NWT CC

Discussion for Question 1.
What are the intellectual goals of the Network

GO TO: "SUMMARY STARTS HERE" for the notes from which the summary were given.

Whole group points: Preliminary Discussion.

- Ideas for exec to get things started: Questions of systems stability at all scales or levels of organization. Network ideally suited for such questions because of the degree of contrasts it incorporates.
- What is the domain for the network as a whole. Systems or emergent properties that can apply across all systems. General principles; comprehensive framework (components, interactions, modeling strategies, abstractions
- Something must be different about the networks as a whole, that differs from the strengths of the individual sites.
- GOAL: What is the theoretical, or conceptual, or intellectual domain of the LTER Network?
- All sites should be able to participate in at least some, not necessarily all, Network syntheses.
- GOAL: Give some examples of the questions or issues that could motivate Network science program. Or core areas for synthesis and network science.
- Assume increased funding, and don't worry about logistics.
- QUESTION: Who has an example of a successful or interesting domain? Boundary domain: "Ecologically significant interactions amongst heterogeneous entities connected by fluxes of organisms, energy, material and information across a differentially permeable or reactive interface, at any spatial and temporal scale"
- Possible domain: spatial and temporal scaling. Augmentation to regional
- Major **ideas emerge from the discussion**: Systems properties; biodiversity; Scaling (unique power of network to synthesize this), synoptic analysis of indiviudal systems, invasability, population and system links, system assembly (succession);
- Example of Domain: biogeophysical template; layer of human action; feedbacks between these. Gradient of human impact on different systems.
- Long-term key. Stability and resilience. External and internal drivers. Short list. And then the interactions.
- Take advantage of the sites each having a regional context that enriches any gradient that the sites themselves represent.
- Another domain idea: Aquatic and terrestrial sites conpared and contrasted across this boundary.
- Domain of turnover of productivity.
- GENERAL DOMAIN: will involve some gradient approach (site based, system structure, system function, human dominance, biota as capacitor/buffer/agent for ecological change), and will involve some generational time scale.
- Address the assumptions behind space-for-time substitution
- Network as a system of gradients.
- We are not doing the same things that other networks of gradients. COHASI, Global change. We will have a retrospective and multidimensional data sets. Better system context. Sites provide a unique base for the questions.

- Judge the points we come up with: why do we have to answer this question across a Network of sites? Understand the diversity fo the landscape of North America. Do so over the entire range of scales that management decisions are made. Go deeper than the apparently singular event.
- Need to clarify what we have in the network. What are our strengths? Help us to explian to NSF that we are theory and hypothesis. Also use this as a justification for getting new resources that we are missing now.
- Use intersite initiative to drive synthetic network work. Resources to allow and add what is needed to accomplish this.
- Way to communicate: lay out some options of how the Network can work best: gradient analysis, ecosystem function, core area list.
- Questions of societial importance: sustainability, ecosystem services; therefore, question of Contol biodiversity and C fluxes and how they control ecosystem services. Network scale

SUMMARY STARTS HERE

Focused Discussion: Major critical and obvious issues that the Network science program could address; and different sites can fit into them as they desire. Introduce complexity as a motivator for all the questions and issues identified. Complexity as pattern and dyanmics and interactions in time and space. Build on long-term, comprehensive data and models.

Domain: causes and consequences of ecosystem dynamics at various scales and over the long-term. The domain is comprised of Physical processes, Human processes, Biotic interactions

Each component of the domain is divided into more specific sets of processes. e.g., Physical climate change, sea level rise, hydrologic change, etc.

1. Question: regional (external) gradient control versus local (internal) control of ecosystem dynamics. Deals with large Earth sciences and physical environmental drivers. Incorporates the existing core areas. Gradients at different scales for response. Relevant to management at different institutional and scalar levels. Constancy, resilience, stability. Multiple drivers in space in time. How does the response vary with scale. Regionalization issues fit here. Dynamics at multiple scales. Can complexity be exploited here because multiple processes and structures are being measured simultaneously at LTER sites. Interactions among multiple components of control. Dear with hiararchires of control from coarse biophysical setting and climate dynamics. RESOLVES INTO: Scale of the responses or drivers of ecosystem dyanmics.

