# Central Arizona - Phoenix Long-Term Ecological Research (CAP LTER)

## Third Annual
## Poster Symposium

January 19, 2001
Arizona Room, Memorial Union
Arizona State University

Sponsored by:
Center for Environmental Studies
Arizona State University

# CAP LTER

Agenda
January 19, 2001
Arizona Room, Memorial Union

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|---|---|
| 9:00-9:15 | Welcome and Introductions<br>*Charles Redman and Nancy Grimm* |
| 9:15-9:30 | Informal poster viewing |
| 9:30-10:30 | Poster Session #1 |
| 10:30:10:45 | Informal poster viewing |
| 10:45-11:45 | Poster Session #2 |
| 11:45-1:15 | Lunch break (on your own) |
| 1:30-2:30 | Synthesis reports |
| 2:30-3:30 | Keynote Address<br>*Michael Rosenzweig*, ***"Habitats for Humanity – and Other Stuff"*** |
| 3:30-4:30 | Social with refreshments |

# DR. MICHAEL ROSENZWEIG

Dr. Rosenzweig is an evolutionary ecologist. He joined the University of Arizona in 1975 as a professor and founding head of its Department of Ecology and Evolutionary Biology. Previously, he served on the faculties of the University of New Mexico, SUNY-Albany, and Bucknell University. He holds a B.A. and a Ph.D. in zoology from the University of Pennsylvania, where he studied with Robert H. MacArthur and W. John Smith.

Dr. Rosenzweig's research combines the fields of ecology, evolution and mathematical theory. It concentrates on the following themes: species diversity; desert mammal ecology; optimal density dependent habitat selection; predation dynamics; and environmental issues and public policy. His most recent book, *Reconciliation Ecology* (in ms.) suggests how we can conserve the Earth's species diversity in a world full of people.

In addition, Michael Rosenzweig is founder and editor-in-chief of the *Evolutionary Ecology Research* journal.

# 2001 CAP LTER Symposium

| Poster Session 1 (9:30-10:30 AM; 22 posters) | Poster Session 2 (10:45-11:45 AM; 20 posters) |
|---|---|
| Bagley | Arrowsmith, Robinson, Fergason, Tyburczy, Holloway, and Wood |
| Berling-Wolff and Wu | Bigler |
| Bolin, Nelson, Hackett, Pijawka, O'Donnell, Smith, Sicotte, and Sadalla | Brazel, Martin, Hope, Ellis, Heisler, Baker, Anderson, Selover, Stabler, Tomalty, and Blair |
| Bruce and Worley | Fergason, Arrowsmith, and Tyburczy |
| Cousins and Stutz | Grimm, Baker, Hope, Zhu, Anderson, Coppola, Edmonds, Grossman-Clarke, Jenerette, Kinzig, Klopatek, Lewis, Luck, Sommerfeld, Westerhoff, Wu, and Xu |
| David and Wu | Hope, Gries, Zhu, Carroll, Nelson, Stabler, Redman, Grimm, and Kinzig |
| Elser and Saltz (3) | Hope, Grimm, Anderson, and Clary |
| Fry, Nogue, Patterson, and Smith (2) | Hope, Grossman-Clarke, Stefanov, and Hyde |
| Harlan, Nelson, Hackett, Kirby, Bolin, Pijawka, Rex, and Hope | Katti and Shochat |
| Jenerette, Gade, Grimm, Hope, Luck, Marussich, and Roach | Martin, Day, Briggs, Stutz, and Sommerfeld |
| Jenerette, Luck, Wu, Grimm, Hope, and Zhu | Marussich, MacHeffner, Fagan, and Faeth |
| Krutz and Woodall | Putnam |
| McCartney | Rango, Shochat, Tseng, Fagan, and Faeth |
| Nelson, Bolin, Hackett, Pijawka, Sadalla, Sicotte, Brewer, and Matrangra | Roach, Coppola, and Grimm |
| Nelson and Harlan | Shochat and Katti |
| Rango, Tseng, and Shochat | Stabler, Martin, and Stutz |
| Redman and Gober | Warren and Kinzig |
| Sicotte | Whitcomb, Stutz, and Martin |
| Stiles and Scheiner | Wu, David, Jenerette, Luck, Berling-Wolff |
| | Zschau, Getty, Gries, and Nash |

# LIST OF POSTERS

## SESSION 1: EDUCATION

Elser, Monica M., and Charlene Saltz. ***Ecology Explorers: K-12 student contributions to the CAP LTER project.*** (Overview poster)

## SESSION 1: MODELING

Berling-Wolff, Sheryl, and Jianguo Wu. ***Simulating the urban growth pattern in the Phoenix metropolitan region: relating pattern to process***.

David, John L., and Jianguo Wu. ***Developing a hierarchical patch dynamics modeling platform.***

Wu, Jianguo, John L. David, G. Darrel Jenerette, Matt Luck, and Sheryl Berling-Wolff. ***Modeling land use change and ecosystem processes of the Phoenix metropolitan landscape.*** (Overview poster)

## SESSION 1: SURVEY 200

Cousins, Jamaica R., and Jean C. Stutz. ***Trap cultures reveal higher species richness of arbuscular mycorrhizal fungi in comparison to soil samples in the Phoenix metropolitan area.***

Hope, Diane, Corinna Gries, Weixing Zhu, Steve Carroll, Amy Nelson, Linda Stabler, Charles L. Redman, Nancy B. Grimm, and Ann Kinzig. ***Application of integrated inventory to the study of urban ecosystem: An extensive 200-site field survey of the Central Arizona-Phoenix LTER.*** (Overview poster)

Jenerette, G. Darrel, Matt A. Luck, Jianguo Wu, Nancy B. Grimm, Diane Hope, and Weixing Zhu. ***Spatial patterns of soil organic matter in central Arizona.***

Rango, Jessamy, Maggie Tseng, and Eyal Shochat. ***200 point survey: Vegetative arthropod community structure.***

Stiles, Art, and Sam M. Scheiner. ***Analysis of desert vegetation data from the 200 sites survey.***

# SESSION 1: HUMAN DIMENSIONS

Bagley, Anubhav. ***Projecting new growth using SAM-IM.***

Bolin, Bob, Amy Nelson, Ed Hackett, David Pijawka, Maureen O'Donnell, Scott Smith, Diane Sicotte, and Edward Sadalla. ***South Phoenix assessment of community and environment.***

Bruce, Chris, and Don Worley. ***Tracking growth in the Valley of the Sun residential completions (1990-1999)***.

Fry, Jana, Leslie Nogue, Chris Patterson, and C. Scott Smith. ***Historic Land Use Phase II***.

Harlan, Sharon, Amy Nelson, Ed Hackett, Andrew Kirby, Bob Bolin, David Pijawka, Tom Rex, and Diane Hope. ***Phoenix area social survey: Long-term monitoring of social interaction, and environmental change in urban neighborhoods.***

Jenerette, Darrel, Kristin Gade, Nancy Grimm, Diane Hope, Matt Luck, Wendy Marussich, John Roach. ***The ecological footprint workshop: Creating an ecological and social sciences interface.***

Krutz, Glen, and Gina Woodall. ***Dynamic political institutions and water policy in Central Arizona-Phoenix.***

Nelson, Amy, Bob Bolin, Ed Hackett, David Pijawka, Ed Sadalla, Diane Sicotte, Debbie Brewer, and Eric Matranga. ***The ecology of risk in a Sunbelt city: A multi-hazard analysis.***

Nelson, Amy and Sharon Harlan. ***Labor market dynamics in a postindustrial city: A spatial and sectoral analysis of employment changes in the Phoenix MSA.***

Redman, Charles L., and Patricia Gober. ***Human dimension of CAP LTER research.*** (Overview poster)

Sicotte, Diane. ***Political and legal controversies over hazardous industrial waste in three central Arizona communities.***

# SESSION 1: DATA MANAGEMENT

McCartney, Peter. ***Ecological informatics at CAP LTER.*** (Overview poster)

## SESSION 2: POPULATIONS

Katti, Madhusudan and Eyal Shochat. ***Phoenix Or Tucson - Does landscape determine where Abert's Towhees choose to live?***

Marussich, Wendy A., Jeanne MacHeffner, William F. Fagan, and Stanley H. Faeth. ***Urban ecology: Population and community patterns.*** (Overview poster)

Putnam, Christopher. ***Cactus Wren condos: Does urbanization affect the characteristics of Cactus Wren roost nests?***

Rango, Jessamy, Eyal Shochat, Maggie Tseng, William Fagan, and Stanley Faeth. ***Ground arthropod community composition in a heterogeneous urban environment.***

Shochat, Eyal, and Madhusudan Katti. ***Bird species diversity in the greater Phoenix area.***

Warren, Paige, and Ann Kinzig. ***Ecological and social factors predicting avian diversity in urban parks.***

## SESSION 2: PRIMARY PRODUCTION

Martin, Chris, Thomas Day, John Briggs, Jean Stutz, and Milton Sommerfeld. ***Primary productivity at the CAP LTER***.

