

12. Please select the response that best represents the type of institution you are affiliated with.

- ◯ College or university
- ◯ Elementary or secondary school
- ◯ Federal agency
- ◯ State agency
- ◯ International agency
- ◯ Nonprofit organization
- ◯ Private entity

Other (please specify)

13. Thank you for taking the survey! We welcome any additional comments you might have.

Appendix 2A

LNO support of goals identified by the Education and Outreach Committee as key to development of the LTER Schoolyard Program (sLTER) and LTER higher education initiatives

Since the founding of the LTER network, member sites have prioritized education and outreach to engage a diversity of students in ecological research, develop LTER-themed education resources, and help build a more ecologically literate society. LTER education initiatives reach tens of thousands of K-12, undergraduate, graduate students, and educators each year, including many from groups traditionally underrepresented in the sciences.

Site education initiatives vary to take advantage of individual sites' research strengths, staff capacity, and target audiences. Collectively, these programs support the LTER Education mission to "use the uniqueness of the LTER programs and network to promote training, teaching, and learning about long-term ecological processes and the Earth's ecosystems" (LTER Network Education mission statement). This letter highlights how the LNO is currently supporting LTER Education initiatives and suggests strategies leading to growth and transformation during the next phase of the LNO.

Current LNO Support

The LNO plays an important role in supporting LTER education initiatives and collaboration between sites. Currently, LNO support of education efforts includes managing committee documents on the LTER intranet, updating education news and resources on the public LTER webpage, providing travel support to the ASM and periodic education representative meetings, assisting with monthly conference call scheduling, and housing and management of the new LTER Educational Digital Library. While this level of support is adequate for our current level of activity, additional funds and network-level staffing could greatly increase our impact.

Role and Outcomes of Schoolyard LTER

The Schoolyard LTER program was formally established in 1998 through funding from the Department of Environmental Biology currently at a per-site rate of $24,000 per year (in 2013). These funds are spent on the unique educational efforts underway at each of the 25 sites, including Research Experience for Teachers (RET) programs and other professional development programs for teachers, robust citizen science programs, field trips for K-12 students, and salary for the site Education Coordinator. The sLTER member sites successfully achieve mission goals within their own communities and actively seek cross-site collaborations to broaden LTER impacts.

The sLTER programs provide valuable broader impacts for LTER researchers and share LTER data and findings with diverse audiences. Projects spawned in the 16 years since origination of sLTER funding include two cross-site NSF-funded projects ("Ecoplexity: Teaching Ecological Complexity" and "Mathematics and Science Partnership for Culturally Relevant Ecology, Learning Progressions and Environmental Literacy"); a successful children's book series; the NSF-funded Journey to El Yunque curriculum (LUQ); and, most recently, the LTER Educational Digital Library (LEDL). Most of these projects were the result of funding beyond the sLTER supplement and benefitted from various levels of LNO

support. The exception is the LEDL which has benefited substantially from technological and fiscal support from the LNO. Phase 1 of the LEDL includes a database of 10 peer-reviewed lessons using LTER data and is housed on the LNO website. Phase 2 is ready to proceed pending funding for the peer review process and technology support to load lessons onto the website.

Role and Outcomes of LTER Higher Education

LTER sites host top-notch research training programs for undergraduate students, ranging in scope from academic-year field trips/courses to summer research internships (e.g., REU). A growing number of sites report outcomes data from their programs that reveal the many, positive, long-term impacts on students' future STEM education/career outcomes.

Sites also collectively employ hundreds of graduate students in LTER-based research and mentorship. Sites offer varying levels of support for student professional development, ranging from graduate research fellowships and stipends to student workshops and events. A committee of graduate student representatives from each site regularly interfaces with the LTER Education committee to develop and strengthen opportunities for this population.

A recent network survey shows that, for most sites, a primary pathway to broadening diversity occurs through recruitment for LTER graduate and undergraduate programs. Ongoing collaboration between LTER Education committee leaders and ESA's SEEDS program, plus emerging collaborations with the Society for Advancement of Chicanos and Native Americans in Science (SACNAS), various community college consortia, and the American Indian Science and Engineering Society (AISES), increase the visibility of LTER research opportunities with students across a wide range of diversity and experience.

