National Center for Ecological Analysis and Synthesis

2006
Report to the National Science Foundation

1. Participants

O.J. Reichman, Director PI

Stephanie Hampton, Deputy Director

Mark Schildhauer, Director of Computing

Partner Organizations
Matching funds have been provided by the University of California and by the University of California, Santa Barbara.

The Andrew W. Mellon Foundation has provided funding to support postdoctoral researchers and the implementation of ecoinformatics tools. During the past year, the Mellon Foundation provided support a scientific programmer and an analytically adept postdoctoral researcher. With additional support provided by the Mellon Foundation, scientists from NCEAS and Kruger National Park in South Africa are participating in a collaborative effort to develop a unified framework for management and the dissemination of heterogeneous data and metadata from the Park.

The David and Lucille Packard Foundation continue to fund working groups and postdoctoral fellows to conduct a distributed graduate seminar focused on a critical review of ecosystem-based management (EBM) efforts relevant to coastal-marine ecosystems and to design a longer-term program of activities to develop the scientific foundations for EBM in coastal marine systems.

Vulcan, Inc. has provided support for working groups and to initiate planning for a UCSB Center focused on scientific solutions to important environmental problems.

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

The Nature Conservancy provided funding to support a one-time workshop focusing on global climate change and adaptation of conservation priorities.

Other collaborators are highlighted on the NCEAS web site:
http://www.nceas.ucsb.edu/fmt/doc?/nceas-web/collaborators.

2. Activities and Findings

Science Advisory Board
For our July 2005 deadline, we received 43 proposals for 48 activities: 15 postdoctoral fellowships, 2 sabbatical fellowships and 29 working groups. The Science Advisory Board met September 7-8, 2005 to review these proposals; based on their recommendations, decisions were made to support 2 postdoctoral fellowships, 1 sabbatical fellowship and 4 working groups.

For our January 2006 deadline, we received 36 proposals for 36 activities: 13 postdoctoral fellowships, 6 sabbatical fellowships and 17 working groups. The Science Advisory Board met March 1-2, 2006 to review these proposals; based on their recommendations, decisions were made to support 3 postdoctoral fellowships, 4 sabbatical fellowships and 3 working groups.

A list of Science Advisory Board members is available on the NCEAS web site: http://www.nceas.ucsb.edu.

Major Research Activities
During the reporting period, May 1, 2005 through April 30, 2006, NCEAS supported 10 sabbatical visitors and 19 postdoctoral researchers. 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 Universidade Federal de Santa Catarina (Brazil), University of British Columbia, University of Guelph (Canada), University of Georgia and Utah State University. Other NCEAS postdoctoral scientists accepted research positions at Consejo Superior de Investigaciones Científicas (Spain), Instituto Argentino de Investigaciones de las Zonas Áridas, Old Dominon University, University of Georgia and University of California, Santa Barbara.

During the reporting period, 684 different scientists participated in activities at NCEAS (935 total visits). NCEAS reported 53 working group meetings, representing the activities of 36 different working groups, and 13 meetings. Fifteen of these working groups focus on issues of immediate relevance to resource managers and policy markers, and these are highlighted in a separate section below.

Sabbatical Fellows

Richard Condit Sabbatical Fellow
12/09/2005-12/08/2007
Geographic distribution of neotropical tree species: Pattern and process
propose a sabbatical at NCEAS to study geographic distributions of tree species in Central and South America. My goal is to gain understanding of the factors that limit tree ranges in neotropical forests, both at local scales (hundreds of meters across topographic or moisture gradients) and regional scales (hundreds of kilometers across climatic gradients). I have assembled extensive and precise datasets from tree plots at both scales in Panama and Ecuador, and I will develop novel population models that describe key biological processes: dispersal, reproduction, and survival of individual trees across habitats. The simulations offer predictions on spatial patterns of individuals relative to topography and habitat, and these will be compared with observed spatial patterns to determine which population processes best account for the data. Neotropical forests hold a substantial share of the worldÆs plant diversity, but our knowledge about speciesÆ ranges there is crude. Understanding the processes limiting ranges at local and regional scales is necessary to accurately predict future impact of deforestation and climate change.

Ed Hackett Sabbatical Fellow

08/15/2004-08/14/2005

Ecology transformed: Social and intellectual change in ecological research

There are two aspects to this Center Fellow proposal (for support during a sabbatical year): (1) research and writing for a study of NCEAS, its effects, and the recent history of ecology; (2) education about ecology and ecological research practice, which will greatly improve my efforts to integrate ecology with social science in various projects at ASU. The work would have direct and specific benefits for NCEAS and more diffuse benefits for the larger tasks of developing integrative interdisciplinary research and education.

Sharon Harlan Sabbatical Fellow

08/15/2004-08/14/2005

Urban ecology, social inequality, and climate: Building an integrative framework at the neighborhood scale

This is a Center Fellow proposal requesting support for a one-year sabbatical at NCEAS to develop new analytical models concerning human activities, inequality, and climate change in urban communities. My principal activities will be: 1) to develop a framework for understanding how climate and environment influence inequalities in human communities; 2) to analyze, synthesize, and write about how human and ecological communities respond to climatic conditions; and 3) to broaden my knowledge of urban ecology and experience with interdisciplinary research. This project deals with enduring methodological problems in interdisciplinary research and may contribute to public policy interventions to alter the course of climate change on the local scale.

Vlastimil Krivan Sabbatical Fellow

02/01/2005-01/31/2006

Merging adaptive behavior and population dynamics

Experimental work clearly shows that changes in population numbers influence animal behavior. What is much less clear is, whether animal behavior, in turn, influences population dynamics. If yes, then we get a feedback loop between population dynamics and animal behavior that must be reflected in models of population ecology. If not then we can use the classical, density mediated models of population ecology. I want to study theoretically interplay between direct and indirect interactions in simple food web modules where individuals of one or more population(s) behave adaptively. In particular, I want to focus on a simple bacterial system described by a bacterial population growing on two or more carbon sources.

David Lodge Sabbatical Fellow

08/04/2004-06/30/2005

Biology and policy of invasive species

Species transported by humans from one region to another—nonindigenous species—sometimes become invasive. That is, they spread widely, and some cause enormous environmental and economic damage. Cheat grass, zebra mussels, and West Nile virus are three of hundreds of examples of invasive species in the US. Over at least the last century, increasing global trade and human travel have caused dramatic rises in both intentional and accidental introductions of nonindigenous species. Undoubtedly, this trend will continue, and perhaps accelerate, as global commerce increases. Although ecologists have long recognized the phenomenon of invasive species, only in recent years have they given it concentrated scientific attention. And only in the

last decade have the societal costs and natural resource management challenges posed by invasive species received serious policy attention at the US federal and state levels. My project is to write a book entitled Biology and Policy of Invasive Species. The volume will synthesize the current scientific and policy situation of invasive species, and recommend how interdisciplinary research and policy development might move forward.

James Lovvorn Sabbatical Fellow
01/05/2006-01/04/2007
Physiological limits on realized patch structure and trophic coupling from krill to diving seabirds
As marine food webs are increasingly altered by climate change and human exploitation, it is often desirable to estimate the amount of prey at one trophic level that is needed to sustain higher trophic levels. Critical to such estimates is the tightness of trophic coupling, or the fraction of prey that are effectively available and eaten by predators. For example, small diving seabirds are limited in dive depth, so that even abundant prey like krill are unavailable unless they come near the surface. Thus, physiological constraints on these predators can make the realized patch structure of available prey quite different from that of the entire prey population. Availability of pelagic prey is also determined by prey behavior, with diel vertical movements that can vary temporally and spatially with bathymetry, light levels, and tides. Overall prey availability may vary predictably with these factors at large scales (fronts) -- however, smaller-scale features (eddies) that concentrate prey into profitable densities are far less predictable, and may not be detected without costly exploratory dives. As a result, much of the prey is never exploited. In this research, I will link models of the foraging energetics of auklets to variations in 3-dimensional dispersion of krill prey over a time series of months and years. In particular, I will explore mechanisms and develop predictive models of how physiological limits on prey availability can control and weaken trophic coupling. Resulting concepts and models will have broad utility in foodweb approaches to marine ecosystem management, for both quantifying prey stocks needed to support top predators, and determining the location and extent of viable foraging habitat.

William Murdoch Sabbatical Fellow
04/04/2005-09/30/2005
International conservation: Expanding the decision framework
Conservation agencies are planning massive expansion of their conservation activities in the largely tropical developing world. Allocating scarce conservation resources among developing nations requires consideration of a broader set of factors than is typically considered in conservation decision-making. Especially important are aspects of political economy that place conservation investments at risk. We will try to develop a support framework for making allocation decisions that should also help guide efforts to ameliorate risks.

Dianna Padilla Sabbatical Fellow
01/17/2005-01/16/2006
Non-native species introductions in marine reserves and protected areas
This proposal is for sabbatical support as a Center Fellow to conduct two projects. (1.) Aquatic ecosystems have been impacted by a variety of anthropogenic factors, leading to concerns about loss of biodiversity, loss of fisheries stocks, and the introduction and spread of non-native species. In response there has been a dramatic increase in scientific and public attention to the protection

of biodiversity and fisheries through marine reserves and protected areas, and the introduction and impacts of non-native species. Although these topics have been the focus of much recent effort, to date there is a lack of attention to the problem of non-native species in marine protected areas and reserves, which will be the focus of my project. For marine systems this problem may be especially important because dispersal and connectedness among marine reserves appears to be a key design features for effective reserve design. These very properties can enhance the likelihood of invasion and spread of non-native species. Marine reserves may also be especially susceptible to aquaculture species, which either escape culture or are deliberately out planted in large abundance to enhance sustainable fisheries and restore ecosystem function that has been lost due to over harvesting. (2) The ecological importance and consequences of phenotypically plastic traits is of great interest to a wide range of scientists. I propose to review the literature on inducible offenses, traits that enhance the ability of consumers or competitors, and contrast this information with what is known about inducible defenses, which have been studied much more extensively. I will explore the similarities and differences between these two types of ecologically important plasticities.

Mark Ritchie Sabbatical Fellow
09/01/2005-08/31/2006
Thermodynamics of trophic interactions: Toward a reconciliation of energy and elements
Management of the world's ecosystems in the face of changes in climate, availability of carbon, nitrogen and other elements, and invasion of new species will require a much better understanding of trophic interactions. The study of trophic interactions has historically focused on either the exchange of energy or of critical limiting elements, such as nitrogen, phosphorus, or carbon. These separate currencies generally prevent ecologists from fully understanding variation in the magnitude of trophic interactions and element fluxes across environments that receive different amounts of energy. During my proposed Fellowship, I plan to develop a thermodynamic theory of trophic interactions that applies principles of the second law of thermodynamics to interactions between plant resources, plants, herbivores, and predators. Preliminary work suggests a theoretical equivalence rule for energy and element concentrations that successfully predicts previously unrecognized trade-offs in plant nutrient concentrations, water-use efficiency (for terrestrial plants), and tolerance vs. resistance to herbivory. Changes in these plant traits across different environments have potentially profound effects on herbivore abundance and diversity and the likely importance and impact of top predators. To test some of these predictions, I plan to synthesize 15 years of experimental data from my own work on plant-herbivore interactions and extensive data from the literature. This work is likely to lead to several high-profile papers and the identification of critical data needs that might be addressed with a future NCEAS working group.

David Stockwell Sabbatical Fellow
10/01/2005-06/01/2006
Preparation of a book and accompanying CD of programs and data entitled "Ecological Niche Modeling: Ecoinformatics in application to biodiversity"
The proposal is to develop a seminal book on ecological niche modeling (ENM) for ecologists that could also be used as an undergraduate or masters course, and general readership. The book would feature a sequence of theory and practical exercises in developing and evaluating ecological niche models using a range of software covering geographic information systems, multivariate modeling, artificial intelligence methods, data handling and information

infrastructure, supplied on accompanying CD-ROM. The book will show applications of predictive modeling methods with reference to valid inference from assumptions. Through theoretical understanding, summary of published applications and examples of inferences that can either lead to plausible or implausible conclusions, the book aims to give the reader the ability to conduct and evaluate ENM projects in any area of application.

Postdoctoral Fellows

Peter Adler Postdoctoral Fellow
09/01/2005-06/30/2006
Coexistence in a changing environment: Evaluating the role of climatic variability in semiarid plant communities
Understanding how climatic variability influences the coexistence of species is critical to forecasting how climate change will affect local species diversity, especially given predicted increases in variability in many regions. The importance of variability is demonstrated by a well-developed body of ecological theory that shows how temporal fluctuations can benefit, harm, or have no effect on coexistence. My proposed research evaluates the influence of climatic variability on species diversity in widespread vegetation types of the central and western U.S. by linking unique long-term, spatially explicit datasets to theory using statistical and simulation models. The results will represent a first step towards predicting the effects of climate change on these plant communities.

Drew Allen Postdoctoral Fellow
03/01/2005-02/28/2007
The role of temperature in the origin and maintenance of biodiversity
The mechanisms responsible for latitudinal gradients in biodiversity are still poorly understood. Mechanistic understanding will require new theory that links short-term species coexistence to long-term speciation-extinction dynamics. My research at NCEAS will involve developing and testing a theoretical framework based on temperature dependence of biological rates and times and the dynamics of speciation and extinction. This framework will involve a synthesis of theory and data that encompasses population genetics, community ecology, and macroevolution. The primary motivations for this work are to better understand and predict changes in biodiversity along temperature gradients, and more generally, to better understand the forces that control the origin and maintenance of species.

Bernardo Broitman Postdoctoral Fellow
01/15/2006-01/14/2007
Bottom-up ecosystem-based management of coastal systems: Social drivers of ecological and economic factors in EBM (EBM – Hosted by NCEAS)
Ecosystem-based management call for the adoption of management practices that explicitly account for the cross-linkages between ecological, economic and social components. I propose an approach to determine the goals of EBM in coastal temperate oceans through a literature review of initiatives where a social process has advanced research priorities for scientists and economists. By examining and compiling these research priorities I will to compile large datasets of the envionmental, ecological and economic variables singled out by the social process. Going one step further, I will generate uncertainty estimates through simulations that I will incorporate into

simple bioeconomic models. This formal approach will allow for a clearer definition and examination of EBM in coastal systems.
Bernardo Broitman is supported by the David and Lucille Packard Foundation.

Marjorie Brooks Postdoctoral Fellow
01/05/2006-01/04/2007
Anthropogenic stressors on aquatic ecosystems: Modeling links between UV radiation, geochemistry, bioaccumulation, and invertebrate communities at a landscape scale
Multiple environmental stressors such as trace metal contaminants, increased ultraviolet (UV) radiation, and climate warming are having synergistic effects on aquatic ecosystems. Abiotic effects propagate through all levels of ecosystem organization, providing opportunities to develop the integrative models needed to assess and predict important interactive effects of multiple stressors. For example, when invertebrates bioaccumulate metals above thresholds beyond which some species cannot regulate metal intake, it leads to impaired growth, reproduction, and survival that alter the structure of invertebrate communities in ways that should be predictable. I propose to develop models that couple the geochemistry of natural waters as altered by UV exposure with the biological uptake of metals and the resulting structure of invertebrate communities. Current regulatory policy for metals generally ignores most natural variation and the synergistic impacts of multiple stressors (e.g., seasonal and temporal fluctuations in metal concentrations coupled with UV exposure). Based on an extensive, regional data set, my models will link atmospheric, climatic, and geochemical effects on the spatial dispersion of invertebrate diversity throughout several watersheds, and will have important implications for both regulatory policy and ecological theory.

Peter Buston Postdoctoral Fellow
10/01/2002-9/31/2005
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

Elsa Cleland Postdoctoral Fellow
08/01/2005-07/31/2006

The response of ecological communities to nutrient enrichment: Utilizing meta-analysis and structural equation modeling to disentangle the influences of functional traits and environmental context

Ecologists have been fascinated by the relationship between plant species diversity and ecosystem productivity for many years. It is becoming increasingly important to understand this relationship as anthropogenic environmental changes such as nitrogen deposition fundamentally alter natural systems. At local scales, experimental research shows that species diversity tends to decline as resource availability increases. To date, diversity responses to nutrient enrichment have been quantified almost entirely by changes in taxonomic richness. Thus, we know little about the characteristics – or functional traits – of those species which decline. This research will seek to determine whether plant functional traits can predict shifts in species composition, species richness, and productivity in response to nutrient enrichment. This focus on functional traits will facilitate comparison across ecosystem types, and generalization regarding species losses and their consequences in response to environmental change.

Karl Cottenie Postdoctoral Fellow
02/01/2003-06/15/2005

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.

John Drake Postdoctoral Fellow
06/01/2004-06/30/2006

Risk analysis for alien species and emerging infectious diseases

Undesirable alien species and emerging infectious diseases (of both wildlife and humans) are urgent environmental concerns. Considerable effort has therefore been invested in understanding the ecology and evolution of invasive species and of infectious diseases. Despite exhibiting similar dynamics that are modeled with the same techniques, these phenomena are commonly studied by separate research communities for the purposes of risk analysis, management, and control. This project will develop techniques for risk analysis of intentional and unintentional introductions of non-indigenous species and will investigate areas of cross-fertilization with epidemiological theory. The products of this study will be tools for decision-making in the presence of uncertainty and specific recommendations for six case studies.