Stabler, L. Brooke, Chris A. Martin, and Jean C. Stutz. ***Potential effects of mycorrhizal associations on urban tree carbon storage potential.***

Whitcomb, Sean A., Jean C. Stutz, and Chris A. Martin. ***Spatial patterns of belowground respiration and related soil parameters in a simulated xeric urban landscape.***

## SESSION 2: BIOGEOCHEMICAL PROCESSES

Grimm, Nancy B., Larry A. Baker, Diane Hope, Weixing Zhu, James Anderson, Aisha Coppola, Jennifer Edmonds, Susanne Grossman-Clarke, G. Darrel Jenerette, Ann P. Kinzig, Jeff Klopatek, David B. Lewis, Matt A. Luck, Milton Sommerfeld, Paul Westerhoff, Jianguo Wu, and Y. Xu. ***Biogeochemical processes in an urban ecosystem, metropolitan Phoenix, Arizona.*** (Overview)

Hope, Diane, Nancy B. Grimm, James Anderson, and Michael Clary. ***Atmospheric deposition of major nutrients across an urban-desert gradient in central Arizona.***

Hope, Diane, Susanne Grossman-Clarke, Will Stefanov, and Peter Hyde. ***Modeling nitrogen dry deposition inputs to the CAP LTER urban ecosystem.***

Roach, W. John, Aisha Coppola, and Nancy B. Grimm. ***Nutrient dynamics in arid urban fluvial systems: Canals and streams.***

Zschau, Toralf, Steve Getty, Corinna Gries, and Thomas H. Nash III. ***Spatial and temporal variation of elemental deposition in Maricopa County, Arizona.***

## SESSION 2: GEOPHYSICAL CHANGES

Arrowsmith, J Ramón, Sarah E. Robinson, Kenneth Fergason, James A. Tyburczy, Stephen D. Holloway, and Steve E. Wood. ***CAPLTER geology and geophysics.*** (Overview poster)

Bigler, Wendy. ***Before the river became a lake: Historical channel change in the Salt River, Tempe.***

Brazel, Anthony J., Chris A. Martin, Diane Hope, Andrew Ellis, Gordon Heisler, Larry Baker, Sharolyn Anderson, Nancy Selover, Linda Stabler, Roger Tomalty, and John Blair. ***CAP LTER climate***. (Overview poster)

Fergason, Kenneth, Ramón Arrowsmith, and James Tyburczy. ***Investigation of changes in groundwater elevation associated with Tempe Town Lake.***

# POSTER ABSTRACTS

All of the following abstracts are listed alphabetically by first author.

Arrowsmith, J R., Robinson, S. E., Fergason, K., Tyburczy, J. A., Holloway, S. D., and Wood, S. E. ***CAPLTER geology and geophysics.*** Department of Geology, Arizona State University, PO Box 871404, Tempe AZ 85287-1404.

The geology and topography of the CAPLTER region provides a primary template for the spatial distribution of materials, processes operating at and near the surface, and the connectivity among those materials and processes. Given their longer time scales of study, these studies also provide important baseline process rates and event sequences. Our studies have focused on the Quaternary (last 2 million years) geologic history because of the clear record preserved on the region's piedmonts and valleys. This record is one of alternating incision and aggradation of the debris aprons surrounding the major ranges of the region, presumably modulated by incision and aggradation along the trunk drainages (Salt-Gila-Lower Colorado River systems). Detailed study areas are the White Tank Mountains and the Union Hills-Cave Creek area of north Phoenix. The western piedmont of the White Tank Mountains, located just west of the greater Phoenix area, provides a valuable natural laboratory in which we have worked to unravel this history and quantify the rates of gravel accumulation, landscape stability, and drainage downcutting. Our mapping and cosmogenic dating results indicate a period of protracted deposition from about 1.5 to 1 Ma, followed by stability and erosion, another period of accumulation at 0.8 to 0.5 Ma, and then stability and incision to the present. These results indicate that Quaternary climate change probably has the most important control on the distribution of materials and processes on piedmonts and thus establishes the physical context for ecological processes here and an approach for integrating geological and geophysical information into long-term ecological research. Along with the piedmont studies, we have undertaken a study of the subsurface geology, hydrogeology, and surface-subsurface water interactions at the Tempe Town Lake (see Fergason, et al. this volume). The construction, filling, and management of Tempe Town Lake in the alluvium-filled Salt River channel have influenced the elevation of groundwater near the lake. Since the filling of the lake in June 1999, water table elevations have been dependent upon the water retention and recovery activities associated with the lake operation. We have monitored well levels and applied detailed microgravity studies to enhance understanding of the lake operations. While groundwater elevations have not shown large variations, the relative shape of the water table has changed, which may cause a shift in flow directions. Our estimations of groundwater storage enhanced with the gravity studies provide a valuable complement and extension of City of Tempe management procedures. We find that the Tempe Town Lake affects groundwater levels out to approximately 1 km from the lake boundaries. This project is a portion of the CAPLTER studies of Tempe

Town Lake that represent a microcosm of the greater CAPLTER region and have important local relevance. In addition, these studies provide background on the broader applied and societal issues concerning the temporal and spatial dimensions of artificially induced changes in groundwater parameters.

Bagley , A. ***Projecting urban growth using SAM-IM.*** Maricopa Association of Governments, 302 N. 1st Ave., Suite 300, Phoenix AZ 85003.

A Subarea Allocation Model and Information Manager (SAM-IM) has been developed to project residences, employment and special population groups by 1500+ Traffic Analysis Zones for the Phoenix metropolitan area. The TAZ forecasts for 2000–2020 are currently used by the Maricopa Association of Governments (MAG) for regional transportation, environmental and human services planning. SAM-IM can also be used to design and evaluate alternative land use scenarios. Planners can interactively alter land use polygons and assess the impact on jobs/housing balance, infill, and urban form.

SAM-IM projects land use and development by simulating factors that influence the value of land and the likelihood that land will be built, based on those factors. It also observes planning policies. For example, General Plan designations controlling the use of land (approved by municipalities in the region) are observed by the model.

Data being collected by the 2000 Census and the ongoing MAG GIS and Database Enhancement Project will be input to SAM-IM to prepare the next set of TAZ projections for the MAG Region during 2002.

Berling-Wolff, S.[1], and J. Wu[2]. ***Simulating the urban growth pattern in the Phoenix metropolitan region: Relating pattern to process.*** [1]Department of Plant Biology, Arizona State University, PO Box 871601, Tempe AZ 85287-1601 and [2]Department of Life Sciences, Arizona State University-West, 4701 W Thunderbird Rd, PO Box 37100, Phoenix AZ 85069-2352.

In order to project future urban growth, it is necessary to identify the predominant factors and processes that drive urbanization. In the past decades, many urban growth models have been developed, but few offer any ecological or social explanations. In this presentation, we describe a spatially explicit urban growth model that is used to simulate the historical land use change and its social and ecological driving forces in the Phoenix metropolitan area. The Phoenix urban growth model is a modified version of HILT, a rule-based urban growth mode originally developed for the San Francisco Bay Area. The modeling framework is a modified cellular automaton that applies growth rules and allows for self-modification during execution of controlling variables. Using land use and other data collected for the Phoenix area, existing growth rules have been selectively modified, and new rules added to help examine key ecological and social factors that affect urbanization. FRAGSTATS, a landscape analysis package, is used to compute landscape indices to compare simulated and empirically mapped land use patterns. Preliminary results show that there are relatively few factors that have significantly influenced the urban growth in the Phoenix metropolitan region. These include growth/density values, land ownership, and dispersal growth that is so elusive to model, and significantly contributes to landscape fragmentation.

Bigler, W. ***Before the river became a lake: Historical channel change in the Salt River, Tempe.*** Department of Geography, Arizona State University, PO Box 870104, Tempe, AZ 85287-0104.

The Salt River in the Phoenix metropolitan area has witnessed substantial changes in the past century. Where and how has the channel changed through the Tempe reach of the Salt River? Through the use of historical photographs and maps, I show how the river's character has changed over time. With the closure of Roosevelt Dam and construction of related diversion projects in the early part of the century, the Salt River through Tempe has been virtually dry since 1938. Infrequent discharge events, sand and gravel mining, channelization, and development have changed the channel's morphology. The most recent change has come in the form of Tempe Town Lake, an impoundment formed by the riverbanks and inflated rubber dams, and filled with water from the Central Arizona Project. The city of Tempe hopes to spark economic growth through the private development of condominiums and shops along the riverbanks. Examining the patterns and interpreting mechanisms of channel change are important, especially in light of the possibility of increased development on the riverbanks.

Bolin, B. [1], A. Nelson[2], E. Hackett[1], D. Pijawka[2], M. O'Donnell[1], S. Smith[3], D. Sicotte[1], and E. Sadalla[4]. ***South Phoenix assessment of community and environment***. [1]Department of Sociology, Arizona State University, PO Box 872101, Tempe AZ 85287-2101, [2]Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85287-3211, [3]Department of Geography, Arizona State University, PO Box 870104, Tempe AZ 85287-0104, and [4]Department of Psychology, Arizona State University, PO Box 871104, Tempe AZ 85287-1104.

