NCEAS

National Center for Ecological Analysis and Synthesis

2003
Report to the National Science Foundation

1. Participants

O.J. Reichman, Director PI

Sandy J. Andelman, Deputy Director Co-PI

Mark Schildhauer, Director of Computing

Partner Organizations

Matching funds have been provided by the University of California ($ 500,000) and by the University of California, Santa Barbara.

The Andrew W. Mellon Foundation has provided funding to support three postdoctoral researchers: Sarah Gergel, Helene Muller-Landau and Diego Vazquez. Their research activities are described in the following section. In addition, the Mellon Foundation has made awards to NCEAS totaling approximately $1,150,000 to support informatics research at NCEAS.

The California Resources Agency is supporting an NCEAS working group (approximately $400,000) to develop a systematic conservation planning approach for the State (see Working Group on Systematic Conservation Planning and California Legacy Program in the following section).

Other Collaborators

Christopher Pyke is a postdoctoral fellow at NCEAS, supported by a David Hamilton Smith Fellowship from The Nature Conservancy.

To facilitate informatics research and to support the informatics needs of the ecological community, NCEAS has formed a research partnership with three other organizations: San Diego Super Computer Center, University of Kansas and University of New Mexico (LTER Network Office).

2. Activities and Findings

Science Advisory Board

For our August, 2002 deadline, we received 31 proposals for 39 activities: 11 postdoctoral fellowships; 5 sabbatical fellowships; and 20 working groups, 1 meeting, and 2 graduate student fellowships. The Science Advisory Board met September 18-19, 2002, to review these proposals and decisions were made to support 2 postdoctoral fellowships; 3 Center Fellows (sabbaticals); and 4 working groups.

For our January, 2003 deadline, we received we received 49 proposals for 53 activities: 24 postdoctoral fellowships; 6 sabbatical fellowships; and 23 working groups. The

Science Advisory Board met March 5-6, 2003 to review these proposals and decisions were made decisions to support 4 postdoctoral fellowships; 2 Center Fellows (sabbatical); and 4 working groups. A list of Science Advisory Board members is available on the NCEAS web site: www.nceas.ucsb.edu.

Major Research Activities

During the reporting period, August 1, 2002 through June 30, 2003, NCEAS supported 7 sabbatical visitors and 19 postdoctoral researchers. Of these, two postdoctoral researchers were supported with funding from the Andrew W. Mellon Foundation and one postdoc was supported with funds from NSF's Knowledge and Distributed Intelligence Program for the Knowledge Network for Biocomplexity. A list of sabbatical and postdoctoral researchers, including descriptions of their projects is provided below. During the past year, NCEAS postdoctoral scientists have accepted faculty positions at Arizona State University, San Diego State University, Washington State University, University of Calgary, University of Toronto and Yale University. One postdoc accepted a research position at University of California, Davis and one has an offer of a faculty position at University of British Columbia and currently is negotiating.

During the reporting period, 579 different scientists participated in activities at NCEAS (796 total visits). NCEAS supported 51 working group meetings, representing the activities of 32 different working groups, and 6 meetings. Fifteen of these working groups focus on issues of immediate relevance to resource managers and policy makers, and these are highlighted in a separate section below.

Sabbatical Fellows and Visiting Scientists:

Mark Burgman Sabbatical Fellow
07/01/2002-06/30/2003
Setting priorities and making decisions for conservation risk management
Risk-based decisions are made routinely in medicine, toxicology, engineering, psychology, insurance and finance. The development of methods in these fields has been rapid but the paths followed and the tools developed have been different. To some extent the differences reflect the kinds of data and the range of problems people need to solve. In part, the differences are because methods have grown in relative isolation. A common problem facing practitioners in conservation biology is to identify priorities that discriminate among a suite of alternative actions. Biologists make decisions on a routine basis, but with little understanding of the techniques for decisions involving risk. The kinds of questions conservation biologists are obliged to answer will benefit substantially from advances in decision analysis and risk assessment made in other disciplines. This project will develop and expand the toolkit for problem solving available to conservation biologists by reviewing risk-based, priority setting methods in different fields, and bringing together people from different disciplines to examine the problems confronting conservation biologists, resulting in new approaches to finding solutions to priority setting and decision making problems.

Cliff Cunningham Sabbatical Fellow
09/01/2002-06/30/2003

The North Atlantic Project: Comparative Ecology of the Temperate Northwestern and Northeastern Atlantic Benthic Communities

Although it is one of the best-studied oceans in the world, many aspects of temperate North Atlantic marine community ecology await synthesis and research coordination. During a fellowship year at NCEAS I will work to: (1) Synthesize available information on the distribution and abundance of closely related populations that exist on both sides of the temperate North Atlantic (trans-Atlantic species). This will include compiling a list of temperate trans-Atlantic species, along with all available information on their life history. (2) Synthesize available information comparing the ecology and relative species abundance of the temperate NW and NE Atlantic nearshore communities. (3) Encourage American and European field ecologists to design and carry out coordinated experiments on both coasts of the temperate North Atlantic.

Kay Gross Sabbatical Fellow
11/01/2002-06/30/2003

Developing a predictive framework for the maintenance and restoration of native plant diversity in grasslands

As a sabbatical fellow at NCEAS I plan to work on the synthesis and integration of data from several field projects in which I have been examining the factors that influence the composition and diversity of plant species in grassland-savanna communities in SW Michigan. My goal is to determine how spatial patterns of heterogeneity in resources and species pools influence these patterns and how to translate these results into an understanding of determinants of species diversity across communities and environmental gradients.

Per Lundberg Sabbatical Fellow
09/01/2002-06/30/03

Dynamics of large mammalian herbivores in changing environments: Alternative modeling approaches

The world's populations of large herbivores have shown dramatically different dynamics during the last two decades. The abundance and distribution of some ungulate species has declined abruptly, while other species have become excessively abundant, and still others have shown complex, oscillatory dynamics. These patterns seem to result from a composite of influences, including those operating at global and local scales. Conventional population models are rooted in assumptions about steady state and do not adequately incorporate environmental variability. We propose a working group that will exploit data sets and expertise from different regions to develop new models of ungulate population dynamics, capable of accommodating the complexity of environmental interactions at different spatial and temporal scales.

Gary Mittelbach Sabbatical Fellow
11/01/2002-06/30/2003

Determinants of Species Diversity at Varying Spatial Scales

Understanding the factors that determine species diversity at varying spatial scales is fundamental to the management and preservation of biodiversity. I would like to spend 9 months of my upcoming sabbatical (Sept. 2002-June 2003) at NCEAS working on three projects that examine the processes regulating species diversity at geographical scales ranging from local communities to cross-continental patterns. The first of these projects examines one of the fundamental mechanisms thought to regulate species diversity within a local community - the extent of spatial heterogeneity in resource availability and the richness of the regional species pool. To examine these mechanisms, I will analyze three years of field data from an experimental manipulation of soil nutrient heterogeneity and regional species pools on the diversity of plant species in a prairie savanna community. Results from this study will be synthesized relative to other studies that have manipulated soil nutrients, plant productivities, and species pools. In the second project, I will be examining the importance of climate and available energy in determining patterns of species richness across very broad spatial scales (e.g., continents). This work will be conducted as part of an ongoing NCEAS working group in "Energy and geographic variation in species richness". The above projects focus on ecological mechanisms thought to regulate biodiversity at varying spatial scales. Differences in species richness between geographical regions or biomes (e.g., tropics versus temperate zone), however, are ultimately determined by differential rates of evolutionary diversification (speciation minus extinction). Therefore, the third project I want to undertake while on sabbatical is to examine how differences in species diversity between the tropics and temperate regions (i.e., the latitudinal gradient) may be generated by differential rates of evolutionary diversification. In addition to these three research projects, I plan to participate in the NCEAS-based Knowledge Network for Biocomplexity (KNB) graduate seminar series on scale-dependent patterns in biodiversity.

Patricia Moehlman Sabbatical Fellow
10/01/2001 – 09/30/2002

The Evolution of Cooperative Breeding in Canidae:
Implications for Extinction Risk

Family Canidae is composed of approximately 36 species. Seven of these species are extinct or threatened with extinction. These seven species all have a mean body mass of over 13 kilograms. Why do larger canids apparently face a higher extinction risk? This book will examine the role of body mass and ecology in the evolution of cooperative breeding in Family Canidae and the implications for population viability. Long-term research on a medium sized canid, e.g. jackals, will provide data sets on kinship, territory tenureship (survival), and relative reproductive success that allow graphic modeling of alternative reproductive tactics. These data will also allow estimates of population viability that include individual, temporal, and spatial variation. The book will then broaden its scope to examine the allometry of canid life history traits and the evolution of cooperative breeding. The final section of the book will search for patterns that examine how some canid species may be limited by their ecology and food resources and also constrained by their reproductive options. A model will be developed that incorporates body mass, kinship, demography, and ecology to assess how these factors affect alternative canid reproductive tactics. Such a model has the potential to elucidate why larger canids experience higher risk of extinction.

