1. Title and Summary:

Theories for Sustainable Futures; Understanding and Managing for Resilience in Human-Ecological Systems

A Proposal To National Center For Ecological Analysis And Synthesis
L. H. Gunderson, C.S. Holling, and G.D. Peterson
University of Florida, Gainesville, Florida, USA

This proposal seeks support to prepare materials and conduct a short course at NCEAS, on the subject “Theories for Sustainable Futures: Understanding and Managing for Resilience in Human-Ecological Systems”. We propose to hold two meetings at NCEAS and locate a post-doctoral position there to help develop models and interactive material for the world wide web. The first workshop will bring together an interdisciplinary group of scholars (ecologists, mathematicians, economists, sociologists and political scientists) to produce a book and a set of Internet-web products. Those products will serve as the set of materials for the second NCEAS activity; a course on understanding and managing ecological systems that will be designed for a multi-disciplinary group of graduate students, and advanced resource practitioners.

2. Problem Statement:

As the human footprint on Planet Earth grows larger, practitioners seek sustainability and scholars seek understanding in an increasingly complex and ever-changing world. At the interface between theory and practice lie myths and models. These constructs are the conduits that move theory to practice. Witness the power of the logistic growth model in renewable resources management or as the underpinning of the many policies and actions seeking sustainability. This proposal will explore assumptions and constructs underlying models, of change in ecosystems, institutions and economies. These models attempt to describe and explain the patterns that are found in our complex world that is composed of surprises, non-linearities and discontinuities.

Three fundamental themes guide our exploration. One emerges from the mathematics of stability, resilience and change (Holling, 1973; Ludwig et al, 1978; Ludwig et. al. 1997). These studies have begun to identify where to look for measurable evidence of resilience and to help discover conditions which indicate qualitatively different types of stability loss—to explain reversibility and irreversibility in ways that have relevance for both economies and ecosystems.

The second theme recognizes that in nature ecological processes interact across scales. These cross-scale interactions range from micro-scale process, such as photosynthesis, that occur at daily at the scale of centimeters, through meso-scale disturbance processes that shape landscapes over kilometers and decades, to macro-scale processes, such as geomorphological processes, that occur over hundreds of kilometers and millennia. Cross-scale interactions also occur in human affairs from
the individual, to the community, to the nation and region, to international patterns of relationships. When the scales of human affairs become decoupled from those of nature, signals of change are eliminated and the learning that such signals can generate begin to wither.

The third theme is one of adaptive change and learning. Cycles of slow accumulation of natural and cultural capital—in ecosystems or societies—are interspersed with rapid phases of reorganization when, for transient moments, novelty can emerge and restructure a system organization (Gunderson et al. 1995). The creation, maintenance and destruction of novelty is one of the least-developed themes in ecology, economics or the social sciences, but its identification and refinement is a necessary foundation for identifying sources and sinks for novelty and renewal.

We propose a set of activities and products which will address these themes by attempting to synthesize the theories and models that underlie patterns of discontinuous structures and cross-scale dynamics in ecological systems with theories and models of change used by other disciplines (including economics, political science, other social sciences, and applied mathematics). This comparison will seek understanding by highlighting the underlying assumptions of these theories, identifying areas of incompleteness and locating theoretical disagreements. Ecological practitioners will be involved, both to challenge these theories, and to discuss how these theories could be utilized and tested in an ever-changing and surprising world. Results of the synthesis will be presented in the form of a book, a series of web-based teaching materials and a short course for graduate students and management professionals.

3. Rationale for NCEAS support

We seek a partnership in supporting the proposed activities. One partner is the "Resilience Network"—enabled by a grant from the MacArthur Foundation to the University of Florida and Beijer International Institute for Ecological Economics. The Resilience Network is an interdisciplinary program to advance theory, policy and practice for the resolution of issues that emerge from the interaction between people and nature. A research component of the Network seeks to understand how economic growth and human development depend upon resilience in ecosystems and flexibility in institutions. A policy component seeks ways to monitor and to maintain those attributes or, if they have been eroded, to restore them. The second partner is the Santa Fe Institute—a leader in development of complex systems theory which is seeking to expand and enrich those theories into ecologic and social systems. The third partner is NCEAS—as a site for collaborative modeling and synthesis, and as a nexus of innovative development for web-based instructional tools.

This three-way partnership provides intellectual and financial synergy among the organizations. Core research is funded by the Resilience Network, with synthesis enabled via the NCEAS workshop and short course. A proposal is also being sent to
Erica Jen, Research Director at SFI, covering another facet of resilience studies; “The Political Economy of Ecological Resilience”. The SFI proposal also seeks support for critical contributions to the NCEAS synthesis and course material. Hence, this proposal is seen as a bridge between ecologists and theorists from other disciplines.