Future Opportunities

We see several opportunities for the LNO to foster coordination, innovation and productivity in education and outreach, listed briefly below.

• Continued financial support for travel to the network-wide ASM and new support for annual site-based meetings to facilitate collaboration and sharing of best practices among Education and Outreach representatives

• Further support for distribution of LTER data-based curricula (e.g., LEDL) and products (e.g., children's books) for K-12, undergrad, and grad classrooms -- and funding for convening meetings/review committees related to these activities

• Centralized technological support at the LNO for the LEDL, citizen science data, and other cyber infrastructure for education, including Committee communications, cross-site telecommunications, and website development/upgrades

• Support for an Education and Outreach Coordinator on the LNO staff, a resource proven to be of great value during the tenure of Sonia Ortega, an NSF staffer who served as a fulltime Education and Outreach coordinator at LNO.

• Coordination of evaluation activities and reporting of the impacts of education projects (Schoolyard, summer undergraduate programs, RET) on students' STEM education/career outcomes
• Help with recruitment and support of diverse students for all programs, in line with NSF's goal of preparing a more diverse STEM workforce
• Additional support to help graduate and undergraduate students serve as mentors to younger students and forge cross-site research collaborations and synthetic projects
• Coordination and support of a more uniformly affordable model for the per-unit cost of teachers' professional development programs offered through sLTER; the academic institution supporting the LNO could administrate affordable credit-bearing professional development courses offered at the site level, as modeled by the AND collaboration with universities in Portland, OR

The LTER education community is a diverse group of dedicated professionals engaged in primarily site-specific K-12, higher education and public outreach activities designed to engage learners of all ages and create a more ecologically literate society. In the NSF-funded *sLTER Phase 1 Evaluation Final report* (McGee, et al, 2011), the authors state "This site autonomy has fostered tremendous creativity and has resulted in a wide array of programs for local and national audiences." They go on to suggest "this plethora of programmatic approaches makes it challenging to draw general conclusions about the sLTER program as a whole without a centralized coordination of evaluation activities." Suggestions for sLTER activities, in addition to evaluation activities, that would benefit from centralized support are listed above. Past network-level coordination of LTER education has focused primarily on K-12/Schoolyard activities, but leadership in the Education Committee has recently shifted to include higher education, citizen science, and other initiatives. Staffing structure for these widely varied activities is inconsistent across sites and involves a mix of full-time and part-time administrators, PIs, post-docs and graduate students. This complex structure presents a communication and collaboration challenge that could be enhanced by support at the LNO. Continued and augmented LNO support for sLTER and higher education endeavors in this next phase of the LNO would provide a solid foundation for moving sLTER forward.

Respectfully,
The LTER Education Committee

Appendix 2B

March 5, 2014

McKnight Panel:

The LTER Communication Committee has been charged with overseeing the implementation of communication strategy articulated in the 2011 LTER Network Strategic and Implementation Plan. This strategy outlined a bold vision for communication at the LTER Network level, which is further defined in the LTER Strategic Communication Plan.

While science communication has not been central to the Network's activities in the past, we believe that it needs to be an integral part of how we conduct business going forward. Given the decades-long datasets accrued by many sites, LTER has a tremendous opportunity to deploy its science network for enhanced decision support in the areas of urban sustainability, forest management, water sustainability, and climate change, just to name a few. To help realize this potential, science communication should serve as the foundation of an expanded program of actionable science that includes stakeholder engagement, problem-oriented synthesis, and communication and outreach. Such an effort would not only enrich LTER research but would offer more creative and transformative approaches for satisfying the broader impacts criterion and the social contract for publically-funded science. It would also raise the visibility and stature of the LTER Network among key audiences. In addition, improving communication of LTER science will help to sustain broad and enduring public support for ecological science, draw in and engage students early in their science careers, and contribute to the long-term sustainability of long-term ecological science.