Sergio Floeter Postdoctoral Fellow
09/01/2003-01/31/2006

Diversity, biogeography and macroecological patterns of Atlantic reef fishes

This proposal aim to develop the great potential of reef-fishes as model taxa for biogeographical and macroecological analysis of reef areas in the Atlantic. Detailed large-scale studies of Atlantic reef fishes were always hampered by the lack of reliable geographical distribution of species. Now a multi-institutional international team of researchers is building the most accurate species distribution database possible for the entire tropical and subtropical Atlantic. This extensive new database covering 2404 species from 74 families will be used to 1) synthesize current knowledge of reef fish diversity and endemism in the Atlantic, 2) search for large-scale patterns and affinities among zoogeographical provinces, and 3) advance our understanding of biogeographical and macroecological marine patterns through the test of a series of hypothesis including the operation of biogeographical barriers, dispersal potential, biotic invasions, and the stepping stones concept.

Allen Hurlbert Postdoctoral Fellow
09/01/2005-08/31/2006

Exploring the Swiss Cheese Effect: The causes and consequences of patchily occupied species ranges

Although the geographic range is a fundamental unit of analysis for many macroecological and biogeographical studies, as a representation of the spatial distribution of individuals it is clearly a scale-dependent abstraction. As any amateur naturalist realizes, a species is not guaranteed to be present at every point within the range delimited by a field guide. The degree to which a species is predictably encountered within its range varies tremendously across species. Using paired datasets on species ranges and survey data for birds, butterflies, and small mammals, I plan to quantify the variation in range occupancy across species, and identify the primary species level traits (e.g. body size, population density, habitat specialization) that explain this variation. The porous nature of species' ranges also has consequences for community level analyses. The overlaying of range maps leads to an overestimate of species richness for local communities, as well as to the perceived coexistence of species that may not actually coexist at a biologically meaningful spatial scale. I also propose to examine the degree to which local community composition as identified by surveys represents a non-random subset of the regional pool (as defined by range maps) using simulation analyses.

Carrie Kappel Postdoctoral Fellow
01/25/2006-01/24/2007

A synthetic approach to the science of ecosystem-based management of coastal marine ecosystems (EBM – Hosted by NCEAS)

As a postdoctoral fellow with the Ecosystem Based Management (EBM) project, I am working on methods for integrating multiple biophysical, social and economic datasets across spatial and temporal scales, estimating the joint uncertainties associated with the integrated data, and incorporating that uncertainty into management decision-making. These activities will be tied to development of system models and a decision-support framework to support marine EBM in coastal California through my involvement in and coordination of the Science Frameworks for EBM working group.

Carrie Kappel is supported by the David and Lucille Packard Foundation.

Kate Lyons Postdoctoral Fellow
08/01/2003-07/31/2006

Temporal and spatial dimensions of mammalian community structure:

Pattern and process
Although progress has been forthcoming concerning macroecological patterns across large spatial scales, relatively little attention has been focused on their temporal dynamics. Moreover, understanding the responses of species to climate change is becoming increasingly important because of the effect humans have on the environment. Predicting how macroecological patterns will change in response to patterns of global warming may allow us to better prepare for the consequences of our actions through informed conservation practices and land use strategies. Comprehensive and spatially explicit data on Pleistocene mammals provide a unique opportunity to perform such spatiotemporal analyses. Community structure was dynamic: many species with historically sympatric ranges are now allopatric. I propose to examine macroecological patterns across the fluid landscape of community structure during the last forty thousand years. As is true in so many instances, the key to predicting the future lies in understanding the past.

Christy McCain Postdoctoral Fellow
01/13/2004-01/12/2007
Elevational trends in biodiversity: Examining theoretical predictions across taxa
Documenting patterns and understanding factors producing and maintaining global biodiversity have been fundamental goals of ecological research since the first expeditions of Darwin and Wallace. After a century and a half of research on biodiversity patterns and processes, Brown asserted that a general explanation for patterns of biodiversity would emerge in the next few years, particularly for elevational and latitudinal patterns. Elevational gradients hold enormous potential for understanding general properties of biodiversity since variable topography is global, and predictable climatic patterns with large concomitant changes in biodiversity occur over small spatial scales. Additionally, biodiversity studies along elevational gradients have been amassed for many taxa on mountain ranges across the globe. Lomolino outlined some testable diversity hypotheses in a research agenda, which would lead to a general explanation for elevational patterns, including climatic hypotheses, species-area effects, community overlap patterns, and historical factors. In the first quantitative synthesis, I tested some of the predictions for elevational diversity patterns of non-volant small mammals (n = 51) with intriguing results. Peak alpha diversity occurred at higher elevations on taller mountains, evidence supporting a combination of climatic factors influencing diversity patterns. In contrast, gamma diversity patterns supported the predictions of the mid-domain effect, displayed a positive, linear trend with latitude, and showed trends consistent with species-area effects. To further examine these preliminary trends, I propose addressing the following questions: (1) Is there a latitudinal trend in elevation of peaks in diversity on mountainsides? (2) Does the species-area relationship inherent to elevational gradients mask other mechanisms producing and maintaining biodiversity? (3) Is there general support for the community overlap hypothesis on elevational gradients? (4) Are there general mechanisms producing elevational diversity patterns across taxa?

Brad McRae Postdoctoral Fellow
11/01/2005-10/31/2006
Linking landscape ecology and population genetics using algorithms from circuit theory
The proposed research addresses a lack of quantitative models that can link data on landscape pattern and gene flow in natural populations. Because current landscape connectivity models focus on dispersal but not emergent patterns of gene flow, they are unable to take advantage of a growing number of population genetic datasets for validation, and cannot predict genetic effects

of landscape change. Similarly, population genetic models either ignore spatial heterogeneity or suffer from prohibitive data and/or computational requirements. I propose to develop models which borrow computationally efficient algorithms from circuit theory to bridge geographic and genetic data and predict effects of landscape pattern on genetic structuring in natural populations.

Carlos Melián Postdoctoral Fellow
02/22/2005-02/21/2007
The evolution of behavior and the structure of ecological networks
Most studies on community ecology have focused on single interaction types (i.e., antagonistic, mutualistic, or competitive). On the other hand, the bulk of behavioral studies have considered interactions among individuals within the same species (i.e., group behavior or group size). To improve our understanding of community structure, I propose to investigate the interdependence between group behavior and the structure of ecological networks integrating multiple interaction types. First, I will introduce behavioral strategies among species within the framework of gametheoretic models. Second, I will complement existing database on food webs by introducing species group size and different interaction types. Third, I will use this enlarged database to test alternative behavioral models of network built up to determine mechanisms generating the structure of ecological networks. This research should provide a first step toward understanding the role of group behavior in the structure of ecological networks with multiple interaction types. The relevance of this work relies on the integration of behavioral and community ecology.

John Orrock Postdoctoral Fellow
06/01/2004-05/31/2007
Interactions between mammalian herbivores and associated plant communities
The grasslands of California represent one of the most dramatic biological invasions in the world: 9.2 million ha (almost 25% of the entire state) are dominated by non-native plants. My work at NCEAS will evaluate whether non-native plants subsidize native consumers, leading to stronger impacts of native consumers on native plants (i.e. apparent competition). I will characterize how differences in consumer behavior among patches change the spatial extent of apparent competition (and thus invasion).

Jennifer Smith Postdoctoral Fellow
10/01/2005-09/30/2006
Coral reef degradation: Determining the relative role of top-down and bottom-up factors in the global decline of coral reefs
Coral reef ecosystems are among the most diverse and highly productive ecosystems on the planet yet are currently threatened by a number of natural and anthropogenic factors (Connell 1978, Hughes et al. 2003, Bellwood et al. 2004). Regardless of the cause, reef degradation generally results in an irreversible phase-shift from dominance by reef-building coral to dominance by fleshy macroalgae (Petraitis and Dudgeon 2004). These shifts are believed to be irreversible and lead to communities that are less diverse and much less complex. While a number of natural disturbances can cause localized coral mortality, reduced top-down control (caused by overfishing) and increased bottom-up control (caused by nutrient pollution) are the most frequently implicated causes of anthropogenic reef degradation (McCook 1999). Past research has focused on either one or the other of these factors independently, has involved large-scale field-based correlations and more recently involved factorial field and laboratory manipulations.

However, despite much effort there is not consensus in the scientific community as to how these factors independently and interactively influence phase-shift formation (Smith 2003). Further, not all phase-shifts are alike; some result in blooms of a single species of algae while others result in a more diverse mixed species assemblage and still others involve invasive non-indigenous species. Through analysis and synthesis of data from the literature I propose to develop conceptual models to determine the relative strength of top-down versus bottom-up control on coral reefs. I also propose to conduct a meta-analysis of these data to test several hypotheses regarding the importance of top-down and bottom-up control across several gradients in the tropics including latitude, diversity and disturbance. Lastly, using a pre-existing database I will assess the role of top-down and bottom-up factors on the success of exotic macroalgae on tropical reefs and conduct a risk assessment to identify species that are likely to be more invasive than others. The information generated by this project will be highly useful in implementing sound science-based management decisions for conservation of coral reef ecosystems across the globe.

Patrick Stephens Postdoctoral Fellow
10/01/2005-09/30/2006

The effects of lineage age on the species richness of regional assemblages

Like area, time is a factor that must constrain diversity at some level, yet very little is known about how time and species richness are related in most groups. It was widely accepted during the first half of the 20th century that time constrained diversity in many groups, though there was little direct evidence for this. Ironically, interest in the relationship waned just before the phylogenetic tools necessary to investigate it directly it were developed. I propose to investigate the relationship between the relative age and species richness of regional assemblages in a wide variety of organisms.

Diego Vázquez Postdoctoral Fellow
10/01/2002-06/30/2005

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.

Mark Vellend Postdoctoral Fellow
09/01/2004-07/31/2005

Forest plant metapopulations in fragmented and dynamic landscapes: Synthesizing models and data

A central goal of ecology and conservation biology is to understand the responses of populations and communities to spatial and temporal landscape heterogeneity. Many regions of Europe and eastern North America share broadly similar histories of land use over the past several centuries, with varying degrees of forest fragmentation via clearance for agriculture, and varying degrees of forest recovery on abandoned agricultural lands. Organisms in such fragmented and dynamic

landscapes exist as metapopulations, but metapopulation theory has only recently begun to incorporate dynamics of the landscape itself (i.e., habitat turnover). The most data-friendly metapopulation model is the “spatially-realistic” Incidence Function Model (IFM) of Hanski. Here I propose to develop modified versions of the IFM to incorporate habitat turnover, and to use these as a theoretical framework in which to synthesize data on forest-plant patch occupancy patterns in landscapes throughout Europe and eastern North America. Data from multiple landscapes will allow models parameterized for one landscape to be tested in others. This integration of models and data will allow metapopulation dynamics and persistence to be projected under a range of scenarios of future land-use change.

Piet Verburg Postdoctoral Fellow
07/16/2004-07/15/2006

Climate forcing of lacustrine energy fluxes

Lakes are warming up globally with the recent climate warming. The effect of the warming on the ecosystems in the lakes depends on the impact on the physics of the lakes. The proposed research investigates the changes since 1980 in energy fluxes leaving and entering lakes in various climatic settings and the relation of these changes with regional meteorology. Implications for aquatic ecosystems will be determined.

Working Groups

Paleobiology Database (Hosted by NCEAS)

John Alroy, Charles Marshall and Arnold Miller – leaders

Aberhan, Martin	Hughes, Nigel	Rogers, Raymond R.
Alroy, John	Ivany, Linda	Sessa, Jocelyn
Behrensmeyer, Anna K.	Kidwell, Susan	Sims, Hallie J.
Blois, Jessica	Kiessling, Wolfgang	Smith, Dena
Bottjer, David J.	Kosnik, Matthew	Stein, William
Buick, Devin	Kowalewski, Michal	Tiffney, Bruce
Carrano, Matthew	Krug, Andrew Zack	Tomasovych, Adam
Clyde, William C.	Looy, Cindy	Uhen, Mark D.
Foote, Michael	Miller, Arnold I.	Wagner, Peter J.
Fursich, Franz T.	Nardin, Elise	Wall, Patrick
Gastaldo, Robert A.	Nowak, Michael	Webster, Mark
Gensel, Patricia G.	O'Donnell, Matthew	Weiser, Michael
Gerber, Sylvain	Patzkowsky, Mark E.	Whatley, Robin
Head, Jason	Plotnick, Roy E.	Wing, Scott
Hendy, Austin	Raymond, Anne	
Holland, Steven M.	Rees, P.M. (Allister)	

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.
The Paleobiology Database project is current funded by an NSF Biocomplexity grant to John Alroy, Charles Marshall, and Arnie Miller, and by an NSF Sedimentary Geology and Paleobiology grant to John Alroy.

Integrating the aquatic with the terrestrial component of the global carbon budget
Jonathan Cole, Carlos Duarte and Yves Prairie – leaders

Cole, Jonathan J.	McDowell, William H.	Striegl, Robert
Downing, John	Melack, John M.	Tranvik, Lars
Duarte, Carlos M.	Middelburg, Jack	
Kortelainen, Pirkko	Prairie, Yves T.	

The traditional compartmentalized approaches to developing inventories of carbons pools and fluxes in the biosphere have generated gaps in the form of key components. Among these key components, freshwater and wetland ecosystems, have been largely ignored or assumed negligible. Recent literature suggests that freshwater ecosystems contribute significantly to some regional carbon balances. We hypothesize, based on a preliminary assessment of the easily available data, that these key components are critical for a reliable estimation of carbon movements at a global scale as well. While the oceans and terrestrial forests are responsible for the net uptake of atmospheric CO2, freshwater ecosystems process a large amount of terrestrially-derived primary production and alter the balance between C sequestration and net CO2 release. This project aims at synthesizing existing information on the linkage between terrestrial and freshwater ecosystems to yield an improved representation of carbon cycling.

Habitat modification in conservation problems: Modeling invasive ecosystem engineers
Kim Cuddington and Jeb Byers – leaders

Byers, Jeb	Hastings, Alan	Lenihan, Hunter S.
Crooks, Jeff	Jones, Clive G.	Talley, Theresa
Cuddington, Kim	Lambrinos, John	Wilson, Will G.

We propose a working group to develop models and analyze data for species that substantially modify their environment. We will incorporate such habitat modification in models describing population and community dynamics of invasive species. Therefore, we will simultaneously develop methods of modeling “ecosystem engineers”, and produce generalizations regarding the effects of invasive habitat modifiers. Finally, we will develop quantitative criteria to determine when it is necessary to consider ecosystem engineering in ecological problems.

Vulnerability of carbon in permafrost: Pool size and potential effects on the climate system
Christopher Field and Josep Canadell – leaders

Bockheim, James	Canadell, Josep	Euskirchen, Eugenie

Field, Christopher B.	Lafleur, Peter	Schuur, Ted
Goryachkin, Sergey V.	Mazhitova, Galina	Tarnocai, Charles
Hagemann, Stefan	Nelson, Frederick	Venevsky, Sergey
Kuhry, Peter	Rinke, Annette	Zimov, Sergei

Ecosystem responses that cause carbon loss to the atmosphere in a warming climate could greatly accelerate climate change during this century. Potentially vulnerable carbon pools that currently contain hundreds of billion tons of carbon could be destabilized through global warming and land use change. Some of the most vulnerable pools on land and oceans are: soil carbon in permafrost, soil carbon in high and low-latitude wetlands, biomass-carbon in forests, methane hydrates in the coastal zone, and ocean carbon concentrated by the biological pump. The risk of large losses from these pools is not well known, and is not included in most climate simulations. Preliminary analyses indicate a risk over the coming century that may be larger than 200 ppm of atmospheric CO2, rivaling the expected release from fossil fuel combustion. This proposal will quantify the carbon content of the vulnerable pools in permafrost soils and analyze the risk of large releases of carbon from these pools over this century.

Analysis of long-term litter decomposition experiments: Synthesis at the site, regional, and global levels

Mark Harmon – leader

Austin, Amy	Currie, William S.	Parton, William J.
Berg, Bjorn	Harmon, Mark	Silver, Whendee L.
Burke, Ingrid C.	Lin, Kuo-chuan	Trofymow, Tony

Although numerous short-term experiments have been used to develop conceptual and simulation models of decomposition, very little is known about the later stages of this process. Exclusion of this later stage has led, at best, to incomplete understanding of ecosystem carbon and nitrogen dynamics. We propose a working group to examine the wealth of litter and decomposition data that has been produced by several recent long-term field experiments. Our analysis will initially be based on data from LIDET (Long-term Intersite Decomposition Experiment Team), a 27-site experiment conducted over a 10-year period. We will then incorporate results of other networks in Canada and Europe as well as other long-term results into this synthesis. Data will be used to reexamine fundamental paradigms that have guided ecosystem analysis for over a decade. We will also test the ability of simulation models developed from short-term experiments to predict long-term trends. Results from our working group will then be used to produce global maps of litter decomposition-related variables including litter production, substrate quality, carbon and nitrogen stores, and decomposition rates.

Spatial and temporal community dynamics: Sharing data to answer questions

Jeff Houlahan, C. Scott Findlay and David Currie – leaders

Cottenie, Karl	Houlahan, Jeff	Stevens, Richard
Ernest, S. K. Morgan	Legendre, Pierre	Woiwod, Ian
Findlay, C. Scott	McArdle, Brian	Wondzell, Steve
Fuhlendorf, Samuel D.	Muldavin, Esteban	
Gaedke, Ursula	Russell, Roly	

General ecological principles can, by definition, only be derived from studies that span multiple taxa, geographic areas, and time periods. Such a broad research agenda implies data-sharing among many researchers from diverse geographic regions. Many of the technological barriers to

data-sharing have been and are being addressed but there still exist many sociological obstacles to data-sharing because researchers are often, understandably, reluctant to share hard-won datasets. We propose to identify the key barriers to data-sharing and provide incentives to overcome these barriers. Once an effective data-sharing model is developed we will build a 'pilot' database using multi-species, site and time period datasets contributed by the working group participants. This database will be used to answer fundamental ecological questions such as; Are more diverse communities more stable? Is the diversity-stability relationship scale, taxon or habitat specific? Are natural communities regulated primarily by biotic or abiotic factors? Does the answer to that question depend on the scale, taxa and/or habitats being studies? Do spatial and temporal variability change in some predictable way with scale? This working group is intended to be a pilot project for a large-scale 'consortium' of ecologists sharing multi-species, site, and time period datasets to derive general ecological principles.