2. Question: Biodiveristy: incorporates legacies, invasability, assembly. (Keep separate for identity and because it is huge.) Relationship of autecology and population biology and ecosystem proecesses. Not all systems will respond in the same way due to their contingent sucessional and evolutionary histories, and history of human intervention. Biodiversity as a more subtle set of variables, not just a catalog. RESOLVES INTO: The relationship of species biology and ecosystem function.

3. Question: Human dimension. Role of institutions and political entities. Not just land use as a variable. Land use as a manifestation of human influences and decisions at various

organizational types. RESOLVES INTO: What is the role of differential human influences and involvement across ecosystems? Feedbacks, and changing variables.

Couple with diverse approaches:

1. Indicate what approaches the Network could take to answering the questions.
2. Cross cutting themes for network science program: forcasting; ecosystem services;
3. Approaches: nested gradient analysis; forcasting; regionalization; modeling, coupling retropsective and prospective approaches, etc.

Core areas subgroup #2
Notes from Tom Schmidt (tschmidt@msu.edu: phone (517) 355-6463 x1606)
9/13/02

Considered NSF recommendations 5, 6 and 7.

#5 –role scope and function of core areas
#6 – biodiversity as a new core area
#7 – should become a research collaborartory, building on successes (not really discussed)

Core areas as a framework for organizing LTER

What is a core area?
Core areas define the principal properties of ecosystems and represent the primary components of general ecosystem models. LTER network has used core areas to define and communicate its niche and communicate. Core areas define a framework that assures a minimal breadth of research, also heard that the core areas were instrumental in design of some of the more recent LTER sites. The consesnsus reached was that core areas are useful, and that they are not restrictive but valuable in that they provide potential links between sites. Agreed that it would be useful to consider reworking the core areas to better represent work is ongoing and plans for future.

Discussion of additional core activities:

Biodiversity:

Consensus that biodiversity should be included in core areas, not necessarily as a separate area but perhaps included in the currently defined second core. It is clearly valuable to consider role of diversity in many aspects of ecosystem function, including invasiveness of new species, resiliancy of ecosystems and role of disturbance. A continuing effort to document biodiversity also provides the basal data against which serendipitous events can be compared.

Biodiversity was broadly defined to include genetic diversity within a population, to species diversity of microbes, to measures of functional diversity.

Climate:
Since climate measurements and models are part of many current sites, it would be valuable to make this core area more explicit (perhaps as part of current research area #4). (Not lots of discussion on this point.)

Natural and Human disturbances:
Includes social sciences as below (#3). Little discussion on this point.

Reworking Core Areas:

Rather than areas or questions, the possibility of stating core areas as core goals was discusse. In this spirit, the following goals were developed to retain the spirit of the original areas, but rework them to include other ongoing research and future plans.

1. Identify and quantify biotic and abiotic variables that control rates and patterns of primary production.

Explore and define biological diversity in relation to ecosystem dynamics and function. Something along this line would broaden the second core area so that it better reflects biodiversity issues. The potential role of biodiversity expands research that focuses on keystone species. Long term census records provide opportunities to document and understand shifts from rare to prominent species. Define biodiversity broadly to include from genetic to functional to regional diversity. Biodiversity could readily be incorporated into this core area.

3. Recognize and quantify the historical and current influences that social and economic drivers have on ecosystems.

Core functions: (considered only briefly)

Archived samples
Informatics

Other notes:

Suggestion was made to reduce the prominence of core areas in communications so that the focus is directed to addressing fundamental ecological questions. It is appealing to use questions as guiding principles, for LTER activities.

Core areas may influence way data is presented and how information systems are designed.

A primary LTER goal is to understand ecosystems in face of change of all kinds, and many questions revolve around that.

Early LTER site proposals may have now moved away from addressing the core areas specifically, while more recently developed sites may have paid closer attention to them in formulating questions.

Are core areas the best way to organize the LTER sites or are there better ways to organize?

Core questions is one alternative, with specific questions being developed by each site. Network wide questions may be a useful way to identify and develop cross site research and synthesis.