Will Wilson Sabbatical Fellow
07/01/2002-06/30/2003
A Broad Look at Organismal Interactions: Linking Intraspecific Social Interactions to an Interspecific Resource-Consumer Framework
Three areas of ecological research have traditionally been considered distinct: resource--consumer processes, behavioral ecology, and the study of social interactions that lead to animal grouping. Recent work has demonstrated that animal grouping can emerge within a spatial resource-consumer model. Such a connection between these two areas provides an ideal situation for linking social interactions between individuals to an individual's resource gathering. This connection enables the general study of the overall selection on an individual possessing both foraging and social behaviors. The sabbatical work proposed here will build upon these results and combine these three areas into one synthetic framework for theoretical analysis. The overall goal is to understand the evolutionary stability of social interactions, and discover under what situations different types of social interactions should be expected. The tangible results of this work will be a book summarizing the empirical and theoretical literature of these three areas, and synthesizing these areas into a single theoretical framework that may provide a roadmap for future research. Simulation code developed for this work will also be made freely available over the Web.

Postdoctoral Fellows:

Peter Buston Postdoctoral Fellow
10/01/2002-9/31/2003
The Ecology of Hermaphroditic Breeding Systems
There is an enormous diversity of hermaphroditic breeding systems distributed throughout the plant and animal kingdoms. To gain a greater understanding of this diversity, I propose to investigate the socio-ecological factors that underlie the evolution of these systems. First, I will develop new game-theoretic models, to generate explicit predictions about how ecological, social, and genetic factors combine to influence the distribution of reproduction within the breeding systems of both sequential and simultaneous hermaphrodites. Second, I will synthesize the extensive, but scattered, empirical literature on plant and animal (vertebrate and invertebrate) hermaphroditic breeding systems, gathering data on the socio-ecological factors that theoretical models indicate might give rise to these systems. Third, I will use this database, in conjunction with the comparative method, to test the alternative models, and determine which factors are indeed the key determinants of the different hermaphroditic breeding systems. The research will provide a comprehensive socio-ecological framework within which the breeding systems of all hermaphrodites can be understood. The work is important because understanding the breeding system of a species can be the key to effectively managing and conserving its populations

Karl Cottenie Postdoctoral Fellow
02/01/2003-01/31/2004

Local versus regional processes: Integrating space and environment

Both local and regional processes can structure local communities, however, their relative roles are poorly understood. The classical methodology used to determine their relative importance is to examine the shape of the relationship between local and regional diversity. However, this approach has been criticized on several conceptual and methodological grounds. This proposal aims to integrate local (biotic and abiotic) and regional (spatial) information, using three novel research methodologies. These will be applied on a range of data sets, starting with zooplankton, but expanding to other aquatic taxa and terrestrial systems. Moreover, I will extend the methodology to genetic data, in order to make a direct comparison between processes working at the interspecific and intraspecific levels. The results will elucidate the processes that generate structure in populations and communities.

Sharon Cowling Postdoctoral Fellow
09/15/2000-09/30/2002

The Carbon Balance of Eurasia and North America

Ecological time series across large spatial and temporal scales are essential for resolving and understanding anthropogenic and natural sources of variability and change in the oceans and prediction of their consequences. However, virtually all marine ecological observational records are too short or infrequent for useful time series analysis, so that prediction of ecological responses to further perturbations is difficult or impossible. Paleoecological, archeological and historical data (hereafter referred to as paleo data) are the only hope for obtaining the necessary long-term perspective. Paleo data are necessarily descriptive rather than experimental, and differ from most observational ecological data in terms of the parameters measured and the common use of geochemical and paleontological proxies to estimate environmental and biological change. Consequently there is much misunderstanding and suspicion of the potential rigor of paleo data among ecologists that hinders their application to help solve ecological problems. The purpose of the proposed working group is to critically examine the potential of paleo records to extend marine ecological time series through a series of concrete examples.

Perry de Valpine Postdoctoral Fellow
09/01/2000-09/30/2002

Analysis of Insect Population Data With Structured Population Models

Agricultural pest control relies on understanding complex communities of herbivores and their natural enemies. Field experiments of agricultural communities have produced voluminous multi-species, spatiotemporal population data. However, conventional data analysis uses model frameworks that lack biological structure and thus are only indirectly related to the hypothesized processes of birth, death, predation and movement. This project will use population models to analyze extensive existing data from three agricultural insect communities and one protist microcosm experiment. The questions for each system are 1) Is there evidence for particular movement behaviors? 2) Is there evidence of particular species interactions? The study systems are 1) pea aphids and natural enemies in Wisconsin alfalfa, 2) cotton aphids, other herbivores, and natural enemies in California of cotton, 3) whiteflies and natural enemies in Arizona cotton, and 4) protist predator and prey in laboratory microcosms. For each system I will develop structured population models, fit the models to data under the null and alternative hypotheses, make statistical hypothesis tests, biologically interpret the conclusions, and test the power and biases of the entire procedure. This project will evaluate important ecological hypotheses that have previously been inpenetrable to statistical analysis and develop and test new analysis tools for future research.

Sarah Gergel Postdoctoral Fellow
09/01/2000-05/31/2003
Protecting Water by Conserving Land:
The Importance of Spatial Arrangement in Influence Ecosystem Processes
Strategic placement of restored wetlands can reduce sediment and nutrient inputs to aquatic systems, attenuating the effects of agricultural conversion. While the role of riparian buffer strips for controlling sediments and nutrient runoff is established, the benefits of strategic placement of conserved land in the rest of a watershed is poorly understood. I will create watershed models of select ecoregions to determine the optimal spatial arrangement of land in an entire a watershed for minimizing sediment and/or nutrient runoff. This work will address a fundamental question of ecology, "When does the spatial arrangement of habitats matter for the functioning of ecosystem processes?" and will provide critical information for managers regarding strategic land acquisition.

Bill Langford Postdoctoral Fellow
02/01/2002-01/31/2004
Evaluation Functions for Ecological Image Segmentation
This project examines and enhances various forms of evaluation functions used in the comparison and optimization of image segmentation algorithms. It defines quantitative criteria for definition of the evaluation functions and uses them in the design and selection of these functions. It also investigates the relationship between errors in landscape pattern metrics and segmentation and classification algorithms. Finally, it coordinates the creation of a repository of correct segmentations of aerial and remotely sensed ecological imagery to improve algorithm development by making rigorous comparison of algorithms possible.

Helene Muller-Landau Postdoctoral Fellow
01/01/2002-12/31/2003
Landscape-scale variation in forest communities and the distribution of tree life history strategies
Tree species vary greatly in their life history strategies, exhibiting variation in their seed size, growth rate, life span, fecundity, and many other characters. The distribution of strategies within a forest affects community structure and dynamics, including successional patterns of species turnover and biomass accumulation, spatial patterns of species occupancy, and resilience to disturbance of various kinds. Landscape-scale variation in factors such as the length of the growing season, nutrient availability, and

disturbance regime influences the distribution of tree life history strategies found within local communities. I propose to use new analytical techniques to estimate the distribution of life history strategies within communities from existing data on tree species composition and species characteristics for as many tropical and temperate forests as possible. Then, I will analyze differences in the distribution of life history strategies between communities, and their associations with climatic and other factors. In parallel, I will continue theoretical work on the evolution of life history strategies within communities. The overall objective is to contribute to a better understanding of the distribution of tree life history strategies within and among communities, and of the implications for forest structure and dynamics.

Jill Murray (formerly Schmidt)   Postdoctoral Fellow
03/05/2001-03/04/2004

Bridging Microbial and Theoretical Ecology to Investigate Cooperative Strategies in Bacteria

Microbiologists have recently become equipped to identify the taxonomy of bacteria in situ, understand phylogenetic relationships among groups, and assay gene expression in individuals, a development that parallels the explosion of natural-history studies by general ecologists a century ago. One of the most exciting recent discoveries is that bacteria engage in extensive chemical signaling and density-dependent behavior, some of which appears to involve cooperative adaptive strategies. Paralleling early ecologists who studied cooperation, microbiologists have not yet developed rigorous theory to test these ideas. Because theoretical and microbial ecology have developed with little interdisciplinary crossover, microbiologists have not capitalized on the existing framework that is now available to investigate cooperation in higher organisms. The gap between empirical microbiology and quantitative theoretical ecology is a common theme that must be addressed as microbial natural history unfolds. I aim to work at the interface of the two fields; my goal is to learn if and how cooperative strategies play a role in the spatial distributions of bacteria in nature. This work will involve predictive numerical and simulation modeling of microbial foraging strategies and their resulting spatial patterns, developed to enable discrimination amongst modes of selective pressure in future experimental tests. A mechanistic understanding of adaptive strategies in bacteria is essential to the understanding microbial food webs, bacterial infections, biogeochemical cycles, and the bioremediation of contaminated habitats. The scaling of ecological theory to microscopic proportions will also benefit general ecology, as long-standing questions can be tested in microbial systems that can be modeled almost perfectly and tested over relatively vast spatial and temporal scales given the sizes and generation times of bacteria.