A quantitative exploration of the role of publication-related biases in ecology

Christopher Lortie, Lonnie Aarssen, Julia Koricheva and Tom Tregenza – leaders

Aarssen, Lonnie	Koricheva, Julia	Lortie, Christopher J.
Budden, Amber E.	Leimu, Roosa	Tregenza, Tom

Progress in a scientific discipline is normally achieved through publication and dissemination of knowledge. Number of publications and their citation frequency are also widely used for academic evaluation of individual researchers, departments, and universities. Therefore, any bias in publication and dissemination of scientific content may potentially affect the development of a field in terms of what kind of information is available for synthesis, who is successfully employed, and where funding is allocated. We will specifically focus on publication bias in ecology in this working group using meta-analysis techniques (and other standard statistics) on several sizeable collections of published papers and related online resources such as citation frequencies and impact factors. We have loosely identified three levels of attributes of the publication and dissemination process in ecology: characteristics of the study (number of hypotheses, effect size, support for main hypothesis), attributes of the publication itself (merit, length, number and gender of authors), and attributes of the journal (reputation, impact factor, circulation). General publication biases identified in medicine and ecology include the file drawer problem, overinterpretation bias, dissemination bias, status bias, visibility bias, and gender bias. Few synthetic studies however have quantitatively tested the importance of these proposed biases nor related these biases to specific attributes of the publication process. Furthermore, there has been no quantitative evaluation of the relative importance and potential interactions between these factors.

Comparative study of adaptive radiation

Jonathan Losos – leaders

Davies, T. Jonathan	Losos, Jonathan B.	Seehausen, Ole
Harmon, Luke	Near, Thomas J.	Weir, Jason

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.

The roles of natural enemies and mutualists in plant invasions

Charles Mitchell and Alison Power – leaders

Agrawal, Anurag	Maron, John	Power, Alison G.
Bever, James	Mitchell, Charles	Seabloom, Eric
Gilbert, Gregory S.	Morris, William F.	Torchin, Mark E.
Hufbauer, Ruth A.	Parker, Ingrid M.	Vazquez, Diego

Invasive plant species both threaten native biodiversity and are economically costly (OTA 1993, Williamson 1996, Wilcove et al. 1998, Mack et al. 2000, Pimentel 2002). Recent results (Mitchell and Power 2003) suggest that invasive plants become widespread problems, in part, because they are released from attack by pathogens relative to their native range. However, the roles of herbivores and mutualists in plant invasions remain controversial (Maron and Vila 2001, Keane and Crawley 2002, Agrawal and Kotanen 2003), and the potential for interactive effects of natural enemies and mutualists has been little considered. This working group will examine the joint roles of herbivores, pollinators, mycorrhizal fungi, and pathogens in plant invasions. The first goal of this working group will be to more fully quantify the effects of plant introductions on their associations with these enemies and mutualists. We will achieve this by synthesizing existing data on the geographic occurrence and impact of insect herbivores, mycorrhizal fungi, pollinators, and pathogens. We will then examine to what degree changes in naturalized plants' associations with these other organisms can explain major patterns in biological invasions, particularly variation among naturalized species in their ecological impacts.

Gradients in biodiversity and speciation

Gary Mittlebach, Howard Cornell and Douglas Schemske – leaders

Allen, Andrew (Drew) P.	McCain, Christy M.	Roy, Kaustuv
Brown, Jonathan	McCune, Amy R.	Sax, Dov F.
Bush, Mark	McDade, Lucinda A.	Schemske, Douglas W.
Cornell, Howard V.	McPeek, Mark A.	Schluter, Dolph
Harrison, Susan	Mittelbach, Gary	Sobel, Jay
Hurlbert, Allen	Near, Thomas J.	Turelli, Michael
Knowlton, Nancy	Price, Trevor	
Lessios, Harilaos A.	Ricklefs, Robert E.	

The diversity of life varies predictably with climate and is greatest where it is warm and wet (the humid tropics). But, the question “why” has puzzled biologists for over a century. Recent attention has focused on evolutionary mechanisms, in particular whether speciation rates may vary predictably with climate/latitude, whether such variation in speciation rates can account for higher species richness in tropical environments, and what mechanisms might cause geographical variation in speciation rates. We propose to bring together an interdisciplinary team

of ecologists, evolutionary biologists, and paleontologists to address the conceptual issues of how climate interacts with ecological and physiological processes to affect speciation rates. Our goal is to test whether speciation/diversification rates vary with climate/latitude using phylogenetic and paleontological data. However, formidable challenges stand in the way of these tests. Therefore, our group will work to identify ways to meet these challenges and to address methodological issues of how to use phylogenetic analysis, as well as paleontological data, to estimate rates of speciation and evolutionary diversification across geographical gradients.

Detritus and dynamics of populations, food webs and communities

John Moore and Quan Dong – leaders

Dong, Quan	Moore, John C.	Vanni, Michael J.
Hastings, Alan	Rooney, Neil	
Melville-Smith, 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.

Seasonality and the population dynamics of infectious diseases

Mercedes Pascual and Andrew Dobson – leaders

Alonso, David	Dobson, Andrew P.	Koelle, Katia
Altizer, Sonia	Grenfell, Bryan	Lele, Subhash R.
Bjornstad, Ottar N.	Hosseini, Parviez R.	Pascual, Mercedes
Cattadori, Isabella	Hudson, Peter	Rohani, Pej
Codeco, Claudia	Kendall, Bruce E.	
De Leo, Giulio	King, Aaron A.	

Seasonal variation takes many forms in the natural world. All of us notice the annual cycles in temperature, day length, and rainfall, and these have profound effects on rates of resource production and availability that plants and animals respond to in order to modify their reproduction and maintenance schedules. These regular cycles impose constraints and create opportunities for transmission of infectious diseases. Humans also superimpose seasonal processes onto their lives in a way that creates opportunities for infectious diseases; for example school semesters and annual vacations. This working group will examine the different ways in which seasonal variation in population size, contact rates and the survival of free-living infectious stages modifies the population dynamics of infectious diseases. The working group will bring together biologists, epidemiologists and mathematicians all of who have worked on different aspects of these problems. The workshop is particularly relevant to our understanding of the potential disease problems associated with climate change.

When, and how much, does fear matter? Quantitatively assessing the impact of predator intimidation of prey on community dynamics

Evan Preisser and Daniel Bolnick – leaders

Abrams, Peter A.	Orrock, John L.	Schmitz, Oswald J.
Bolnick, Daniel I.	Pantel, Jelena	Sih, Andrew
Dill, Lawrence M.	Peacor, Scott	Trussell, Geoffrey
Grabowski, Jonathan	Peckarsky, Barbara	Vonesh, James R.
Luttbeg, Barney	Preisser, Evan L.	Werner, Earl E.

Interactions between predators and their prey are the cornerstone of food-web ecology. Ecologists have traditionally thought of such interactions in terms of the number of prey consumed by predators. A mounting array of evidence suggests that prey are far from helpless victims, however, and that they employ a wide array of defensive strategies. The costs of these strategies can include reduced energy income, lower mating success, or increased vulnerability to other predators. Predators can thus reduce prey density both through direct consumption (density-mediated interactions, 'DMIs') and through the costs arising from anti-predator strategies (trait-mediated interactions, 'TMIs'). The presence of TMIs can introduce nonlinearities into species interactions that profoundly affect both short-term interactions and longterm population dynamics. We will use meta-analysis to evaluate patterns of TMIs across a range of ecosystems, taxa, and as a function of predator, prey, and resource density, and to determine the relative importance of different forms of TMIs (reductions in feeding, mating opportunities, reproductive allocation, etc) in shaping predator-prey interactions. Our empirical results will be used to help develop models of predator-prey interactions incorporating both density-mediated and a range of trait-mediated effects, in turn allowing us to generate new hypotheses testable by meta-analysis. We will produce: 1) a series of articles, including one which proposes TMIappropriate experimental methodologies; 2) an article for the general public; and 3) a comprehensive database of TMI research.

Ecological and evolutionary models for homeland security strategy

Rafe Sagarin – leader

Blumstein, Daniel	Lafferty, Kevin	Taylor, Terence
David, Ruth	Madin, Elizabeth M.P.	Thayer, Bradley A.
Dietl, Gregory P.	Madin, Josh	Tooby, John
Hochberg, Michael	Prescott, Elizabeth M.	Vermeij, Geerat
Johnson, Dominic	Sagarin, Rafe	Villarreal, Luis
Jordan, Ferenc	Smith, Katherine F.	

Biological organisms have developed a remarkable number of strategies to mitigate conflict with a broad range of adversaries in their environment. The diversity and success of these strategies, as illustrated by the millions of extant species on the Earth today, suggests that biological evolution may be a field rich with lessons for guiding societal conflict resolution and security strategy. The working group will bring leading security policy analysts together with evolutionary biologists, anthropologists and ecologists to draw on their expertise and identify evolutionary strategies that are applicable to security challenges faced by people, institutions and nations in the 21st century. These biological analogies will be developed into models of decision-making and behavior to explore alternative hypotheses related to strategies for security planning. The combination of biological and policy-oriented perspectives will allow both a rich theoretical discussion and a realistic assessment of the barriers to practical applications of theory.

Exotic species: A source of insight into ecology, evolution, and biogeography

Dov Sax, Steven Gaines and Jay Stachowicz – leaders

Blackburn, Tim M.	Holt, Robert D.	O'Connor, Mary I.
Brown, James H.	Hughes, Randall	Pelc, Robin
Bruno, John	Lafferty, Kevin	Rice, William
Cassey, Phillip	Lockwood, Julie	Sax, Dov F.
D'Antonio, Carla	Mack, Richard N.	Stachowicz, Jay
Gaines, Steven D.	Mayfield, Margie	Tilman, David
Hastings, Alan	Needles, Lisa	Vellend, Mark

Exotic species pose a serious threat to the structure and function of native ecosystems and cause significant economic damage. In spite of these costs, exotic species present unique opportunities to advance our conceptual understanding of ecological patterns and processes. By using exotic species as a vast array of natural experiments we can address questions at scales that would otherwise be non-experimental, and we can observe processes that have occurred repeatedly in the past, but that have previously gone unrecorded. Indeed exotic species may present one of the best inroads available to understanding ecology, evolution and biogeography. The goals of this working group are three-fold. First, to explore the insights that exotic species provide to fundamental conceptual issues in ecology, evolution and biogeography. Second, to provide a model for the budding field of invasion biology, which currently is focused strongly on applied issues, but which could be redirected to simultaneously study both applied and conceptual issues. Third, to use the insights we gain to ecology, evolution and biogeography to in turn improve our ability to manage and mitigate the damage caused by exotic species. To accomplish these goals, we propose a novel model that includes the delegation of work prior to the first meeting of the working group; we have identified a motivated body of scientists who are ready to initiate this work. This approach should allow us to produce a great number of conceptual insights, as well as a great number of important publications, that will advance the study of ecological systems and our ability to effectively manage them.

Comparing trophic structure across ecosystems

Jonathan Shurin, Helmut Hillebrand and Daniel Gruner – leaders

Borer, Elizabeth T.	Elser, James J.	Shurin, Jonathan B.
Bracken, Matthew	Gruner, Daniel S.	Smith, Jennifer E.
Cardinale, Brad	Harpole, W. Stanley	Smith, Melinda D.
Cebrian, Just	Hillebrand, Helmut	Strong, Donald R.
Cleland, Elsa	Ngai, Jackie	Wolkovich, Elizabeth
Cottingham, Kathryn L.	Sandin, Stuart	
de Mazancourt, Claire	Seabloom, Eric	

Trophic structure, the partitioning of biomass among organisms at different positions in a food web, varies both within and among ecosystems. However, the causes of this variation are poorly understood. Elton's "pyramid of numbers", where primary producers dominate and consumer densities decrease as trophic levels become more remote from the base of production, applies well to most terrestrial systems. However, many aquatic ecosystems apparently violate Elton's rule with inverted biomass pyramids, or ratios of heterotroph-to-autotroph biomass (H:A) greater than one. In this proposal, we describe synthetic work aimed at understanding differences in trophic structure and the relative strength of bottom-up and top-down inputs between diverse freshwater,

marine and terrestrial ecosystems. We will test candidate hypotheses for this variation based on factors known to distinguish food webs in the two habitats, such as nutrient limitation and turnover rates, productivity (quantity) and nutrient stoichiometry (quality). Meta-analysis of local-scale herbivore manipulation experiments will be integrated with theoretical development of food web models, and with larger-scale temporal and spatial patterns from resource gradients. This work will move us closer to a comprehensive trophic-dynamic theory, unified across taxa and ecosystem types. It will also increase our mechanistic understanding of how human impacts, such as eutrophication or predator extirpation, propagate or attenuate in ecosystems through trophic interactions.

The fate of nitrogen inputs to terrestrial ecosystems

Pamela Templer, Michelle Mack and Knute Nadelhoffer – leaders

Compton, Jana	Holland, Keri	Schleppi, Patrick
Currie, William S.	Hooper, Dave	Scott, Neal
Dail, Bryan	Kappel Schmidt, Inger	Sommerkorn, Martin
D'Antonio, Carla	Mack, Michelle	Spoelstra, John
Emmett, Bridgett	Nadelhoffer, Knute	Templer, Pamela
Epstein, Howie	Osenberg, Craig W.	Wessel, Willem W.
Goodale, Christine	Perakis, Steve	
Hobbie, Sarah	Schimel, Josh	

Recent technical innovations in the use of 15N stable isotopic tracers at the ecosystem scale have produced a wealth of data on the fate of N inputs to terrestrial ecosystems. Although this analytically intensive technique has been used at over 20 sites world wide, there have been few attempts at cross-site synthesis. Here we propose a series of working group activities to synthesize ecosystem-scale 15N tracer experiments across a wide geographic range of ecosystem types. While at NCEAS, we propose to develop three products: (1) a standardized protocol for application and analysis of 15N tracer studies, (2) a meta-analysis of the fate and redistribution of N across sites and ecosystem types, and (3) an inter-site comparison with the TRACE model, a simulation model that predicts the fate of N inputs over long time scales. Through these activities, we will address questions about controls over the fate of N inputs in terrestrial ecosystems and the consequences of increased N deposition.

Evolutionary and ecological sorting in space

Mark Urban and Mathew Leibold – leaders

Amarasekare, Priyanga	Loeuille, Nicolas	Urban, Mark
de Mazancourt, Claire	Norberg, Jon	Vellend, Mark
DeMeester, Luc	Pantel, Jelena	Wade, Michael
Leibold, Mathew	Strauss, Sharon	

The last fifteen years have witnessed an increasing realization that ecological dynamics operating at coarse spatial scales have important ecological consequences. One of the more exciting ideas that has ensued is the ‘metacommunity’ (Figure 1), a concept that has contributed significant insights about population, community and ecosystems ecology (see Leibold et al. 2004 for a recent review, Holyoak et al. 2005 for the scope of this idea). To date, however, the metacommunity concept has been evaluated in a purely ecological context. Nevertheless, close parallels and obvious interrelations exist between ecological and evolutionary dynamics at multiple spatial scales (McPeek and Gomulkiewicz 2005). Mounting evidence suggests that

evolutionary dynamics can occur on time scales similar to those involving ecological dynamics (Cousyn et al. 2001, Kinnison and Hendry 2001, Grant and Grant 2002, Yoshida et al. 2003). If so, metacommunity and evolutionary dynamics may interact strongly. Yet, we are only now beginning to understand this interaction. While metacommunity ecology will continue to contribute interesting insights about a diverse array of ecological phenomena, we foresee that these insights will soon be constrained by our limited knowledge about how ecological and evolutionary processes interact in metacommunities. We seek to bring together scientists from diverse backgrounds to synthesize current knowledge and generate new understanding about evolutionary and metacommunity dynamics. We intend to 1) develop and refine an evolving metacommunity framework, 2) explore the potential for emergent dynamics by incorporating evolution into existing metacommunity models; 3) evaluate how multi-species interactions impact community evolution and dynamics; and 4) develop tools to test and apply the theory. The proposed synthesis of evolutionary and metacommunity theory promises to improve our understanding of species coexistence and provide strategies for preserving biodiversity and controlling rapidly evolving pests and pathogens

Global change and infectious disease

Mark L. Wilson and Leslie A. Real – leaders

Ahumada, Jorge	Gupta, Sunetra	Real, Leslie A.
Bouma, Menno J.	Hay, Simon	Smith, David L.
Dobson, Andrew P.	Pascual, Mercedes	Wilson, Mark L.

A major element underlying many emerging and reemerging infectious diseases is environmental change. This may be manifested through direct and intentional landscape changes(e.g. hydroelectric dams, agricultural development projects, irrigation, urban expansion, mining, deforestation), indirect habitat changes that favor transmission (e.g. increased vector breeding sites, evolution of virulence, or enhanced contact with infectious agents), and the possibility that other indirect abiotic effects including climate change might alter the intensity or distribution of various diseases. A better understanding of these processes is needed for risk is to be understood and reduced, and for outbreak forecasts are to be made accurate and credible. The goal of this sub-group is to explore various associations between environmental change and specific infectious diseases that have strong environmental links by analyzing data sets with extensive and well-documented temporal and/or spatial variation.