We understand now better than before how important it is to strategically use the many communication media available to understand the science needs of diverse audiences and to share relevant scientific knowledge for decision-making, teaching, and learning. The LTER Network is not alone in recognizing this. Other major scientific endeavors such as NEON, NCEAS, SESYNC, NOAA's National Estuarine Research Reserve Collaborative Science Program, the US Department of Interior Climate Centers, and the USGS Powell Center have included synthesis, science communication, and tools for public engagement as important components of their operations.

Our Strategic Communication Plan rests on three goals:

- To be recognized as a leading resource for long-term ecological research by the broader scientific community, decision makers, and the media.
- To harness the power of long-term ecological research for decision making through two-way exchange between LTER scientists and policy makers, natural resource managers, funders and the media.
- To advance scientific collaboration and innovation by strengthening communication within the LTER Network and between the LTER Network and the broader scientific community.

While we have made strides over the last three years in implementing activities to address these goals, communication has been under-funded within the Network sites and LTER Network Office, which has limited what we could achieve. The opportunity exists for investing in strategic science communication and public engagement to achieve LTER's potential as the nation's pre-eminent source of rigorous and actionable ecological science.

Going forward, we believe this actionable science/communication program should have adequate funding to support 1.5 to 2 FTEs with a budget for hosting cross-site workshops together with stakeholders around particular themes identified by the LTER Science Council, delivering professional development workshops in collaborative science and science communication to graduate students and PIs, providing seed funds for problem-oriented synthesis efforts, developing a range of communication products that flow the synthesis efforts and other activities, and organizing outreach to journalists and other target audiences.

Increasingly, our society is demanding that scientific knowledge be co-produced and shared outside the academy and used to solve problems and teach youth the skills and knowledge that they need to meet the challenges of the 21st century. Our purpose with this letter is to underline the importance of including communication as a component of the RFP for the LTER Network Office, however that may be conceived. Science communication in the LTER Network needs to be reflective of the considerable investment NSF and the American people are making in science at LTER sites. It should be of the same standard of sophistication as the science that LTER scientists conduct in order to reach targeted audiences with the scientific knowledge needed for decision making and education. We believe that strategic science communication and public engagement are essential for LTER science to attain its transformative potential.

Sincerely yours,

Co-chairs, LTER Communication Committee

David Foster, Harvard Forest LTER
Christopher Neill, Plum Island Ecosystem LTER
Marcia Nation, Central Arizona-Phoenix LTER

Appendix 2C

To: NSF Task Force on envisioning the next LTER Network Office

From: LTER Network Information System Advisory Committee (NISAC), but with recusal by members of the LTER Network Office and Aaron Ellison.

Date: Sunday, March 2nd, 2014

Attached is a position paper for your consideration written in support of continued development, deployment and maintenance of an LTER Network Information System. During the upcoming transition from the current LTER Network Office (LNO), it is particularly important to maintain the momentum led by the LNO and that permeates the broader network. The NIS, and in particular PASTA, is a core network-wide initiative that has helped reshape and harmonize both the technological and human infrastructure of the LTER as it applies to information management and data accessibility. As LTER enters an era of increasing cross-site synthesis, the NIS will play an increasingly important role. We encourage the NSF Task Force to include specific provisioning of NIS and PASTA support in its recommendations to ensure continuity through what inevitably will be a challenging transition and to ensure realization of the vision that all of LTER has for discovery, access and use of LTER data.

Sincerely,

Paul Hanson, M. Gastil-Buhl, and Suzanne Remillard

Co-Chairs of NISAC, on behalf of NISAC

Appendix 2D

Position paper on the continuity of the LTER Network Information System (NIS)

by the LTER Network Information System Advisory Committee (NISAC)

A network information system enables LTER to operate effectively as a science network by catalyzing collaboration on data, models and theory. These three components are inextricably linked, such that each is required to support the other two. Here we focus on the data component and provide a specific recommendation for the continuation of an LTER NIS including the Provenance Aware Synthesis Tracking Architecture (PASTA), a technology around which a paradigm of data discovery and access has been built.

