Outline

1. Timeline and progress to date
2. Overarching question and conceptual premise
3. Conceptual models
   a. Ecological systems submodels
   b. Human systems submodels
   c. Integrated social-natural systems model
4. Implementation framework
5. Summary
6. Potential 2007 Funding Initiatives
New Timeline & Project Plan

- Proposal and program development phase
- June '05 - Infrastructure - Knowledge - Partners
- Conference Committee
- May '06 Sept '06 CC Mtg ASM
- NSF
- CI
- NEON

Sept '03 ASM
Exec Proposal G100 NSWGs
OVERARCHING QUESTION

How do changes in human populations and their behavior, climate variation, altered biogeochemical cycles, and biotic structure interact to affect ecosystem structure and function and their services to society?
OVERARCHING QUESTION

How do changes in human populations and their behavior, climate variation, altered biogeochemical cycles, and biotic structure interact to affect ecosystem structure and function and their services to society?

- Changes in human population density
- Redistribution of population nationally and locally
- Increased availability and distribution of limiting resources
- Altered biotic composition and structure
- Increased variability in environmental drivers (e.g. climate, sea level rise)
Central Premise

⇒ Human activities tend to be associated with changes in key resources and drivers (e.g., CO₂, nitrogen, H₂O, sea level rise).
⇒ These changes can be classified as either pulses (discrete events) and presses (continuous).
Central Premise

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⇒ These changes can be classified as either pulses (discrete events) and presses (continuous).
⇒ Individual species have evolved adaptations to capture and use resources and to respond to various environmental drivers.
⇒ Thus, changes in resource availability or environmental drivers are likely to have significant consequences for species interactions, community structure and ecosystem functioning.
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⇒ Individual species have evolved adaptations to capture and use resources and to respond to various environmental drivers.
⇒ Thus, changes in resource availability or environmental drivers are likely to have significant consequences for species interactions, community structure and ecosystem functioning.
⇒ Human social systems are also spatially and temporally dynamic, and also respond to [and cause] pulse and press events.
⇒ Social system drivers and dynamics (tax laws, regulations, preferences, behaviors) directly affect ecological processes.
⇒ Ecological processes have feedbacks that affect human social systems.
Approach

Establish a framework for an integrated long-term multi-site research program based on (anthropogenic) pulse-press interactions in ecosystems.

Press factor – variable or driver that is applied continuously at rates ranging from low to high (e.g., atmospheric nitrogen deposition, elevated CO2). Includes changes in rates (increases, decreases) relative to some historical baseline.

Pulse factor – variable or driver that is applied once or at periodic intervals (e.g., fire, extreme climatic events). Includes changes in the size, magnitude and frequency at which pulses occur.

Ecosystem functioning

1°/2° production, decomposition, nutrient cycling

Human behavior (society, policy, economics)

Biotic structure
rank-dominance curves, life-history traits

Ecosystem services
food, pest/disease control, erosion control, soil fertility

Long-term “press”
e.g., N deposition, species invasions, temperature

Short-term “pulse”
e.g., fire, storms

Conceptual Model

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food, pest/disease control, erosion control, soil fertility

Human behavior (society, policy, economics)

Long-term “press”

e.g., N deposition, species invasions, temperature

Short-term “pulse”

e.g., fire, storms

How do press & pulse disturbances interact to alter structure & the functioning of different ecosystems?

How is biotic structure both a cause and consequence of ecological fluxes of energy & matter?

How do changes in vital ecosystem services feedback to alter human behavior?
Ecosystem functioning

1°/2° production, decomposition, nutrient cycling

Biotic structure
rank-dominance curves, life-history traits

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Human component
On the Edge of the Exurbs

Over the next decade, New River is expected to grow to 4,800 housing units, and include a 200-acre town center with offices and commercial space. Today it has about 400 homes.

Demographics of buyers of KB homes in New River

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<th>INCOME</th>
<th>27%</th>
<th>35%</th>
<th>14</th>
<th>14</th>
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<tr>
<td>AGE</td>
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<td>Under 30</td>
<td>18%</td>
<td>23</td>
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<td>FAMILY TYPE WITH CHILDREN</td>
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<td>Married or living together</td>
<td>84%</td>
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<td>Married or living together</td>
<td>84%</td>
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</table>

Sources: KB Home, ORNL LandScan 2003, UT/Earth LLC. The New York Times; satellite image from DigitalGlobe via Google Earth
REGIONAL AND LOCAL ATTRACTORS:
- Water
- Cost of living
- Landscape Aesthetics/BD

FUTURES/OUTCOMES/SCENARIOS:
- Landscape, regional, continental
- Created by meeting of all stakeholders
- CONCEPTUAL MODELS

IMPLICATIONS:
- For: Eco Services, Biotic Structure, Policy and Economics
- E.g. Spatial/Temporal variation in fluxes of nutrients, water, temperature
- Conduct cross-site EXPERIMENTS (socioeconomic and ecological)
Model: Inter-Regional Population Distribution, Trade:
- water scarcity; landscape; climate; natural resource base for economy or quality of life; cost of living; regional economic policy; shipping access.