Specifically, we propose to begin by analyzing two categories of infectious disease. The first is vectorborne disease. Within this category we focus on a mosquito-borne anthroponosis, human malaria, which will be analyzed using data from various sites and sources throughout the world. Time-series analysis and study of spatial patterns among cases and environmental variables will be undertaken using standard time-series and GIS-based statistical models. An attempt will be made to test hypotheses that are based in the biology of vectors, human ecological relations with the environment and each other, and climatic factors that influence transmission. Diarrheal diseases comprise the second category. Evolutionary theory and empirical studies indicate that diarrheal diseases evolve increased or decreased virulence in response to environmental changes. Specifically, this work suggests that when waterborne routes of transmission are available natural selection will favor highly exploitative pathogen variants because in such environments the costs of exploitation are low. Even ill, immobilized hosts can act as sources of infection because fecal material is removed and washed in water that can contaminate supplies of drinking water. Conversely, if safe water supplies are provisioned, we

predict pathogens to evolve toward benignity. There exists a great amount of data in the literature and in unpublished records (e.g., located in ministry of health archives) that we propose to analyze to test this prediction. Our focus in this second category will be on the bacterial agents of dysentery, because the inherent virulence of these agents varies at the species level, and the frequencies of these species in human populations spans the length of time over which water supplies have been improved (i.e., over the past century).

Toward an adequate quantification of CH4 emissions from land ecosystems: Integrating field and in-situ observations, satellite data, and modeling

Qianlai Zhuang, Jerry Melillo, Ronald Prinn, A. David McGuire – leaders

Crill, Patrick	McGuire, A. David	White, Jeffrey R.
Dlugokencky, Ed	Melack, John M.	Wickland, Kimberly
Gedney, Nicola	Reeburgh, William S	Zhuang, Qianlai
Keller, Michael	Turetsky, Merritt R.	Zimov, Sergei
Khalil, Aslam	Walter, Katey	

Emissions of CH4 from natural and managed land ecosystems account for a significant source of greenhouse gases to the atmosphere. In recent decades, extensive field observations of CH4 emissions and atmospheric CH4 concentrations have been made during a time in which process-based and inversion modeling approaches have matured as powerful tools in estimating regional and global CH4 emissions. However, there are still substantial uncertainties in estimating CH4 exchange with the atmosphere. Much of this uncertainty arises from uncertainties in the extent of wetland distributions and incomplete understanding of the controls and mechanisms of methanogenesis, methanotrophy, and CH4 transport pathways to the atmosphere. Furthermore, there is variability in which factors control CH4 production and consumption in different natural and managed ecosystems. For example, in northern high latitudes, permafrost dynamics significantly influences emissions, while the seasonality of wetland extent is critical in determining emissions from tropical regions. For managed ecosystems (e.g., rice paddies), irrigation and fertilization significantly impact both methanogenesis and methanotrophy. Here we propose a Working Group to make progress in synthesis of CH4 dynamics through three activities: 1) to identify key issues in quantifying CH4 emissions from land ecosystems through conducting comparisons of model and field observations for different geographical locations and ecosystems; 2) to parameterize and extrapolate process-based models at regional and global scales and explore the uncertainty of CH4 emissions; and 3) to couple process-based estimates with inversion modeling approaches to constrain the uncertainty with air-borne, satellite, and in-situ observed datasets and to identify the factors, mechanisms, and controls to the uncertainty of emissions at large-scales.

The 60-year data set of plankton dynamics in Lake Baikal: Examining facets of the jewel of Siberia

Evgeny Zilov, Marianne Moore and Stephanie Hampton – leaders

Dennis, Brian	Mokryy, Andrey V.	Peshkova, Ekaterina V.
Hampton, Stephanie E.	Moore, Marianne V.	
Izmestyeva, Lyubov R.	Paromchuk, Anna	

This international working group will use time-series analysis to analyze a 60-year data set describing the plankton community of Lake Baikal (Siberia) – the deepest, oldest, and most biotically diverse lake on the planet. Due to financial constraints on scientific research in Russia

during the post-Soviet era, an extraordinary data set describing the dynamics of the plankton community in Lake Baikal has been greatly underutilized, and it is nearly unknown by the international scientific community. Using this high-resolution data set, we will explore spatial-temporal patterns in plankton abundance and community structure, and compare effects of perturbations on plankton dynamics. This work will increase our understanding of ecosystem functioning in one of the world's great lakes, and it will bring the Lake Baikal dataset to international recognition, encouraging future exploitation of this rich scientific resource.

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

Knowledge and capacity-building to support ecosystem-based management for sustainable coastal-marine systems (EBM – Hosted by NCEAS)
O.J. Reichman – leader
Altman, Irit
Meyer, John
Young, Thomas
The recent U.S. Commission for Ocean Policy Report (2004) calls for a new national ocean policy that balances use with sustainability, and moves towards ecosystem-based management (EBM) founded on sound science. But, as yet, there is no scientific consensus on (1) the basic elements or processes involved in ecosystem-based management; (2) the scientific understanding of coastal-marine systems that it will require; or (3) how best to integrate that scientific understanding into decision-making processes. The David and Lucile Packard Foundation has developed a strategic vision to fill this urgent need – a carefully designed science program to help create and ensure the use of the knowledge, tools, and skills needed for EBM of sustainable coastal-marine systems.

In June 2004, the Packard Foundation awarded $2,060,292 to the National Center for Ecological Analysis and Synthesis (NCEAS), at the University of California, Santa Barbara for a three year program of activities, involving the analysis and synthesis of existing data and development of new tools to address gaps in knowledge that are critical to successful implementation of ecosystem-based management. The NCEAS activities will include support for working groups, postdoctoral fellowships, graduate student support, and a distributed graduate seminar.

In this program, NCEAS will go beyond publishing academic papers to devise specific strategies to make the scientific knowledge developed through the project directly useful for practitioners and policy makers. Previous attempts to implement ecosystem-based management have been hindered by the failure to effectively incorporate scientific understanding into the decision-making process, and by neglecting to include the stakeholders whose support will be essential to action. We expect that this set of NCEAS activities will lead to the development of a coherent body of knowledge that will change the conceptual foundations for managing coastal-marine ecosystems and help develop the necessary capacity among individuals and institutions to catalyze this sea-change.

Both goals and approaches for EBM vary, depending on geographic location, social values, institutional settings, economic constraints, etc. Nonetheless, it is clear that EBM entails some level of understanding of the scale, complexity and dynamic nature of both ecological and human systems

The EBM project is funded by the David and Lucille Packard Foundation.

Biodiversity and conservation value of agricultural landscapes of Mesoamerica

Robin Chazdon and Daniel Griffith – leaders

Altierri, Miguel	Finegan, Bryan	Morales, Helda
Bonesso Sampaio, Alexandre	Ford, Anabel	Nigh, Ronald
Bongers, Frans	García -Barrios, Luis	Ochoa Gaona, Susana
Boucher, Douglas	Griffith, Daniel M.	Philpott, Stacy
Calvo, Julio	Harvey, Celia	Saenz, Joel
Chazdon, Robin L.	Holl, Karen	Sekercioglu, Cagan H
Cole, Rebecca	Lawrence, Deborah	Soto-Pinto, Lorena
Daily, Gretchen	Martinez-Ramos, Miguel	Wishnie, Mark
Ferguson, Bruce	Montagnini, Florencia	

This working group will synthesize information from research conducted across eight Mesoamerican countries to elucidate and promote principles for conservation action in human-impacted landscapes of Mesoamerica and to enhance the contribution to biodiversity conservation of forest fragments, extant agriculture, post-agricultural secondary forests, and forest restoration projects. Substantial ecological data sources are available now to develop such a synthesis and to promote the use of current knowledge in conservation planning, biodiversity assessment, corridor development, and transnational cooperation, all with local community participation. We anticipate that this internationally-based effort will provide scientific information critical to the Mesoamerican Biological Corridor and to harmonizing biodiversity conservation and agricultural production throughout Mesoamerica.

Conservation planning for ecosystem functioning: Testing predictions of ecological effectiveness for marine predators (EBM – Hosted by NCEAS)

Daniel Doak, Jim Estes, Tim Wootton and Terrie Williams – leaders

Carruthers, Tim J.	Hughes, Randall	Short, Frederick T.
Dennison, William C.	Kendrick, Gary A.	Waycott, Michelle
Duarte, Carlos M.	Kenworthy, W. Judson	Williams, Susan
Fourqurean, James W.	Olyarnik, Suzanne	
Heck, Kenneth L.	Orth, Robert J.	

At a major symposium on marine ecosystem-based management at the 2005 AAAS meetings, one of the three principal themes deemed critical for future progress was interaction web dynamics—the way in which species interact with one another and their physical environment. In particular, the scientific basis for marine ecosystem-based management must better incorporate understanding of the influences of multiple predator species on interaction web dynamics. These interactions are increasingly recognized as critical to the maintenance and restoration of marine communities and hence to the planning of marine reserves and other conservation strategies. Our working group will directly tackle this important issue, asking what approaches are most successful in estimating the interaction strength, also termed ecological effectiveness, of predator species on nearshore communities and how to use limited information on these effects to best conduct conservation planning in these ecosystems. We will focus our initial efforts on three extremely well-studied predator guilds of West Coast, near shore communities: sea otters in kelp forests; predatory whelks in mid-intertidal benthic communities, and wading shore birds in high to mid intertidal communities. For each of these very different

systems, extensive data exist on the effects of predator abundance, physiology, and individual behavior. We will assemble these diverse data sets and use them to develop detailed interaction models as well as more broad-brush models that may be applicable to less-well-studied communities. Our overall goal is to use these models to ask what aspects of predator physiology and behavior, and what aspects of prey community structure, most determine the ecological effectiveness of predators and thus must be understood in order to plan viable marine conservation strategies.
This EBM project is funded by the David and Lucille Packard Foundation.

Understanding, valuing, and managing dynamic ecosystem services under stress: Synthesizing across the LTER Network

Stephen Farber and Robert Costanza – leaders

Childers, Dan L.	Hopkinson, Chuck	Pincetl, Stephanie
Costanza, Robert	Iwaniec, David	Troy, Austin
Farber, Stephen	Kahn, James R.	Warren, Paige S.
Gibson, Patrick	Morlock, Summer	Wilson, Matthew A.

This project utilizes the LTER site network to develop understanding of the biogeophysical dynamics in stressed ecosystems and the implications of those dynamics for the valuation and management of ecosystem services and underlying ecological support systems. It uses a variety of LTER sites, in different ecological and economic contexts but all subject to existing or potential human stressors. It addresses the appropriateness of valuation methods, how valuations can be transferred among different contexts, and how databases can be developed consistently across sites to assist in ecological management. It also addresses the special management needs demanded of complex, dynamic systems.

Putting ocean wilderness on the map: Building a global GIS atlas of "pristine" marine environments

Ben Halpern, Kimberly Selkoe, Fiorenza Micheli and Hunter Lenihan – leaders

Halpern, Ben	Micheli, Fiorenza
Kappel, Carrie	Selkoe, Kimberly

Terrestrial conservation has long recognized the need for setting global priorities, and a common strategy for such efforts has been to focus on wilderness, or pristine, areas. Only recently have conservation groups begun to consider marine ecosystems, and efforts to take a global approach remain nascent at best. In order to move forward, conservation groups need global-scale data on which to base their priority models, but such data are currently highly dispersed and poorly synthesized. We propose a working group to address two questions that should greatly help close this gap: first, what is a pristine marine ecosystem, and second, where are the remaining pristine areas of the world's oceans? The definition of pristine will be based on an ecologically rigorous assessment of anthropogenic influences on marine ecosystems, and will guide us in identifying existing global-scale datasets that we will use to map the distribution of pristine areas across all marine environments. Our final product will be a GIS-based, interactive atlas of the pristine and impacted areas of the ocean that can be used as a practical tool by conservation groups in developing marine conservation priority models, by academic scientists in future ecological and biogeographic research, and by educators in efforts to increase awareness of ocean conservation needs.

Narrowing the gap between theory and practice in mycorrhizal management

Jason Hoeksema, Nancy Johnson and James Umbanhowar – leaders

Abbott, Lyn	Koide, Roger	Swenson, William
Bever, James	Miller, R. Michael	Umbanhowar, James A.
Chaudhary, Bala	Moore, John C.	Walters, Lawrence
Gehring , Catherine	Pringle, Anne	Wilson, Gail W.
Hoeksema, Jason D.	Schwartz, Mark	Zabinski, Catherine
Johnson, Nancy C.	Simard, Suzanne	

Research on interactions between plants and their symbiotic mycorrhizal fungi has increased dramatically during the last decade, generating a confusing body of theoretical and empirical results. Simultaneously, there has been an explosion in commercial applications of mycorrhizal fungi in agriculture, horticulture, forestry and ecosystem restoration. Considering the unexpected consequences of many human introductions of non-native plants and animals, and our current lack of understanding of the factors controlling mutualistic performance of mycorrhizas, it is alarming that so little caution is being used in commercial applications of mycorrhizal fungi. Our proposed working group will: 1) perform meta-analyses to synthesize the currently disparate body of empirical and theoretical work on mycorrhizal function within communities and ecosystems, 2) develop models of mycorrhizal performance with environmental conditions and plant and fungal phenotypes as variables, 3) generate recommendations and precautions regarding the commercial use of mycorrhizal inoculum, 4) establish an online database that documents inoculation trials and tracks their outcome over time, and 5) organize a symposium at an international conference. In addition to contributing to the development of principles to guide mycorrhizal management, our efforts will help generate better theories for understanding the roles of mutualisms in population and community dynamics.

Conservation priorities: Can we have our biodiversity and ecosystem services too?

Peter Kareiva, Taylor Ricketts, Gretchen Daily and Stephen Polasky – leaders

Armsworth, Paul R.	Heiner, Michael	Nelson, Erik
Brauman, Kate	Hulse, David	Polasky, Stephen
Camm, Jeffrey	Kareiva, Peter	Qi, Ye
Chan, Kai	Kremen, Claire	Regetz, James
Daily, Gretchen	Lande, Russell	Ricketts, Taylor
Du, Qun	Lifeng, Li	Sanchirico, James N.
Fagan, William F.	Liu, Jack	Shaw, M. Rebecca
Farley, Kathleen	Lonsdorf, Eric	West, Paul
Gao, Jixi	Lotze, Heike K.	Worm, Boris
Goldberg, Emma	Murdoch, William W.	
Goldstein, Joshua	Naidoo, Robin	

The delineation of biodiversity hotspots that protect as many species as possible with as little land as possible has been the dominant paradigm in conservation science. Recently, however, this paradigm has been challenged on two accounts. The first challenge is that the burgeoning human population will make it impossible to adequately secure biodiversity in "protected areas", and that instead we must turn to working landscapes with substantial human use as places of biodiversity value. Second, with so much of the world impoverished, there is a need for land management that first and foremost ensures that basic natural services (or "ecosystem services") are provided to people. We intend to explore the spatial congruence

between ecosystem services and biodiversity at multiple spatial scales, and in so doing ask to what extent the provision of ecosystem services and biodiversity protection can be aligned, and what are the tradeoffs where they are not aligned?

This will be much more than a simple mapping exercise because it will be important to extend methods of ecosystem valuation to services and levels of detail that have been lacking thus far in the literature. Most existing maps of ecosystem services simply categorize each land area as a habitat type, and then assign to that habitat type some "generalized dollar value". In contrast we seek to create a spatially explicit accounting of biodiversity targets and ecosystems services, along with a consideration of who benefits from the services, and who might be expected to pay for them and how.

Our purpose is not to replace the goal of biodiversity protection with the goal of ecosystem service protection. Rather we seek to understand if and how the two goals might both be met, as well as how to minimize tradeoffs between the two goals where biodiversity and services are not strongly correlated. In addition to doing the spatial analyses of services and biodiversity, we will explore financial mechanisms that might help pay for the services.

Our working group will start with a mapping and valuation exercise entailing the Upper Yangtze River in China because of the many critical resource decisions this biodiversity rich region is currently facing. We will then extend our analyses to other systems, as well as different spatial scales. Our working group will be fluid with membership varying depending on the systems and analyses under discussion; however the two hallmarks of this effort are its mix of on-the-ground conservation experience from international conservation NGO's and academic scholars, including economists, ecologists and conservation planners.

Restoring an ecosystem service to degraded landscapes: Native bees and crop pollination

Claire Kremen and Neal Williams – leaders

Adams, Laurie	Keitt, Timothy H.	Regetz, James
Aguilar, Ramiro	Klein, Alexandra-Maria	Ricketts, Taylor
Aizen, Marcelo A.	Kremen, Claire	Roulston, T'ai
Crone, Elizabeth E.	LeBuhn, Gretchen	Steffan-Dewenter, Ingolf
Cunningham, Saul	Minckley, Robert	Vazquez, Diego
Gemmill-Herron, Barbara	Packer, Laurence	Williams, Neal M.
Greenleaf, Sarah	Potts, Simon	Winfree, Rachael

Ecosystem services are critical to human survival; managing ecosystems for services could also provide important benefits for biodiversity. Unfortunately, we seldom understand the ecology of these services well enough to manage them. Pollination services are necessary for 15 – 30% of our food supply, and are comparatively well-understood relative to other ecosystem services. We propose to synthesize data on bee populations, pollinator communities and pollination services across agro-natural landscapes, in order to: (1) develop models of the persistence of populations, communities and pollination function at the landscape scale; (2) design an experiment to restore and monitor pollination function in agro-natural landscapes, replicated across sites, landscapes and regions; and (3) extend this example to create a general, conceptual framework for analyzing and managing ecosystem services. This work will improve our ability to manage agricultural lands, which occupy 38% of terrestrial area, with benefits for food security, human health and biodiversity.