Christopher Pyke   Postdoctoral Fellow
12/05/2000-09/09/2002

Climate, ecosystems, and land-use: Understanding environmental variability in human-dominated landscapes

Environmental variation creates both risk and opportunities for conservation. The implications of environmental variation in any particular situation vary depending on climatic processes, ecosystem responses, and land-use patterns. Consequently, it is

necessary to understand potential interactions between these factors in order to design conservation strategies that use variation to reduce risk and take advantage of opportunities to increase species persistence. Informed action can offset the natural tendency for risk from environmental variation to increase as the total amount of habitat in a landscape decreases. The proposed research addresses this issue by: (1) simulating how climate, ecosystems, and land-use interact over time to change patterns of environmental variation, and (2) applying this framework to evaluate risks faced by vernal pool ecosystems in the Central Valley of California. The results of this work will help conservationists develop better tools for reserve design, understand processes underlying patterns of environmental variability, and manage local vernal pool landscapes to reduce risks associated with landscape and climate change.
Christopher Pyke is supported by a David Hamilton Smith Postdoctoral Fellowship from The Nature Conservancy.

Helen Regan Postdoctoral Fellow
12/04/2000-12/03/2002
Developing and testing methods for classifying species conservation status and estimating extinction risk
Decisions about species conservation status have critical implications for allocation of public and private funding, land use planning decisions, and regulatory actions. Currently, a broad range of methods is used to classify species conservation status at a variety of geographic scales (e.g., local, national, international). Different methods produce very different results, yet there is no rationale or benchmark for judging their adequacy or appropriateness. Existing systems also are incomplete because they lack rules that allow decisions to be made when the data are uncertain. No systematic testing of any such system has been undertaken. In this project, we will synthesize and evaluate existing protocols for classifying species conservation status applied in the United States, Australia, and internationally. We will measure their performance in three ways: first, by comparing the classifications resulting from individual protocols with assessments of extinction risk from detailed population and metapopulation studies for specific species; second, by comparing classifications with simulations of hypothetical species for which ‘true’ underlying dynamic processes are known; and third, by comparing classifications with the conservation outcomes for a large number of existing species, for which some populations have gone extinct. The synthesis of these lines of evidence will allow us to evaluate critically the current techniques, and to recommend new approaches and testing procedures.

Shane Richards Postdoctoral Fellow
12/05/2000-09/09/2002
Spatial Ecology of Infectious Disease
The ecology of infectious diseases is receiving increased attention from both public health officials and traditional population biologists. It is clear that the ability to predict and forecast disease outbreaks will require a greater understanding of spatial dynamics and the analysis of spatial patterns of spread. The goal of this Working Group is to analyze large spatial data sets of disease occurrence and spread drawn from natural, agricultural, and public health databases. By comparing the spatial ecology of disease

across these different systems we hope to arrive at some basic generalizations about spatially-dependent disease dynamics.

Cheryl Schultz Postdoctoral Fellow
03/01/1999-12/31/2002

Managing Natural Areas: How Do We Select Among Land Management Options?

Land management will be a pivotal conservation issue in the coming decades as we begin to face the mounting problems of how to manage land that has recently been set aside in parks and reserves. Whereas much ecological theory has been applied to reserve design and reserve siting (island biogeography, e.g. Williams 1984; viability models, e.g. Armbruster and Lande 1993; metapopulation models, e.g. McCollough 1996), virtually no theory has been applied to "reserve management." I propose to seek generalizations from two standpoints: by looking for general lessons that emerge from a synthetic analysis of current land management activities and by searching for ways simple decision theory can help reserve managers choose among potential management strategies. The first focus will include an assessment and synthesis of current land management techniques (e.g. burning, flooding, weeding, and restoring), and a meta-analysis of the success of well-documented management actions. For the second approach, I will examine general theories and ask whether they are pertinent, or whether specific models can ever be pertinent. It is important to emphasize that issues in reserve management may be so particular to local natural history that they offer little guidance. I do not intend to go into this project with the objective of finding a "universal theory" but rather with the objective of looking for avenues where theory will provide helpful perspectives. The practical outcome of this part of the investigation will be using a decision theory framework to build a simple interactive simulation model to look at the relative benefits of one management strategy over another.

Eric Seabloom Postdoctoral Fellow
06/01/1997-05/31/2004

Effects of plant-community composition on animal movement

The evolution of behavior and plant-community dynamics are two seemingly disparate elements in ecology. However, the movement of animals through a landscape can have strong impacts on the competitive coexistence of various plant life-history strategies, and the distribution of resources can alter animal-movement patterns. Accordingly, animal behavior and plant-community dynamics can be inextricably linked by the influence of animal movement on the composition of plant communities and, in the case of herbivores, the effects of plant-community composition on animal movement. For disturbance-generating herbivores, the link between the animal-movement patterns and plant-community composition is particularly strong, because the animal's foraging success is dependent on the composition of the plant community and the animal's movement generates disturbances that can profoundly alter the competitive balance among plant species. Disturbance-generating herbivores are of additional interest because of their strong effects on the physical environment. For example, the tunneling behavior of pocket gophers can increase the heterogeneity of soil nitrogen, phosphorous, and carbon at the soil surface, but soil mixing will decrease vertical variability. In addition, the burrowing activity of gophers will lower soil bulk density and increase water infiltration, temperature, and litter decomposition rates. Pocket gopher activity is also a major force determining the rates of soil movement on hillslopes. In my research, I am using a variety of modeling techniques to examine the interactions between the behavior of disturbance-generating animals, the structure of the associated plant community, and the ecosystem processes that result from this interaction. These models range from spatially-explicit movement models to analytical models of animal energetics and soil erosion. This modeling work is closely coordinated with a series of field experiments designed to test the predictions in the California grassland system. This system is of particular interest, because of the high density of pocket gophers and their large apparent impacts on plant community composition and soil, nutrient, and water flux. In addition, the outcome of these studies is of profound conservation interest, because of widespread invasion of California native grasslands by exotic annual species.

Jonathan Shurin Postdoctoral Fellow
09/01/2000-08/31/2003
Detecting Species Interactions in Survey Data: New Approaches and Applications
Geographic variation in community structure can be driven by the physical environment, biotic interactions, stochastic factors such as colonization and disturbance history, or by interactions among all three. The question of what factors are most important in structuring communities remains highly contentious. This proposal describes work aimed at integrating techniques for detecting interspecific associations with ordination approaches for analyzing patterns of species distributions with respect to the physical environment. My goal is to generate synthetic models of community dynamics that include biotic and abiotic processes. I will apply the new method to the analysis of a large data set of zooplankton species distributions and limnological features among lakes, and to time series data of species abundances within lakes.

Richard Stevens Postdoctoral Fellow
12/15/2002-12/14/2003
Environmental Determinants of Biodiversity
Understanding the mechanistic bases of patterns in biodiversity has challenged ecologists and evolutionary biologists alike for more than a quarter of a century (Rosenzweig 1995). Although the ubiquity of gradients in species richness is well documented at coarse scales of resolution, it is unclear to what extent patterns are recapitulated at the level of local communities or for any other aspect of biodiversity (Stevens and Willig 2001). Biodiversity represents the totality of variation in living things (Tilman 2000). Thus, it is likely that no one measure such as species richness, or any one perspective, such as that of taxonomic diversity, can provide a comprehensive characterization. Investigations that simultaneously explore fundamental components of biodiversity (i.e., taxonomic, functional, or phylogenetic diversity) will allow for analyses that provide deeper, more comprehensive understanding regarding the distribution of biota across space and time. Although secondary gradients (e.g., latitudinal diversity gradients) have been described ubiquitously, much less is known about the primary environmental gradients or suite of gradients that cause such patterns. Numerous biotic and abiotic characteristics vary spatially in different but correlated

ways. Distinguishing the relative contributions of a number of environmental characteristics to gradients in biodiversity will contribute substantially to our understanding of ecology, biogeography, and evolution. Moreover, resolution of the effects of primary gradients on the spatial distribution of biodiversity may also greatly enhance our understanding of the mechanistic basis of secondary gradients such as those described for latitude.

Diego Vázquez Postdoctoral Fellow
10/01/2002-09/30/2003
Null Models for Specialization and Asymmetry in Plant-Pollinator Systems
Pollination biologists have recently suggested that pollination systems may have a greater degree of generalization in plant pollinator interactions than previously thought. However, there have been no attempts to provide null models against which to compare the observed patterns. I propose to conduct research to develop such models, and to use them to test patterns of specialization observed in available datasets of plant-pollinator interactions. My proposed research has the potential to provide important insights about how plants and pollinators interact, and to synthesize ideas on plant-pollinator interactions, species-abundance patterns, and abundance-range size relationships.