The South Phoenix area hosts a disproportionate number of hazardous industries, waste handling facilities, and toxic waste sites. It is also an area that is home to some of Phoenix's oldest African American and Latino neighborhoods. There are significant concerns at the neighborhood level about health, safety, equity, and quality of life as a result of these environmental burdens. To gain a fuller understanding of environmental problems facing South Phoenix, this research initiative will have two major foci. The first is to conduct, in collaboration with community-based organizations, a survey that assesses risk perceptions, neighborhood quality of life factors, and household health measures. The second component of the study will focus on specific neighborhoods impacted by recent commercial fires and resulting acute chemical releases. This phase of the study will examine specific household indicators of risk perceptions, health impacts, and perceived neighborhood characteristics as a result of the impacts of these incidents. In addition to an assessment of residents' contemporary concerns, historical and contextual factors that have produced this ecology of risk also will be examined.

Brazel, A.J.[1], C. A. Martin[2], D. Hope[3], A. Ellis[1], G. Heisler[4], L. Baker[5], S. Anderson[1], N. Selover[1], L. Stabler[2], R. Tomalty[1], and. J. Blair[6]. ***CAP LTER climate***.
[1]Department of Geography, Arizona State University, PO Box 8730104, Tempe AZ 85287-0104; [2]Department of Plant Biology, Arizona State University, PO Box 871501, Tempe AZ 85287-1501; [3]Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85287-3211; [4]5 Moon Library, SUNY-CESF, Syracuse NY 13210; [5]Baker Environmental Consulting, 8001 Greenwood Drive, Moundview MN 55112; and [6]School of Planning and Landscape Architecture, Arizona State University, PO Box 872005, Tempe AZ 85287-2005.

The climate system is an important part of earth's geosystem and is studied at each LTER site. CAP LTER ecosystem components are driven from without by long-term, inter-decadal, and quasi-periodic atmospheric variations. Climate within CAP LTER is not only a function of global/regional forces, but of city population growth and associated aerosol emissions, land cover/land use changes, existence of water across variable terrain in central Arizona, and the terrain itself. CAP LTER scientists (in coordination with Baltimore Ecosystem Studies as well) have conducted new climate research through: (a) mobile temperature/humidity transects across urban-rural gradients, (b) urban-rural, long-term weather data comparisons, (c) land cover change detection of the urban fringe with remote sensing, (d) special sites to observe wet/dry deposition, and (e) initiation of new monitoring stations in and out of the city. Future climate-related research is geared toward: (a) micro-meso scale monitoring/modeling of urban climate and ecosystem change and feedbacks, (b) further analyses of historical weather records linking global/regional signals to local change, and (c) development of cross-site (BES) and independent studies on mass, energy, and momentum flux processes in urban and rural areas.

Bruce, C. and D. Worley. ***Tracking growth in the Valley of the Sun residential completions (1990-1999) Maricopa County, Arizona (urban area).*** Maricopa Association of Governments, 302 N. 1st Ave, Suite 300, Phoenix AZ 85003.

Over 250,000 new residential housing units were constructed in Maricopa County between the 1990 Census and June 30, 1999. The Maricopa Association of Governments (MAG) collects residential completion data from each of its 27 member agencies and, using the address of the housing unit, geocodes (assigns coordinates to) every unit. Each point shown on the map represents the completion of a single family unit, townhouse/condo or mobile home; or an apartment complex. This map also identifies the completions for the time periods between the 1990 Census and the 1995 Special Census of Maricopa County; between the 1995 Special Census and June 30, 1998; and between July 1, 1998 and June 30, 1999.

Because the street addresses are geocoded to determine the geographic location of each completion, a GIS point coverage is generated, allowing the completion data to be summarized by any geographic unit. This allows MAG to use these data for many purposes, including the production of yearly population estimates by municipality and producing annual population estimates by water service area for the Arizona Department of Water Resources. Other uses of these data include analysis and mapping of residential completions for the U.S. Census Bureau's efforts to locate new housing for Census 2000, preparing annual population updates by Census geographies, preparing maps and analysis of housing growth by defined study areas, and assisting Arizona State University in the Long Term Ecological Research project.

Cousins, J. R., and J. C. Stutz. ***Trap cultures reveal higher species richness of arbuscular mycorrhizal fungi in comparison to soil samples in the Phoenix metropolitan area.*** Department of Plant Biology, Arizona State University, PO Box 871601, Tempe AZ 85287-1601.

This research represents the second phase of a project assessing the arbuscular mycorrhizal fungal (AMF) diversity at sites in the CAP-LTER Survey 200 pilot study. Soil samples were collected from twenty sites located in the Phoenix valley in May of 1999 and AMF spores were extracted and identified. AMF species richness, composition and abundance were calculated for each site. AMF diversity based on soil samples alone may be underestimated for two reasons: 1) spores extracted from soil are often impossible to identify due to parasitism and 2) not all AMF species may be sporulating at the time the soil sample is collected. Therefore, trap cultures were established using *Sorghum sudanese* as a host and grown in the greenhouse for 4 months to stimulate sporulation and determine if additional AMF species could be detected. After analyzing the trap cultures, the species richness increased from the 0-6 species detected per site in the soil samples to 2-10 species per site. The number of species detected across the study area increased from 14 to 18 species. Additionally, the frequency with which most species were detected increased, and the number of species found to predominate the area (as seen by the highest frequency of occurrence) increased from 1 to 4. These results indicate that many AMF species were present in soil samples but not sporulating at the time of sampling. Levels of AMF biodiversity would be grossly underestimated if only soil samples were used for assessment.

David, J. L.[1,2], and J. Wu[2]. ***Developing a hierarchical patch dynamics modeling platform.*** [1]Department of Plant Biology, Arizona State University, PO Box 871601, Tempe, AZ 85287-1601 and [2]Department of Life Sciences, Arizona State University-West, 4701 W Thunderbird Rd, PO Box 37100, Phoenix AZ 85069-2352.

We describe a hierarchical patch dynamics modeling platform developed to explicitly model processes occurring at their characteristic scales of observation or influence. As an initial demonstration of its utility, we developed an urban growth model using a stochastic cellular automata approach to model the probability of land use change due to three different processes: 1) local proximity or adjacency, 2) domains of influence, and 3) the effects of hierarchical linkages across scales.

Classic stochastic cellular automata model the state transition probability as a function of local rules. These local-interactions are assumed to be the primary causal factors in the dynamics exhibited by the system, and that higher order patterns, or emergent properties, are the result of those local-interactions only. However, in real-world phenomena, local-interactions can be modified by spatially extended domains of influence. These influences may either be spatially fixed (as in the case of property ownership boundaries and zoning ordinance restrictions) or variable (such as the land use change due to the proximity to roads), and act as top-down constraints or driving functions for lower-scale processes which are important factors in generating observed real-world patterns. Based on hierarchy theory, we allow lower-level effects to propagate up levels to modify these top-down constraints, thereby changing the overall dynamics of the system.

The flexibility of this modeling approach was designed to facilitate multiple-scale modeling whereby local processes may be modified by top-down constraints, while at the same time explicitly allowing for bottom-up propagation of information to hierarchically link interactions between scales.

Elser, M.M., and C. Saltz. ***Ecology Explorers: K-12 student contributions to the CAP LTER project.*** Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85287-3211.

Students from across the Phoenix metropolitan area have been involved in collecting population data in their schoolyards. Students from several schools will be preparing and presenting posters. We are expecting the following posters:

*From Brimhall Jr. High School:* A former student of Dave Boomgaard's has turned their local arthropod project into a research project he hopes to enter in the Central Arizona Regional Science Fair and he will be presenting his results at this poster session.

*From Mountain View High School*: Students from several of Wendy Blasdell's classes are involved in surveying vegetation and birds at their school and Usery Mountain Park. They will be sending their best posters and some students to the poster session.

*From Hendrix Junior High School*: Larry Langstaff's 8th grade students have been collecting arthropod, bird and vegetation data and will put together a poster displaying their questions and findings.

*From Ecology Explorers*: Ecology Explorers is a program that integrates the K-12 community with the CAP LTER project. We will be presenting the program components and directions for future projects.

Fergason, K.[1], R. Arrowsmith[2], and J. Tyburczy[2]. ***Investigation of changes in groundwater elevation associated with Tempe Town Lake.*** Department of Geological Sciences, Arizona State University, PO Box 871404, Tempe AZ 85287-1404.

The construction, filling, and management of Tempe Town Lake in the alluvium-filled Salt River channel have influenced the elevation of groundwater near the lake. Since the filling of the lake in June 1999, water table elevations have been sensitive to the water retention and recovery activities associated with the lake operation. Along with the City of Tempe, we monitored well levels at 36 different well locations surrounding the lake from January 1998 to September 2000. Their variations through time and space were studied. Initially the elevation of the water table increased by several feet, especially in the upstream vicinity of the lake. The downstream end of the lake showed a steady increase through the first 40 days that subsequently leveled out. At the upstream portion of the lake, water table elevations are dependent upon operation of the recovery wells. Upstream well levels decreased post-filling by up to 10 feet from the initial rise (to approximately 5 feet below levels prior to lake filling). While groundwater elevations have not shown large variations, the relative shape of the water table has changed, which may cause a shift in local flow directions. In addition, a microgravity survey that included 53 monuments (9 located at well locations) was repeated 8 times. Values for specific yield were calculated at the 9 co-located stations. The amount of seepage lost to the groundwater is calculated for the overall water budget for the lake (City of Tempe). This seepage volume was used to guide calculations using well level data and specific yield values to calculate a detailed model of water seepage into near- and far-field groundwater and vadose zone reservoirs. The two approaches show similar trends. The gravity data were also used to model the depth to bedrock. The modeled results were interpreted to indicate that at least 2 easterly dipping normal faults are present in the subsurface beneath the lake. This matches well with and enhances the current interpretations of local geology.