For microbial sciences, biodiversity studies make sense. Microbiologists don't know what microbes are present in most any environment. In some ways microbiology is where botany was 100 years ago, i.e. simply defining what organisms are present. However new methodological advances offer the advantage for rapidly increasing understanding of microbial diversity. The results from microbial surveys are frequently based on gene sequences, so they can be databased and compared. It may be valuable to include some examples/discussion of microbes in biodiversity area.

Species translocations and dislocations
Ecosystem services
Human enterprise
Geophysical drivers
Biogeochemical drivers
    Ecology of infectious disease

List of technologies
    Information technology
    Field applications of genomics tools
    Nano instrumentation
    Communication
    Visualization

Competition for technology center among national labs

How do we fits humans into ecosystems?

Rather

How do we fit ecosystems into the hierarchy of human enterprises?

Brain-storm session on X-site vs. network science

How to do it?

- Model – facilitate intersite research – example of Forest Service RFP in NE to do just that (brought in all LTERs) NERC – many sites, not just LTERs.
- Model – NSF- funded multi-site proposal in regular programs – e.g., ^{15}N use to study nitrate cycling in streams. LINX project.
- Specific LTER cross-site RFPs – should not be last-minute, have to be predictable. Health of the network also depends upon bringing in investigators from other sites too
  - LTER niche is leadership, long-term data sets
- There is a problem that the projects may produce rewards that are not visible to the home institutions and yet be costs to the LTER sites.
  - Don't forget that there are many long-term benefits such as future projects that are not obvious at first.
- Should cross-site competitions be run by LTER or by NSF?
  - Probably should by NSF-run
- What should review criteria include?
  - Should cross-site be a part of site funding or a separate entity? – discussion said separate
- How important is compatibility in data gathering, data storing?
  - Not an absolute requirement.
  - One way of collecting is not necessarily optimum for another question
- Shouldn't we also consider process-based research where cross-site research gives a more complete picture of the controls on a process. Goal is predictive modeling, scaling to regional levels.

Distillation

Recommendation #7

- Yes, agreed that LTER program should become more collaborative
  - Synthesis of existing data
  - Synthesize some, augment with additional data
  - Design whole new set of research
- At what level
  - Few LTER sites
  - Region
  - Whole network
- What type of question
  - Single question
  - Incorporate new technologies, disciplines but may have to start these at the site level first
- Where do opportunities derive from?
  - Should be developed as bottom-up from community, not from high levels (NSF or network office)

Recommendation #8

- Strongly support concept of incentives for collaboration but incentives have to be real and not another 3% chance
  - How should funding be channeled?
    - NSF
      - Real program, formal program, but not usual panels
      - Specifically for cross-site
      - Predictable
      - Long time lead on proposals
      - Could be from genomics to carbon cycling to theory {non-prescriptive)
    - Other mechanisms too
- Should encourage
  - young investigators
  - Should draw in non-LTER sites

Recommendation #9

- We support the recommendation in principal
  - Sites should be rewarded for cross-site activity
    - There should be more emphasis in reviews on cross-site activities
      - room in site proposals for reporting, evaluating cross-site
  - An evaluation criteria that is for 20% of activities (not 20% of funds) for cross-site is reasonable
- But all sites should be participating in cross-site activities allocation
- What about allocation of site resources for these activities?
  - These should be specifically funded from outside of the site awards as this is an increased burden for the site
  - Participation should include facilities for visitors, courses for upgrades, infrastructure
- New money should be made available to bring site data and data management to the level necessary for cross-site integration and synthesis (sell as informatics)

Consensus

- We agree with the three recommendations in principal that there should be more cross-site activity (7,8,9)
- The funding mechanism should be broadly based, separated from regular LTER budgets
  - Seed money comes from network office
  - Real money from DEB
  - Encourage diversity of age classes, disciplines
- Site infrastructure for cross-site research
  - Catch-up on informatics,
  - site infrastructure (trucks, lodging, update skills)
  - travel
- Evaluation
  - Should be based on performance