4. Proposed Activities and Timetable

Synthesis Workshop. We propose to hold a workshop at NCEAS (late 1998) to discuss, critique and synthesize material among disciplines. That workshop will involve senior authors of a proposed book (see anticipated results) and produce a rough draft of the book to be submitted to a publisher.

Development of Web Instructional Material. The synthesis workshop will also be used to outline and design a set of web based materials that will enrich and complement the hard copy output. For example, computer animations would be developed to help explain key points and dynamic patterns across disciplines. Another effort would put key families of space/time models on the web, so that users could explore complex dynamics in ecologic systems. The output and models, as described above, would be posted on the web as a set of interactive teaching tools. The development would be overseen by staff at NCEAS and directed by a post-doctoral associate (Garry Peterson). We envision a post-doc term of two years; joining NCEAS prior to the first workshop, and staying after the short course to distribute course materials.

Short Course. The book and web material will be used in a two-week short course to be held at NCEAS, during 1999. The course will be open to graduate students and resource professionals, in a wide range of disciplines. The book and web material will be widely distributed.

5. Anticipated Results and Beneficiaries

Anticipated results include a set of materials for the short course on understanding and managing for change in complex, adaptive systems. That material is described in the following sections on a) web-based instructional resources and b) as chapters in a book, tentatively entitled "Myths, Metaphors and Models of Change". This material will also be of general interest and use to a wide community of scholars and resource practitioners.

a) Web based instructional material such as;
   * Graphic material - charts, animations from book chapters,
   * Instructional, interactive material (electronic workbooks)
   * Models - web software to build and use
   * Web hyperlinks to: i) set of recommended readings, ii) on-line policy dialogues that discuss key papers/topics and iii) other nodes in Resilience Network
b) Book: "Myths, Metaphors and Models of Change: Understanding Resilience in Ecologic and Social Systems"

Section I. Theories of Change
- Resilience in Ecosystems, Flexibility in Economies and Adaptive Capacity in Institutions (Gunderson, Holling, Pritchard and Peterson)
- A Complex View of Economics (Pritchard and Peterson)
- Hierarchies and Panarchies in Ecological and Social Systems. (Holling, Gunderson and Peterson)
- Organizational Panarchies, Mapping organizational theory and insight into cross-scale interactions (Westley)
- Hierarchy (reprint-Simon)
- Functional Diversity and Ecological Resilience (Peterson, Allen and Holling)
- Sources and Sinks of Evolutionary Novelty (Kinzig)

Section II. Models of Change
- Models and Metaphors of Resilience (Ludwig, Walker and Holling)
- Trajectories of Development; Using complex theories to understand development patterns (Gallopin and Brock)
- A taxonomy of shifting stability domains: bifurcations in ecologic, economic and social systems (Scheffer, Brock and Westley)
- Interdisciplinary Modeling: Non-Point pollution (Carpenter, Brock and Ludwig)
- Quantitative Analysis of Resource: the Spruce Budworm (Ludwig, Jones and Holling)
- Simples models of Adaptive Choice in Complex Worlds (Holling, Dill)
- Models and Metaphors of the Adaptive Cycle (Brock and Peterson)
- Diversity and Discontinuities in Ecologic and Economic Systems (Allen, Perrings and Brock)

Section III. Linking Theory to Practice
- Challenges for Adaptive Management (Walters)
- Transitions from Paradise Lost to Paradise Gained (Pritchard, Folke)
- Institutions and Remembrance (Folke)
- The Political Ecology of Resilience (Sanderson and Pritchard)
- Planning for Resilience: Scenarios, Surprises and Branch Points (Gallopin)
- Local Control and Resource Exploitation-- another Iron Triangle (M.Gadgil)
- Cultural Theory and Perspective on the Future (Marco Jansen)
- Synthesis: Why are systems of people and nature not just ecosystems, institutions or economies? (Carpenter, Westley and Gunderson)

c) Partial List of Participants for NCEAS project.

Craig Allen  
Dept. Of Wildlife  
Univ. Of Florida,  
Gainesville, FL, USA

William(Buz) Brock  
Dept. of Economics  
University of Wisconsin  
Madison, Wisconsin, USA
Steven Carpenter  
Center for Limnology  
University of Wisconsin  
Madison, WI, USA  

Carl Folke  
Systems Ecology, Univ. Of Stockholm,  
Stockholm, Sweden  

Gilberto Gallopin  
Stockholm Environmental Institute  
Stockholm, Sweden  

B.O. Janssen  
Systems Ecology, Univ. Of Stockholm,  
Stockholm, Sweden  

Ann Kinzig  
Dept. of Ecology and Evolution  
Princeton University  
Princeton, NJ, USA  