Fry, J.[1], L. Nogue[2], C. Patterson[3], and C. S. Smith[4]. ***Historic Land Use Phase II***.
[1]Information Technology, Arizona State University, PO Box 870101, Tempe AZ 85287-0101, [2]Department of Anthropology, Arizona State University, PO Box 872402, Tempe AZ 85287-2402, [3]Department of Exercise Science and Physical Education, PO Box 870701, Tempe AZ 85287-0701, and [4]School of Planning and Landscape Architecture, Arizona State University, PO Box 872005, Tempe AZ 85287-2005.

Phase II of the historic land-use project provides detailed information of a large sample of specific localities and how they have changed over the past sixty years. The localities to be studied coincide with the 206 points selected as the basic monitoring locations for the overall CAP LTER project. During the spring of 2000 teams of ecologists visited each of these point locations and recorded a wide range of physical, biological, and socio-economic data. These locations will be re-examined each third year, to provide additional information to the basic long-term database of the changing central Arizona urban environment.

The historic land-use project, reported here in two posters, examines documentary, air photo, and remotely sensed data on the square mile area surrounding each of the sample points. For the approximate years 1934, 1949, 1961, 1970, 1980, 1990, 1995 and 2000 information on land use for areas within the square mile will be recorded according to a detailed classification of 45 categories adapted from the well-known Anderson system. In addition to understanding the characteristic patterns and trajectories of land use, the legacy and associated social effects of historic land use will be identified.

Poster one includes a project description (i.e., abstract and scope of work), progress report (i.e. current status and planned agenda for completing Phase II) and project methodology (i.e. how the data are developed).

The second poster comprises example applications and synthesis of the land use data with social area indices (1970-1995) and other demographic information. Also included on the second poster will be a historic, socioeconomic account of two point areas with respect to how these areas fit in to the regional context.

Grimm N. B.[1], L. A. Baker[2], D. Hope[1,3], W. Zhu[4], J. Anderson[5], A. Coppola[1], J. Edmonds[1], S. Grossman-Clarke[3,5], G. D. Jenerette[1,6], A. P. Kinzig[1], J. Klopatek[7], D. B. Lewis[1,3], M. A. Luck[3], M. Sommerfeld[7], P. Westerhoff[8], J. Wu[6], and Y. Xu[8].
***Biogeochemical processes in an urban ecosystem, metropolitan Phoenix, Arizona.*** [1]Department of Biology, Arizona State University, PO Box 871501, Tempe AZ 85287-1501; [2]Baker Environmental Consulting, 8001 Greenwood Drive, Moundview MN 55112; [3]Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85287-3211; [4]Department of Biological Sciences, Box 6000, Binghamton University – SUNY, Binghamton NY 13902-6000; [5]Department of Mechanical and Aerospace Engineering, Arizona State University, PO Box 876106, Tempe AZ 85287-6106; [6]Department of Life Sciences, Arizona State University-West, 4701 W. Thunderbird Rd, PO Box 37100, Phoenix AZ 85069-2352; [7]Department of Plant Biology, Arizona State University, PO Box 871601, Tempe AZ 85287-1601; and [8]Department of Civil and Environmental Engineering, Arizona State University, PO Box 875306, Tempe AZ 85287-5306.

Urban ecosystems provide an opportunity to examine especially pronounced human alterations of biogeochemical cycles. Biogeochemical research in the CAP LTER has focused both on the whole ecosystem and on patterns and processes within and between urban landscape patches. Questions at the whole ecosystem scale include: is the city a source or a sink for different elements? What are the hot spots of element retention in the urban landscape?, and How are elements transported in airshed-watershed interactions? Within and between patches, we ask: How does urbanization affect nutrient dynamics? and What are the hot spots of element storage in soils? A mass balance for N showed that most of the input occurred via anthropogenic means, either deliberate (import of food, fuels, etc.) or inadvertent (conversion of $N_2$ to $NO_x$ as a by-product of fossil fuel combustion). Furthermore, inputs exceeded outputs, indicating either an underestimated sink or accumulation of N in the ecosystem. Comparison of element transport via surface water into and out of the city, another whole-system measure, revealed much higher concentrations of organic carbon, nutrients, and major ions downstream from the city than upstream. Atmospheric deposition of many elements also conformed to a gradient of reduced deposition from more urban to more rural sites. Nitrogen deposition is being modeled to generate a more accurate estimate of N flux to the CAP ecosystem.

Material storage and movement varies among patches. Examination of soil samples, although preliminary, reveals that urban patches (residential, commercial/ industrial, and institutional) have higher nutrient contents than desert or intermediate agricultural sites. Loads of nutrients and metals that might be expected to enter watercourses during storms were estimated for asphalt surfaces in different patches within the urban area, and were shown to exceed by an order of magnitude loads predicted from desert soils. Recipient systems for materials transported during rainstorms and flash floods include retention basins, artificial urban lakes, highly modified urban washes ("greenways"), and dry river channels.

Preliminary indications are that both pool sizes and flux rates are large in these systems. Long-term monitoring of trace N gas fluxes, soil nutrients, and nutrient loads in stormwater runoff from residential and other permanent plots will begin in spring 2001. Opportunities for integration of biogeochemical research with other areas will be exploited in integrative research such as the urban parks project, which will examine variation in human uses of parks along a socioeconomic gradient, and the ecosystem consequences of that variation (for example in trace gas fluxes).

Harlan, S.[1], A. Nelson[2], E. Hackett[1], A. Kirby[3], B. Bolin[1], D. Pijawka[4], T. Rex[5], and D. Hope[2]. ***Phoenix area social survey: Long-term monitoring of social interaction, and environmental change in urban neighborhoods.***
[1]Department of Sociology, Arizona State University, PO Box 872101, Tempe AZ 85287-2101; [2]Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85287-3211; [3]Department of Social and Behavioral Sciences, Arizona State University-West, 4701 W Thunderbird Rd, PO Box 37100, Phoenix AZ 85069-3051; [4]School of Planning and Landscape Architecture, Arizona State University, PO Box 872005, Tempe AZ 845287-2005; and [5]Center for Business Research, Arizona State University, PO Box 874011, Tempe AZ 8528-4011.

Our main objective in the Phoenix Area Social Survey (PASS) is to examine the reciprocal relationships, or the interplay, between the social and natural environments in an urban ecosystem. In order to understand this complex process, social scientists affiliated with the Long-Term Ecological Research (LTER) project propose to conduct a spatially-explicit, longitudinal social survey of residents in the Phoenix-Mesa MSA. The survey will measure the social ties of individuals to their communities, values and sentiments regarding communities, behaviors that affect the natural environment, and satisfaction with the quality of life in the area. The community that people experience most intimately is the neighborhood. Our central research questions ask how neighborhood social ties, values, and behaviors are connected with one another in ways that reflect willingness to act socially and politically with respect to the environment, and how changing environmental conditions, in turn, affect the quality of human life.

Hope, D.[1], C. Gries[1], W. Zhu[2], S. Carroll[3], A. Nelson[1], L. Stabler[4], C. L. Redman[1], N. B. Grimm[3], and A. Kinzig[3].***Application of integrated inventory to the study of urban ecosystem: an extensive 200-site field survey of the Central Arizona-Phoenix LTER.*** [1]Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85287-3211; [2]Department of Biological Sciences, Box 6000, Binghamton University – SUNY, Binghamton NY 13902-6000; [3]Department of Biology, Arizona State University, PO Box 871501, Tempe AZ 85287-1501; [4]Department of Plant Biology, Arizona State University, PO Box 871601, Tempe AZ 85287-1601.

