

## GLOBAL CLIMATE CHANGE ECOLOGY

What is the role of a land-grant research institution in the 21<sup>st</sup> century? In a highly settled and urban state such as Massachusetts, citizens of the commonwealth are likely to point to pressing environmental issues as some of the main issues they would like to see addressed by scientific research. One of the most far-reaching of these concerns is that of global change. In its broadest sense, this encompasses global warming, increased atmospheric CO<sub>2</sub>, higher ozone levels, air, land and water pollution, and the encroachment of invasive species that cost billions of dollars in control efforts every year.

Examining how global change will affect our lives, and how to ameliorate the most negative possibilities, is an enormous and transdisciplinary undertaking that requires effort from engineers, geoscientists, policy makers, social scientists, urban planners, chemists, atmospheric scientists, hydrologists, medical researchers, and biologists. While this seems an overwhelming task, UMass-Amherst already has great strength in many of these areas, with research that explicitly addresses global change issues. Faculty on campus in Geosciences, Environmental Engineering, Natural Resources Conservation, Landscape Architecture and Regional Planning, and Biology, as well as the nearby USGS Conte Anadromous Fish Research Center and Harvard Forest, already have dedicated faculty researching issues pertaining to global climate change.

An understanding of how global climate change will affect the lives of our citizens requires **ecology** as a central discipline. Ecology is the study of factors that determine the distribution and abundance of species; ecological research is necessary to predict how invasive species, fisheries, crops, forests, diseases and their vectors, and the organisms living in our backyard will be affected by global change. Although the UMass-Amherst campus already has great strength in ecology research, including faculty from Plant, Soil and Insect Science, Natural Resources Conservation, Geosciences, and Biology, we are largely lacking in research that bridges our ecological strength with our need to address pressing global environmental issues.

Aside from the immediate benefits of increased research addressing a critical regional, national and global issue, an investment in global change ecology could pay off in multiple future venues:

- The US Geological Survey has initiated a climate change center with interest in placing research hubs at universities. An investment by UMass-Amherst in Global Change research may provide leverage that demonstrates our commitment to this pressing issue and attracts a future investment in USGS-funded faculty hires.

- Two other cluster hire proposals have been submitted that focus on aspects of climate change. Each of the three proposals is distinct and addresses a different critical aspect of climate change, with this proposal focused on the biotic component. Combined, these proposals indicate a campus-wide strength and interest in developing climate change research as a top priority on campus, with much potential synergy.

- We would urge that the hire of these positions is accompanied by a UMass-Amherst Global Change Center that facilitates communication across the many disciplines studying global change on campus. With strength in global change research

and an organizing structure in place, we would be well-positioned to submit a competitive IGERT (Integrative Graduate Education and Research Traineeship) to the National Science Foundation to fund corresponding research at the graduate level.

- The positions proposed below, in addition to contributing to an internationally-established research arena, will also fill critical teaching needs for current undergraduate and graduate programs in Natural Resources Conservation, Plant Soil and Insect Science, Environmental Science, Entomology, Biology, and Organismic and Evolutionary Biology.

- Perhaps most importantly, with increasing national focus regarding a diversity of global change issues, funding this proposal will synergize current strengths on campus and result in new grants to a multitude of agencies, including the National Science Foundation, National Institutes of Health, United States Department of Agriculture, National Oceanographic and Atmospheric Administration, the Department of Energy, and the US Forest Service, as well as state agencies and commodities-based research.

We propose the following **four** positions to support a cluster in Global Change Ecology. We request one position per year for the next four years, to build upon existing strengths in a deliberate manner and allow the earliest hires to play a role in selecting their future colleagues.

**Invasive Plant Ecology (PSIS).** Global climate change has induced major shifts in the distribution animals and plants. Invasive plants are second only to habitat loss as a cause of the reduction of diversity in native plant populations worldwide, and billions of dollars are spent nationally each year to control invasive species across agricultural habitats, forests, open fields, and waterways. At UMASS we have research strengths in invasive insects and pathogens, but lack parallel research on invasive plants. This is a key position that was identified by many faculty as a high priority to fill gaps in our research and teaching mission. .