A synthetic approach to the science of ecosystem-based management of coastal marine ecosystems (EBM – Hosted by NCEAS)

Fiorenza Micheli and Andrew Rosenberg – leaders

Broad, Kenneth	Kappel, Carrie	Osio, Giacomo
Brumbaugh, Dan	Lluch Cota, Salvador	Rosenberg, Andrew A.
Costello, Christopher	Mangel, Marc	Sanchirico, James N.
Fogarty, Michael J.	Martone, Rebecca	Shester, Geoffrey G.
Gaines, Steven D.	Menzel, Susanne	Siegel, David A.
Halpern, Ben	Micheli, Fiorenza	

We will develop a modeling and data integration framework for EBM and apply that framework to a case study from coastal California. By bringing experts in the modeling of natural and human systems together with policy specialists, the working group will develop a policy relevant modeling approach that includes the dynamics of social, biophysical and economic components of the ecosystem and critical feedbacks among them, and an explicit risk assessment component. Then, in collaboration with scientists and managers knowledgeable about the coastal California system, we will develop a detailed case study using this modeling approach as a basis. Key questions about how to cope with uncertainty, how to define ecosystem boundaries, and what constitute appropriate and effective indicators of ecosystem health and performance, will be addressed through the case study. The result will be a tool that scientists and policy makers use to develop an ecosystem-based approach to management of this system, and by extension others. *This EBM project is funded by the David and Lucille Packard Foundation.*

Stochastic demography for an increasingly variable world

William Morris, Catherine Pfister and Shripad Tuljapurkar – leaders

Boggs, Carol	Gaillard, Jean-Michel	Mastrandrea, Michael
Boyce, Mark	Haridas, Chirakkal V.	Dechen
Bruna, Emilio M.	Horvitz, Carol C.	Menges, Eric
Coulson, Tim	Kalisz, Susan	Morris, William F.
Doak, Daniel	Kendall, Bruce E.	Pfister, Catherine A.
Drake, John	Lee, Charlotte	Tuljapurkar, Shripad

Both the means and the variances of such important environmental variables as growing-season temperature and rainfall are projected to increase in many regions over the 21st century. While effects on organisms of changes in mean conditions have often been anticipated, the potential effects of increasing variability have been relatively neglected. We propose a Stochastic Demography Working Group to assess how increasing environmental variability is likely to impact populations of plants and animals. Using unpublished demographic data for a diverse set of taxa and new theoretical tools developed by group members, we will compare the effects of changes in the means vs. the variances of environmental variables, as well as the pattern of sensitivity to environmental variability across species, life histories, and habitats. In addition, we will ask whether the demographic processes that most influence population growth are the least sensitive to environmental variation, a pattern that has been observed in the relatively small number of species previously tested and that would serve to buffer populations against increasing environmental variability. Our ultimate goal is to improve the ability of ecologists to forecast the consequences for the long-term viability of populations of not only overall trends in environmental conditions but also expected changes in year-to-year variability.

Global trajectories of seagrasses: Establishing a quantitative basis for seagrass conservation and restoration

Robert Orth and William Dennison – leaders

Carruthers, Tim J.	Hughes, Randall	Short, Frederick T.
Dennison, William C.	Kendrick, Gary A.	Waycott, Michelle
Duarte, Carlos M.	Kenworthy, W. Judson	Williams, Susan
Fourqurean, James W.	Olyarnik, Suzanne	
Heck, Kenneth L.	Orth, Robert J.	

Seagrasses are a group of flowering plants that have evolved a unique set of characteristics to live, grow, and reproduce in marine underwater habitats (Les et al., 1997), with key ecosystem services that they provide to coastal areas of the world (Costanza et al., 1997). During the past two decades there has been a significant increase in the number of studies on the distribution, abundance, biology and ecology of seagrasses, including the recent publication of a seagrass atlas (Green and Short, 2003); methods book (Short and Coles, 2001) and research synthesis (Larkum et al., in press). However, the need for a better understanding of seagrasses today has taken on a new meaning and increased urgency. The rate of ecosystem alteration in coastal regions where seagrasses reside is accelerating (Cohen et al., 1997), and these alterations are occurring globally (Short and Wyllie-Echeverria, 1996). The very survival of seagrasses, which have been present for the past 100 million years, depends on their ability to cope with these natural and anthropogenic alterations. The goal of the 'Global Seagrass Trajectories' working group, and the designated sub-groups, will be to use quantitative approaches to critically evaluate the types of changes that seagrasses are experiencing and evaluate likely causes. A previous qualitative examination of the literature indicates that seagrasses are experiencing loss rates (Green and Short, 2003) which match or exceed those of other threatened coastal habitats, such as salt marshes, mangrove forests, and coral reefs (e.g., Pandolfi et al., 2003), for which there is ample scientific and social awareness. Yet, a global assessment with quantitative data for seagrasses is lacking and is the focus of this effort. Synthesizing available information and conveying them to the broader scientific community and society in an effective way will be a key outcome of this project.

Ecosystem-based management for the oceans: The role of zoning

Gail Osherenko, Elliott Norse, Larry Crowder, Oran Young and Satie Airame – leaders

Airame, Satie	Hanrahan, Michael	Peach, Robbin
Crowder, Larry B.	Langdon, Stephen J.	Sanchirico, James N.
Day, Jon	McLeod, Karen	Schwager, Katherine
Douvere, Fanny	Norse, Elliott	Wilson, James
Ehler, Charles	Osherenko, Gail	Young, Oran R.

The proposed working group on Ocean Ecosystem Management will explore the role of place-based systems in achieving ecosystem-based ocean management. The U.S. Commission on Ocean Policy (2004) and the Pew Oceans Commission (2003) both recommend ecosystem-based management of the 4.4 million square miles of ocean within the jurisdiction of the United States. The Pew Oceans Commission Report, as well as numerous scientists, managers, and advocacy organizations, has called for development of ocean zoning as a key component of ecosystem-based management. Ocean zoning is the authoritative regulation and allocation of access and use to specific marine geographic areas. Zoning systems aim to separate competing uses, reduce conflict, increase certainty among users, and protect sensitive marine resources. Fisheries management has increasingly used spatial regulation to determine access, protect nursing and spawning areas, reduce gear impacts, etc. More recently, place-based marine management is

growing through the establishment of marine protected areas (MPAs), including fully protected no-take reserves and areas offering protection from a limited set of uses. This working group will bring together ecologists and social scientists to explore the concept, practice, and opportunities for ocean zoning in a unique political and social climate primed for change. We will focus particularly on the question of whether or not and how zoning systems can be used to implement ecosystem-based management of oceans within the jurisdiction of the United States. The working group goals are to: (1) compile and synthesize information on existing systems of ocean zoning and their ecological and social impacts, (2) compile and synthesize available ecological and social data necessary to design and develop effective zoning systems, (3) develop the concept of ocean zoning within the context of ecosystem based management, and (4) design a set of principles and policies for creation of sustainable and resilient ecosystem-based ocean zoning systems. We have identified a group of leading thinkers engaged in developing an understanding of the complex ecological and social dynamics of ocean systems. The resources of NCEAS will enable us to bring these experts together to advance our understanding of marine ecosystems and our ability to implement scientifically based and effective ecosystem management.

A synthetic analysis of the scientific basis of ecological restoration of stream ecosystems

Margaret Palmer and J. David Allan – leaders

Allan, J. David	Goodwin, Peter	McFall, Jeanne
Bernhardt, Emily	Hart, David	Meyer, Judy
Carr, Jamie	Hassett, Brooke	O'Donnell, T. Kevin
Clayton, Steve	Haupt, Mac	Palmer, Margaret A.
Dahm, Cliff	Katz, Stephen L.	Sudduth, Elizabeth
Fahlund, Andrew	Kusler, Jon A.	Treuer, Remi
Follstad-Shah, Jennifer	Lake, P. S.	Williams, Philip B.
Galat, David L.	Malakoff, David	

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.

Lianas and tropical forest dynamics: Synthesis of Pan-tropical patterns from regional data sets

Stefan Schnitzer and Robyn Burnham – leaders

Bongers, Frans	DeWalt, Saara J.	Kenfack, David
Burnham, Robyn J.	Ewango, Corneille E.N.	Lohmann, Lucia
Chave, Jerome	Fine, Paul	Muller-Landau, Helene
Clark, David	Gerwing, Jeff	

Narayanaswamy, Parthasarathy	Putz, Francis	Thomas, Duncan
Perez Salicrup, Diego	Romero Saltos, Hugo	Webb, Campbell O.
	Schnitzer, Stefan A.	

Lianas (woody vines) are an important component in tropical forest dynamics, altering forest regeneration, species diversity and ecosystem-level processes such as carbon sequestration. Recently, the study of liana ecology has increased substantially throughout the tropics; however, methods for collecting liana data are only rarely consistent and there is little comparability in liana abundance, biomass, diversity, composition, or community dynamics across large areas of the tropics. Until these data sets are combined and synthesized, many large-scale questions on the ecology of lianas will remain unanswered. We propose an NCEAS Working Group to standardize, combine, and synthesize the many liana data sets from research groups around the world. In doing so, we will compile a pan-tropical data set with which we can answer specific questions about the contribution of lianas to forest diversity and biomass worldwide, as well as the pan-tropical distribution of many important liana taxa. Four main goals will be addressed during two Working Group Meetings and the intervening year. (1) Establish logical and useable guidelines for censuses of lianas, given different research goals. (2) Assemble and synthesize preexisting data sets on liana stem diameter, abundance, and diversity using empirically derived correction factors to generate a uniform, pan-tropical data set on lianas. (3) Estimate liana biomass at the whole-forest and regional levels using new and substantially more robust stem diameter-to-biomass equations. (4) Create standard systematic databases and maps of the geographic distribution of liana taxa and maps of liana hotspots to identify conservation priorities.

Linking marine biodiversity to ecosystem functions and services

Boris Worm and Enric Sala – leaders

Barbier, Edward	Jackson, Jeremy	Selkoe, Kimberly
Baron, Nancy	Lotze, Heike K.	Watson, Reg
Duffy, Emmett	Sala, Enric	Worm, Boris
Halpern, Ben	Schmittner, Andreas	

Biodiversity, or biological diversity, is the variation of life at all levels of organization, from the level of genetic variation within and among species to the level of variation within and among communities, ecosystems and biomes. It is well-documented how human impacts are changing biodiversity in terrestrial (Wilson 1999) and marine ecosystems (NRC 1995). Historical studies in marine systems have further shown that long-term impacts often lead to the simplification of food webs, as species and species groups are driven to such low abundances that they become functionally extinct (Jackson et al. 2001, Lotze and Milewski 2002). The general consequences of these trends and changes for ecosystem functions, such as primary and secondary productivity, carbon and nutrient cycling, food and habitat provision are little understood in marine systems. The recent research focus on biodiversity, however, has generated a significant, albeit diffuse body of theory and empirical studies. Without synthesis, it is difficult to communicate to the public and to environmental managers why marine biodiversity matters, what the ecological and economic consequences of species loss and changes in biodiversity are, and how dramatic consequences can be prevented. The proposed working group aims to fill this gap. In addition to quantifying the link between marine biodiversity and ecosystem functioning, we will analyze the potential for the disruption of marine ecosystem services, which are those functions that are vital to our food supply, economies, and human health (see Fig. 1). Finally, we will use the results from our analyses to evaluate the costs and benefits of maintaining the status quo versus

implementing significant global conservation measures. In three consecutive workshops we will (1) collate experimental and observational evidence on how marine biodiversity and ecosystem functions are linked in a web-accessible database, (2) conduct and publish a series of meta-analyses to derive generalizations about the effects of species loss, ecological simplification and changes in marine biodiversity on ecosystem functions and services, (3) write a policy paper that translates our results into management strategies.

Meetings Hosted by NCEAS

Name	Sponsor and Project Title
Sandy Andelman	Tropical Ecology, Assessment, and Monitoring (TEAM) Monitoring Meeting, Conservation International
Doug Beard	GAP Meeting, National Biological Information Infrastructure (NBII)
Barbara Benson	LTER Information Management Executive Committee Meeting
Elsa Cleland	Fertilization Synthesis
Andrew Dobson	Ecology and Health
Ed Hackett	Ecology transformed: Social and intellectual change in ecological research
Matthew Jones	BEAM/KR/SMS Meeting
Matthew Jones	Kepler's Developer's Conference
Travis Longcore	Meta-analysis of management and monitoring data of endangered species: Status and trends of Western Snowy Plover on California’s Central Coast
Jim Reichman	A unified framework for management and dissemination of heterogeneous data and metadata from Kruger National Park
Rebecca Shaw	Climate Change and Conservation Planning, The Nature Conservancy
Michael Willig	High Performance Computing Conference, National Science Foundation
Ali Whitmer	LTER Grant Committee and Advisory Committee Meeting

Scientific Visitors

Name	Project Title
Jordi Bascompte	Consejo Superior de Investigaciones Científicas

Ross Cressman	Wilfrid Laurier University
Kristin Jenkins	NESCent Outreach and Education Team
Richard Krause	Virginia Polytechnic Institute
Thomas Koellner	Gesellschaft für Organisation und Entscheidung m.b.H. (GOE)
Christine Laney	New Mexico State University
Andrew Liebhold	USDA Forest Service
Hugh Possingham	University of Queensland
John Sabo	Arizona State University
Jennifer Stempien	Virginia Polytechnic Institute
William Swenson	University of California, Riverside
Bob Ulanowicz	University of Maryland
Jory Weintraub	NESCent Outreach and Education Team

Center Associates Hosted by NCEAS

Name	Project Title
Marcelo Aizen	Universidad Nacional del Comahue, Argentina (Fulbright)
John Alroy	Paleobiology Database
Nancy Baron	SeaWeb
Ellen Damschen	University of California, Santa Barbara
Margaret Kinnaird	Wildlife Conservation Society
Timothy O'Brien	Wildlife Conservation Society
Kim Selkoe	University of Hawaii
Tommaso Zillio	International School of Advanced Studies (ISAS), Italy

Research Training Activities

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

Graduate Student Interns

Intern	Sponsor and Project Title
Emily Althoen	Margaret Connors Kids Do Ecology
Sean Benison	Ben Halpern Putting ocean wilderness on the map: Building a global GIS atlas of "pristine" marine environments
Christina Cairns	Gail Osherenko Ecosystem-based management for the oceans: The role of zoning
Elliot Chasin	Ellen Damschen The causes and consequences of patchiness in kelp forests and implications for coastal marine reserve design (Hosted by NCEAS)
Julia Ekstrom	Gail Osherenko Ecosystem-based management for the oceans: The role of zoning O.J. Reichman Knowledge and capacity-building to support ecosystem-based management (EBM) for sustainable coastal-marine systems (Hosted by NCEAS)
John Kefauver	Christy McCain Elevational trends in biodiversity: Examining theoretical predictions across taxa
David Lamb	John Alroy Paleobiology Database (Hosted by NCEAS)
Corey Lawrence	Josh Schimel Can we now determine if, when, and how microbial community composition impacts ecosystem processes? Will that understanding yield critical new information about ecosystem function and response to change?
Candace Low	Elsa Cleland The response of ecological communities to nutrient enrichment: Utilizing meta-analysis and structural equation modeling to disentangle the influences of functional traits and environmental context

Brent Miller	John Orrock Interactions between mammalian herbivores and associated plant communities (Hosted by NCEAS)
Suzanne Olyarnik	Robert Orth and William Dennison Global trajectories of seagrasses: Establishing a quantitative basis for seagrass conservation and restoration
Jelena Pantel	Evan Preisser and Daniel Bolnick When, and how much, does fear matter? Quantitatively assessing the impact of predator intimidation of prey on community dynamics
Matthew Perry	Ben Halpern, Kimberly Selkoe, Fioenza Micheli and Hunter Lenihan Putting ocean wilderness on the map: Building a global GIS atlas of "pristine" marine environments
Catherin Schwemm	Carlos Melian The evolution of behavior and the structure of ecological networks

Undergraduate Student Interns

Intern	Sponsor and Project Title
Helen Claudio	John Gamon SpecNet

Education and Outreach Activities

In summer 2005, the Center hired an Outreach Coordinator to work with the Director, resident scientists, and the Center's Science Advisory Board to develop a comprehensive outreach plan. After the plan's completion, it was subsequently enhanced in response to NSF reviewer recommendations.

We began a marketing initiative in fall 2005 to increase awareness of NCEAS opportunities, targeting groups including foreign scientists, scientists from small, non-research universities, scientists from underrepresented groups, government, NGO's, and private organizations. This effort included rewriting our recruitment materials to provide clearer instructions to applicants, E-marketing our Call for Proposals, and getting coverage for our program on web sites and in newsletters, i.e. The American Institute of Biological Science's Eye on Education. We targeted underrepresented groups for opportunities at NCEAS using available databases and contacts at the Ecological Society of America, SACNAS and the National Science Foundation, among others.

We initiated a partnership with the National Evolutionary Synthesis Center's Working Group on Evolution Education at Historically Minority Universities to develop ideas and actions for increasing awareness of careers in ecology and evolution among under-served and under-

represented students throughout the country. Participating with colleagues in the spring 2006 meeting provided us with important contacts for extending our successful Distributed Graduate Seminars Program to minority serving institutions.

To support current outreach and education goals, we developed the design and structure for a new Center website which includes news items of interest, better access to working groups' activities, and additional communication tools for working groups' interactions. Research summaries geared for the general public, an expanded section on opportunities, and enhanced content illustrating the breadth and depth of NCEAS activities will be included.

NCEAS' Kids Do Ecology (KDE) program has been our primary means of outreach to K-12 students since 1995. KDE includes two major initiatives:

(1) A classroom program in which NCEAS scientists work locally with 5th grade classes to provide inquiry- based instruction in the scientific method as applied to ecological questions. The experiential approach to learning provides a perfect complement to the educational goals of NCEAS. The classroom program continues to be very successful locally. We have been working with the UCSB Office of Outreach, the Vernon I. Cheadle and Katherine Esau Botanical Collection, and the Santa Barbara Museum of Natural History to identify collaborative opportunities.