A central question of the Central Arizona-Phoenix LTER project is "What are the ecological conditions associated with the range of current land uses across metropolitan Phoenix and how do these conditions vary in space and with time?" To answer this question we adopted a whole system approach, using a random sampling design to conduct an extensive field survey and integrated inventory of a number of key variables. A tessellation-stratified design was used, consisting of a 4 km x 4 km grid overlaid on the sample area (6387 $km^2$). Within the developed urban core one sample point was randomly located in each grid cell, outside this area every third grid cell was sampled (206 sites). Field plots were 30 m x 30 m square and were surveyed exactly where they fell - unless access was not possible (12 such cases) when they were moved to the nearest available point with same characteristics (possible at all but 2 sites), giving a total sample of 204 sites. A suite of physical, biological, chemical and human variables were inventoried and georeferenced (including: map of surface cover types; id plant genera of all trees, shrubs, cacti and succulents; vegetation biovolume and built structure dimensions; collected soil samples for analysis of soil texture, nutrient content, mycorrhizal activity and prokaryotic diversity; microclimate measurements; documentary photographs; bird survey). Examples of the types of data analysis taking place will be given in three areas. Firstly the land use coverage, vegetation diversity and soil N/organic matter content of the main land use types will be described. Secondly the approach to an interdisciplinary study of the relationship between plant diversity and socio-economic, ethnicity and household indices derived from census data obtained at the neighborhood scale will be presented. Thirdly we will outline a scheme for defining an indirect urban gradient or "index of urban-ness," along which patterns in key survey variables will be examined. We will also set out the additional applications of the survey design. For example it will provide a framework around which data collection for many other projects (historical land use change, bird and insect monitoring) will be based, aiding integration of different disciplinary studies. The survey will also be repeated every 5 years to form a core component of long-term monitoring at CAP LTER. In addition the data generated will provide ground truthing for remotely-sensed imagery and data for use in ecosystem modeling.

Hope, D.[1], N. B. Grimm[2], J. Anderson[3], and M. Clary[1]. ***Atmospheric deposition of major nutrients across an urban-desert gradient in Central Arizona.*** [1]Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85287-3211; [2]Department of Biology, Arizona State University, PO Box 871501, Tempe AZ 85287-1501; and [3]Department of Mechanical and Aerospace Engineering, Arizona State University, PO Box 876106, Tempe AZ 85287-6106.

Man is increasingly affecting biogeochemical cycling. This is particularly so in cities where nutrient and material fluxes may be significantly modified compared with less human-impacted ecosystems and in some cases may represents one of the larger inputs to the ecosystem nutrient budget. Atmospheric deposition is measured as part of several regional pollutant monitoring networks in the United States (e.g., the National Atmospheric Deposition Program and NOAA's AIRMON and CASTNET programs), but these networks sampling urban areas. Hence there is only a poor knowledge of atmospheric deposition rates in and near cities. The aims of the atmospheric deposition research at CAP LTER are to i) quantify the spatial variation in deposition of major nutrients and ions across the entire metropolitan Phoenix area, ii) estimate the annual input of major nutrients and ions to the CAP ecosystem in the form of both wet and dry fall, and iii) determine the importance of atmosphere-land nutrient transfer compared to other fluxes in the mass balance for the CAP ecosystem. As a first step towards this goal, wet-dry bucket collectors (Aerochem Metrics, Inc. Model 301) have been installed at 8 sites across the CAP study area, from the urban center to agricultural areas and undisturbed desert beyond the urban fringe. These "surrogate surface" collectors allow extended sampling times and are cheap and easy to operate. Data from the first 12 months of sampling showed that deposition rates of major nutrients varied along the urban-desert gradient, with highest rates near the city center. Average nitrate-N deposition was dominantly in the form of dry deposition and varied from 43 to 162 mg $m^{-2}$ $yr^{-1}$ i.e., an enhancement of around 2.5 times in urban versus desert sites. For ammonium-N a significant proportion of total deposition (10 to 300 mg $m^{-2}$ $yr^{-1}$) occurred in rain; there was an enhancement for both wet and dry ammonium-N deposition of between 25 and 35 times between city versus desert sites. Annual deposition of DOC (182 to 1116 mg $m^{-2}$ $yr^{-1}$) was predominantly in the form of dryfall and inputs at city sites exceeded those at outlying desert sites by 5-fold. While the use of bucket collectors is sufficient for sampling large particulate matter, such surrogate surfaces are inadequate for elements such as nitrogen for which significant dry deposition occurs via fine particulate and gaseous phases and total N deposition may be significantly higher than reported here. Therefore future research will be targeted at improving the measurement of fine particulate and gaseous deposition, via a combination of modeling and intensive field measurements (see Hope et al., this symposium).

Hope, D. [1], S. Grossman-Clarke[2], W. Stefanov[1,3] and P. Hyde[4]. ***Modeling nitrogen dry deposition inputs to the CAP LTER urban ecosystem***. [1]Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85287-321; [2]Department of Mechanical and Aerospace Engineering, Arizona State University, PO Box 876106, Tempe AZ 85287-6106; [3]Department of Geological Sciences, Arizona State University, PO Box 871404, Tempe AZ 85287-1404; and [4]Arizona Department of Environmental Quality, 3033 N. Central Ave, Phoenix AZ 85012.

In arid ecosystems dry deposition is typically a significant component of atmospheric nitrogen (N) inputs. This flux can be significantly enhanced within and downwind of urban areas, due to the production and subsequent deposition of particulate nitrate and gaseous nitric acid formed from the atmospheric conversion of nitric oxide emissions from fossil fuel combustion. While dry N deposition in heavily urbanized parts of the Los Angeles basin has been estimated at between 25 and 88 kg ha$^{-1}$ yr$^{-1}$, available data for CAP suggests that inputs are typically around 1.7 kg N ha$^{-1}$ yr$^{-1}$. However the only monitoring station where accurate determination of both nitrate and nitric acid deposition are made (an AIRMoN monitoring site operated by NOAA at Lost Dutchman State Park) is located in undeveloped desert 15 miles to the east of the urban area. The wet-dry bucket collectors currently used to determine patterns of deposition across the CAP study area (Hope et al, this symposium) are known to significantly underestimate fine particulate and gaseous N deposition, of which, according to the conventional understanding of the atmospheric nitrogen oxides cycle, nearly all is dry deposited within the ecosystem. Total $NO_x$ emissions for the Phoenix metro area were estimated to be 320 t d$^{-1}$ in 1996. The aim of our study is to accurately estimate how much of this N is dry deposited annually in the entire CAP ecosystem, by developing a diagnostic simulation model. Hourly dry deposition fluxes will be calculated for each cell within a 2 km x 2 km grid superimposed across the entire Phoenix metro area. Fluxes between the reference height and the surface will be obtained by means of flux-gradient relationships, in combination with logarithmic wind profiles. Input data for the model include meteorological data (wind speed, dry and wet bulb temperatures, solar radiation) and air pollutant concentrations obtained from ADEQ and Maricopa County monitoring stations. Aerodynamic characteristics and deposition velocities will be characterized for nine land cover/surface types, derived from the classified 1998 Landsat TM satellite image. Deposition fluxes for each land cover type will be weighted by the percent cover in each grid cell. Future work will include field testing modeled air pollutant concentrations. We would also like to apply an atmospheric dispersion model to better account for local inhomogeneities in meteorological conditions and account for variations in air pollutant concentrations by incorporating emission inventory data for the study area. Additional physical parameters derived from remotely sensed data (surface albedo and temperature) will be incorporated to further constrain the atmospheric model.

Jenerette, D.[1,2], K. Gade[1], N. Grimm[1], D. Hope[3], M. Luck[1,2], W. Marussich[1], and J. Roach[1]. ***The ecological footprint workshop: Creating an ecological and social sciences interface.*** [1]Department of Biology, Arizona State University, PO Box 871501, Tempe AZ 85287-1501 and [2]Department of Life Sciences, Arizona State University-West, 4701 W Thunderbird Rd, PO Box 37100, Phoenix AZ 85069-2352.

The dynamics of ecological and social systems are inter-dependent. Understanding the feedbacks between these systems is a current challenge spanning many disciplines, including ecology, economics, geography, geology, sociology, engineering, and others. We are developing a interdisciplinary workshop to investigate one mechanism by which ecological and social processes are coupled. In addition to conducting interdisciplinary research, an important goal of this workshop is to develop a methodology for identifying the most interesting questions existing beyond a single academic domain and approaches to answering them. We have begun by identifying a inclusive research topic, the ecological footprint, which serves as a common set of ideas that can bring together a team of people from various backgrounds. We will achieve a breadth of expertise through the committed involvement of team members with a differing knowledge base. The core group will be complemented with short-term invited guests having specific expertise beyond the collective team background. Initially, we are scheduling weekly meetings throughout the spring semester. During these meetings we will review work completed, identify problems, and assign tasks. However, the workshop will have an adaptive structure to take advantage of our changing needs and experience. The success of this workshop will be assessed in relation to meeting our stated goal; we expect to have a manuscript submitted to an appropriate scientific journal by June 2001.

Jenerette, G. D.[1,2,] M. A. Luck[1,2], J. Wu[1], N. B. Grimm[2], D. Hope[3], and W. Zhu[4]. ***Spatial patterns of soil organic matter in central Arizona.*** [1]Department of Life Sciences, Arizona State University-West, 4701 W Thunderbird Rd, PO Box 37100, Phoenix AZ 85069-2352. [2]Department of Biology, Arizona State University, PO Box 871501, Tempe AZ 85287-1501, [3]Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85287-3211, and [4]Department of Biological Sciences, Box 6000, Binghamton University – SUNY, Binghamton NY 13902-6000.