Observational/natural experiments/data on policy

Multi-site Ecology Experiments inform: landscape and biotic conditions.

Outcomes/Scenarios inform LTER/companion experiments; stakeholder/scientist futuring

Model: Local Population Distribution:
- Drivers: local water scarcity; transport, telecom, house cost; landscape to urban amenity gradient; biotic diversity; land use control, incentive policies.

Economic incentives/policy experiments affecting land use: fragmentation, nutrients, carbon, water

Implications: Spatio-temporal press and pulse disturbances or inflows to ecosystem
- range of nutrient concentration, location;
- Habitat fragmentation, invasion
- Water stresses
Socio-economic approaches

- Quantify regional scale vs. local scale drivers of human population redistribution and behavior.
- Contrast how attitudes and drivers of human population dynamics vary among regions.
- Catalogue impacts of population dynamics and decisions on ecosystem services and biotic structures.
- Develop ecological scenarios and present scenarios to stakeholders.
- Assess human perceptions, desires, and expectations for ecosystem goods and services.
- Determine how changes in ecosystem services feed back to affect population preferences, movement patterns, etc.
The Non-Human Component

**Ecosystem functioning**
- 1°/2° production, decomposition, nutrient cycling

**Ecosystem services**
- food, pest/disease control, erosion control, soil fertility

**Biotic structure**
- rank-dominance curves, life-history traits

**Human behavior**
(society, policy, economics)

**Long-term “press”**
e.g., N deposition, species introductions, temperature

**Short-term “pulse”**
e.g., fire, storms

**Ecological succession**
Long-term e.g., N deposition, species introductions, temperature

**Short-term** e.g., fire, storms

**Ecosystem services**
- food, pest/disease control, erosion control, soil fertility

**Biotic structure**
- rank-dominance curves, life-history traits

**Human behavior**
(society, policy, economics)
System Response Trajectories
A “punctuated equilibrium” model

Press (e.g. N deposition)

Organismal response

Community re-ordering

Community change

Time

Biotic Response
**System Response Trajectories**

Press (e.g. N deposition)

- Rapid community-level response
- Invasive species
- Pulse (e.g., fire)
- Organismal response
- Community re-ordering
- Community change
- Very resistant system

Time

Biotic Response
Ecological Approach

1. Observational:
   - Capture gradients and spatiotemporal variation: human-dominated, climatic, N-loading, etc.
   - Measure variables above in consistent, coordinated manner over long-term.
   - Inclusion of sites within and outside of LTER network.
Ecological Approach

2. Experimental

A. Manipulations:
   • press driver * pulse driver * biotic structure
     Ex: N deposition * fire/drought/storm * dominant taxa

B. Measurements:
   • coordinated & comparable response variables
   • scale-independent measures of community structure
     across trophic levels
   • some measure of connectivity among trophic levels
   • rates of primary & secondary production / community
     metabolism
   • system efficiency (retention & export of C, N, P)
Ecological Approach

3. Modeling

- Simulation models
- Conceptual models
- Forecasting/scenario models
- Economic models
- Human demographics and land use change models
Ecosystem functioning includes production, decomposition, and nutrient cycling.

Biotic structure is characterized by rank-dominance curves and life-history traits.

Human behavior, including societal, policy, and economic aspects, impacts ecosystems.

Ecosystem services provide benefits such as food, pest/disease control, erosion control, and soil fertility.

Long-term “press” events, such as N deposition and temperature changes, affect ecosystems.

Short-term “pulse” events, like fires and storms, have immediate effects.

Linkages between human behavior, ecosystem functioning, and ecosystem services include impact scenarios and management strategies.

Experimental and observational results help identify changes.

Linkages between human behavior and ecosystem services involve adaptive modeling, valuation, and forecasting.
Key Features

• Explicitly integrates social and ecological science.
• Iterative, interactive, and adaptive.
• Site-based and synthetic, can include participation by all LTER sites.
• Multi-site, coordinated.
• Includes both long-term and short-term research.
• Will take advantage of existing knowledge and strengths of the LTER network.
• Will expand beyond the existing LTER network.
• Will complement NEON and other networks.
• Will offer novel education and training initiatives.
• Will foster novel solutions to new CI challenges.
• Will yield information relevant to decision makers
• Does not come at a cost to existing site-based science.