(2) A nationally recognized educational, participatory, bilingual (Spanish/English) website. Our website has received numerous commendations and is linked from educational sites throughout the world. A local fifth-grade teacher is writing new material for the site and we are updating features and design. NCEAS scientists have been recruited to serve as experts for the site's "Ask an Ecologist" service.

In May 2005, KDE held a poster session at NCEAS to display work completed during the prior school year. Invited to this event were approximately 180 students from six classrooms at four different schools, who participated in the standard KDE program, and approximately 60 students and two teachers from one school, who participated in a pilot project where the scientists visited for only one day in the classroom.

We extended our outreach to K-12 this year by collaborating with UCSB's Marine Science Institute and LTER, and participating for the first time in the Santa Barbara County Science Fair. NCEAS provided a resource for educational materials on statistics, graphing, mapping, and data sharing: http://www.nceas.ucsb.edu/nceas-web/kids/sciencefair.

We continue to emphasize technical training for our own scientists as well as periodic nationwide trainings. NCEAS scientific computing staff provides support and training in the use of ecoinformatics tools for hundreds of scientists participating at NCEAS. Additionally, NCEAS' Ecoinformatics Program collaborates with partners in providing training groups for junior and senior scientists in workshops around the country.
In-house training of our scientists in communicating with the media has been extended to include IGERT Fellows from UCSB's Economics and Environmental Science Program as well as NCEAS Graduate Assistants.

Publications

Below we list publications for the reporting period May 1, 2005-April 30, 2006. 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.

Citations in italics were previously reported as in press.

Abrams, Peter A. 2004. When does periodic variation in resource growth allow robust coexistence of competing consumer species?. Ecology. Vol: 85. Pages 372-382.

Adler, Fred; Muller-Landau, Helene C. 2005. When do localized natural enemies increase species richness?. Ecology Letters. Vol: 8. Pages 438-447.

Apsit, Victoria; Sork, Victoria L.; Dyer, Rodney. 2002. Patterns of mating in an insect-pollinated tree species in the Missouri Ozark Forest Ecosystem Project. Edited by Shifley, R. Stephen; Kabrick, J.M. Proceedings of the Secong Missouri Ozark Forest Ecosystem Symposium: Post-treatment results of the landscape experiment, 17-18 October 2000. U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. St. Paul, Minnesota. Pages 213-227.

Austerlitz, Frederic; Dick, Christopher W.; Dutech, Cyril; Klein, Estienne K.; Oddou-Muratorio, Sylvie; Smouse, Peter; Sork, Victoria L. 2004. Using genetic markers to estimate the pollen dispersal curve. Molecular Ecology. Vol: 13. Pages 937-954.

Bascompte, Jordi; Melian, Carlos J.; Sala, Enric. 2005. Interaction strength combinations and the overfishing of a marine food web. Proceedings of the National Academy of Sciences. Vol: 102(15). Pages 5443-5447.

Bastviken, David; Cole, Jonathan J.; Pace, Michael; Tranvik, Lars. 2004. Methane emissions from lakes: Dependence of lake characteristics, two regional assessments, and a global estimate. Global Biogeochemical Cycles. Vol: 18. Pages doi:10.1029/2004GB002238.

Becerra, Judith X. 2004. Molecular systematics of Blepharida beetles (Chrysomelidae: Alticinae) and relatives. Molecular Phylogenetics and Evolution. Vol: 30(1). Pages 107-117.

Bohannan, Brendan. In press. Patterns in microbial biodiversity. Edited by Lappin-Scott, H. Prokaryotic diversity: Mechanisms and Significance. Society for General Microbiology. Reading, UK.

Briggs, Cherie J.; Borer, Elizabeth T. 2005. Why short-term experiments may not allow long-term predictions about intraguild predation. Ecological Applications. Vol: 15(4). Pages 1111-1117.

Burgman, Mark. 2005. Risks and Decisions for Conservation and Environmental Management. Cambridge University Press. Cambridge, UK.

Callaway, Ragan; Kikodze, David; Chiboshvili, M.; Khetsuriani, L. 2005. Unpalatable plants protect neighbors from grazing and increase plant community diversity. Ecology. Vol: 86(7). Pages 1856-1862.

Cary, Geoff; Keane, Robert; Gardner, Robert H.; Lavorel, Sandra; Flannigan, Michael; Davies, Ian; Li, Chao; Lenihan, Jim; Rupp, Scott; Mouillot, Florent. In press. Comparison of the sensitivity of landscape-fire-succession models to variation in terrain, fuel pattern, climate and weather. Landscape Ecology.

Case, Ted; Holt, Robert D.; McPeek, Mark A.; Keitt, Timothy H. 2005. The community context of species' borders: Ecological and evolutionary perspectives. Oikos. Vol: 108. Pages 28-46.

Cattadori, Isabella; Boag, B.; Bjornstad, Ottar N.; Cornell, S. J.; Hudson, Peter. 2005. Peak shift and epidemiology in a seasonal host–nematode system. Proceedings of the Royal Society: Biological Sciences. Vol: 272. Pages 1163-1169.

Coleman, Felicia C.; Figueira, Will F.; Ueland, Jeffery S.; Crowder, Larry B. 2004. The impact of United States recreational fisheries on marine fish populations. Science. Vol: 305. Pages 1958-1960.

Cottenie, Karl. 2005. Integrating environmental and spatial processes in ecological community dynamics. Ecology Letters. Vol: 8. Pages 1175-1182.

Coulson, Tim; Guinness, F.; Pemberton, J.; Clutton-Brock, T. 2004. The demographic consequences of releasing a population of red deer from culling. Ecology. Vol: 85(2). Pages 411-422.

Coulson, Tim; Kruuk, L.; Tavecchia, G.; Pemberton, J.; Clutton-Brock, T. 2003. Estimating selection on neonatal traits in red deer using elasticity path analysis. Evolution. Vol: 57(12). Pages 2879-2892.

Cox, Stephen B.; Willig, Michael R.; Scatena, F. N. 2002. Variation in nutrient characteristics of surface soils from the Luquillo Experimental Forest of Puerto Rico: A multivariate perspective. Plant and Soil. Vol: 247. Pages 189-198.

Craig, J. Kevin; Crowder, Larry B. 2005. Hypoxia-induced habitat shifts and energetic consequences in Atlantic croaker and brown shrimp on the Gulf of Mexico shelf. Marine Ecology Progress Series. Vol: 294. Pages 79-94.

de Valpine, Perry. 2004. Monte Carlo state-space likelihoods by weighted posterior kernel density estimation. Journal of the American Statistical Association. Vol: 99(466). Pages 523-536.

Drake, John. 2005. Density-dependent demographic variation determines extinction rate of experimental populations. Public Library of Science Biology. Vol: 3(7). Pages 1300-1304.

Drake, John. 2005. Population effects of increased climate variation. Proceedings of the Royal Society: Biological Sciences. Vol: 272. Pages 1823-1827.

Drake, John; Costello, Christopher; Lodge, David M. 2005. When did the discovery rate for invasive species in the North American Great Lakes accelerate?. BioScience. Vol: 55(1). Pages 4.

Drake, John; Lodge, David M. 2006. Allee effects, propagule pressure and the probability of establishment: Risk analysis for biological invasions. Biological Invasions. Vol: 8. Pages 365-375.

Drake, John; Lodge, David M.; Lewis, Mark A. 2005. Theory and preliminary analysis of species invasions from ballast water: Controlling discharge and location. American Midland Naturalist. Vol: 154. Pages 459-470.

Duque, Ricardo B.; Ynalvez, Marcus; Sooryamoorthy, R.; Mbatia, Paul; Dzorgbo, Dan-Bright S.; Shrum, Wesley. 2005. Collaboration paradox: Scientific productivity, the Internet, and problems of research in developing areas. Social Studies of Science. Vol: 35(5). Pages 755-785.

Dyer, Rodney; Sork, Victoria L. 2001. The effects of autocorrelated patterns among adults on pollen pool differentiation. Edited by Degen, B.; Loveless, M.D.; Dremer, A. Modeling and Experimental Research on Genetic Processes in Tropical and Temperate Forests. Embrapa Amazonia Oriental. Balen PA, Brazil. Pages 89-93.

Dyer, Rodney; Westfall, Robert; Smouse, Peter. 2004. Two-generation analysis of pollen flow across a landscape V: A stepwise approach for extracting factors contributing to pollen structure. Heredity. Vol: 92. Pages 204-211.

Farber, Stephen; Costanza, Robert; Childers, Dan L.; Erickson, Jon D.; Gross, Katherine L.; Grove, Morgan; Hopkinson, Chuck; Kahn, James R.; Pincetl, Stephanie; Troy, Austin; Warren, Paige S.; Wilson, Matthew A. 2006. Linking ecology and economics for ecosystem management. BioScience. Vol: 56(2). Pages 117-129.

Ferreira, C. E. L.; Gasparini, J. L.; Carvalho-Filho, A.; Floeter, Sergio R. 2005. A recently extinct parrotfish species from Brazil. Coral Reefs. Vol: 24. Pages 128.

Festa-Bianchet, Marco; Gaillard, Jean-Michel; Cote, S. D. 2003. Variable age structure and apparent density dependence in survival of adult ungulates. Journal of Animal Ecology. Vol: 72(4). Pages 640-649.

Field, John; Francis, Robert C. In press. Considering ecosystem-based fisheries management in the California Current. Marine Policy.

Field, John; Francis, Robert C.; Aydin, Kerim. 2006. Top-down modeling and bottom-up dynamics: Linking a fisheries-based ecosystem model with climate hypotheses in the Northern California Current. Progress in Oceanography. Vol: 68. Pages 238-270.

Floeter, Sergio R.; Behrens, M. D.; Ferreira, C. E. L.; Paddack, M. J.; Horn, M. H. 2005. Geographical gradients of marine herbivorous fishes: Patterns and processes. Marine Biology. Vol: 147. Pages 1435-1447.

Floeter, Sergio R.; Halpern, Ben; Ferreira, C. E. L. 2006. Effects of fishing and protection on Brazilian reef fishes. Biological Conservation. Vol: 128. Pages 391-402.

Floyd, Melissa M.; Tang, Jane; Kane, Matthew; Emerson, David. 2005. Captured diversity in a culture collection: Case study of the geographic and habitat distributions of environmental isolates held at the American Type Culture Collection. Applied and Environmental Microbiology. Vol: 71(6). Pages 2813-2823.

Fortin, Marie-Josee; Keitt, Timothy H.; Maurer, Brian A.; Taper, Mark L.; Kaufman, Dawn; Blackburn, Tim M. 2005. Species' geographic ranges and distributional limits: Pattern analysis and statistical issues. Oikos. Vol: 108. Pages 7-17.

Fryxell, John M.; Wilmshurst, John F.; Sinclair, Anthony R. E.; Haydon, Daniel T.; Holt, Robert D.; Abrams, Peter A. 2005. Landscape scale, heterogeneity, and the viability of Serengeti grazers. Ecology Letters. Vol: 8(3). Pages 328-335.

Gabriel, Wilfried. 2005. How stress selects for reversible phenotypic plasticity. Journal of Evolutionary Biology. Vol: 18. Pages 873-883.

Gabriel, Wilfried; Luttbeg, Barney; Sih, Andrew; Tollrian, Ralph. 2005. Environmental tolerance, heterogeneity, and the evolution of reversible plastic responses. American Naturalist. Vol: 166(3). Pages 339-353.

Gasparini, J. L.; Floeter, Sergio R.; Ferreira, C. E. L.; Sazima, I. 2005. Marine ornamental trade in Brazil. Biodiversity and Conservation. Vol: 14. Pages 2883-2899.

Gelfand, Alan E.; Schmidt, Alexandra M.; Wu, Shanshan; Silander, John; Latimer, Andrew; Rebelo, Anthony G. 2005. Modelling species diversity through species level hierarchical modelling. Journal of the Royal Statistical Society: Series C (Applied Statistics). Vol: 54(1). Pages 1-20.

Gelfand, Alan E.; Silander, John; Wu, Shanshan; Latimer, Andrew; Lewis, Paul; Rebelo, Anthony G.; Holder, Mark. 2003. Explaining species distribution patterns through hierarchical modeling. Bayesian Analysis. Vol: 1(1). Pages 1-35.

Gerber, Leah; Tinker, M. Tim; Doak, Daniel; Estes, James. 2004. Mortality sensitivity in life-stage simulation analysis: A case study of Southern sea otters. Ecological Applications. Vol: 14(5). Pages 1554-1565.

Goodale, Christine; Apps, Michael; Birdsey, Richard A.; Field, Christopher B.; Heath, Linda S.; Houghton, Richard A.; Jenkins, Jennifer; Kohlmaier, Gundolf; Kurz, Werner; Liu, Shirong; Nabuurs, Gert-Jan; Nilsson, Sten; Svidenko, Anatoly. 2002. Forest carbon sinks in the Northern Hemisphere. Ecological Applications. Vol: 12(3). Pages 891-899.

Gordon, E. R.; Curns, A.; Krebs, J. W.; Rupprecht, Charles; Real, Leslie A.; Childs, James E. 2004. Temporal dynamics of rabies in a wildlife host and the risk of cross-species transmission. Epidemiology and Infection. Vol: 132. Pages 515-524.

Green, Jessica L.; Bohannan, Brendan. In press. Are microbes fundamentally different? Scaling relationships in microbial diversity. Edited by Storch, D.; Marquet, P.; West, G.; Brown, J. Scaling and Biodiversity. Cambridge University Press. Cambridge.

Gross, John E.; McAllister, R. R.J.; Abel, N.; Stafford Smith, Mark; Maru, Y. In press. Australian rangelands as complex adaptive systems: A conceptual model and preliminary results. Environmental Modelling and Software .

Hackett, Edward J. 2005. Essential tensions: Identity, control, and risk in research. Social Studies of Science. Vol: 35(5). Pages 787-826.

Hackett, Edward J. 2005. Introduction: Special guest-edited issue on scientific collaboration. Social Studies of Science. Vol: 35(5). Pages 667-671.

Hadiprakarsa, Y.; Kinnaird, Margaret F. In press. Foraging characteristics of an assemblage of four Sumatran hornbill species. Bird Conservation International.

Hamlin, C. S.; Lodge, David M. 2006. Ecology and religion for a post natural world. Edited by Lodge, David M.; Hamlin, C.S. Religion and the New Ecology: Environmental Prudence in a World in Flux. University of Notre Dame Press. Notre Dame, Indiana.

Hart, K. M.; Mooreside, Peter; Crowder, Larry B. 2006. Interpreting the spatio-temporal patterns of sea turtle strandings: Going with the flow. Biological Conservation. Vol: 129. Pages 283-290.

Hassett, Brooke; Palmer, Margaret A.; Bernhardt, Emily; Smith, Sean; Carr, Jamie; Hart, David. 2005. Restoring watersheds project by project: Trends in Chesapeake Bay tributary restoration. Frontiers in Ecology and the Environment. Vol: 3(5). Pages 259-267.

Hedges, Simon; Tyson, Martin J.; Sitompul, Arnold F.; Kinnaird, Margaret F.; Gunaryadi, Donny; Aslan, -. 2005. Distribution, status, and conservation needs of Asian elephants (Elephas maximus) in Lampung Province, Sumatra, Indonesia. Biological Conservation. Vol: 124. Pages 35-48.

Hilderbrand, Robert; Watts, Adam; Randle, April. 2005. The myths of restoration ecology. Ecology and Society. Vol: 10(1). Pages 19.

Holt, Robert D.; Keitt, Timothy H. 2005. Species' borders: A unifying theme in ecology. Oikos. Vol: 108. Pages 3-6.

Holt, Robert D.; Keitt, Timothy H.; Lewis, Mark A.; Maurer, Brian A.; Taper, Mark L. 2005. Theoretical models of species' borders: Single species approaches. Oikos. Vol: 108. Pages 18-27.

Holyoak, Marcel; Leibold, Mathew; Holt, Robert D. 2005. Metacommunities: Spatial dynamics and ecological communities. University of Chicago Press. Chicago, IL. Pages 515.

Chase, Jonathan; Amarasekare, Priyanga; Cottenie, Karl; Gonzalez, Andy; Holt, Robert D.; Holyoak, Marcel; Hoopes, Martha F.; Leibold, Mathew; Loreau, Michel; Mouquet, Nicolas; Shurin, Jonathan B.; Tilman, David. 2005. Competing theories for competitive metacommunities. Edited by Holyoak, Marcel; Leibold, Mathew A.; Holt, Robert D. Metacommunities: Spatial Dynamics and Ecological Communities. University of Chicago Press. Chicago. Pages 335-354.

Cottenie, Karl; DeMeester, Luc. 2005. Local interactions and local dispersal in a zooplankton metacommunity. Edited by Holyoak, M.; Leibold, M.; Holt, R. Metacommunities: Spatial Dynamics and Ecological Communities. University of Chicago Press. Chicago. Pages 189-211.

Holt, Robert D.; Holyoak, Marcel; Leibold, Mathew. 2005. Future directions in metacommunity ecology. Edited by Holyoak, Marcel; Leibold, Mathew A.; Holt, Robert D. Metacommunities: Spatial Dynamics and Ecological Communities. University of Chicago Press. Chicago. Pages 465-489.

Holt, Robert D.; Hoopes, Martha F. 2005. Food web dynamics in a metacommunity context. Edited by Holyoak, Marcel; Leibold, Mathew A.; Holt, Robert D. Metacommunities: Spatial Dynamics and Ecological Communities. University of Chicago Press. Chicago. Pages 68-93.