**Ecosystem ecology (NRC).** Global climate change is driven by human-caused modifications to the global carbon cycle. Ecosystem ecology is the study of the movement of energy and matter through ecosystems, and examines areas such as nutrient cycling (especially carbon, nitrogen and phosphorous cycles), primary productivity, trophic dynamics, and global biogeochemistry. An ecosystem ecologist would provide a bridge between our current research strengths in atmospheric science and ion ecology, and would interact with faculty across many departments.

**Theoretical population ecology (PSIS).** Theoretical ecologists formulate, solve, and interpret models that describe how biological systems work. Much of the work in global climate change is done by constructing simulation models of the global weather systems. A theoretical population ecologist would use these models to predict the impact of climate change on species abundance and distribution. Such models would provide a general framework for predictions that can be tested with experimental studies. Notably, theoretical ecologists require relatively low investments in lab space and startup costs.

**Physiological ecology (NRC).** Global climate change primarily affects organisms via changes in the temperature and other physical attributes of the environment. A physiological ecologist studies the impact of the physical environment on organism physiology and how physiological attributes determine species response to global change. This area would fill a critical gap in current research on campus. For example, research at UMASS has shown that winter temperatures limit the northern spread of particular invasive species and that global warming is likely to alter the future distribution of these organisms. A physiological ecologist could explain the physiological basis of these temperature effects to make predictions about future spread and costs of invasive species.

### **Appendix A. Current strengths in ecology pertaining to global change**

Here we list faculty already conducting research relevant to ecology and global change at UMass-Amherst. A comprehensive list including all possible faculty with relevant interests would be beyond the scope of this document; we highlight key players to demonstrate our strength in this area while highlighting our need for ecologists to fill gaps in critical areas (invasive plants, ecosystem, theory and physiological ecology).

#### *Plant, Soil and Insect Science*

**Lynn Adler** (Assistant Professor): ecology of plant-insect interactions

**Anne Averill** (Associate Professor): land use change, pollination, pest management

**Joe Elkinton** (Professor): invasive forest insect pests, biocontrol

**Adam Porter** (Associate Professor): population ecology, genetics, hybrid zones

**Stephen Rich** (Associate Professor and Dept. Head): evolutionary dynamics of human diseases and their hosts

**Roy Van Driesche** (Professor): invasive species and biological control

#### *Natural Resources Conservation*

**Curt Griffin** (Professor): wetland wildlife ecology and management, biodiversity conservation

**Matt Kelty** (Associate Professor): silviculture and forest ecology

**David King** (Adjunct Assistant Professor, USGS): wildlife ecology and conservation, habitat management

**Dave Kittredge** (Professor): ecosystem approach to forest management, outreach to natural resources professionals

**Kevin McGarigal** (Associate Professor): landscape ecology, ecosystem management, wildlife ecology

**Paul Sievert** (Research Associate Professor, USGS): conservation biology, physiological ecology, and biostatistics

**Paige Warren** (Assistant Professor): urban-suburban wildlife ecology

*Geosciences*

**Lynn Margulis** (Distinguished University Professor): microbial and environmental evolution

**Stan Stevens** (Associate Professor): cultural/political ecology, environmental history, conservation

*Biology*

**Peter Alpert** (Associate Professor): plant ecology and conservation

**Sheila Patek** (Assistant Professor): ecological physiology

*USGS Conte Anadromous Fish Research Center*

**Ben Letcher** (Adjunct Assistant Professor in NRC): Fisheries population Ecology

**Stephen McCormick** (Adjust Assistant Professor in NRC): fish ecology and physiology, endocrine disruptors

*Harvard Forest*

**Aaron Ellison**: invasive forest species, nutrient dynamics, plant ecology

**Kristina Stinson**: population ecology, climate change and invasive species

*Mt. Holyoke Department of Biology*

**Martha Hoopes** (Assistant Professor): plant ecology, invasive species

**Appendix B. Current strengths in other aspects of global change research**

Global change research is transdisciplinary, encompassing fields from sociology to hydrology. Here we list faculty conducting research related to global change in aspects other than ecology; this list is meant to emphasize our current strength in global change research while highlighting our need for faculty studying the ecological aspects of global change.

