NSF Biocomplexity final report
UCR fund 21585, NSF award BES-0083383

1. Personnel

A. What people have worked on this project (originally listed as PIs or senior people, as well as any others, including graduate students)

All of the principals on this project contributed more than 120 hours in the first year. In addition, the following faculty and graduate students have participated in the project through the interdisciplinary seminar series and/or interdisciplinary research proposals:

Edith Allen	Assoc. Professor of Plant Ecology
Mike Allen	Director Center for Conservation biology
Juliann Allison	Assistant Professor of Political Science
Christopher Amrhein	Associate Professor of Soil Chemistry
Gene Anderson	Professor of Anthropology
Michael Anderson	Associate Professor of Soil Chemistry
Janet Arey	Professor of Atmospheric Chemistry
Roger Atkinson	Distinguished Professor of Atmospheric Chemistry
Andrew Chang	Professor of Environmental Science
Chris Chase-Dunn	Professor of Sociology
Mike Clegg	Distinguished Professor of Genetics
Donald Cooksey	Professor of Plant Pathology
Carl Cranor	Professor of Philosophy
David Crohn	Associate Professor of Environmental Science
David Crowley	Assistant Professor of Environmental Science
Marc Deshusses	Assistant Professor of Chemical and Environmental Engineering
Peter Diage	Lecturer, Dept of Environmental Sciences
Don Dye	Dean of Graduate School of Management
David Eastmond	Associate Professor of Environmental Toxicology
Walter Farmer	Professor of Environmental Science
Linda Fernandez	Assistant Professor of Resource Economics
Robert Haddon	Distinguished Professor of Engineering and Chemistry
William Jury	Distinguished Professor of Soil Physics
Keith Knapp	Professor of Resource Economics
James M. Lents	CE-CERT Associate Director
Mark Matsumoto	Professor of Chemical and Environmental Engineering; Associate Dean of Bourns College of Engineering
Tom Meixner	Assistant Professor of Hydrology
Wayne Miller	CE-CERT Senior Manager
Richard Minnich	Professor of Earth Sciences
Max Neiman	Director, Center for Social & Behavioral science
Joseph Norbeck	Director, CE-CERT; Professor of Chemical and Environmental Engineering
Stephen Park	Associate Professor of Earth Sciences
David Parker	Associate Professor of Environmental Science
Dan Schlenk	Professor of Aquatic Toxicology
Kurt Schwabe	Assistant Professor of Resource & Environmental Economics
Tom Scott	Extension Natural Resource Specialist, Earth Sciences
Linda Stearns	Professor of Sociology
Gail Tonnesen	CE-CERT Senior Manager, Assistant Research Engineer, Chemical and Env. Eng.
Akula Venkatram	Professor of Chemical and Environmental Engineering

Anders Wistrom	Assistant Professor of Chemical and Environmental Engineering
Laosheng Wu	Assistant Professor of Environmental Sciences
Marylynn Yates	Professor of Environmental Microbiology
Paul Ziemann	Assistant Professor of Atmospheric Chemistry

Other faculty:
Leonard Nunney, Professor of Biology
Bia-Lian Li, Associate Professor of Botany and Plant Sciences
Arlee Montalvo, Post-Doctoral Researcher, Botany and Plant Sciences
Michael Hamilton, Field Station Director, Center for Conservation Biology
John Rotenberry, Professor of Biology

Others from Professors Mike Allen's Center for Conservation Biology:
Season Snyder, Post-Doctoral Researcher, Biology
William Swenson, Post-Doctoral Researcher, Biology

Graduate students who helped organize the seminar series:
Janni Aragon, Graduate Student in Political Science
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B. What other organizations have been involved as partners?

University of California, Irvine
U.S. Forest Service Fire Laboratory
U.S. Salinity Laboratory

C. Have you had other collaborators or contacts?

Yes, with visiting speakers (Nancy Grimm, University of Arizona Urban LTER), with the UCR graduate program, and with the University of California Office of the President. In addition, four co-PIs and cooperators participated in an ecosystem management symposium with faculty at the University of Beyreuth, Germany that will help initiate collaboration with that institution.