Hoopes, Martha F.; Holt, Robert D.; Holyoak, Marcel. 2005. The effects of spatial processes on two species interactions. Edited by Holyoak, Marcel; Leibold, Mathew A.; Holt, Robert D. Metacommunities: Spatial Dynamics and Ecological Communities. University of Chicago Press. Chicago. Pages 35-67.

Law, Richard; Leibold, Mathew. 2005. Assembly dynamics in metacommunities. Edited by Holyoak, Marcel; Leibold, Mathew A.; Holt, Robert D. Metacommunities: Spatial Dynamics and Ecological Communities. University of Chicago Press. Chicago. Pages 263-278.

Mouquet, Nicolas; Hoopes, Martha F.; Amarasekare, Priyanga. 2005. The world is patchy and heterogeneous!. Edited by Holyoak, Marcel; Leibold, Mathew A.; Holt, Robert D. Metacommunities: Spatial Dynamics and Ecological Communities. University of Chicago Press. Chicago. Pages 237-262.

Resetarits, W. J.; Binckley, Christopher A.; Chalcraft, David R. 2005. Habitat selection, species interactions, and processes of community assembly in complex landscapes. Edited by Holyoak, Marcel; Leibold, Mathew A.; Holt, Robert D. Metacommunities: Spatial Dynamics and Ecological Communities. University of Chicago Press. Chicago. Pages 374-398.

Shurin, Jonathan B.; Srivastava, Diane. 2005. New perspectives on local and regional diversity. Edited by Holyoak, Marcel; Leibold, Mathew A.; Holt, Robert D. Metacommunities: Spatial Dynamics and Ecological Communities. University of Chicago Press. Chicago. Pages 399-417.

Shurin, Jonathan B.; Srivastava, Diane. 2005. New perspectives on local and regional diversity: Beyond saturation. Edited by Holyoak, M.; Holt, R.; Leibold, M. Metacommunities. University of Chicago Press. Chicago. Pages 271-290.

Hosseini, Parviez R.; Dhondt, Andre A.; Dobson, Andrew P. 2004. Seasonality and wildlife disease: How seasonal birth, aggregation and variation in immunity affect the dynamics of Mycoplasma gallisepticum in house finches. Proceedings of the Royal Society: Biological Sciences. Vol: 271. Pages 2569-2577.

Hughes, Jennifer B.; Bohannan, Brendan; Brown, James H.; Colwell, Robert K.; Fuhrman, Jed; Green, Jessica L.; Kane, Matthew; Krumins, Jennifer; Kuske, Cheryl; Morin, Peter J.; Naeem, Shahid; Ovreas, Lise; Reysenbach, Anna-Louise; Smith, Val H.; Staley, James T. 2006. Microbial biogeography: Putting microorganisms on the map. Nature Reviews Microbiology. Vol: 4(2). Pages 102-112.

Jacobson, A. R.; Provenzale, A.; Von Hardenberg, A.; Bassano, B.; Festa-Bianchet, Marco. 2004. Climate forcing and density dependence in a mountain ungulate population. Ecology. Vol: 85(6). Pages 1598-1610.

Jennings, Michael D.; Williams, John W.; Stromberg, Mark. 2005. Diversity and productivity of plant communities across the Inland Northwest, USA. Oecologia. Vol: 143. Pages 607-618.

Jones, Matthew B.; Berkley, Chad; Bojilova, Jivka; Schildhauer, Mark P. 2001. Managing scientific metadata. IEEE Internet Computing. Vol: 5(5). Pages 59-68.

Kaplan, David; Botsford, Louis W. 2005. Effects of variability in spacing of coastal marine reserves on fisheries yield and sustainability. Canadian Journal of Fisheries and Aquatic Sciences. Vol: 62. Pages 905-912.

Keane, Robert; Cary, Geoff; Davies, Ian; Flannigan, Michael; Gardner, Robert H.; Lavorel, Sandra; Lenihan, Jim. In press. Understanding global fire dynamics by classifying and comparing spatial models of vegetation dynamics. GCTE Project Science Volume.

Keane, Robert; Cary, Geoff; Davies, Ian; Flannigan, Michael; Gardner, Robert H.; Lavorel, Sandra; Lenihan, Jim; Li, Chao; Rupp, Scott. 2004. A classification of landscape fire succession models: Spatial simulations of fire and vegetation dynamics. Ecological Modelling. Vol: 179. Pages 3-27.

Kearns, Carol. 2002. Flies and flowers, and enduring partnership. Wings. Vol: Fall.

Kearns, Carol. In press. Solicited book review: Conserving Migratory Pollinators (ed. G. Nabhan). Quarterly Review Biology.

Keitt, Timothy H.; Amaral, Luis A. N.; Buldyrev, Sergey V.; Stanley, H. Eugene. 2002. Scaling in the growth of geographically subdivided populations: Invariant patterns from a continent-wide biological survey. Philosophical Transactions of the Royal Society B: Biological Sciences. Vol: 357. Pages 627-633.

Kerkhoff, Andrew J.; Martens, Scott N.; Milne, Bruce T. 2004. An ecological evaluation of Eagleson's optimality hypotheses. Functional Ecology. Vol: 18. Pages 404-413.

Kerkhoff, Andrew J.; Martens, Scott N.; Shore, Gregory A.; Milne, Bruce T. 2004. Contingent effects of water balance variation on tree cover density in semiarid woodlands. Global Ecology and Biogeography. Vol: 13. Pages 237-246.

Kikvidze, Zaal. 2002. Facilitation and competition in alpine plant communities. Global Environmental Research. Vol: 6(1). Pages 53-58.

Kikvidze, Zaal; Pugnaire, Francisco; Brooker, Robin; Choler, Philippe; Lortie, Christopher J.; Michalet, Richard; Callaway, Ragan. 2005. Linking patterns and processes in alpine plant communities: A global study. Ecology. Vol: 86(6). Pages 1395-1400.

Kinnaird, Margaret F.; O'Brien, Timothy G. 2005. Fast food in the forest: The influence of figs on primates and hornbills across Wallace's Line. Edited by Dew, J. Lawrence; Boubli, Jean P. Tropical Fruits and Frugivores: The Search for Strong Interactors. Springer. New York. Pages 155-184.

Knight, Tiffany; Steets, Janette; Vamosi, Jana; Mazer, Susan J.; Burd, Martin; Campbell, Diane; Dudash, Michele R.; Johnston, Mark O.; Mitchell, Randall; Ashman, Tia-Lynn. 2005. Pollen limitation of plant reproduction: Pattern and process. Annual Review of Ecology, Evolution, and Systematics. Vol: 36. Pages 467-497.

Koelle, Katia; Pascual, Mercedes; Yunus, Md. 2005. Pathogen adaptation to seasonal forcing and climate change. Proceedings of the Royal Society: Biological Sciences. Vol: 272. Pages 971-977.

Koenig, Walter; Liebhold, Andrew S. 2005. Effects of periodical cicada emergences on abundance and synchrony of avian populations. Ecology. Vol: 86(7). Pages 1873-1882.

Kolstad, Charles. 2004. Special issue on the economics of biodiversity. Resources and Energy Economics. Vol: 26(2). Pages 103.

Krivan, Vlastimil. 2006. The ideal free distribution and bacterial growth on two substrates. Theoretical Population Biology. Vol: 69. Pages 181-191.

Lafferty, Kevin. 2004. Fishing for lobsters indirectly increases epidemics in sea urchins. Ecological Applications. Vol: 14(5). Pages 1566-1573.

Lee, Y. F.; McCracken, Gary F. 2005. Dietary variation of Brazilian free-tailed bats links to migratory populations of pest insects. Journal of Mammalogy. Vol: 86(1). Pages 67-76.

Legendre, Pierre; Dale, Mark; Fortin, Marie-Josee; Casgrain, Philippe; Gurevitch, Jessica. 2004. Effects of spatial structure on the results of field experiments. Ecology. Vol: 85(12). Pages 3202-3214.

Lewison, R. L.; Crowder, Larry B.; Read, Andrew J.; Freeman, S. A. 2004. Understanding impacts of fisheries bycatch on marine megafauna. Trends in Ecology and Evolution. Vol: 19(11). Pages 598-604 .

Lewison, R. L.; Freeman, S. A.; Crowder, Larry B. 2004. Quantifying the effects of fisheries on threatened species: The impact of pelagic lonlines on loggerhead and leatherback turtles. Ecology Letters. Vol: 7. Pages 221-231.

Lodge, David M. 2004. Across the border. Nature. Vol: 432. Pages 276-277.

Lodge, David M.; Hamlin, C. S. 2006. Introduction: Fluxes of nature, fluxes of thought. Edited by Lodge, David M.; Hamlin, C.S. Religion and the New Ecology: Environmental Prudence in a World in Flux. University of Notre Dame Press. Notre Dame, Indiana.

Lodge, David M.; Hamlin, C. S. 2006. Religion and the New Ecology: Environmental Prudence in a World in Flux. University of Notre Dame Press. Notre Dame, Indiana. Pages 336.

Ludaescher, Bertram; Altintas, Ilkay; Berkley, Chad; Higgins, Dan; Jaeger, Efrat; Jones, Matthew B.; Lee, Edward A.; Tao, Jing; Zhao, Yang. In press. Scientific workflow management and the Kepler system. Concurrency and Computation: Practice and Experience.

Lyons, Kate. 2005. A quantitative model assessing community dynamics of Pleistocene mammals. American Naturalist. Vol: 165(6). Pages E168-E185.

McCullough, Deborah G.; Work, Timothy; Cavey, Joseph F.; Liebhold, Andrew S.; Marshall, David. In press. Interceptions of nonindigenous plant pests at U.S. ports of entry and border crossings over a 17 year period. Biological Invasions.

Meijaard, E.; O'Brien, Timothy G. 2005. Life After Logging: Reconciling Wildlife Conservation and Production Forestry in Indonesian Borneo. CIFOR. Bogor, Indonesia. Pages 345.

Michalet, Richard; Brooker, Robin; Cavieres, Lohengrin; Kikvidze, Zaal; Lortie, Christopher J.; Pugnaire, Francisco; Valiente-Banuet, Alfonso; Callaway, Ragan. In press. Do biotic interactions shape both sides of the humped-back model of species richness in plant communities. Ecology Letters.

Micheli, Fiorenza; Halpern, Ben. 2005. Low functional redundancy in coastal marine assemblages. Ecology Letters. Vol: 8(4). Pages 391-400.

Milne, Bruce T.; Gupta, V. K.; Restrepo, Carla. 2002. A scale invariant coupling of plants, water, energy, and terrain. Ecoscience. Vol: 9(2). Pages 191-199.

Mitchell, Charles; Agrawal, Anurag; Bever, James; Gilbert, Gregory S.; Hufbauer, Ruth A.; Klironomos, John N.; Maron, John; Morris, William F.; Parker, Ingrid M.; Power, Alison G.; Seabloom, Eric; Torchin, Mark E.; Vazquez, Diego. In press. Biotic interactions and plant invasions. Ecology Letters.

Moehlman, Patricia D. 2005. Endangered wild equids. Scientific American. Vol: March. Pages 86-93.

Morgan, Lance; Botsford, Louis W. 2001. Managing with reserves: Modeling uncertainty in larval dispersal for a sea urchin fishery. Proceedings of the Symposium on Spatial Processes and Management of Marine Populations. University of Alaska, Sea Grant. Pages 720.

Morgan, Martin; Wilson, Will G. In press. Self fertalization and the escape from pollen limitation in a variable environment. Evolution.

Morgan, Martin; Wilson, Will G.; Knight, Tiffany. 2005. Plant population dynamics, pollinator foraging, and the selection of self-fertilization. American Naturalist. Vol: 166(2). Pages 169-183.

Muller-Landau, Helene C.; Hardesty, B D. 2005. Seed dispersal of woody plants in tropical forests: Concepts, examples, and future directions. Edited by Burslem, D.; Pinard, M.; Hartley, S. Biotic Interactions in the Tropics. Cambridge University Press. Cambridge. Pages 267-309.

Munch, S.; Snover, M.; Watters, George; Mangel, Marc. 2005. A unified treatment of top-down and bottom-up control of reproduction in populations. Ecology Letters. Vol: 8(7). Pages 691-695.

Munday, Philip L.; Buston, Peter M.; Warner, Robert R. In press. Diversity and flexibility of sex-change strategies in animals. Trends in Ecology and Evolution.

Norse, Elliott; Crowder, Larry B. 2005. Marine Conservation Biology: The Science of Maintaining the Sea's Biodiversity. Island Press. Washington, D.C. Pages 470.

Crowder, Larry B. 2005. Back to the future in marine conservation. Edited by Norse, Elliot A.; Crowder, Larry B. Marine Conservation Biology: The Science of Maintaining the Sea's Biodiversity. Island Press. Washington, D.C. Pages 19-29.

Heppell, Selina; Heppell, Scott A.; Read, Andrew J.; Crowder, Larry B. 2005. Effects of fishing on long-lived marine organisms. Edited by Norse, Elliot A.; Crowder, Larry B. Marine Conservation Biology: The Science of Maintaining the Sea's Biodiversity. Island Press. Washington, D.C. Pages 211-231.

Kim, Kiho; Gulland, Frances; Harvell, Drew. 2005. Diseases and the conservation of marine biology. Edited by Norse, Elliott A.; Crowder, Larry B. Marine Conservation Biology: The Science of Maintaining the Sea's Biodiversity. Island Press. Washington, D.C. Pages 149-166.

Lipcius, Romuald; Crowder, Larry B.; Morgan, Lance. 2005. Metapopulation structure and marine reserves. Edited by Norse, Elliot A.; Crowder, Larry B. Marine Conservation Biology: The Science of Maintaining the Sea's Biodiversity. Island Press. Washington, D.C. Pages 328-345.

Norse, Elliott; Crowder, Larry B. 2005. Why marine conservation biology?. Edited by Norse, Elliot A.; Crowder, Larry B. Marine Conservation Biology: The Science of Maintaining the Sea's Biodiversity. Island Press. Washington, D.C. Pages 1-18.

Norse, Elliott; Crowder, Larry B.; Gjerde, Kristina; Hyrenbach, K. David; Roberts, Callum; Safina, Carl; Soule, Michael E. 2005. Place-based ecosystem management in the open ocean. Edited by Norse, Elliot A.; Crowder, Larry B. Marine Conservation Biology: The Science of Maintaining the Sea's Biodiversity. Island Press. Washington, D.C. Pages 302-327.

Palumbi, Stephen R.; Hedgecock, Dennis. 2005. The life of the sea: Implications of marine population biology to conservation policy. Edited by Norse, E.; Crowder, L. Marine Conservation Biology: The Science of Maintaining the Sea's Biodiversity. Island Press. Chicago. Pages 33-46.

Roberts, Callum. 2005. Marine protected areas and biodiversity conservation. Edited by Norse, Elliott A.; Crowder, Larry B. Marine Conservation Biology: The Science of Maintaining the Sea's Biodiversity. Island Press. Washington, D.C. Pages 265-279.

O'Brien, Timothy G.; Kinnaird, Margaret F. 2004. Conservation policy in coffee landscapes: Response. Science. Vol: 303. Pages 625-626.

O'Brien, Timothy G.; Kinnaird, Margaret F.; Groom, Martha; Coppollilo, P. 2005. Ecologically functional populations: Revisiting how much is enough. Edited by Groom, Martha J.; Meffe, Gary K.; Carroll, Ronald Principles of Conservation Biology. Vol: 3rd edition. Sinauer Associates, Inc. Sunderland, MA. Pages 779.

Ogutu, Joseph O.; Owen-Smith, Norman. 2003. ENSO, rainfall and temperature influences on extreme population declines among African savanna ungulates. Ecology Letters. Vol: 6(5). Pages 412-419.

Owen-Smith, Jason D. 2005. Dockets, deals, and sagas: Commensuration and the rationalization of experience in University licensing. Social Studies of Science. Vol: 35(1). Pages 69-97.

Owen-Smith, Norman; Mason, D. M.; Ogutu, Joseph O. 2005. Correlates of survival rates for 10 African ungulate populations: Density, rainfall and predation. Journal of Animal Ecology. Vol: 74. Pages 774-788.

Palmer, Margaret A.; Bernhardt, Emily; Allan, J. David; Lake, P. S.; Alexander, Gretchen; Brooks, Shane; Carr, Jamie; Clayton, Steve; Dahm, Cliff; Follstad-Shah, Jennifer; Galat, David L.; Loss, S. G.; Goodwin, Peter; Hart, David; Hassett, Brooke; Jenkinson, Robin; Kondolf, G. Mathias; Lave, Rebecca; Meyer, Judy; O'Donnell, T. Kevin; Pagano, Laura; Sudduth, Elizabeth. 2005. Standards for ecologically successful river restoration. Journal of Applied Ecology. Vol: 42. Pages 208-217.

Pandolfi, John; Jackson, Jeremy; Baron, Nancy; Bradbury, Roger; Guzman, H. M.; Hughes, Terence P.; Kappel, Carrie; Micheli, Fiorenza; Ogden, John C.; Possingham, Hugh P.; Sala, Enric. 2005. Are U.S. coral reefs on the slippery slope to slime?. Ecology. Vol: 307. Pages 1725-1726.

Parody, Jennifer M.; Milne, Bruce T. 2004. Implications of rescaling rules for multi-scaled habitat models. Landscape Ecology. Vol: 19. Pages 691-701.

Pascual, Mercedes; Dobson, Andrew P. 2005. Seasonal patterns of infectious diseases. Public Library of Science Medicine. Vol: 2(1). Pages 18-20.