Soil organic matter (SOM) measurements were obtained from 200 sampling sites in central Arizona. The samples were distributed in a spatially stratified random design that encompassed an area of 6387 km$^2$. The study area includes the urbanized, suburbanized, and agricultural areas of metropolitan Phoenix and the surrounding native desert ecosystem. The objective of this study was to determine the spatial pattern of SOM content and then to scale-up the point measurements to generate a regional SOM estimate. We hypothesized that land cover would be an important factor explaining the variability of SOM content. In addition, we also hypothesized that the multiple stressors associated with urbanization would be

manifested as an urban to wildland gradient in SOM content. Three alternative methods will be used to estimate regional SOM content. 1) We will use regression analysis to predict SOM content as a function of other spatially distributed variables. 2) We will estimate a patch specific SOM content by overlaying a classified TM satellite image with the sample locations, and generated a regional estimate by integrating field measures with remotely sensed data. 3) We will identified spatial correlations in the data and then interpolated with a Kriging algorithm. Preliminary results showed that patch type alone was not an adequate predictor of SOM content. A significant ($p<.05$) second-order spatial trend in SOM content was observed centered on the urbanized region. Understanding SOM patterns is a necessary first step in understanding the biogeochemical controls in this region.

Katti, M. and E. Shochat. ***Phoenix Or Tucson - does landscape determine where Abert's Towhees choose to live?*** Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85287-3211.

Local species diversity in urban environments is influenced by the regional species pool, habitat diversity and productivity within the city, and landscape configuration. Studies on urban bird communities have focused more on habitat factors, but less on landscape structures, such as corridors, that influence species distribution. We studied the influence of riparian corridors on the distribution of Abert's Towhee (*Pipilo aberti*), a common resident of Arizona, in urban areas. Previous studies describe this species as common in residential habitats in Phoenix, but scarce in Tucson, though it is common in natural habitats surrounding both cities. An important difference between these cities is that several major riparian corridors cross residential habitats in Phoenix, but not in Tucson. We tested the hypothesis that these riparian corridors influence the distribution and abundance of Abert's Towhee in Phoenix. We estimated Towhee abundance from point counts at 51 locations throughout the Phoenix area. We found that Towhees did not occupy all neighborhoods, and that their abundance decreased with distance from riparian corridor. This suggests that riparian corridors may facilitate towhee dispersal into residential habitats, and that the lack of such corridors in Tucson may explain their absence. The lack of towhees from neighborhoods far from riparian corridors may suggest landscape mediated source-sink population dynamics along a riparian-residential habitat gradient. We suggest that studies on residential habitat used by bird species need to incorporate appropriately large spatial scales and landscape elements, since data from only one city, regardless of size, may represent pseudoreplication.

Krutz, G., and G. Woodall. ***Dynamic political institutions and water policy in central Arizona-Phoenix.*** Department of Political Science, Arizona State University, PO Box 872001, Tempe AZ 85287-2001.

This poster gives preliminary results from a study of the impact of dynamic political institutions on central Arizona-Phoenix's water policy. Our overarching goal is to relate change in water decision-making institutions to outputs (defined as what water goes where for what purpose). The study includes a qualitative component (in-depth interviews with prominent 'water experts' throughout the Valley) and a quantitative component (a compilation of data on water usage rates and trends from various agencies and cities). Here, we focus on one important water decision-making entity with a particularly rich history, the Salt River Project. We analyze qualitative and quantitative data gathered to date. The preliminary findings suggest a recursive relationship between institutional change and policy outputs. That is, the relationship between institutions and policy may not be a one-way street as many assume. It may be better described as a dance between the two.

Martin, C., T. Day, J. Briggs, J. Stutz, and M. Sommerfeld. ***Primary productivity at the CAP LTER***. Department of Plant Biology, Arizona State University, PO Box 871601, Tempe AZ 85287-1601.

NO ABSTRACT

Marussich, W. A., J. MacHeffner, W. F. Fagan, and S. H. Faeth. **Urban ecology: Population and community patterns.** Department of Biology, Arizona State University, PO Box 871501, Tempe AZ 85287-1501.

Organisms, populations, and communities are typically distributed differently in patches of varying size and quality. Human activities in urban settings have altered the frequency, quality, distribution, and life span of these patches. We aim to identify the spatiotemporal patterns of population regulation and community change and structure as a function of urbanization. Research at the population and community level is focused on 5 groups: vascular plants, mycorrhizal fungi, arthropods, insect pollinators, and birds. In 1998 we initiated pilot studies using existing datasets and data-gathering by K-12 classes and volunteers from the community. Information generated from these pilot studies has fed into the core-monitoring program, and some studies have been re-designed to complement the core monitoring. The *vascular plant project* has 3 main goals: 1) to create a preliminary classification of desert plant communities; 2) to relate this classification to remotely sensed information; and 3) to coordinate with the education project to enlist schools in extending sampling efforts. The *mycorrhizal fungi project* is examining components of arbuscular mycorrhizal diversity including species richness, composition and abundance. The primary goals of the *arthropod project* are: 1) establish long-term monitoring of populations and communities of arthropods, 2) characterize arthropod assemblages as functions of land use and land cover, and 3) predict patterns of arthropod diversity with future urban development. To understand the effects of urbanization on insect/plant interactions, we investigated causes of variation in population density between urban and

natural desert sites in 3 species of seed-eating beetles. The primary goal of the *insect pollinator project* is to assess the effects of urban horticulture on insect pollinator community structure by examining richness and abundance among urban land-use types. The goals of the *bird project* are to study changes in species and population diversity, abundance, and distribution over time and space as a result of urbanization. A project focusing on physiological responses of birds to urbanization was initiated in July 2000 with the goal of understanding the mechanisms underlying the distribution and abundance of native and non-native bird species in different habitats. Ultimately, we will synthesize our experimental results with a patch dynamic model to better understand how inter-patch differences impact regional fluctuations in plants, herbivores, and predators, and the interactions between human populations and natural populations.

McCartney, P. ***Ecological Informatics at CAP LTER***. Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85287-3211.

If we envision environmental information from a network perspective, we see LTER sites as nodes interacting within a cross-cut fabric of networks including other departments and projects within the institution, regional partners, other LTER sites, and so on. A variety of tools and solutions have been used at CAP to create a system through which information are generated, managed and disseminated within the CAP LTER research cycle. More advanced methods are now being applied to better integrate the products of CAP research with those of other collaborators within and beyond ASU. These efforts and the collaborative projects through which they are being carried out illustrate some of the network connections that integrate only data, but also new partnerships for research.

Nelson, A.[1], B. Bolin[2], E. Hackett[2], D. Pijawka[3], E. Sadalla[4], D. Sicotte[2], D. Brewer[5], E. Matranga[6]. ***The ecology of risk in a Sunbelt city: A multi-hazard analysis.*** [1]Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85287-3211; [2]Department of Sociology, Arizona State University, PO Box 872101, Tempe AZ 85287-2101; [3]School of Planning and Landscape Architecture, Arizona State University, PO Box 872005, Tempe AZ 85287-2005; [4]Department of Psychology, Arizona State University, PO Box 871104; [5]Morrison School of Agribusiness and Environmental Management, Arizona State University-East, 7001 E Williams Field Rd, Mesa AZ 85212; and [6]Department of Geography, Arizona State University, PO Box 870104, Tempe AZ 85287-0104.

This project examines the spatial distributions of four point-source hazard sources in the Phoenix, Arizona, metropolitan area. The key focus is on the locations of hazardous industrial and toxic waste sites in relation to the demographic composition of proximal neighborhoods. Our interest is to determine whether hazardous sites, including industrial facilities in the Environmental Protection Agency's Toxic Release Inventory, other Large Quantity Generators of hazardous wastes, Treatment, Storage, and Disposal Facilities for hazardous substances, and Superfund sites are inequitably located in areas with lower income and minority residents. We examine patterns of environmental injustice in the context Phoenix, Arizona, a sprawling southwestern Sunbelt city with a substantial postfordist industrial sector. Using 1996 EPA data for four types of technological hazards and 1995 Special Census data for Maricopa County (Phoenix), Arizona, we utilize GIS mapping to plot the spatial distributions of hazardous sites and analyze the demographic characteristics of census tracts with and without hazard points. A second methodology is used to produce a relative risk index for census tracts based on the number hazard zones – one-mile radii circles around each facility – that overlay each tract. Both methodologies disclose clear patterns of social inequities in the distribution of technological hazards analyzed by the demographic composition of at-risk census tracts. The findings point to a consistent pattern of environmental injustice across a range of technological hazards in the Phoenix metropolitan region.

Nelson, A.[1], and S. Harlan[2]. ***Labor market dynamics in a postindustrial city: A spatial and sectoral analysis of employment changes in the Phoenix MSA.*** [1]Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 87287-3211 and [2]Department of Sociology, Arizona State University, PO Box 872101, Tempe AZ 85287-2101.