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Group 3A: Core Areas

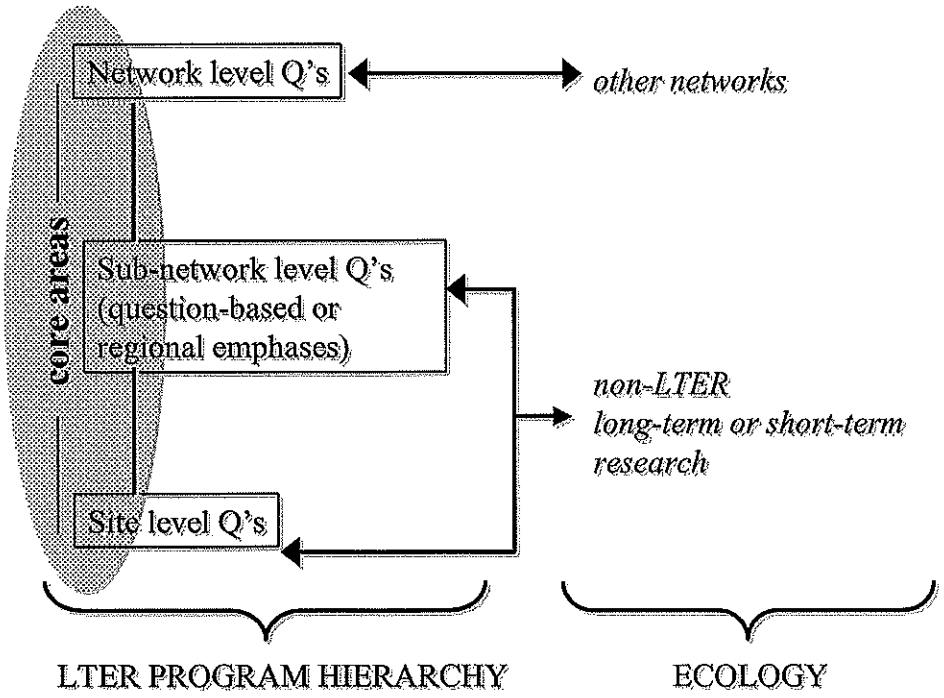
1. Core areas recognized as important for new sites, to organize activities
2. Older sites do collect data in core areas, organize around more synthetic questions
3. Possible alternatives are to substitute questions for core areas
4. Most do not want to change in this way, want to keep core areas

Review, evaluation, and revision of core areas (NB Grimm summary of group 3A, with liberal additions of own thoughts)

The five ecological core areas, as pointed out by both the 10- year and 20-year reviews, have remained essentially unchanged since the program's inception. The consensus view of the CC is that the core areas remain a valuable element of the LTER program, in that they

- Provide a framework for organizing research, especially for the newer projects
- Are, to variable extents, areas in which data are collected by all sites, even though older sites tend to organize their research around cross-cutting questions
- Represent the principal, fundamental components of ecosystems and, as such, are the areas in which all LTER sites obtain long-term data

The role of the core areas has not been adequately defined at all hierarchical levels of the LTER program (e.g., site, sub-network, network; Fig. 1). The core area concept deals with the *subject matter* of long-term ecological research, not the approach, methodology, questions, hypotheses, predictions, or theories. The core areas do remain an essential part of what we do and should not be eliminated. However, the core areas should be given less prominence in the promotion and outreach elements of the LTER program, and exemplary, cross-cutting questions that can be answered at the site, sub-network, or network level might be substituted for them.