Peterson, Garry. 2002. Using ecological dynamics to move towards an adaptive architecture. Edited by Kibert, C.; Sendzimir, J.; Guy, G.B. Construction Ecology: Nature as the Basis for Green Buildings. Spon Press. London. Pages 127-150.

Pyke, Chris; Andelman, Sandy J.; Midgley, Guy F. 2005. Identifying priority areas for bioclimatic representation under climate change: A case study for Proteaceae in the Cape Floristic Region, South Africa. Biological Conservation. Vol: 125(1). Pages 1-9.

Regan, Helen; Ben-Haim, Yakov; Langford, Bill T.; Wilson, Will G.; Lundberg, Per; Andelman, Sandy J.; Burgman, Mark. 2005. Robust decision-making under severe uncertainty for conservation management. Ecological Applications. Vol: 15(4). Pages 1471-1477.

Regan, Helen; Ferson, Scott; Berleant, D. 2004. Equivalence of methods for uncertainty propagation of real-valued random variables. International Journal of Approximate Reasoning. Vol: 36. Pages 1-30.

Regan, Helen; Sample, B. E.; Ferson, Scott. 2002. Comparison of deterministic and probabilistic calculation of ecological soil screening levels. Environmental Toxicology and Chemistry. Vol: 21(4). Pages 882-890.

Reiners, William A. 2005. Reciprocal cause and effect between environmental heterogeneity and transport processes. Edited by Lovett, G. M.; Jones, C. G.; Turner, M. G.; Weathers, K. C. Ecosystem Function in Heterogeneous Landscapes. Springer. New York.

Reiners, William A.; Driese, Kenneth L. 2003. Transport of energy, information, and material through the biosphere. Annual Review of Environment and Resources. Vol: 28. Pages 107-135.

Rex, Michael A.; McClain, Craig R.; Johnson, Nicholas A.; Etter, Ron J.; Allen, John A.; Bouchet, Philippe; Waren, Anders. 2005. A source-sink hypothesis for abyssal biodiversity. American Naturalist. Vol: 165. Pages 163-178.

Romanach, Stephanie S.; Reichman, O. J.; Seabloom, Eric. 2005. Seasonal influences on burrowing activity of a subterranean rodent, Thomomys bottae. Journal of Zoology. Vol: 266(3). Pages 319-325.

Romanach, Stephanie S.; Seabloom, Eric; Reichman, O. J.; Rogers, W. E.; Cameron, G. N. 2005. Effects of species, sex, age, and habitat on geometry of pocket gopher foraging tunnels. Journal of Mammalogy. Vol: 86(4). Pages 750-756.

Rosenthal, S. K.; Lodge, David M.; Muohi, W.; Ochieng, P.; Mkoji, G. M.; Mavuti, K. M. In press. Comparing macrophyte herbivory in Kenya by introduced Louisiana crayfish (Procambarus clarkii) and native dytiscid beetles (Cybister tripunctatus). African Journal of Aquatic Science.

Sax, Dov F.; Stachowicz, Jay; Gaines, Steven D. 2005. Species Invasions: Insights into Ecology, Evolution, and Biogeography. Sinauer Associates, Inc. Sunderland, Massachusetts. Pages 495.

> Blackburn, Tim M.; Gaston, Kevin J. 2005. Biological invasions and the loss of birds on islands: Insights into the idiosynchrasies of extinction. Edited by Sax, Dov F.; Stachowicz, John J.; Gaines, Steven D. Species Invasions: Insights into Ecology, Evolution, and Biogeography. Sinauer Associates, Inc. Sunderland, Massachusetts. Pages 85-110.
>
> Bruno, John; Fridley, Jason; Bromberg, Keryn D.; Bertness, Mark D. 2005. Insights into biotic interactions from studies of species invasions. Edited by Sax, Dov F.; Stachowicz, John J.; Gaines, Steven D. Species Invasions: Insights into Ecology, Evolution, and Biogeography. Sinauer Associates, Inc. Sunderland, Massachusetts. Pages 13-40.
>
> Cassey, Phillip. 2005. Insights into ecology. Edited by Sax, Dov F.; Stachowicz, John J.; Gaines, Steven D. Species Invasions: Insights into Ecology, Evolution, and Biogeography. Sinauer Associates, Inc. Sunderland, Massachusetts. Pages 9-12.

D'Antonio, Carla; Hobbie, Sarah. 2005. Plant species effects on ecosystem processes: Insights from invasive species. Edited by Sax, Dov F.; Stachowicz, John J.; Gaines, Steven D. Species Invasions: Insights into Ecology, Evolution, and Biogeography. Sinauer Associates, Inc. Sunderland, Massachusetts. Pages 65-84.

Holt, Robert D.; Barfield, M.; Gomulkiewicz, Richard. 2005. Theories of niche conservatism and evolution: Could exotic species be potential tests?. Edited by Sax, Dov F.; Stachosicz, John J.; Gaines, Steven D. Species Invasions: Insights into Ecology, Evolution, and Biogeography. Sinauer Associates, Inc. Sunderland, Massachusetts. Pages 259-290.

Kinlan, Brian; Hastings, Alan. 2005. Rates of population spread and geographic range expansion: What exotic species tells us. Edited by Sax, Dov F.; Stachowicz, John J.; Gaines, Steven D. Species Invasions: Insights into Ecology, Evolution, and Biogeography. Sinauer Associates, Inc. Sunderland, Massachusetts. Pages 381-419.

Labra, Fabio A.; Abades, Sebastian R.; Marquet, Pablo A. 2005. Distribution and abundance: Scaling patterns in exotic and native bird species. Edited by Sax, Dov F.; Stachowicz, John J.; Gaines, Steven D. Species Invasions: Insights into Ecology, Evolution, and Biogeography. Sinauer Associates, Inc. Sunderland, Massachusetts. Pages 421-446.

Lafferty, Kevin; Smith, Katherine F.; Torchin, Mark E.; Dobson, Andrew P.; Kuris, Armand. 2005. The role of infectious diesases in natural communities: What introduced species tell us. Edited by Sax, Dov F.; Stachowicz, John J.; Gaines, Steven D. Species Invasions: Insights into Ecology, Evolution, and Biogeography. Sinauer Associates, Inc. Sunderland, Massachusetts. Pages 111-134.

Lockwood, Julie. 2005. Insights into biogeography. Edited by Sax, Dov F.; Stachowicz, John J.; Gaines, Steven D. Species Invasions: Insights into Ecology, Evolution, and Biogeography. Sinauer Associates, Inc. Sunderland, Massachusetts. Pages 309-313.

McKinney, Michael L.; Lockwood, Julie. 2005. Community composition and homogenization: Evenness and abundance of native and exotic plant species. Edited by Sax, Dov F.; Stachowicz, John J.; Gaines, Steven D. Species Invasions: Insights into Ecology, Evolution, and Biogeography. Sinauer Associates, Inc. Sunderland, Massachusetts. Pages 365-380.

Novak, Stephen J.; Mack, Richard N. 2005. Genetic bottlenecks in alien plant species: Influence of mating systems and introduction dynamics. Edited by Sax, Dov F.; Stachowicz, John J.; Gaines, Steven D. Species Invasions: Insights into Ecology, Evolution, and Biogeography. Sinauer Associates, Inc. Sunderland, Massachusetts. Pages 201-228.

Rice, William; Sax, Dov F. 2005. Testing fundamental evolutionary questions at large spatial and demographic scales: Species invasions as an underappreciated tool. Edited by

Sax, Dov F.; Stachowicz, John J.; Gaines, Steven D. Species Invasions: Insights into Ecology, Evolution, and Biogeography. Sinauer Associates, Inc. Sunderland, Massachusetts. Pages 291-308.

Sax, Dov F.; Brown, James H.; White, Ethan; Gaines, Steven D. 2005. The dynamics of species invasions: Insights into the mechanisms that limit species diversity. Edited by Sax, Dov F.; Stachowicz, John J.; Gaines, Steven D. Species Invasions: Insights into Ecology, Evolution, and Biogeography. Sinauer Associates, Inc. Sunderland, Massachusetts. Pages 447-465.

Sax, Dov F.; Gaines, Steven D.; Stachowicz, Jay. 2005. Introduction. Edited by Sax, Dov F.; Stachowicz, John J.; Gaines, Steven D. Species Invasions: Insights into Ecology, Evolution, and Biogeography. Sinauer Associates, Inc. Sunderland, Massachusetts. Pages 1-7.

Sax, Dov F.; Stachowicz, Jay; Gaines, Steven D. 2005. Capstone: Where do we go from here?. Edited by Sax, Dov F.; Stachowicz, John J.; Gaines, Steven D. Species Invasions: Insights into Ecology, Evolution, and Biogeography. Sinauer Associates, Inc. Sunderland, Massachusetts. Pages 467-480.

Stachowicz, Jay; Tilman, David. 2005. Species invasions and the relationships between species diversity, community saturation, and ecosystem functioning. Edited by Sax, Dov F.; Stachowicz, John J.; Gaines, Steven D. Species Invasions: Insights into Ecology, Evolution, and Biogeography. Sinauer Associates, Inc. Sunderland, Massachusetts. Pages 41-64.

Vellend, Mark; Hughes, A. R.; Grosberg, Richard K.; Holt, Robert D. 2005. Introduction: Insights into evolution from species invasion. Edited by Sax, D. F.; Gaines, S. D.; Stachowicz, J. J. Species Invasions: Insights to Ecology, Evolution, and Biogeography. Sinauer Associates, Inc. Sunderland, Massachusetts.

Vellend, Mark; Hughes, Randall; Grosberg, Richard K.; Holt, Robert D. 2005. Insights into evolution. Edited by Sax, Dov F.; Stachowicz, John J.; Gaines, Steven D. Species Invasions: Insights into Ecology, Evolution, and Biogeography. Sinauer Associates, Inc. Sunderland, Massachusetts. Pages 135-137.

Wares, John; Hughes, Randall; Grosberg, Richard K. 2005. Mechanisms to drive evolutionary change: Insights from species introductions and invasions. Edited by Sax, Dov F.; Stachowicz, John J.; Gaines, Steven D. Species Invasions: Insights into Ecology, Evolution, and Biogeography. Sinauer Associates, Inc. Sunderland, Massachusetts. Pages 229-257.

Schaefer, Jacob; Gido, Keith; Smith, Melinda D. 2005. A test for community change using a null model approach. Ecological Applications. Vol: 15(5). Pages 1761-1771.

Schenk, H. Jochen; Jackson, Robert B. 2005. Mapping the global distribution of deep roots in relation to climate and soil characteristics. Geoderma. Vol: 126(1-2). Pages 129-140.

Seabloom, Eric; Bjornstad, Ottar N.; Bolker, Ben; Reichman, O. J. 2005. Spatial signature of environmental heterogeneity, dispersal, and competitition in successional grasslands. Ecological Monographs. Vol: 75(2). Pages 199-214.

Shurin, Jonathan B.; Gruner, Daniel S.; Hillebrand, Helmut. 2006. All wet or dried up? Real differences between aquatic and terrestrial food webs. Proceedings of The Royal Society: Biological Sciences. Vol: 273. Pages 1-9.

Shurin, Jonathan B.; Seabloom, Eric. 2005. The strength of trophic cascades across ecosystems: Predictions from allometry and energetics. Journal of Animal Ecology. Vol: 74. Pages 1029-1038.

Sitompul, Arnold F.; Kinnaird, Margaret F.; O'Brien, Timothy G. In press. Size matters: The effects of forest fragmentation and resource availability on a large frugivore, the endemic Sumba Island hornbill. Bird Conservation International.

Smith, Melinda D.; Wilcox, Julia C.; Kelly, Theresa; Knapp, Alan K. 2004. Dominance not richness determines invasibility of tallgrass prairie. Oikos. Vol: 106. Pages 253-262.

Smith, Val H.; Foster, Bryan L.; Grover, James P.; Holt, Robert D.; Leibold, Mathew; deNoyelles Jr., Frank. 2005. Phytoplankton species richness scales consistently from laboratory microcosms to the world's oceans. Proceedings of the National Academy of Sciences. Vol: 102(12). Pages 4393-4396.

Smouse, Peter; Sork, Victoria L. 2004. Measuring pollen flow in forest trees: An exposition of alternative approaches. Forest Ecology and Management. Vol: 197. Pages 21-38.

Snyder, R. E.; Borer, Elizabeth T.; Chesson, Peter L. 2005. Examining the relative importance of spatial and nonspatial coexistence mechanisms. American Naturalist. Vol: 166(4). Pages E75-E94.

Sobek, Sebastian; Tranvik, Lars; Cole, Jonathan J. 2005. Temperature independence of carbon dioxide supersaturation in global lakes. Global Biogeochemical Cycles. Vol: 19(2). Pages GB2003.

Sole, Ricard V.; Bascompte, Jordi. 2006. Self-Organization in Complex Ecosystems. Edited by Levin, Simon A.; Horn, Henry S. Princeton Monographs in Population Biology. Vol: 42. Princeton University Press. Princeton.

Sork, Victoria L.; Dyer, Rodney; Davis, Frank W.; Smouse, Peter. 2002. Mating system in California Valley Oak, Quercus lobata Nee. Edited by Standiford, R.; McCreary, D. Oaks in California's Changing Landscape: Fifth Symposium on Oak Woodland Savanna. San Diego, California. Pages 427-440.

Sork, Victoria L.; Dyer, Rodney; Smouse, Peter; Apsit, Victoria; Westfall, Robert. 2005. A two-generation analysis of pollen pool genetic structure in flowering dogwood, Cornus florida (Cornaceae), in the Missouri Ozarks. American Journal of Botany. Vol: 92(2). Pages 262-271.

Srivastava, Diane; Vellend, Mark. 2005. Biodiversity-ecosystem function research: Is it relevant to conservation?. Annual Review of Ecology, Evolution, and Systematics. Vol: 36. Pages 267-294.

Stevens, Richard; Willig, Michael R.; Gamarra de Fox, I. 2004. Comparative community ecology of bats from Eastern Paraguay: Taxonomic, ecological, and biogeographic perspectives. Journal of Mammalogy. Vol: 85(4). Pages 698-707.

Stoms, David; Davis, Frank W.; Andelman, Sandy J.; Carr, Mark H.; Gaines, Steven D.; Halpern, Ben; Hoenicke, Rainer; Leibowitz, Scott; Leydecker, Al; Madin, Elizabeth M.P.; Tallis, Heather; Warner, Robert R. 2005. Integrated coastal reserve planning: Making the land-sea connection. Fronteirs in Ecology and the Environment. Vol: 3(8). Pages 429-436.

Suding, Katharine N.; Gross, Katherine L. 2004. Alternative states and positive feedbacks in restoration ecology. Trends in Ecology and Evolution. Vol: 19(1). Pages 46-53.

Taper, Mark L.; Lele, Subhash R. 2004. The Nature of Scientific Evidence: Statistical Philosophical, and Empirical Considerations. University of Chicago Press. Chicago, IL.

Thompson, John N. 2005. The Geographic Mosaic of Coevolution. University of Chicago Press. Chicago. Pages 443.

Tuda, Midori; Shimada, Masakazu. 2005. Complexity, evolution, and persistence in host-parasitoid experimental systems with Callosobruchus beetles as the host. Advances in Ecological Research. Vol: 37. Pages 37-75.

Urban, Dean; Keitt, Timothy H. 2001. Landscape connectivity: A graph-theoretical perspective. Ecology. Vol: 82(5). Pages 1205-1218.

Vellend, Mark. 2005. Species diversity and genetic diversity: Parallel processes and correlated patterns. American Naturalist. Vol: 166. Pages 199-215.

Vellend, Mark; Geber, M. A. 2005. Connection between species diversity and genetic diversity. Ecology Letters. Vol: 8. Pages 767-781.

Vellend, Mark; Verheyen, Kris; Jacquemyn, Hans; Kolb, A.; Van Calster, H.; Peterken, G.; Hermy, M. 2006. Extinction debt of forest plants persists for more than a century following habitat fragmentation. Ecology. Vol: 87(3). Pages 542-548.

Wagner, Frederic H. 1999. Perspective. Yellowstone Science. Vol: 7(3). Pages 12-14.

Walters, Carl; Hilborn, Ray. 2005. Exploratory assessment of recruitment patterns using relative abundance and catch data. Canadian Journal of Fisheries and Aquatic Sciences. Vol: 62. Pages 1985-1990.

Wilf, Peter; Johnson, K. 2004. Land plant extinction at the end of the Cretaceous: A quantitative analysis of the North Dakota megafloral record. Paleobiology. Vol: 30(3). Pages 347-368.

Williams, Paul; Faith, Dan; Manne, Lisa L.; Sechrest, Wes; Preston, Chris. 2006. Complementarity analysis: Mapping the performance of surrogates for biodiversity. Biological Conservation. Vol: 128. Pages 253-264.

Wilsey, Brian J.; Chalcraft, David R.; Bowles, Christy; Willig, Michael R. 2005. Relationships among indices suggest that richness is an incomplete surrogate for grassland biodiversity. Ecology. Vol: 86(5). Pages 1178-1184.

Wilson, Will G.; Abrams, Peter A. 2005. Coexistence of cycling and dispersing consumer species: Armstrong and McGehee in space. American Naturalist. Vol: 165(2). Pages 193-205.

Work, Timothy; McCullough, Deborah G.; Cavey, Joseph F.; Komsa, Ron. 2005. Arrival rate of nonindigenous insect species into the United States through foreign trade. Biological Invasions. Vol: 7. Pages 323-332.

Wright, Joseph; Muller-Landau, Helene C.; Calderon, O.; Hernandez, Andres. 2005. Annual and spatial variation in seedfall and seedling recruitment in a neotropical forest. Ecology. Vol: 86(4). Pages 848-860.