The first published reference to the LTER NIS, in 2000, describes a grassroots development effort and information flow from individual sites into cross-site administrative databases such as the all-site data catalog and bibliography and research databases such as ClimDB. Formal development and direction of the LTER NIS began in 2003 with the formation of NISAC and subsequent release of the LTER NIS Strategic Plan in 2005. The defined goals were to increase 1) data quality through standard approaches, 2) data available for synthetic activities, and 3) knowledge discovery through synthesis. Network approval of NISAC and the concept of a network information system lead to increased support from the Network office and the solidification of these early database efforts into a more formal NIS.

While there are many models for information management in distributed networks, there are functional priorities within the LTER community that inform model design. We see

the following concepts as those priorities:

- Access to LTER data in a manner that is convenient and consistent across the Network for the broader scientific community and the general public
- Common 'data terminology' and defined sets of processes (protocols and workflows) to improve efficiency and reliability of data access in support of science
- Leveraging the diverse expertise of the LTER community so that technology (the melding of terminology and process with compute capacity) can harmonize effort across the Network and allow for site-based initiatives to bubble up and become part of the NIS

The LTER NIS is comprised of many varied components (i.e., data catalog, user portal, site data and metadata, network databases like PersonnelDB, BiblioDB, and SiteDB, synthesis data products generated by workflows, web services). Some of these components are obvious to the user as they facilitate the access and discovery of data. Other components are behind the scene, but core to the operation and functionality of the system and the ability to synthesize data.

The LTER Network Office (LNO) described the framework of the NIS using PASTA in their Operational Plan (2009-2015), which detailed how this cyberinfrastructure would support research activities. The NIS was further clarified in the Strategic and Implementation Plan (SIP), 2010. The overall success of this framework was critically dependent on site participation, specifically site Information Managers (IMs), informing PASTA framework component development and creating well documented and quality data products for harvesting into the NIS. Since that time, individual sites and site

personnel have invested a significant amount of effort and resources to contribute to the activities outlined in the Operational Plan and SIP. The outcome has been improved conformance at the site level to a common data standard, improved understanding of the common mission, supporting processes of the NIS, and an acceleration of the flow of data from sites to the common repository of PASTA. Thus, consensus on the goal of PASTA has led to improvements in human and technological infrastructure for LTER in addition to the goal of centralization of access to LTER data.

An effective NIS is more than a technology. It is an amalgamation of human expertise, technology, and process that evolves in response to the growing needs of the Network. LTER data synthesis is promoted by an effective NIS, and PASTA is both the foundation and catalyst for Network-level data harmonization. The LTER NIS facilitates data synthesis efforts by ensuring quality data and metadata. Currently, dataset packages downloaded from PASTA come with a guarantee that a defined set of quality control checks have been passed. No other data repositories provide this type of guarantee. These properly described data function in scripts or programs used to transform, merge and synthesize data. Although support of these workflows is inherent in PASTA design and output products from synthesis can be stored in the NIS, this has yet to be fully realized. Our vision of a centrally supported NIS would offer expertise to aid scientists in crafting workflows. We see that the foundation has been set and now is the time to build upon this foundation by exploring the possibilities of cross-site synthesis that PASTA was designed to provide.

The LTER NIS requires administration and maintenance by an entity that understands the broader vision of the LTER Network and that is in a position to facilitate coordination

among sites. Experience has shown that without dedicated administration, progress diminishes and sites cannot plan for implementation of the product. Site IMs are not in a position to perform this type of administration. It is important that IMC grassroots efforts towards an end product are realized on a network level and not left uncompleted. A dedicated administration also helps to build consensus around interface standards and encourages participation, cooperation and engagement.

The LTER NIS provides essential cyberinfrastructure services which include access to data and coordination of Network activities and databases. With the implementation of PASTA, Network developers have created a robust system to store site data and metadata, provide quality checks, and discover and access site data. Sites, too, have invested in improving their data collections to meet the higher standards of PASTA. With the development of PASTA, as a base platform, the potential horizon is broadened to really accommodate building value-added and cross-site synthetic databases. We expect to reap the benefits for years to come. To ensure this, any future vision of the LTER Network central office needs to include a transition, administration, support and maintenance of the NIS and continued development in conjunction with PASTA. It is critical that cyberinfrastructure needs of the LTER Network be continued and supported so that scientists can progress with transformative Network-wide research at broad scales.