David Chalcraft 06/09/2002-12/17/2003 Postdoctoral Fellow
Melinda Smith 06/17/2002-06/16/2004 Postdoctoral Fellow
Jack Williams 06/17/2002-06/16/2003 Postdoctoral Fellow
A Knowledge Network for Biocomplexity: Building and Evaluating a Metadata-based Framework for Integrating Heterogeneous Scientific Data
Complexity is an inherent property of living systems that arises from direct and indirect interactions among the earth's physical, chemical, and biological components. Biocomplexity includes the structural and functional attributes of dynamic systems that arise at all levels of biological organization, including individuals, populations, and communities. Importantly, ecological components of biocomplexity (e.g., biodiversity, ecosystem services) are in crisis, and are undergoing potentially irreversible changes in the face of rapid human population growth and economic development. Wise stewardship, based on all available scientific knowledge concerning these natural systems, is essential. Catalyzed by these societal concerns, and facilitated by technology advances, scientists focused on complex ecological systems have generated an explosion of ecological and environmental data. When integrated with data from other disciplines, these data have the potential to greatly enhance understanding of biocomplexity. However, broad-scale and synthetic research is stymied because these data are largely inaccessible due to their spatial dispersion and their extreme structural and semantic heterogeneity, and complexity.
These three postdocs are supported by the National Science Foundation Grant No. DEB99-80154 for the Knowledge Network for Biocomplexity. David Chalcraft is located in the Department of Biology, Texas Tech University.

Working Groups:

Paleobiology Database

John Alroy, Charles Marshall and Arnold Miller -leaders

Alroy, John	Jernvall, Jukka	Rees, P.M. (Allister)
Behrensmeyer, Anna K.	Johnson, Kirk R.	Rogers, Raymond R.
Carrano, Matthew	Kidwell, Susan	Sims, Hallie J.
Fara, Emmanuel	Kosnik, Matthew	Stein, William
Fortelius, Mikael	Kowalewski, Michal	Tiffney, Bruce
Fursich, Franz T.	Lidgard, Scott	Uhen, Mark D.
Gastaldo, Robert A.	Looy, Cindy	Wagner, Peter J.
Gensel, Patricia G.	Marshall, Charles R.	Wang, Xiaoming
Head, Jason	Olszewski, Tom	Werdelin, Lars
Holland, Steven M.	Plotnick, Roy E.	Wilf, Peter
Hunter, John P.	Raymond, Anne	Wing, Scott

Our picture of global diversification and extinction on long time scales is mostly based on generalized data for Phanerozoic marine macroinvertebrates. While every effort was made to guarantee the comprehensiveness of this data set, the community has been aware that sampling artifacts may contribute to the observed trends. Until now, we have been unable to remove these effects. Several robust methods for doing this are now available, but these methods use locality-specific data that are not a part of the existing, more generalized compilations. In order to confirm the reality of the major observed patterns, a collaborative data compilation project needs to be initiated. We wish to form a working group to do this. As a first step, we propose a workshop this August involving workers who have specialized in analyzing paleontological diversity data. This workshop will determine the scope, goals, structure, and time table of a database project. Immediately after the workshop, a post-doc who will serve as project coordinator will begin a two-year residency at NCEAS. Over the following two years, experts specializing on particular parts of the fossil record will meet at NCEAS to guide the data collection process. A final meeting will focus on preparing collaborative publications showing how these data influence our picture of marine diversification and extinction.

Understanding the Ecology and Evolution of Infectious Diseases in Mammalian Mating and Social Systems

Sonia Altizer and Charles Nunn -leaders

Altizer, Sonia	Fulford, Jenny	Poss, Mary
Antonovics, Janis	Jones, Kate	Pulliam, Juliet
Daszak, Peter	Lindenfors, Patrik	Thrall, Peter
Dobson, Andrew P.	Nunn, Charles L.	Vitone, Nick
Ezenwa, Vanessa	Patel, Nikki	
Fenton, Andrew	Pedersen, Amy	

Variation in animal mating and social behavior has important consequences for the origin and persistence of infectious diseases. These behavioral processes determine local host density and govern the type and frequency of contacts that occur within and among groups of animals. Ecologists have made great progress in understanding infectious disease dynamics operating on ecological time scales, yet next to nothing is known about patterns of disease at broad evolutionary scales. Given the increasing availability of information on socio-ecological parameters and disease in wild populations, along with robust phylogenies, the time is right to integrate efforts across these levels of analysis. Thus, our interdisciplinary working group will coordinate empirical and theoretical approaches to investigate how host social organization and mating behavior affect the maintenance and spread of infectious diseases in mammals. We will use large datasets and phylogenies in three groups of mammals, primates, ungulates, and carnivores, to conduct phylogenetically controlled comparative studies and formulate predictive models of the consequences of variation in socio-ecological parameters for disease risk. Simultaneously, we will use computer simulations and population modeling techniques to generate predictions that can be examined with the comparative data. By filling the enormous gaps in our knowledge regarding the links between disease and mating and social systems, our study will identify key factors responsible for the dynamics and evolution of infectious diseases in animal populations.

Beyond hand-pollinations: Linking pollen limitation to plant population biology

Tia-Lyn Ashman, Tiffany Knight, Susan Mazer, and Martin Morgan -leaders

Amarasekare, Priyanga	Dudash, Michele R.	Mitchell, Randall
Ashman, Tia-Lynn	Johnston, Mark O.	Morgan, Martin
Burd, Martin	Knight, Tiffany	Steets, Janette
Campbell, Diane	Mazer, Susan J.	

Pollen sufficiency is an important determinant of plant reproductive success, and thus a major driver in plant ecology and evolution. Despite hundreds of empirical studies addressing the causes and consequences of pollen limitation, we lack a quantitative synthesis. Our working group will bring together evolutionary biologists, pollination ecologists, plant demographers, and theoreticians to produce new insight into the ecological and evolutionary significance of pollen limitation. We will 1) use contemporary theory as a framework for synthesis (via meta-analysis) of published and unpublished empirical data to determine the ecological attributes that are generally associated with pollen limitation, and 2) develop new theory that integrates pollen limitation with plant modularity, resource allocation and perenniality, as well as with plant demography, population growth rates and time to extinction.

Comparative Study of Adaptive Radiation

Brendan Bohannan, Peter Morin, Anna-Louise Reysenbach, and Jennifer Hughes -leaders

Bohannan, Brendan	Kuske, Cheryl	Petchey, Owen
Brown, James H.	Leibold, Mathew	Reysenbach, Anna-Louise
Colwell, Robert K.	Morin, Peter J.	Smith, Val H.
Fuhrman, Jed	Murray, Jill L.S.	Staley, James T.
Horner-Devine, Claire	Muyzer, Gerard	Ward, David M.
Hughes, Jennifer B.	Naeem, Shahid	
Kane, Matthew	Ovreas, Lise	

Despite intensive study over the past half century, our conceptual understanding of adaptive radiation has advanced relatively little. A primary reason is that there has been no synthetic, integrative study of adaptive radiation across different evolutionary lineages. The result is that our database on adaptive radiation is composed of a hodgepodge of studies. Disparities among studies in approach, methodology, and organisms mean that each study is unique and that, as a result, testing general hypotheses, much less deriving new generalities, is difficult. This working group will bring together experts in ecology and evolutionary biology with different taxonomic specialties to develop appropriate methods to conduct a comparative study of adaptive radiation. Group members will gather data from both their own studies and from other studies on related taxa, thus amassing a large base of comparable data, allowing for the testing of general questions about adaptive radiation, as well as leading to the development of new approaches and questions. Members of current working groups focusing on related questions will be invited to participate in some of this working group's activities, leading to mutually beneficial advances and synthesis.

Facilitation and competition on alpine elevation gradients: a global experiment on the organization of plant communities

Ragan Callaway, Richard Michalet, Robin Brooker, and Christopher Lortie -leaders

Berlow, Eric	Cavieres, Lohengrin	Michalet, Richard
Bowman, William D.	Choler, Philippe	Pugnaire, Francisco
Brooker, Robin	Hacker, Sally	Smith, Molly
Callaway, Ragan	Lortie, Christopher J.	Valiente-Banuet, Alfonso

We propose to organize three meetings, each 7-10 days, in order to analyze data and develop conceptual, empirical, and mathematical models with a working group that has been loosely organized and conducting experiments on interactions in alpine plant communities around the world. Results from one of the nine sites for which data have been collected, the French Alps, and other preliminary analyses indicate that interactions shift from highly competitive in low elevation alpine meadows to highly facilitative in communities »1000m higher and near the physical limits of plant growth. These competitive and facilitative interactions also appear to be coupled with community properties such as biomass, diversity, evenness, and the relative abundance of target species. Furthermore, shifts in species interactions and the intensity of species interactions along elevation gradients appear to correlate with community characteristics and regional climate. We are requesting funds from NCEAS to solve the problems inherent to such a large group of investigators from different parts of the world with a large data set. Funding will allow us to work cohesively as a group on statistical analyses of experimental data, to integrate experimental results with community properties in innovative ways, and to develop empirical and conceptual models for the relationship between climate, biogeography, and plant interactions on gradients.

Ecological Processes and Evolutionary Rates

Niles Eldredge and John Thompson -leaders

Brakefield, Paul M.	Jablonski, David	Miller, William
Eldredge, Niles	Lenski, Richard E.	Thompson, John N.
Gavrilets, Sergey		

In recent years, the science of ecology has become increasingly directed toward questions at larger spatial and temporal scales. The same is true of evolutionary biology. Our working group will be a direct attempt to evaluate where and when evolutionary biology is important to our understanding of ecological analyses of large-scale spatial and temporal processes. This evolutionary/ecological link is at the heart of the major questions identified at the recent combined GSA/ESA symposium (Hunter 1998). This group will also build explicitly upon one of the research areas that has already become established at NCEAS through related working groups: the role of ongoing evolution in the organization of biodiversity.

