

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.

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

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 environmental, 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
01/05/2006-01/04/2007

Postdoctoral Fellow

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
10/01/2002-9/31/2005

Postdoctoral Fellow

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
08/01/2005-07/31/2006

Postdoctoral Fellow

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

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

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 carbon 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
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Field, Christopher B.
Goryachkin, Sergey V.
Hagemann, Stefan
Kuhry, Peter

Lafleur, Peter
Mazhitova, Galina
Nelson, Frederick
Rinke, Annette

Schuur, Ted
Tarnocai, Charles
Venevsky, Sergey
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
Berg, Bjorn
Burke, Ingrid C.

Currie, William S.
Harmon, Mark
Lin, Kuo-chuan

Parton, William J.
Silver, Whendee L.
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
Ernest, S. K. Morgan
Findlay, C. Scott
Fuhlendorf, Samuel D.
Gaedke, Ursula

Houlahan, Jeff
Legendre, Pierre
McArdle, Brian
Muldavin, Esteban
Russell, Roly

Stevens, Richard
Woiwod, Ian
Wondzell, Steve

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 studied? 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.	McPeck, 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, Parvizeh 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 long-term 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 TMI appropriate 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 ^{15}N 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 ^{15}N 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 ^{15}N 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 (McPeck 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

Altieri, 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

Aguilar, Ramiro

Aizen, Marcelo A.

Crone, Elizabeth E.

Cunningham, Saul

Gemmill-Herron, Barbara

Greenleaf, Sarah

Keitt, Timothy H.

Klein, Alexandra-Maria

Kremen, Claire

LeBuhn, Gretchen

Minckley, Robert

Packer, Laurence

Potts, Simon

Regetz, James

Ricketts, Taylor

Roulston, T'ai

Steffan-Dewenter, Ingolf

Vazquez, Diego

Williams, Neal M.

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
Douve, 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
Perez Salicrup, Diego

Putz, Francis
Romero Saltos, Hugo
Schnitzer, Stefan A.

Thomas, Duncan
Webb, Campbell O.

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
Baron, Nancy
Duffy, Emmett
Halpern, Ben

Jackson, Jeremy
Lotze, Heike K.
Sala, Enric
Schmittner, Andreas

Selkoe, Kimberly
Watson, Reg
Worm, Boris

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

<u>Name</u>	<u>Sponsor and Project Title</u>
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

<u>Name</u>	<u>Project Title</u>
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

<u>Name</u>	<u>Project Title</u>
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

<u>Intern</u>	<u>Sponsor and Project Title</u>
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

<u>Intern</u>	<u>Sponsor and Project Title</u>
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.

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