*Plant, Soil and Insect Science*

**Bill Manning** (Professor): plant pathology, air pollution and ozone effects on plants

**Om Parkash** (Assistant Professor): phytoremediation of soil toxins

**Peter Veneman** (Professor): wetland delineation, soil pollution, groundwater impact

**Baoshan Xing** (Professor): environmental fate, behavior and ecotoxicity of engineered nanoparticles, soil remediation

*Natural Resources Conservation*

**Paul Fiset** (Professor and Dept. Head): Sustainable building systems

**Simi Hoque** (Assistant Professor): Environmental systems and sustainable designs

**Brian Kane** (Assistant Professor): commercial arboriculture

**Robert Muth** (Associate Professor): Human dimensions of natural resources, natural resource policy, social conflict of natural resources

**Craig Nicolson** (Assistant Research Professor): simulation and managing natural resources using computer models, with 13 years experience in climate change research

**Timothy Rhandir** (Assistant Professor): Watershed management, water resources, hydrology, climate change, GIS and dynamic modeling, optimization, ecological economics and sustainability, resource policy

**Dennis Ryan** (Professor): Arboriculture, urban forestry

**Charles Schweik** (Associate Professor, also Center for Public Policy and Administration): geographic information systems, remote sensing, natural resources management and policy

*Geosciences*

**David Boutt** (Assistant Professor): hydrogeology, watershed hydrology

**Raymond Bradley** (Distinguished University Professor; Director of the Climate System Research Center): climatology, paleoclimatology, global change, Arctic paleoenvironments

**Julie Brigham-Grette** (Professor): glacial and Quaternary geology, Arctic paleoenvironments

**Stephen Burns** (Professor; Associate Dean, NSM): paleoclimatology, stable isotope geochemistry;

**Jack Creilson** (Lecturer; Manager of the Climate System Research Center): climatology, remote sensing, climate change

**Rob DeConto** (Associate Professor): paleoclimatology, paleoceanography, Earth system modeling, global climate change

**Piper Gaubatz** (Professor): urban studies, China, Japan, U.S.

**Mark Leckie** (Professor): paleoceanography, paleoecology, global climate change

**William McCoy** (Associate Professor): Quaternary geomorphology and paleoenvironments

**Steve Petsch** (Associate Professor): biogeochemistry, organic geochemistry, geomicrobiology

**Eve Vogel** (Assistant Professor): political and environmental geography

**Jon Woodruff** (Assistant Professor): sediment transport, coastal processes, sea-level change, paleotempestology

**Qian Yu** (Assistant Professor): biogeography, environmental geography, GIS, remote sensing

**Richard Yuretich** (Professor): environmental geochemistry, lake environments

*Environmental Engineering*

Paul Siquera

FYI - Paul Siquera had contacted us in NRC with an interest in linking remote sensing (microwave) and his center to a climate change cluster hire proposal...

*Landscape Architecture and Regional Planning*

**Elizabeth Brabec** (Professor and Dept Head): land conservation and the design and planning of sustainable open space

**Robert Ryan** (Associate Professor): environmental psychology and landscape planning

*Resource Economics*

**Tom Stevens** (Professor): non-market valuation techniques to estimate the economic value of wildlife species, ecosystem management of forests, wetlands, and recreation on public lands

**Sylvia Brandt** (Assistant Professor, also Center for Public Policy and Administration): relationships between institutions, strategic behavior of firms and individuals, and regulatory design in fisheries economics and health economics

*Economics*

**Lee Badgett** (Professor, also Director of CPPA): labor economics, economics of sexual orientation

**James Boyce** (Professor): Development economics and environmental economics

**Michael Ash** (Associate Professor, also CPPA): environment, health, health disparities, labor