SpecNet

John Gamon -leader

Dungan, Jennifer	Oechel, Walter C.	Sims, Dan
Gamon, John A.	Oliphant, Andrew	Steffey, Duane
Huemmrich, Karl F.	Rahman, Faiz	

SpecNet (Spectral Network) is a network of terrestrial flux tower sites where 'near surface' remote sensing is being conducted to improve our understanding of controls on the biosphere-atmosphere carbon exchange. SpecNet sampling closely matches the spatial and temporal scale of flux measurements, allowing a direct comparison of remotely sensed signals to factors affecting fluxes. We propose a SpecNet Working Group that will examine the optical, thermal, and flux data emerging from these sites. A primary goal will be to standardize the remote sensing instrument, algorithms, data processing protocols, and data products for comparative analyses. The next step will be to compare results across ecosystems to reveal contrasting controls on carbon flux. This effort will help link remote sensing to fluxes, assist in validating satellite products (e.g. NPP derived from the MODIS sensor), and will provide an improved scientific foundation for emerging carbon policy.

Phylogeny and Conservation - Problems in the Quantification of Biodiversity

John Gittleman and Michael McKinney -leaders

Bielby, John	Grenyer, Richard	Price, Sam
Bininda-Emonds, Olaf	Habib, Mike	Sechrest, Wes
Cardillo, Marcel	Jones, Kate	
Gittleman, John L.	Mace, Georgina	

We propose a working group to assess the usefulness of algorithms and quantitative approaches to measuring biodiversity in terms of 'taxonomic distinctiveness' or 'independent evolutionary units'. We will critically evaluate whether and how phylogenetic information can be used to measure species value. Specifically, we will analyze the effects of sample size, topology, branch lengths and model of evolutionary change on various quantitative measures of phylogenetic diversity. Measures of phylogenetic diversity will then be applied to various conservation problems such rarity, species' conservation status, and extinction risk. The working group will provide a collaborative effort among ecologists, evolutionary biologists, paleontologists, systematists (both molecular and morphological) and conservation biologists, all of who deal with synthetic comparative data in their respective fields. The end product will be a series of papers and an edited volume, Phylogeny and Conservation.

Patterns in Microbial Biodiversity

Alan Hastings -leader

Baskett, Marissa	Gaines, Steven D.	Rosenberg, Andy
Botsford, Louis W.	Gaylord, Brian P.	Wahle, Charles
Brumbaugh, Dan	Hastings, Alan	Warner, Robert R.
Carr, Mark H.	Largier, John L.	Yoklavich , Mary
Fluharty, Dave	Micheli, Fiorenza	

Microorganisms represent the vast majority of Earth's biodiversity and they play a crucial role in nearly every process of environmental importance. However we know very little about how microbial diversity is generated and maintained. Our ignorance is due in part to the isolation of microbial diversity studies from the general study of biodiversity. The proposed working group will bring together microbial biologists who are gathering microbial diversity data and ecologists who study biodiversity, to share tools and approaches, to look for patterns in microbial diversity data, and to propose future directions for microbial biodiversity research.

Energy and Geographic Variation in Species Richness

Bradford Hawkins and Howard Cornell –leaders

Cornell, Howard V.	Kerr, Jeremy T.
Currie, David	Mittelbach, Gary
Hawkins, Bradford A.	

Understanding the latitudinal gradient in species diversity presents ecology with one of its greatest challenges. Despite the complexities that must be involved, the "energy hypothesis" may provide a parsimonious explanation for much of the gradient. However, there are a number of unresolved issues related to the energy hypothesis that need to be addressed, including (1) the relationship between energy and other determinants of diversity and how to distinguish them, (2) which of two versions of the energy hypothesis, the "productivity hypothesis" or the "ambient energy hypothesis" may apply to different taxa, (3) the relative roles of currently operating climatic factors and historical forces, (4) the probability that different factors operate in different latitudinal zones. (5) possible scale dependence of energy-diversity relationships, and (6) the most appropriate statistical methodology for testing the hypothesis. The proposed working group will address these issues, with the goal of providing a rigorous statement of what the energy hypothesis claims and providing a standardized format for the generation of data to test it. A further goal is to use the new format to generate a data base comprising all existing data related to the energy hypothesis. Finally, we will analyze this database to determine the current state of the hypothesis and identify areas requiring additional research. Our general goal is to convert what is currently a haphazard approach to testing geographic variation in species diversity into a systematic search for underlying causes.

Analysis of Diversity Reduction Experiments to Address the Ecosystem Consequences of Biodiversity Loss

Laura Huenneke, Sandra Diaz and F. Chapin -leaders

Bret-Harte, Syndonia
Diaz, Sandra
Lyons, Kelly
Solan, Martin
Suding, Katharine N.
Symstad, Amy

A diversity reduction working group will examine the relationship between species diversity and ecosystem functioning in a wide range of natural and managed ecosystems. We will evaluate the results of field experiments in which species diversity and composition of plants, animals, and/or microbes have been reduced and ecosystem processes have been measured. We propose two approaches: (1) a meta-analysis of the species-removal literature and (2) a synthesis of comparative measurements to be made in ongoing species-removal experiments in a diverse array of natural ecosystems.

Science Environment for Ecological Knowledge (SEEK)

Matthew B. Jones, Mark P. Schildhauer, James H. Beach, Bertram Ludaescher, William K. Michener -leaders

Beach, James H.
Jones, Matthew B.
Michener, William K.
Rajasekar, Arcot
Schildhauer, Mark P.

The goals of the Science Environment for Ecological Knowledge (SEEK) are to make fundamental improvements in how researchers can 1) gain global access to ecological data and information, 2) rapidly locate and utilize distributed computational services, and 3) exercise powerful new methods for capturing, reproducing, and extending the analysis process itself. The project involves a multidisciplinary team of computer scientists, ecologists and technologists from the Partnership for Biodiversity Informatics (PBI), a consortium comprising the National Center for Ecological Analysis and Synthesis (NCEAS); the San Diego Supercomputer Center (SDSC); the University of Kansas (KU); and the University of New Mexico (UNM) and partnering institutions (Arizona State University, University of North Carolina, University of Vermont, and Napier University in Scotland).

This activity is supported by award # 0225665 from the ITR program of the National Science Foundation.

An Ecological-Economic Analysis of Pest-control Services: The Brazilian Free-tailed Bat as a Model

Thomas Kunz -leader

Betke, Margrit
Clark, Donald R.
Cleveland, Cutler
Correa Sandoval, Adriana Nelly
Crampton, Stephen
Federico, Paula
Frank, Jeff D.
Gomez, Irma A.
Gopal, Sucharita
Hallam, Thomas G.
Horn, Jason
Kunz, Thomas H.
Lopez, Juan
Lopez, Juan
McCracken, Gary F.
Medellin, Rodrigo A.
Moreno-Valdez, Arnulfo
Sansone, Chris
Stevens, Richard
Westbrook, John

Ecosystem services underpin human existence, yet we know little about the magnitude of these services in terms of what policy makers need to incorporate into decision-making frameworks. The objective of this project is to analyze existing databases for developing an ecological-economic model of pest-control services provided by an important insectivorous bat (Tadarida brasiliensis). Computer algorithms will be developed for estimating numbers of bats based on infrared thermal imaging, and population models of pest species will be developed based on available life-history data. Dynamic modeling and GIS will be used to integrate extant databases on bat foraging from Dopper radar (NEXRAD) data, crop and insect phenology, seasonal migration of bats and insects, and agricultural crop distribution, yield, and inputs. Ultimately, models will include sensitivity analysis to estimate the monetary value of the pest-control service, and thus provide the first comprehensive analysis of a major vertebrate predator of importance to agroecosystem productivity in North America.

The Meta-Community Concept: A Framework for Large Scale Community Ecology?

Mathew Leibold –leader

Amarasekare, Priyanga
Chase, Jonathan
Gonzalez, Andy
Holt, Robert D.
Holyoak, Marcel
Hoopes, Martha F.
Leibold, Mathew
Loreau, Michel
Mouquet, Nicolas
Shurin, Jonathan B.
Tilman, David

The concept of meta-communities was developed in an effort to link community ecology theory at the local level with regional and global models at larger spatial scales. Currently there are two contrasting views of meta-communities. The "patch-dynamics" perspective is based on the idea that similar local habitat patches are colonized by species that interact to produce communities consisting of different species depending on their dispersal abilities. In contrast, the "species-sorting" view assumes that sites differ in their abiotic environment, causing interacting species to sort themselves differently along gradients depending on their competitive abilities at different sites. The first view ignores local population dynamics and therefore allows for non-equilibrial abundances but it ignores intrinsic heterogeneity among local sites. The second view is generally modeled using equilibrium models of local population dynamics but accounts for heterogeneity among sites. Empirical evidence suggests that both of these approaches are useful for understanding patterns in real communities. Thus there is a need for a more synthetic approach. We propose to form a collaborative group to work on such a synthesis. Our goal is to explore what happens when both sets of metacommunity processes occur. We hope to use this synthetic approach to explore their roles in regulating phenomena such as the trophic structure, patterns of diversity and composition along environmental gradients and the role of regional processes such as dispersal in ecosystem processes.

