Frontiers in Ecosystem Ecology: Energizing the Research Agenda

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OVERVIEW and OUTCOMES:

1. Objective

Community assessment of the value and future direction of ecosystem ecology: Energize the research agenda

2. Why?

The ecosystem is "a fundamental unit of organization of nature"

Ecosystem ecology is increasingly mechanistic

Cutting edge of ecosystem ecology is at the interface with other disciplines

Many of the 'grand challenges' in environmental science focus on ecosystems

Therefore, NSF- funded Workshop

3. Process

(a) Steering Committee planning meetings (many)

(b) Town Hall discussions and surveys at meetings of scientific societies:
ESA, LTER, ASM, AGU, SSSA, ISME,
ASLO (Japan and New Orleans)

(c) Final Workshop, SESYNC, Annapolis, MD

(d) Ethnographic assessment
(*Van Dolah et al., see outcomes*)

(e) Presentation of findings at meetings of scientific societies
(this is it!)

(f) Peer reviewed publication (forthcoming)

4. Data

(a) Text analysis of ~70 soapbox talks:
Systematic process of inductively and deductively coding text to identify themes and sub-level themes of frontiers.

(b) Compilation of 300 surveys:
Used to collect demographic information and feedback on frontiers presented in soapbox presentations. Data was used to compare emergent themes across a broader population.

(c) Reality checking (expert interviews)
In-depth interviews with 13 experts to validate findings from analysis of soapbox presentations and surveys.

5. Emergent Themes

Text analysis of soapbox presentations was used to identify a list of themes that emerged from three pre-defined categories: 1) F**rontiers 2) Capacity Building, and 3) Barriers**. These themes were identified through a systematic process of inductive and deductive coding of the text. The emergent themes are identified in the table below. The number of quotes associated with each theme are presented in parentheses.

Expert interviews validated these themes, but also provided the necessary context for explaining their relationship to one another, and the ways in which they contribute to or hinder advancements in ecosystem science.

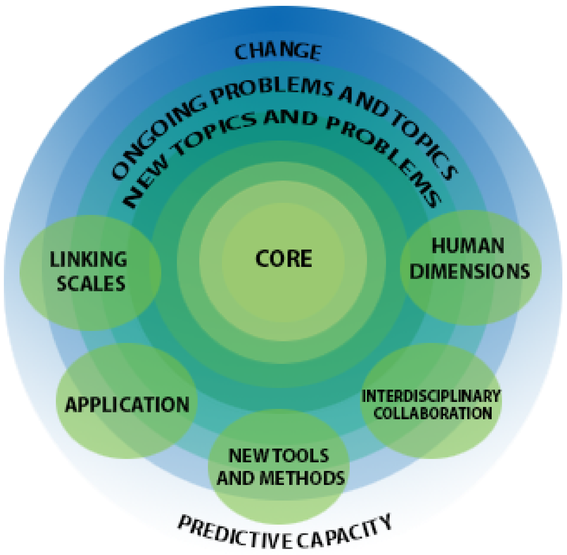
Frontiers: What research themes were identified as future investment needs?	**Capacity Building: What are the components needed to generate frontiers?**	**Barriers: What is preventing progress on frontier research?**
Better understanding of ecosystem process and function (33)	Cross-disciplinary collaboration (17)	Theoretical thinking is limiting (16)
Better understanding of drivers of ecosystem change (25)	Holistic approaches (17)	Fragmentation across ecosystem sciences (17)
Human dimensions of ecosystem science (16)	Data (13)	Data access and data synthesis (9)
Problem-solving/applied research (12)	Technology investment (12)	Not enough funding/support (7)
Enhance Prediction Capabilities (4)	Public support for research (7)	Solutions to Barriers (12)
	Training (4)	Opportunities to Overcome Barriers (14)

SURPRISES

6. Links between "the core" and "frontiers" are stronger than expected. Key components of frontiers include:

1. **Core Relevance:** *"Frontiers are jumping past the edge and then kind of working your way back … So you're really starting to jump to a new place and then build the bridge back to ecosystem science".*
2. **Linking Scales: "***They [frontiers] push us to think on larger scales. They push us to link – you know, to think more explicitly about why things may be functioning differently in one spot versus another spot."*
3. **Change:** *Climate change; anthropogenic change; resilience and tipping points; rates of change; events*
4. **Human Dimensions:** *human-nature coupled systems approach; urban environments; agricultural systems; collaboration with social sciences*
5. **Interdisciplinary Collaboration:** *"Ecosystem science is by nature interdisciplinary." Pushes disciplinary and theoretical boundaries; importance of team-based collaboration.*
6. **New Tools and Methods:** *enables new lens on/approaches to existing topics/problems; e.g., modeling, sensory technology, molecular, experimental tools.*
7. **Application:** *Must be translational for policy and management; transformational science is "use-inspired* and *fundamental"; important core goal of ecosystem science.*
8. **New Topics and Problems:** *push boundaries into "the murky" areas of science; emergent problems help develop theory of core*
9. **Ongoing Challenges and Topics:** *The core of ecosystem science remains frontier; unpack complexity to advance core*
10. **Predictive Capacity:** *enhancing prediction depends on expanding core understandings; develops relevance of science for forecasting and intercepting catastrophic change*

Conceptual Model of Ecosystem Science Frontiers:



The core of ecosystem science provides the foundational knowledge that bounds ecosystem science as a discipline, and defines the edges of knowledge as its currently understood. Frontiers expand the edges of the core in a ripple effect fashion, pushing outward in response to environmental change, emerging environmental problems and topics, and ongoing challenges in order to find new ways of making sense of complexity and developing a more holistic understanding of ecosystems. Without the foundation of the core, frontier research cannot sustain its transformation power.
Source: Van Dolah and Paolisso report.