This study investigates the effects of long-term labor market changes in the United States on gender, social class, and racial/ethnic inequalities in urban areas. The economic changes under study are: 1) economic restructuring, which social scientists define as the loss of manufacturing jobs and an increase in service jobs; and 2) spatial relocation of jobs within a metropolitan area. Outcome variables are employment indicators for different social groups and social and economic conditions in urban neighborhoods. The study focuses on the Phoenix Metropolitan Statistical Area (MSA) to represent the economic expansion in Sunbelt cities. In the future, we will apply the results to a comparative project using the Baltimore MSA to represent the economic decline of manufacturing typical of Eastern cities. Data sets from three federal agencies for a 15-year period will be linked to develop area economic profiles, including the location and gender/racial composition of occupations in individual firms, wages for occupations in each area, and social indicators on urban neighborhoods where employers are located. Statistical techniques used to analyze the data will be based on multiple regression and logistic regression estimation procedures. The study will address the concerns of many social scientists that the current economic prosperity enjoyed in America is not being shared equally by all segments of society. It will also enhance understanding of human impacts on the ecosystem by examining employment distribution as an economic driver that influences migration and settlement patterns and, in turn, ecosystem disturbance.

Putnam, C. ***Cactus Wren condos: Does urbanization affect the characteristics of Cactus Wren roost nests?*** Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85287-3211.

Cactus Wrens (*Campylorhynchus brunneicapillus*) are a common bird native to the Sonoran Desert, and are also quite successful in the urban environment. A characteristic feature of Cactus Wrens is they build and maintain roost nests in the winter (in addition to summer breeding nests), presumably to help with nocturnal thermoregulation. If roost nests serve to maintain a certain internal microclimate for presumed thermoregulatory benefits, then roost nests in urban habitat are expected to be similar to those in natural habitat in terms of internal microclimate. On the other hand, nest site habitat characteristics in urban areas will be significantly different from those in undisturbed desert habitat. For instance, the preferred nest substrate in the desert are cholla cacti (*Opuntia* spp.), which are scarce in urban areas. I am studying the effects of urbanization on winter roost nests using two groups of active nests: one located in undisturbed desert habitat and the other in urbanized habitat. I measure the roost nest internal temperature, entrance orientation, prevailing wind direction at the nest as well as nest site habitat characteristics. I will test the hypothesis that, (a) Cactus Wren roost nests differ between urban and desert habitats in terms of characteristics such as nest substrate, location and orientation, but (b) these differences will have little or no effect upon their internal microclimate temperature.

Rango, J.[1], E. Shochat[2], M. Tseng[1], W. Fagan[1], and S. Faeth[1]. ***Ground arthropod community composition in a heterogeneous urban environment.***
[1]Department of Biology, Arizona State University, PO Box 871601, Tempe AZ 85287-1601 and [2]Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85287-3211.

The richness and abundance of ground arthropods were systematically monitored for two years (June 1998 to May 2000) at 16-24 sites in the Phoenix, Arizona, metropolitan area. These sites represented six types of urban land use, including xeric residential, mesic residential, industrial, agricultural, urban desert remnants and desert fringe. Species richness and total arthropod abundance were different between landuse types with the most rich and abundant communities found in agricultural fields and mesic residential yards and the least rich and abundant communities found in desert, industrial and xeric residential yards. This suggests that the six landuse types can be classified into two major groups based on water availability. In both years the most commonly collected arthropod taxa were mites (ACARI), ants (HYMENOPTERA: FORMICIDAE), and springtails (COLLEMBOLA). Rarefaction curves revealed that while in xeric residential yards, desert fringe and urban desert remnants the number of individuals was comparatively low, their species diversities were significantly higher than in industrial, mesic residential yards and agricultural lots - that supported a much higher total arthropod density. These results will be useful in predicting effects on biodiversity from future urban development. In particular, our results indicate that the spatial heterogeneity of land use in the Phoenix area promotes biotic diversity.

Rango, J.[1], M. Tseng[1], and E. Shochat[2]. ***200-point survey: Vegetative arthropod community structure.*** [1]Department of Biology, Arizona State University, PO Box 871601, Tempe AZ 85287-1601 and [2]Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85287-3211.

Arthropod communities were systematically collected off of plants as part of the 200-point monitoring effort. The 200-point survey sites could be grouped into five major landuse types including desert (n=66), urban (n=57), mixed (defined as sites including more than one landuse type, n=39), agriculture (n=23), and other (transportation, riparian, water, and vacant sites grouped together, n=18). Across all landuse types, the most commonly collected arthropod taxa included aphids (Homoptera: Aphididae), thrips (Thysanoptera), and mites (Acari). Arthropod communities were the most rich at desert sites and the least rich at urban sites. There were no significant differences in the total number of arthropods collected across the different landuse types. The top five plants most commonly sampled for arthropods at the 200 point survey sites were *Larrea*, *Ambrosia*, *Citrus*, *Nerium*, and *Prosopis*. The most abundant arthropod communities were collected off of two plants native to the Sonoran Desert, including *Larrea* and *Prosopis*. The least abundant arthropod communities were collected off of *Nerium*, a poisonous species exotic to the Sonoran Desert. *Larrea* was sampled across several landuse types (desert, mixed and urban) allowing for a comparison of the arthropod communities. We found differences in the arthropod communities depending on where *Larrea*

plants were located. Specifically, arthropod communities were the least rich when *Larrea* were sampled in urban sites. Results from the 200-point survey suggest that urban development leads to depauperate arthropod communities.

Redman, C. L.[1] and P. Gober[2]. ***Human dimension of CAP LTER research.*** [1]Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85278-3211 and [2]Department of Geography, Arizona State University, PO Box 870104, Tempe AZ 85287-0104.

From its very establishment the CAPLTER has accepted as a working principle that human activities, perception, and valuation are dominant influences in the operation of the Central Arizona-Phoenix ecosystem. This has led us to pay special attention to the historical development of localities and the city as well as the changing spatial layout and juxtaposition of phenomena in this region. In order to elucidate these influences and the central role humans and their institutions play in ecosystem function numerous projects have been undertaken. The urban fringe has been one locus of studies on the interaction of human and natural systems. Urban growth at the fringe occurs in waves of new housing development that influence microclimatology, runoff patterns, and ecological processes. Other projects have involved collecting information on human decisions that directly affect landscape variables, such as land use change, residential landscaping choice, irrigation regimes. Another promising line of inquiry has involved the co-association of social patterns such as wealth or ethnic aggregations with perceived and real environmental risks such as air pollution or toxic releases. A fourth set of projects focus on the development and impact of institutions that link individuals with environmental processes of special importance such as water policy or fire suppression.

Roach, W. J., A. Coppola, and N. B. Grimm. ***Nutrient dynamics in arid urban fluvial systems: Canals and streams.*** Department of Biology, Arizona State University, PO Box 871501, Tempe AZ 85287-1501.

Urbanization results in fluvial systems that contrast sharply with more pristine streams. The cycling and retention of important nutrients like nitrogen and phosphorus as well as biotic variables are expected to be markedly different in urban watercourses. We are investigating how changes due to urbanization in nutrient inputs, hydrology, and geomorphology affect nutrient dynamics in the fluvial systems of the Central Arizona-Phoenix ecosystem. Our work has focused on two contrasting systems: the Tempe-Southern Canal and Indian Bend Wash.

Shochat, E. and M. Katti. ***Bird species diversity in the greater Phoenix area.*** Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85287-3211.

Previous studies on breeding bird communities in urban environments showed that though urban habitats support higher bird densities than surrounding natural habitats, they reduce species diversity, and are occupied by mostly abundant commensal species. We tested whether the same patterns exist during the nonbreeding season, in the greater Phoenix area. During October-November 2000 we counted nonbreeding birds in 51 sites covering four habitats: desert (15 sites), agricultural (7), riparian (11), and residential (18). We found a significant difference in total bird abundance, but not in average species richness between habitats. The total species richness was highest in riparian habitat and lowest in desert. We used rarefaction to control for differences in sample size between habitats. We found that species diversity was highest in riparian and lowest in residential habitat. Desert and agricultural habitats showed very similar rarefaction curves, that fell between the riparian and residential curves.

Sicotte, D. ***Political and legal controversies over hazardous industrial waste in three central Arizona communities.*** Department of Sociology, Arizona State University, PO Box 872101, Tempe AZ 85287-2101.

This study is a work in progress which uses a multiple case-study research design to focus on three communities of different types in central Arizona. In each of these communities, hazardous facilities have been sited, and in each there have been political and legal controversies over possible contamination by hazardous industrial waste. The three cases are: south-central Phoenix (the urban site of a geographic cluster of hazardous waste treatment, storage and disposal facilities); Queen Creek (the suburban site of a factory using hazardous materials); and Hayden (the rural site of copper mining, smelting and production). I am investigating the racial, ethnic and income demographics; historical settlement patterns; history of planning and siting; scientific research done on health problems; and political response for each of the three communities. The major research questions I seek to answer in this study are as follows: What is the history of the racial composition of the population in the area? What is the history of zoning, planning and the siting of hazardous industry in the area? Does a rural, suburban or urban location make a difference in siting patterns? Which factors determine whether a controversy will become politicized, or remain a personal/ social problem? How do scientific research and scientific experts influence the legal and political outcomes of these struggles? And finally, what are the determinants of the community's response to the controversy?

Stabler, L. B., C. A. Martin, and J. C. Stutz. ***Potential effects of mycorrhizal associations on urban tree carbon storage potential.*** Department of Plant Biology, Arizona State University, PO Box 871601, Tempe AZ 85287-1601.