PrecipNet: Analysis and Synthesis of Precipitation and Ecosystem Change

Michael Loik –leader

Fay, Phil
Haddad, Brent
Huxman, Travis E.
Knapp, Alan K.
Loik, Michael E.
Pockman, William T.
Shaw, M. Rebecca
Tissue, David T.
Weltzin, Jake F.
Zak, John C.
Koch, George W.
Schwinning, Susan
Smith, Stanley D.

The goal of the NCEAS PrecipNet Synthesis Group is to analyze and synthesize results of the effects of climate change on ecosystems. In particular, we will analyze data from studies on the effects of altered timing and magnitude of rain and snowfall across different ecosystems and geographic regions. Another important goal is to promote interdisciplinary research between natural and social scientists regarding the impacts of precipitation and ecosystem change and the interrelationships with human systems and institutions. Our meeting will result in: a review article on the current state of knowledge about precipitation change effects on ecosystems; development of databases on the world wide web and on CD-ROM that would be available for all global change studies; and maps predicting how ecosystem responses to precipitation change will affect ecological communities across regional scales. The PrecipNet Synthesis Group includes James Ehleringer (Univ. Utah), Brent Haddad (UC Santa Cruz), John Harte (UC Berkeley), Rod Heitschmidt (Ft. Keogh Range Exp. Sta.), Alan Knapp (Kansas State Univ.), Guanghui Lin (Biosphere II, Columbia Univ.), Michael Loik (UC Santa Cruz), William Pockman (Univ. New Mexico), Rebecca Shaw (Carnegie Inst. For Plant Biology), Eric Small (New Mexico Tech), Stan Smith (Univ. Nevada, Las Vegas), David Tissue (Texas Tech Univ.), Jake Weltzin (Univ. Tennessee), David Williams (Univ. Arizona), and John Zak (Texas Tech Univ.).

Detritus and Dynamics of Populations, Food Webs and Communities

John Moore and Quan Dong -leaders

Callaway, Duncan	Moore, John C.	Scow, Kate
Dong, Quan	Morin, Peter J.	Vanni, Michael J.
Hastings, Alan	Post, David M.	Wall, Diana H.
Johnson, Nancy C.	Rosemond, Amy	de Ruiter, Peter C.
Melville, Kim	Sabo, John	

Food web theory was developed in large part on the pathway of primary production from plants to herbivores to predators even though most primary productivity is uneaten by herbivores and enters the food web as detritus. What happens to this dominant chunk of the world's productivity? Is the detrital food web a self-contained sink internally recycling energy and nutrients or a link that affects the population dynamics of classic herbivore webs? Do these dynamics differ with system productivity or among habitats, e.g., aquatic versus terrestrial? Whatever the case, we should understand much more about this fundamental component of communities. This working group will focus on the role of detritus in the dynamics and structure of communities; determine systematic differences in its production, quality, and use among habitats; and delineate a framework to integrate detrital and classic food webs.

An Information Infrastructure for Vegetation Science

Robert Peet, Dennis Grossman, Michael Jennings and Marilyn Walker -leaders

Boyle, Brad	Harris, John	Tart, David L.
Cooper, Jerry	Hennekens, Stephan	Walker, Marilyn D.
Faber-Langendoen, Don	Jennings, Michael D.	Wiser, Susan K.
Farrell, Gabriel	Lee, Michael	
Grossman, Dennis H.	Peet, Robert K.	
	Roberts, David W.	

Vegetation classification is of central importance to biological conservation for planning and inventory, to resource management for monitoring and planning, and to basic scientific research as a tool for organizing and interpreting ecological information. All of these activities require that ecological units be defined and that their distribution on the landscape be known and understood. Vegetation classification contributes significantly to analysis of ecological problems that vary in scale from persistence of tiny populations of endangered species to global projections of the impact of climate change. Technological advances have made practical large-scale analyses that cross agency jurisdictions or geographic regions and address applied ecological issues as diverse as global change, ecosystem management, and conservation planning. However, all such efforts depend on having available a common set of well defined and broadly accepted classification units.

Testing Alternative Methodologies for Modeling Species' Ecological Niches and Predicting Geographic Distributions

A. Townsend Peterson and Craig Mortiz -leaders

Elith, Jane	Huettmann, Falk	Overton, Jake
Ferrier, Simon	Loiselle, Bette	Peterson, A. Townsend
Graham, Catherine	Michener, William K.	Scachetti Pereira, Ricardo
Guisan, Antoine	Moritz, Craig	Williams, Stephen
Howell, Chrissy	Nakamura, Miguel	Wisz, Mary

Knowledge of world biodiversity remains sparse, with millions of species left to be described, most species' geographic distributions poorly understood and the ecological and evolutionary processes that underpin geographic patterns of diversity still far from resolved. Many large-scale conservation projects, however, depend critically on more complete descriptions of species' distributions and there is increasing interest in incorporating process as well as pattern into biodiversity evaluation. The inferential step that leads from incomplete present knowledge to a explicit prediction of geographic distribution is presently made via diverse methods which have not been tested against each other to establish which would provide the greatest predictive ability for different types of questions and data. We propose a NCEAS working group that will review and compare diverse predictive modeling approaches with the goal of producing an ideal strategy for modeling parameters related to ecological niches and predicting geographic distributions.

Macro-Ecology and Biogeography: Hierarchical (Bayesian) Model Development Using Data from South Africa

John Silander -leader

Barber, Jarrett	Laurie, Henri	Silander, John
Gelfand, Alan E.	Lewis, Paul	Smit, Walter
Holder, Mark	Midgley, Guy F.	Wu, Shanshan
Holsinger, Kent	Rebelo, Anthony G.	
Latimer, Andrew	Schmidt, Alexandra M.	

We propose a Working Group that will focus on developing hierarchical (Bayesian) statistical models to explain joint spatial patterns in plant species distributions (and thus diversity), using unique datasets from South Africa.

The statistical models will: be individual species-based, be spatially explicit, utilize individual species attributes (including phylogenetic information), and include various explicit sources of environmental heterogeneity. The models will be hierarchical in attempting to explain joint patterns of species distributions, thus getting at diversity directly from a mechanistic perspective. We know of no other studies which have taken this approach. In building, validating and comparing the models, we have access to unique data sets from South Africa: 1) the Protea Atlas species inventory; 2) A set of explanatory GIS data layers for the Cape Floristic Region (CFR); 3) cladistic/phylogenetic data on taxa in the Proteaceae; 4) a database of up to 4000 releves from the CFR; and 5) potentially, access to a database of the distribution (at ¼ degree grid cells) of all 23,000 flowering plant species in Southern Africa. The CFR is one of the world's hottest hotspots of plant diversity, and the Protea Atlas dataset may be the most complete presence-absence data set for any taxonomic group across any region.

Working Groups With Near Term Relevance for Resource Managers and Policy Makers

A Knowledge Network for Biocomplexity: Building and Evaluating a Metadata-based Framework for Integrating Heterogeneous Scientific Data

Jim Reichman, Sandy Andelman James Brunt, John Helly, Matthew Jones and Michael Willig - leaders

Andelman, Sandy J.
Biggs, Harry
Bowles, Christy
Branan, Bill
Carney, Karen
Chalcraft, David R.
Cleland, Elsa
Collins, Scott L.
Cox, Stephen B.
Devine, Claire
Drake, John
Dukes, Jeff
Emery, Sarah
Fegraus, Eric
Garrett, Karen
Gotelli, Nicholas J.
Gramling, Joel
Gross, Katherine L.
Horner-Devine, Claire
Jennings, Michael D.
Keddy, Paul
Knapp, Alan K.
Kruger, Judith
Loreau, Michel
Mau-Crimmins, Theresa
McPherson, Guy
Peel, Mike
Smith, Melinda
Stromberg, Mark
Swemmer, Tony
Trollope, Winston
Vandermast, David
Waide, Robert B.
Williams, Jack
Willig, Michael R.
Wilsey, Brian J.
Wojdak, Jeremy
Zambatis, Nick

Complexity is an inherent property of living systems that arises from direct and indirect interactions among the earth's physical, chemical, and biological components. Biocomplexity includes the structural and functional attributes of dynamic systems that arise at all levels of biological organization, including individuals, populations, and communities. Importantly, ecological components of biocomplexity (e.g., biodiversity, ecosystem services) are in crisis, and are undergoing potentially irreversible changes in the face of rapid human population growth and economic development. Wise stewardship, based on all available scientific knowledge concerning these natural systems, is essential. Data Catalyzed by these societal concerns, and facilitated by technology advances, scientists focused on complex ecological systems have generated an explosion of ecological and environmental data. When integrated with data from other disciplines (e.g., meteorology), these data have the potential to greatly enhance understanding of biocomplexity. However, broad-scale and synthetic research is stymied because these data are largely inaccessible due to their spatial dispersion, extreme structural and semantic heterogeneity, and complexity.