Appendix 3. NEON & LTER

The National Ecological Observatory Network (NEON) has been designed as a continental-scale ecological observatory, consisting of 60 sites across the US and instrumented to study the impacts of climate change, land-use change, and invasive species. It is presently supported through funding from NSF's Major Research Equipment and Facilities Construction (MREFC) program to NEON Inc.

Because both networks have sites distributed across the U.S. – sometimes with co-location of NEON instrumentation at LTER sites – there is often confusion about the distinction about the roles of these two networks. Yet, these networks have multiple differences, in design, scope, governance, and operations. At the most basic level, LTER and its LNO have developed from the bottom up in a relatively grassroots fashion, with an emphasis on individual sites that each have varying measurement priorities and approaches and experiments; by contrast, NEON is a centrally operated continental-scale user facility designed in response to the grand challenges questions in environmental science. Both networks operate separately, but have multiple potential areas for complementarity and for interaction.

In mid-November, 2013, LNO Task Force members Diane McKnight, Christy Goodale, and Jessica Ebert visited the NEON offices in Boulder, CO. They met first with NEON's new Observatory Science Director, Scott Ollinger, then later with NEON's Steve Berukoff (Assistant Director for Data Products), Hank Loescher (Program Developer, International Initiatives), Leah Wasser (Senior Science Educator – Universities) and Wendy Gram (Chief of Education and Public Engagement).

The meetings highlighted several additional contrasts in perceptions and priorities between the NEON and LTER networks, including:

- NEON is specifically designed as a continental scale observatory that rarely focuses on regional questions, but LTER's strength to date has often been at the site- or regional scale. LTER may provide a grounding and regional connection for NEON's nationally focused observations.
- LTER may be more flexible and swift in adding or modifying data collection approaches at each site, whereas NEON's strength and constraint is its standardized protocols for consistent continental-scale measurements.
- Large-scale ecosystem experiments are common to many LTER sites, but NEON lacks that experimental focus (except for its STREON stream experiments), while focusing instead on observational measurements.

The meeting also identified several valued functions and strengths of the LTER network and the LNO that have little or no parallel within NEON, including:

- The LTER All-Scientists Meetings has no parallel organization of NEON scientists or science meeting.
- Some NEON staff were aware of the PASTA system, but NEON as a whole is taking a separate route for data management and a data portal development. Much of this is approach at NEON is under development.
- NEON is focusing its education and outreach nation-wide on undergraduates and will rely on established partners (e.g., textbook publishers), and it does **not** have a program analogous to the Schoolyard program or a focus on K-12 education. LTER has more of a local and regional presence than NEON.

The group identified some areas where the LNO-NG could possibly help bridge some limitations to current LTER –NEON cooperation including:

- **Synthesis**. Both networks are generating large volumes of often complementary data that would greatly benefit from opportunities for investment in data analysis and synthesis. Joint or coordinated synthesis activities between LTER with NEON have the potential to advance use both networks. Yet, synthesis activities fall outside of the mission of NEON, and have been limited to small awards to working groups within LTER and the LNO. Even synthesis options through current NSF such as Macrosystems Biology or Research Coordination Networks or RCNs do not meet these synthesis needs. The focus of SESYNC (National Socio-Environmental Synthesis Center) on socio-environmental research does not overlap directly with the data use/synthesis needs for ecological data from NEON and from much of LTER. Advancing synthesis opportunities could fill a major need of both networks.
- **Communication** between the LNO and NEON has been limited to date, and would benefit from enhancement.
- **IT/Data coordination**. NEON's information infrastructure and web portal will focus on delivering NEON data to many users and will emphasize data integrity as part of interoperability; some of the criteria for NEON data are not readily applicable to LTER data, especially the long term trend data. Although site-level interactions with some individual LTER sites were strong, LTER's complex and decentralized governance structure could form a barrier to cooperation on data issues, and would benefit from LNO coordination.