Don Ludwig  
Univ. Of British Columbia  
Vancouver, B.C., Canada  

Lisa Naughton Treves  
Dept. of Geography  
Madison, WI USA  

Lowell Pritchard  
Tropical Conservation and Development  
Stockholm, Sweden  

Steve Sanderson  
Vice President for Arts and Sciences  
Emory University  
Atlanta, GA, USA  

Marten Scheffer  
Inst. Inland Water Mgt. & Waste Water Treatment, RIZA  
The Netherlands  

Frances Westley  
McGill University  
Faculty of Management  
Montreal, Canada  

Literature Cited  

6. Budget  
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Expenses
(Visitor days x $140.00) $8820 $14,000 0

Salary *** 2 years
(for Center Fellows)

Other expenses 0

*** Postdoctoral Associate applicants need not supply a budget; salaries and expenses are fixed

7. Keywords Worksheet:
1. Organizational Focus: Global
2. Regional Focus: Global,
3. Ecological Theme: Complex Systems, Ecological Economics, Biodiversity
4. Taxonomic Group: None
5. Methods: Statistical modeling, Simulation, Visualization
6. Research Application: ecosystem management, environmental policy, pollution
7. Biomes: Terrestrial, Freshwater Aquatic, Wetlands

8. Curriculum Vitae of Project Leaders

Lance H. Gunderson
Current Address: 110 Bartram Hall
PO Box 118525
Dept. of Zoology,
University of Florida,
Gainesville, Florida, 32611-8525
phone: 352-392-6914
fax: 352-392-3704
e-mail: gunderson@zoo.ufl.edu

Current Position:
1997- Assistant Research Professor, University of Florida.

Education:
B. S. Botany, 1975.
M.S. Botany, 1977.
Relevant Publications:


Crawford Stanley Holling

Current Address: 111 Bartram Hall
P. O. Box 118525
University of Florida
Department of Zoology
Gainesville, FL 32611
Phone: (904) 392-6917
FAX: (904) 392-3704
e-mail:holling@zoo.ufl.edu

Current Position: Eminent Scholar
Arthur R. Marshall Jr. Chair in Ecological Sciences
Dept. Of Zoology, University of Florida

Education:
B.A., University of Toronto, Honours Biology, 1948-1952
M.Sc., University of Toronto, Zoology, 1954
Ph.D., University of British Columbia, Zoology, 1957

Relevant Publications:


Garry D. Peterson

Current Address: PO Box 118525
Dept. of Zoology,
University of Florida,
Gainesville, FL 32611
phone: (352) 392-6913
fax: (352) 392 3704
e-mail: garry@zoo.ufl.edu


Education:
1986-1991 University of Waterloo
BASc, Systems Design Engineering, 1991
1989 Exchange student, Social Systems Engineering, University, Japan,
1992 Complex systems summer school, Santa Fe Institute.
1991-1994 University of Florida,
MSc, Environmental Engineering Science, 1994
1994- University of Florida
PhD, Zoology, (anticipated in 1998).

Awards
NASA Earth Systems Science Fellowship 1996-
Post-Graduate Scholarship
British Columbia Provincial Scholarship 1986-1987
Stewart Memorial Scholarship 1986-1987

Professional Experience:
Research Assistant, Tropical forest simulation, Environmental Policy Institute, U. of Florida, Fall 1991.
Co-op student, Medical imaging, ISG Technology, Toronto, Summer 1990.
Co-op student, Medical imaging, Teijin Systems Technology, Osaka, Fall 1989.
Co-op student, Network simulation, Bell-Northern Research, Ottawa, Spring 1989, Summer 1988, Fall 1987.

Publications:

Invited Talks:
Peterson, G.D. Cross-Scale Ecological Dynamics. Scaling from Site-Specific to Global Model Grids, Aspen Global Change Institute, July 7-17, 1997, Aspen, CO.

Talks at Scientific Meetings:
Peterson, G.D. Emergent Discontinuous landscape dynamics in the Canadian Boreal Forest. At the Ecological Society of America 1995 annual meeting, July 30- August 3, Snowbird, UT.
Peterson, G.D. Fires and Forests: emergent discontinuous landscape dynamics. At the Tenth U.S. Landscape Ecology Symposium, April 22-26, 1995, Minneapolis, Minnesota.

Posters at Scientific Meetings:

Peterson, G.D. Forest history, fire spread, and climate change. At the Ecological Society of America 1996 annual meeting, August 10-14, Providence, RI.


Other Experience:
Co-editor: Young Scholar’s Dialogue in Conservation Ecology
Supervisor of undergraduate research:
  Relationship of landscape structure to mammal community structure. Spring 1996.
Co-organizer of Eco-lunch student weekly seminar series. Fall 1996-Fall 1997.

Languages:

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9. For Postdoctoral Associate applicants
3 letters of reference for Garry Peterson will be sent as separate document.