This project is supported by the National Science Foundation Grant No. DEB99-80154 for the Knowledge Network for Biocomplexity

Global Gap Analysis: an Assessment of the Global Network of Protected Areas

Mohamed Bakarr -leader

Andelman, Sandy J.
Bakarr, Mohamed
Boitani, Luigi
Brooks, Thomas
Dinerstein, Eric
Fishpool, Lincoln
Long, Janice
Marquet, Pablo A.
Pressey, Robert
Rodrigues, Ana S. L.
Schipper, Jan
Sechrest, Wes
Underhill, Les G.
Yan, Xie
da Fonseca, Gustavo

Setting priorities and making decisions for conservation risk management

Mark Burgman -leader

Ben-Haim, Yakov
Burgman, Mark
Costello, Christopher
Cumming, Geoff
Ferson, Scott
Fidler, Fiona
Fox, David
Langford, Bill T.
Lundberg, Per H.
Mayo, Deborah
Possingham, Hugh P.
Regan, Helen
Rowley, Kath
Ruckelshaus, Mary
Spanos, Aris
Starfield, Anthony
Stirling, Andy
Walley, Peter
Wilson, Will G.
Wintle, Brendan

Risk-based decisions are made routinely in medicine, toxicology, engineering, psychology, insurance and finance. The development of methods in these fields has been rapid but the paths followed and the tools developed have been different. To some extent the differences reflect the kinds of data and the range of problems people need to solve. In part, the differences are because methods have grown in relative isolation. A common problem facing practitioners in conservation biology is to identify priorities that discriminate among a suite of alternative actions. Biologists make decisions on a routine basis, but with little understanding of the techniques for decisions involving risk. The kinds of questions conservation biologists are obliged to answer will benefit substantially from advances in decision analysis and risk assessment made in other disciplines. This project will develop and expand the toolkit for problem solving available to conservation biologists by reviewing risk-based, priority setting methods in different fields, and bringing together people from different disciplines to examine the problems confronting conservation biologists, resulting in new approaches to finding solutions to priority setting and decision making problems.

Global Change Impacts on Landscape Fires

Michael Flannigan and Sandra Lavorel -leaders

Cary, Geoff
Flannigan, Michael
Gardner, Robert H.
Keane, Robert

A major problem in projecting ecological change and understanding its mechanisms is the lack of non-equilibrium dynamics in ecological models. The inclusion of disturbance, especially fire is essential for dynamic vegetation models to simulate transient changes in vegetation composition and structure. Understanding landscape dynamics in relation to fire, and how these dynamics may be altered by climate and land use changes is a priority. The development of fire-vegetation models at landscape scales is a crucial gap in land management. Additionally, understanding human impacts on the fire regime is critical for projecting vegetation change in human-modified landscapes, which now occupy large proportions of the globe. The objective of this working group is to use the current well-developed understanding of fire behavior/fire ecology and fire-weather to develop a set of dynamic fire-climate-vegetation models that simulate fire effects at temporal and spatial scales relevant to vegetation change. We will use a common modeling environment, LAMOS, to conduct this research. LAMOS (a Landscape Modeling Shell) is an interactive and flexible landscape modeling platform designed to include alternative methods for simulating vegetation response to landscape change. This proposal specifically addresses three questions: 1) How well do different landscape fire models reproduce fire statistics under current climate, both with respect to each other and with respect to fire history records at selected sites, 2) At what spatial and temporal scales does landscape pattern influence the fire regime, and 3) Under which weather conditions are fire patterns sensitive to fuel landscape pattern, and how often under present / future climate is the threshold of sensitivity crossed.

Models of Alternative Management Policies for Marine Ecosystems

Robert Francis and James Kitchell -leaders

Dalton, Michael	Gaichas, Sarah	Nelson, Russel
Field, John	Hinke, Jefferson	Olson, Robert J.
Fluharty, Dave	Kaplan, Isaac	Walters, Carl
Francis, Robert C.	Martell, Steve J.	Watters, George

We ask support to the activities of a working group that will attempt to identify robust approaches to the exploitation of large marine ecosystems. We intend to achieve this by employing the comparative approach to identify similarities and differences between five large marine ecosystems in the North Pacific Ocean. Each of these ecosystems has served as the focus of controversy over the ecological consequences of fishery management practices, protection for threatened or endangered species, and the relative importance of large-scale environmental variability, and each has been the focus of model development effort using the common framework of an Ecopath/Ecosim approach. By defining a common set of objective criteria for evaluating conservation strategies, economic goals and ecosystem management objectives, we will employ these five models as the basis for evaluating policy outcomes, clarify the conflict of alternatives, and provide guidance to realistic expectation from management actions.

Development of Tools for the Practical Design of Marine Reserves

Alan Hastings -leader

Baskett, Marissa	Gaines, Steven D.	Rosenberg, Andy
Botsford, Louis W.	Gaylord, Brian P.	Wahle, Charles
Brumbaugh, Dan	Hastings, Alan	Warner, Robert R.
Carr, Mark H.	Largier, John L.	Yoklavich , Mary
Fluharty, Dave	Micheli, Fiorenza	

We propose a working group to examine the general question of moving from theory to policy, specifically looking at the design of marine reserves, building on the quantitative results obtained under a previous NCEAS working group, "A Theory of

Marine Reserves", by J. Lubchenco, S. Gaines and S. Palumbi. Whereas the modeling in that working group was a development of a general theory of marine reserves, the focus of the working group proposed here will be an application of that theory to specific problems. Rather than consider ideal optimal reserve configurations, we will study implementing actual marine reserves, given a specific situation and constraints (i.e., current fishing rate, current state of the ecosystem, limited area under consideration, uncertainty in larval dispersal, fisher behavior). The goal will be to develop scientifically sound design tools that can be used in ongoing and future implementation efforts for reserve systems, considering reserves designed both to improve fisheries and to conserve natural marine ecosystems. This effort can be viewed as a paradigm for the problem of translating ecological theory into practical policy applications.

The Ecology of Marine Diseases

Drew Harvell -leader

Baron, Nancy	Harvell, Drew	Pascual, Mercedes
Connell, Joseph H.	Kim, Kiho	Porter, James W.
Dobson, Andrew P.	Kuris, Armand	Smith, Garriet
Ellner, Stephen P.	Lafferty, Kevin	Sutherland, Kathryn
Gerber, Leah	McCallum, Hamish	Ward, Jessica

The working group on marine diseases will bring together researchers working with diverse diseases of marine organisms with theoreticians and statisticians. Epidemiological studies of diseases in marine systems have been rare and there is a paucity of information regarding even the most basic properties of marine pathogens (e.g. identity, host-specificity) and factors (e.g. environmental correlates) affecting disease processes (Harvell et al. 1999). In particular, little is known about the mechanisms of either disease transmission or host resistance and their roles in facilitating disease outbreaks. Although theoretical and experimental practices developed to model infectious disease in humans (Anderson & May 1991), wildlife (Daszak et al. 2000) and agricultural systems (Real 1996) have provided some useful insight, the applicability of these "terrestrial" models to comparatively more open system like the ocean is not known. Moreover, knowledge of mechanisms of host resistance among marine invertebrates is effectively a black box; we lack understanding of basic disease resistance mechanisms and their interaction with environmental stressors. Using a few well studied host-pathogen interactions or those with long-term monitoring data, we will 1) synthesize what is currently know about marine diseases and their environmental drivers, 2) develop new epidemiological theory for analysis of marine diseases, and 3) review differences between disease ecology in marine and terrestrial habitats, including the consequences of spill-over of infectious micro-organisms from farmed into wild populations.

Restoration in a Landscape Context

Karen Holl, Elizabeth Crone and Cheryl Schultz –leaders

Crone, Elizabeth	Holl, Karen	Schultz, Cheryl B.

Current restoration activities often focus narrowly on sites actively being restored. The success of these restorations, however, will often depend on their position in the landscape, relative to the condition, land use, and community composition of land in the surrounding area. Restoration ecologists have often discussed landscape-level processes in general. Nonetheless, theory has rarely led to recommendations that are put to use on the ground. We propose to address the process of the exchange of information from academic theory to applied management in the following ways. First we will synthesize what has been written about landscape-level processes that affect restoration, and about statistical and modeling tools that can be used to judge restoration success. Then we will use the synthesis to address two landscape-level restoration projects - one population-focused habitat restoration and the second a community-focused ecosystem restoration. We will develop new quantitative methods to prioritize what landscape-level concerns will significantly affect the success of restoration efforts in these and other projects. The purpose of this working group will be to move beyond broad generalizations and ask how we can apply relevant ecological knowledge to large-scale restoration activities.

Serengeti: The Origins and Future of a Complex Ecosystem

Craig Packer and Stephen Polasky -leaders

Banyikwa, Feetham	Galvin, Kathy	Munson, Linda
Borner, Markus	Gereta, Emmanuel	Mwangomo, Ephraim
Cleaveland, Sarah	Hilborn, Ray	Nunez, Cassandra
Costello, Christopher	Holt, Robert D.	Olff, Han
Coughenour, Michael B.	Kimbrell, Tristan	Packer, Craig
Dobson, Andrew P.	Little, Peter	Polasky, Stephen
Donalson, Douglas	McNaughton, Samuel	Ritchie, Mark
Durant, Sarah	Mduma, Simon A. R.	Runyoro, Victor
Fryxell, John M.	Mlingwa, Charles	Sinclair, Anthony R.E.