2. Activities and Findings

A. Describe major research and educational activities of the project.

This is a planning grant whose purpose is to enable us to develop and present a program for a sustainability research and educational program at UCR. A group of environmentally oriented UCR faculty has been meeting twice per month for the purpose of sharing self-education seminars so we all can learn in more detail about the research activities of others on campus. The seminars proved popular even when held at 8 a.m. during summer and fall 1999. In January 2000 we shifted the seminars to dinner meetings with opportunities for social interaction from 5:30 to 9:00 p.m. Attendance was consistently been between 25 and 35 participants, and faculty and students expressed great enthusiasm for the seminar series.

Beginning in January 2001, a sub-group formed to develop a research proposal for the 2001 NSF Biocomplexity competition. The group met weekly from January through March 2001, and submitted a proposal. The proposal was not selected for funding, however, the group was encouraged to resubmit the proposal in 2002. Beginning in January 2002 the same team began weekly meetings to develop a revised proposal, which was submitted in March of 2002. This proposal was also not selected for funded. The group resumed weekly meeting in October 2003, and intends to submit a revised proposal in response to the call for proposals due in January 22, 2004 for Coupled Biogeochemical Cycles.

Several planning meetings have been held with the principals and other key UCR faculty to plan strategies for seminar series, for research proposals and for other initiatives.

Project participants submitted a proposal to the UCR administration in May 2001 in a competition for new campus wide initiatives. The Environmental Initiative was one of three selected, and it was the highest rated in part due to the level of activity and organization among the faculty involved in the NSF incubation activity. As of October 2003 the Environmental Initiative remains a high priority and discussions are underway among the chancellor and executive vice chancellor in regard to implementing this initiative.

Project participants conducted a research retreat in June 2001. The purpose of this meeting was to provide opportunities for liaisons and development of proposals among subgroups of faculty interested in various interdisciplinary research topics.

A significant outcome of the seminar series was the development of a conference on environmental health for Inland Southern California, a region that is also commonly referred to as the "Inland Empire" of southern CA. On Nov. 7 and 8, 2002 the conference was held on the UCR campus, titles "The Environmental Health of Inland Southern California 2010: Biodiversity and Ecological Sustainability in an Urbanizing Region. Continuing education units were offered for professional attending the conference. (Course listing: Environmental Science 875A, 0.8 CEU). The conference was envisioned as the first in a series of conferences focusing on different topics on the environmental health of Inland Southern California.

The goal of this conference was to bring together leaders in the local efforts to provide an overview of the status of scientific information for sustainable biodiversity planning, monitoring and management for this region as a model system. Speakers described progress in the different plans, and show how monitoring and adaptive management are being applied, or how they may be applied. The conference was sponsored by the UCR Center for Conservation Biology, UCR Cooperative Extension, the College of Engineering, the Department of Environmental Sciences, and the UCR Extension Office, with partial travel support from the NSF incubation grant. Speakers included several faculty from the Biocomplexity Incubation grant (M. Allen, E. Allen, W. Jury, and K. Baerenklau, J. Rotenberry, M. Hamilton) Tom Scott also provided a presentation from Chile with the assistance of the US Embassy. The program also included international

collaborators (J. Jimenez-Osornio from the University of Yucatan, Mexico, and J. Tenhunen from the University of Bayreuth, Germany), as well as community representatives from the County of Riverside Board of Supervisors (Tom Mullen). Participants included NGO's, several local agency personnel (US Fish and Wildlife Service, Biological Resources Division, US Forest Service, Bureau of Land Management, California Department of Fish and Game), public officials, especially from the County of Riverside, and members of the public.

In a related activity, a private donor initiated a planning process to explore the possibility of establishing an interdisciplinary center for research on sustainability in suburban development. Each of the co-PI's participated in this initiative which included a 3 day conference on development in southern CA held at UCR in spring of 2003. This led to the establishment in September 2003 of the Edward J. Blakely Center for Sustainable Suburban Development. One of the co-PI's on this project, Dr. Lents, was appointed as the interim Director of the new center.