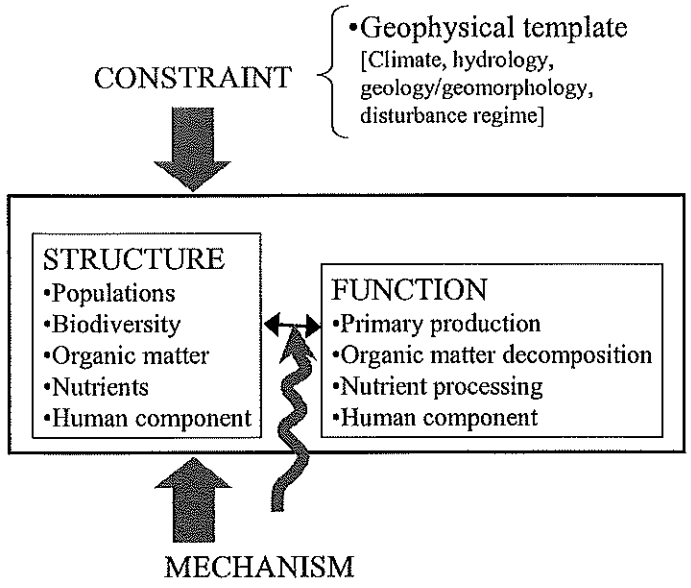


Figure 2. Conceptual model of ecosystems in context of an explanatory hierarchy. Proposed and existing core areas are bulleted.

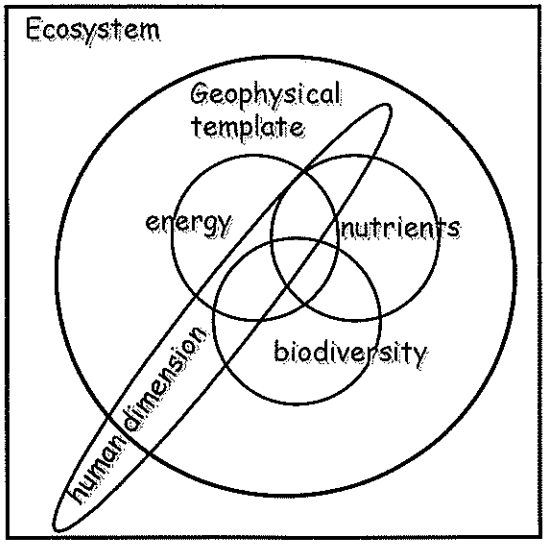


Figure 3. Conceptual model of ecosystems in terms of core areas and their intersection.

Alternatively, the activities of LTER sites with respect to the core areas could be summarized in a conceptual model of ecosystems that is placed in a context of an explanatory hierarchy (Fig. 2) or a conceptual model that shows the relationship among different existing and candidate core areas (Fig. 3). Such models exist in various forms in each of the LTER projects; some of these models are similar in form and generality to those proposed for as overall organizing models (Fig. 4 compared to Fig. 2, e.g.).

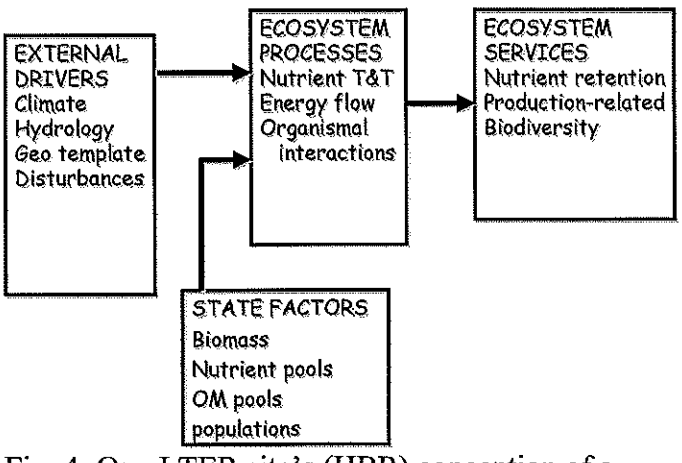


Fig. 4. One LTER site's (HBR) conception of a general ecosystem model. After Groffman et al. in review (from Gary Lovett's sketch by memory with NBG additions of possible core areas).

The LTER program as it exists today embraces interdisciplinary approaches and includes scientists and research projects from other disciplines. For example, every LTER site monitors climate, and many include measurement of hydrologic variables (e.g., streamflow) among their routine data collection protocols. Increasingly, LTER researchers are including data on a rich array of social variables (e.g., institutional action or human perception and behavior rather than just demographic information). Geomorphic structure and land cover classification are

geophysical variables that are among those most commonly included in LTER databases. Thus, in addition to the recommendation to add biodiversity to the LTER core areas, we believe that geophysical and social core areas that already exist as suites of measurement variables within the network should be recognized as viable core areas.