The Serengeti ecosystem exemplifies a number of general features of terrestrial food web dynamics and can therefore be viewed as a model system for studying a complex interplay of basic ecological principles. These include: (1) the diverse roles of generalist top predators in governing coexistence in prey communities, (2) the importance of omnivory and intraguild predation in modulating the magnitude of 'top-down' impacts of predators, (3) trophic cascades; (4) the implications of movement, landscape pattern, and spatial heterogeneity for food web dynamics, and, (5) the impact of temporal variation on stability and species composition of local communities. The Serengeti, like many ecosystems, is subject to increasing human use. Understanding human behavior and the links between humans and the ecosystem provides a necessary foundation for conservation.

A Synthetic Analysis of the Scientific Basis of Ecological Restoration of Stream Ecosystems

Margaret Palmer and J. David Allan -leaders

Alexander, Gretchen	Bratrich, Christine	Galat, David L.
Allan, J. David	Brooks, Shane	Gergel, Sarah E.
Beard, Doug	Castleberry, Dan	Gloss, Steve
Bernhardt, Emily	Clayton, Steve	Goodwin, Peter
Boutillier, Shay	Dahm, Cliff	Hart, David

Hassett, Brooke
Jenkinson, Robin
Kondolf, G. Mathias
Lake, P. S.
Lave, Rebecca
MacBroom, Jim
Meyer, Judy
Miller, Peter
Palmer, Margaret A.
Pess, George
Powell, Bruce
Ransel, Katherine
Relyea, Scott
Shah, Jennifer J.F.
Skidmore, Peter
Smith, Sean
Srivastava, Puneet
Sudduth, Elizabeth
White, Meg

We will assess the quality of the science underlying ecological restoration activities using stream ecosystems as model restoration systems. We will assemble a unique data set that spans multiple ecoregions and many different types of restoration activities performed by diverse groups with various stakeholder interests. Specifically, our data set will address: what kinds of restoration activities, at what scale, and by what means, are taking place; how goals were set and success measured in these restoration efforts; the extent to which scientific criteria were used; the extent to which adaptive management was an explicit component of the restoration activity; and the extent to which scientists are forming partnerships with restorationists in order to use restoration projects as opportunities for scientific experimentation. Our synthesis will facilitate the linkage between the practice of ecological restoration and the science of restoration ecology and will attempt to establish standards for data gathering to scientifically assess restoration methods and success.

Dynamics of Large Mammalian Herbivores in Changing Environments: Alternative Modeling Approaches

Norman Owen-Smith -leader
Berkley, Heather
Boone, Randall B.
Cope, David
Coulson, Tim
Festa-Bianchet, Marco
Fryxell, John M.
Gordon, Iain J.
Gross, John E.
Hilborn, Ray
Hobbs, N. Thompson
Illius, Andrew W.
Kendall, Bruce E.
Lundberg, Per H.
Moehlman, Patricia D.
Ogutu, Joseph O.
Owen-Smith, Norman
Sinclair, Anthony R.E.
Vucetich, John

The world's populations of large herbivores have shown dramatically different dynamics during the last two decades. The abundance and distribution of some ungulate species has declined abruptly, while other species have become excessively abundant, and still others have shown complex, oscillatory dynamics. These patterns seem to result from a composite of influences, including those operating at global and local scales. Conventional population models are rooted in assumptions about steady state and do not adequately incorporate environmental variability. We propose a working group that will exploit data sets and expertise from different regions to develop new models of ungulate population dynamics, capable of accommodating the complexity of environmental interactions at different spatial and temporal scales.

Research Training Activities

Seven graduate student interns and seven undergraduate interns were involved with research activities at NCEAS during the reporting period. They are listed below, along with the titles of the projects they worked on.

Graduate Student Interns

Intern	Sponsor and Project Title
Britta Bierwagen	Jim Reichman Kids Do Ecology
Eric Fegraus	Sandy Andelman A Knowledge Network for Biocomplexity: Building and Evaluating a Metadata-based Framework for Integrating Heterogeneous Scientific Data
Julie Love	Jim Reichman Integrating Marine Ecology Data for Scientific Analysis and Resource Management: A Community Database Prototype
Kim Melville	John Moore Detritus and Dynamics of Populations, Food Webs and Communities
Jill Wertheim	John Alroy Paleobiology Database
Robin Whatley	John Alroy Paleobiology Database

Mary Wisz	A. Townsend Peterson Testing Alternative Methodologies for Modeling Species' Ecological Niches and Predicting Geographic Distributions

Undergraduate Student Interns

Intern	Sponsor and Project Title
Valerie Bullard	Sandy Andelman Kids Do Ecology
Dan Camuso	Sandy Andelman A Knowledge Network for Biocomplexity: Building and Evaluating a Metadata-based Framework for Integrating Heterogeneous Scientific Data
Jeremy Goldberg	Diego Vázquez Null Models for Specialization and Asymmetry in Plant-Pollinator Systems
Rupech Naik	Diego Vázquez Null Models for Specialization and Asymmetry in Plant-Pollinator Systems
Ben Turner	Christopher Pyke Climate, ecosystems, and land-use: Understanding environmental variability in human-dominated landscapes
Mark Villanueva	Partricia Moehlman The Evolution of Cooperative Breeding in Canidae: Implications for Extinction Risk
Gerhard Wolff	Partricia Moehlman The Evolution of Cooperative Breeding in Canidae: Implications for Extinction Risk

Education and Outreach Activities

NCEAS' Kids Do Ecology (KDE) program continues as our primary means of outreach to the K-12 Santa Barbara schools. Britta Bierwagen, a graduate student intern, coordinates KDE activities. Visits by NCEAS and UCSB-associated scientists to 5th-grade classrooms remain the core of our local outreach activities. During these visits, scientists help students formulate and execute an ecological experiment, including data analysis and presentation.

Four Santa Barbara classes and five scientists participated in the "Scientist in the Classroom" program during the past year. A total of 105 students participated, including 69 minority students (65.7%). The projects were entitled: "Fishermen vs. Sea Otters fighting for Urchins", "Spiders' favorite Habitats", "How does the Vegetation affect the amount of Diversity of Insects at the Douglas Preserve?" and "Accumulation of poison in the California condor food chain". The students presented their projects at a poster session at NCEAS in May, 2003, to share what they learned with each other and NCEAS residents. State Assemblywoman Hannah Beth Jackson was on hand for the presentations.

A total of 14 classes and 12 scientists participated in the "Common Ground in Conservation" project. This included three classes in Santa Barbara, four in Davis, CA, and seven in Missoula, MT, in grades 3 through 5. Approximately 350 students participated in 2 states. Students learned about the California sea otter, California tiger salamander, green sturgeon, and black-backed woodpecker. They exchanged projects in the form of paper quilts, booklets, poems with drawings, poster, and a large-format board game. .

We are in the process of updating the Kids Do Ecology web site. The revised web site will be released this summer. The new version of the site contains a simpler front page where students can select the topics of interest. The topics for kids are: Learn about Ecology, World Biomes, Marine Mammals, Kids Do Ecology in Santa Barbara, EcoLinks, and Conservation Projects. Learn about Ecology contains information describing what ecology is, what ecologists do, as well as information about how to become an ecologist and what type of preparation is required. This part of the site also explains the general purpose of Kids Do Ecology and where to find more information, organized for different grade levels. World Biomes contains information about different biomes geared towards a 5th grade level. This section also contains information about research that NCEAS residents do in different biomes. Marine Mammals pages describe the marine mammal species found in the Santa Barbara Channel and archives the data collected by students in the Los Marineros program. These pages also contain learning activities pertaining to data collection and graphing results. KDE in Santa Barbara is devoted to the projects that the local 5th grade classes do each yea,r as well as pictures and descriptions from the poster session. EcoLinks provides students with further links to learn about Ecology on other web sites. Conservation Projects is devoted to the Common Ground in Conservation program and showcases the species that students learn about, as well as the projects that they have exchanged each year.

There are separate links to find out about NCEAS and the entire Kids Do Ecology project, teachers, and contact information. The section for teachers contains information about Kids Do Ecology projects, how to get involved, and links to other sites (e.g. ESA's educators web site) where they can find curriculum information. The Kids Do Ecology web site (before its update) is featured in the 2003 Educators Road Map to the Web released by T.H.E. Journal.

Two undergraduate students were involved in the Kids Do Ecology program during June 2002 and one undergraduate during the summer and fall of 2002. Heather Bracken finished the Marine Mammal pages for the web site, doing research and write-ups on each species. Nikki Preyss wrote guidelines for teachers and scientists for the Common Ground in Conservation project, and wrapped up the details of the exchanges that occurred during the spring. Val Bullard designed World web pages during the summer and fall of 2002. Additional information is available on the Kids Do Ecology Web Page: http://www.nceas.ucsb.edu/nceas-web/kids/.

Publications

Below we list publications for the reporting period 1 August 2002, 30 June, 2003. Note that this list includes publications that have been reported to us by participants in NCEAS activities during this period, and actual publication dates may precede this period.

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