B. Describe major findings resulting from these activities.

We have identified a number of potential barriers to the type of interdisciplinary research and educational programs that we are pursuing. Among them:

- Faculty normally are not comfortable working on large-scale problems requiring a huge breadth of expertise.
- Interdisciplinary research may not fare well in our current merit and promotion evaluation process, particularly for young faculty seeking to show evidence of "superior intellectual attainment" in support of the tenure decision.
- Communication is difficult among disciplines that have previously been isolated from one another, but which are an integral part of sustainability research.
- Programmatic leadership requires broad training and holistic thinking, commodities that are scarce in academic environments.
- Many feel that the University should not be competing with consultants in planning for sustainable development.
- Grant funding for large, multi-disciplinary investigations is very competitive.
- UCR lacks many of the resources that larger institutions have in place for such an enterprise.

Overcoming these barriers will be a major step toward the eventual success of our program. Our meetings and workshops have resulted in a number of actual and potential collaborations on proposals and projects already. It is premature to report findings from them. However, these activities have included collaborations between Political Science and Engineering faculty in evaluation of distributed energy generation systems, collaboration between air pollution modelers, surface water modelers, biologists and botanists in evaluating atmospheric nitrogen deposition and soil nitrification.

C. Describe opportunities for training and development provided by the project.

The Nov. 7 and 8, 2002 the "Environmental Health" conference provided two days of seminars, posters sessions and discussions groups involving faculty, students, area professionals, and community members.

We already have created a framework for graduate students to be trained in multiple disciplines. For example, two graduate students in political science have participated actively in College of Engineering environmental research projects regarding air quality and energy efficiency. We expect to develop additional opportunities that will precipitate broader training for graduate students and greater interaction among faculty of different disciplines.

CE-CERT and other departments always have provided numerous training opportunities for undergraduates and students in secondary schools. These opportunities will expand as we continue to develop and implement the interdisciplinary sustainability program.

UCR is designated a "growth campus" within the UC system. The faculty and administration have identified a modest number of programs in which we will seek pre-eminence as we grow. One of these subject areas is environmental research.

D. Describe outreach activities the project has undertaken.

More than 40 faculty already have participated in meetings and seminars. Notices of seminars have been broadcast throughout UCR and to selected collaborators at other institutions. Two collaborators have UC Cooperative Extension appointments and have been able to disseminate information related to the project statewide to county extension offices and stakeholders. Two on-campus workshops were held on development issues and impacts to the environment, jointly organized by the co-PIs of the Incubation grant, the Center for Conservation Biology, and UCCE.

The workshop on Environmental Health of Inland Southern California 2010: Biodiversity and Ecological Sustainability in an Urbanizing Region attracted over 70 participants ranging from Federal Officials to individual homeowners.

The interactions from this workshop also led to the Center for Conservation Biology being asked to review the science in the Western Riverside County Multiple Species Habitat Conservation Plan for the County of Riverside.
The NSF Incubation Project served as the catalyst for an intercampus proposal to the University of California Office of the President for a "California Institute for Science and Innovation" in 2000, but it was not selected for development. The exercise, however, established new collaborations between UCR, UC Irvine, and UC Santa Barbara.

3. Publications and Products

A. What have you published as a result of this work?

Journal

Fenn, M.E., Haebuer, R., Tonnesen, G.S., Baron, J.S., Grossman-Clarke, S., Hope, D., Jaffe, D.A., Copeland, S., Geiser, L., Rueth, H.M., Sickman, J.O., 2003. Nitrogen Emissions, Deposition and Monitoring in the Western United States, *BioScience*, 53(4): 391-403

Fenn, M.E., Baron, J.S., Allen, E.B., Rueth, H.M., Nydick, K.R., Geiser, L, Bowman, W.D., Sickman, J.O., Meixner, T., Johnson, D.W., Neitlich, P., Ecological Effects of Nitrogen Deposition in the Western United States, *Bioscience, 53(4)*: 404-420.

Books or other non-periodical publications

Tonnesen, G.S., Wang, Z.S., Omary, M., Chien, C.J, Model simulations of formation, transport and deposition of ozone, fine particulates and nitrates in the Sierra Nevada, in Ozone Air Pollution in the Sierra Nevada – Distribution and Effects on Forests, Vol 2 Developments in Environmental Sciences, Editors: A. Bytnerowicz, M. Arbaugh, and R. Alonso, Amsterdam (Netherlands), Elsevier Press. 2003..