Core areas for the LTER program, therefore, should

- Represent the components of ecosystems
- Include the higher-level factors (geophysical) that constrain ecosystems
- Include humans as part of ecosystems
- Provide a guide, but not a rigid requirement, for research variables to be monitored in LTER projects
- Provide opportunities for synthesis at the sub-network or network level

Furthermore,

- The "populations" core area should be replaced with a "biodiversity" (or just diversity) core area.
- Diversity should be envisioned at levels of organization from gene (e.g., molecular diversity) to landscape (e.g., land cover diversity or landscape patch diversity). Indeed, all core areas potentially manifest at multiple levels.
- Each core area represents a topic that includes a suite of possible measurement variables, not all of which will be measured at every LTER site

Older functions for core areas that can be eliminated include

- Ensuring diversity of research
- Criterion for evaluating proposals

Some possible core areas:

1. Geophysical template, including geology/geomorphology, climate, and hydrology
2. Pattern and control of energy flow processes
3. Pattern and control of nutrient transport, transformation, and retention processes
4. Pattern and control of biodiversity (diversity)
5. Human component of ecosystems, including sub-areas from Social Science group*

another permutation:

1. Geophysical template, including geology/geomorphology, climate, and hydrology
2. Pattern & control of primary production
3. Pattern of organic matter storage and decomposition
4. Pattern of movement, transformation, and retention of nutrients
5. Pattern and frequency of disturbance
6. Biodiversity (or just diversity)
7. Human component

and another:

1. Geologic/geomorphic template
2. Climate
3. Hydrology
4. Primary production
5. Biodiversity
6. Organic matter
7. Nutrients
8. Disturbance
9. Demography
10. Technological change
11. Economic growth
12. Political and social institutions
13. Culturally determined attitudes, beliefs, and values
14. Information and its flow

Note that all of these core areas (any of the above permutations) should be multiscaled and include measurement of spatial (usually) and temporal (always) patterns

**Proposed* Social Patterns and Processes (from Redman et al., *in review*)

- Demography: growth, size, composition, distribution, and movement of human populations;
- Technological change: affecting the accumulated store of cultural knowledge about how to adapt to, make use of, and act upon the physical environments and their material resources in order to satisfy human needs and wants
- Economic growth: affecting the sets of institutional arrangements through which goods and services are produced and distributed;
- Political and social institutions, representing the enduring sets of ideas about how to accomplish goals generally recognized as important in a society. For instance, most societies have some form of family, religious, economic, educational, health, and political institutions that characterize the core of its way of life;
- Culturally determined attitudes, beliefs, and values, which purport to characterize some aspect of collective reality, sentiments, and preferences of various groups at different scales, times, and places; and
- Information and its flow: the genetic and symbolic communication of instructions, data, knowledge, ideas and so on.

Group 3

Reed – took core areas seriously in designing their program; surprised that some of the older no longer take them seriously

Elliot – core areas provide basis for larger scale questions

Covich – core areas internalized

Core areas as a framework – importance for network

New proposals often irganized this way
Older sites not organized around but opr=erationalized; do measurements in them

Answering larger questions today using core areas as building blocks

Define an ecosystem ensures
We don't leave anything out
Population biology
Genetics
Stress

Organize around questions, not cores

Series of questions
Specific questions – answers not best for network
Network activities demand core data collection by site

New potential core areas

Biodiversity
Functional diversity
Socioeconomic drivers
Demography
Social hierarchies
Informatics
Social institutions
Economics
Genetic to landscape diversity
Climate
Hydrology
Geomorphology

Core area vs. core function

Other organizational schemes
General ecosystem model
Cross-cutting questions

Function of core areas?
Principal properties of ecosystems
Components of general ecosystem model

??/concepts of ecosystems

Understand ecosystems in the face of change, many questions evolve around that

Put core areas in appropriate context, more specific research questions provide a defining role for LTER science

Core areas nor be abandoned
Need to be refined to some degree
Need to be fit into the hierarchy of network activities