Tonnesen, G.S., Allen, E., Meixner, T., Modeling and Measurements of Anthropogenic NOx Emissions and Their Contribution to the Nitrogen Budget in the Southern California, paper submitted to the Tenth International Scientific Symposium on Transport and Air Pollution, Boulder, CO, September 17-19, 2001.

Tracy Tennant, Michael F. Allen, and Fred Edwards (July 12, 2001) Perspectives in Conservation Biology in Southern California: I. Current Extinction Rates and Causes. http://repositories.cdlib.org/ccb/

Michael F. Allen and Tracy Tennant (November 2, 2000) Evaluation of Critical Habitat for the California red-legged frog (Rana aurora draytonii). http://repositories.cdlib.org/ccb/

Allen, M.F. et al. 2003. Scientific Review Panel Review of: Final Draft of the Western Riverside County MSHCP Document. Unpublished document. 21 pages.

B. What web site or other Internet sites have you created?

The project has supported purchase of disk drive that are being used for a website to disseminate results of model simulations of regional haze, O3 and deposition of important trace species. Development of this website and databases is a large effort that has been primarily supported by other projects, however, the NSF funding has been instrumental for providing sufficient disk storage to house databases of interest to other researchers. The url for this website is www.cert.ucr.edu/rcm.

The project facilitated expansion of the web site (led by Tom Scott) for information for the public and policy makers for the Western Riverside County MSHCP at http://ecoregion.ucr.edu/

Also, the project helped the CCB initiate the web site for outreach which is currently undergoing redevelopment by adding field guides to species of concern and for input from the public on sightings and comments at http://www.ccb.ucr.edu/

C. What other specific products (databases, physical collections, educational aids, software, instruments, or the like) have you developed?

Model simulations of atmospheric chemistry and transport have been performed on several geographical domains and for several scenarios and time periods. The development of the model inputs and model simulations have been supported by other funding agencies. The NSF incubation project has supported development and analysis of nitrogen deposition databases derived from the model simulations. The project has also funded the purchase of several high capacity disk drives to store this model output. These output include geographically resolved, time varying deposition rates for ammonium, sulfate and sever nitrate species.

We are currently expanding the databases on the distribution of species of concern and the ecology of those species which will be accessible by agency personnel and other scientists in early 2004.

4. Contributions

A. Explain how the work, findings, and products are significant and contribute to the principal disciplines of the project.

The significance of this planning effort is that it will build a framework for researchers from UCR and other institutions to work together to address a pressing issue. Without concerted effort to address all of the pressures of a growing population on a delicate ecosystem (Southern California), we will end up with haphazard development, inadequate planning, and, at best, partially successful solutions to environmental quality, food supply, water supply, mobility, and land use. The NSF Planning Grant has enabled us to bring together experts from a number of disciplines to begin developing a common perspective and even a common language to use in understanding and addressing these problems. We expect that the eventual results will be tools that the public and private sector can use for evaluating the impacts of growth and making the best choices for accommodating it.

B. Explain the contribution to other disciplines of science and engineering.

As noted earlier, the project involves multiple disciplines, including:

Anthropology.
Aquatic Toxicology.
Atmospheric Chemistry.
Biology.
Chemical Engineering.
Chemistry.
Earth Sciences.
Economics.
Environmental Engineering.
Environmental Microbiology.
Environmental Science.
Environmental Toxicology.
Genetics.
Hydrology.
Management.
Philosophy.
Plant Pathology.
Political Science.
Sociology.
Soil Science.

C. Describe contributions to development of human resources

Through planning meetings, seminars, and other outreach activities (see Section 5 below), we are attracting new graduate and undergraduate students and offering them opportunities to explore pressing issues through a variety of disciplinary approaches.

D. What are the contributions to the physical, institutional, or information resources that form the infrastructure for research and education?

Initiated web sites for public distribution of data and information transfer from ecosystem processes to a form that can be used by the public for policy decisions.

E. Other aspects of public welfare beyond science and engineering, such as commercial technology, the economy, cost-efficient environmental protection, or solutions to social problems.

Commercialization of new technologies is likely. Cost-efficient environmental protection is one of the key objectives. Appropriate resource allocation and social justice are central to our objective.