Field and greenhouse studies were conducted to test how arbuscular mycorrhizal fungi (AMF) associations might affect urban tree carbon sink potential in the Phoenix, Arizona, metropolitan area. Soil samples and roots were collected from the rhizosphere of trees at three remnant Sonoran desert sites and at three drip irrigated, residential sites to evaluate degree of root colonization and to produce inocula for greenhouse studies. AMF inocula prepared from successive trap cultures from each site type compared how the two populations affected growth, $CO_2$ assimilation (A), root respiration, and potential carbon storage in three urban tree species relative to uninoculated controls. Trees were more highly colonized by AMF at desert sites and fungal species composition differed in inocula from the two site types. AMF increased growth of *Acacia* and *Fraxinus* and A in *Acacia*. Root respiration was highest in uninoculated controls for *Acacia* and *Fraxinus.* Estimated increase of carbon storage due to colonization by the desert AMF population was 95 and 51 per cent for *Acacia* and *Fraxinus*, respectively. No AMF treatment effects were seen in *Cercidium*. Based on these data, we conclude that AMF might significantly increase urban tree carbon storage, depending on tree species and edaphic conditions.

Stiles, A.[1] and S. M. Scheiner[2]. ***Analysis of desert vegetation data from the 200 sites survey.*** [1]Department of Plant Biology Department, Arizona State University, PO Box 871601, Tempe AZ 85287-1601 and [2]Division of Environmental Biology, National Science Foundation, Washington, D.C.

In accordance with its mission to study the ecological characteristics of a large urban center, the CAP LTER has recently undertaken a large scale sampling of the Phoenix metropolitan area and the surrounding landscape. A sample point was randomly assigned from each of two hundred grid cells established over the study area. Data collected at each point includes information describing the plants, arthropods, birds, soils, and human influences within a 900 m2 quadrat. This poster presents the results of initial analyses conducted on the plant data collected in undeveloped desert locales. Multivariate methods, including ordination and classification, are used in order to identify major community types occurring throughout the study area. From this information, abundances of each community type are calculated. Additionally, comparisons regarding species richness and composition are made between: outlying areas beyond the urban fringe versus remnant patches within the urban matrix, disturbed versus nondisturbed areas, habitat types (e.g. flats, washes, slopes), and Arizona Uplands versus Lower Colorado River provinces of the Sonoran Desert.

Warren, P. and A. Kinzig. ***Ecological and social factors predicting avian diversity in urban parks.*** Department of Biology, Arizona State University, PO Box 871501, Tempe AZ 85287-1501.

Biodiversity in urban landscapes is both a central question of urban ecology and a central concern for residents of urban areas, making the study of biodiversity a natural avenue for integrative, cross-disciplinary research. This is especially true of avian diversity since many people enjoy bird watching. Neighborhood parks are often the primary open space in residential areas. As such, they may be reservoirs of species diversity or refugia for sensitive species. In a desert landscape, the shade and water provided in parks act as artificial oases. In addition, the value of parks to humans is likely to vary culturally and therefore the design and use of parks will vary culturally. We hypothesize that in urban parks, it is the interaction of ecological factors with social factors that determines the number of species and their abundances. To address this question, we have begun a study of avian diversity in neighborhood parks in Phoenix. Both ecological and social factors will be measured and a model fitted to determine what factors best predict avian diversity. We are conducting a census of birds in the parks and in their surrounding neighborhoods using a the standard 15 minute point count protocol used in other studies at CAP LTER, with three observers sampling each point four times per year. Eighteen neighborhood parks will be censused. These eighteen are classified as falling in high, middle or low socioeconomic neighborhoods using market cluster data. Additional measures of landscape and habitat characteristics will be used to determine whether park design features or other landscape features are correlated with socioeconomic status. This study is part of a larger project (see other posters) examining the ecological and social role of parks in an urban landscape. Both on its own and in combination with the larger study of park ecology, this study will help elucidate the complex array of forces generating patterns of biodiversity in urban landscapes.

Whitcomb, S. A., J. C. Stutz, and C. A. Martin. ***Spatial patterns of belowground respiration and related soil parameters in a simulated xeric urban landscape.*** Department of Plant Biology, Arizona State University, PO Box 871601, Tempe AZ 85287-1601.

Soil respiration accounts for about 25% of global CO2 evolution, but it is one of the most variable soil parameters and is therefore difficult to quantify. Because soil respiration samples are likely to be autocorrelated, it is essential to understand their spatial and temporal patterns so that sampling designs capture the variability present. Little research has focused on spatial heterogeneity of soil respiration, and none has been performed in an arid urban environment. This research project will quantify the spatial heterogeneity of soil respiration and other soil parameters present in a simulated urban landscape at the Desert Botanical Garden in Phoenix, Arizona. A 9.2 × 9.2 m plot planted with six species of woody landscape plants was overlaid with a grid of one hundred 92 × 92 cm quadrats. Forty-four 46 × 46 cm quadrats are nested within the grid in areas surrounding plants. CO2 evolution will be measured at the center of each quadrat with an infrared gas analyzer once each season. Soil cores will be sampled from each quadrat once per season to quantify root biomass, arbuscular mycorrhizal colonization, and gravimetric moisture. Soil pH, total N, total C, and available P will also be measured for each quadrat. Multivariate statistics will be used to determine the correlation matrix for all of the soil parameters. Geostatistical methods will be used to quantify the scale and degree of soil heterogeneity in the plot. Preliminary data indicate a great deal of heterogeneity in soil respiration at the plot scale.

Wu, J.[1], J. L. David[1,2], G. D. Jenerette[1,2], M. Luck[3], and S. Berling-Wolff[2]. ***Modeling land use change and ecosystem processes of the Phoenix metropolitan landscape.*** [1]Department of Life Sciences, Arizona State University-West, 4701 W Thunderbird Rd, PO Box 37100, Phoenix AZ 85069-2352; [2]Department of Biology, Arizona State University, PO Box 871501, Tempe AZ 85287-1501; and [3]Center for Environmental Studies, Arizona State University, PO Box 873211, Tempe AZ 85287-3211.

How has the landscape pattern of the Phoenix metropolitan area changed as a result of urbanization? What are the major factors controlling this landscape transformation? How does land use change affect ecological conditions and processes (e.g., biodiversity measures, net primary productivity, biogeochemical cycles)? Are there alternative land-use patterns that are more likely to lead to ecological sustainability given the rapidly increasing human population in this region? These are some of the major research questions for the CAPLTER project in general and the modeling team in particular. To address these questions, we have been conducting a series of multiple-scale landscape analyses and developing simulation models to quantify the landscape heterogeneity and its changes in time and space, simulate the pattern and process of urbanization, and link landscape pattern with ecosystem processes. The research activities of the modeling team include: (1) Landscape Pattern Analysis (urbanization gradient analysis, quantitative analysis of historical land use change, multiple-scale analysis of the current urban landscape, spatial ecological footprint), (2) Land Use and Land Cover Change Modeling (a CA-Markov-GA model, a rule-based urban growth model, a hierarchical land use and land cover change model), (3) Ecosystem Modeling (development of PALS-PHX and CAECO), and (4) Development of the Hierarchical Modeling Platform that facilitates the development of and interface between land use change and ecosystem process models.

Major research findings so far include: (1) With exponential urban expansion into the desert in the past several decades, the structural complexity and fragmentation of the Phoenix regional landscape have dramatically increased. The extent of urban area is linearly correlated with the population size, suggesting that human population may be, at least at the regional scale, used as a surrogate variable representing a suite of factors that have driven land use changes in the Phoenix metropolitan region in the past several decades. (2) Areas of higher human impact are usually characterized by a higher degree of fragmentation (smaller patches and greater in number) and more regular patch shape (square or rectangular). (3) Topography does not seem to have limited the urban expansion in the Phoenix region, meaning that while the city grows out, it also climbs up. (4) Urbanization gradients in this region can be quantitatively defined using landscape metrics, and extensive spatial analyses suggest the existence of multiple-scale structure of the urban landscape. In addition, our research on pattern and scale analysis has generated insight into the following questions regarding the issue of pattern and scale: (i) How does changing extent affect the results of different landscape metrics? (ii) How does changing grain size affect the results of different landscape metrics? (iii) How does changing the direction (or orientation) of analysis affect the results of different landscape metrics? (iv) How do the responses of landscape metrics to scale changes resemble or differ from each other across scales and across landscapes, and are these changes predictable? In addition, we have developed and adapted three land use change models, which together provide numerous insights into the pattern and process of urbanization in the Phoenix metropolitan region.

Zschau, T.[1], S. Getty[2], C. Gries[1] and T. H. Nash III[1]. ***Spatial and temporal variation of elemental deposition in Maricopa County, Arizona.*** [1]Department of Plant Biology, Arizona State University, PO Box 871601, Tempe AZ 85287-1601 and [2]Department of Geosciences, University of New Mexico, Albuquerque NM 87106.

Trace elemental deposition patterns in Maricopa County were assessed using lichens as deposition receptors for a spatial grid of 28 field sites collected in 1998. In addition, historical trends were assessed for six sites, from which lichen collections from the mid-1970's were available. After cleaning and wet digesting, samples were analyzed for Sr, Cr, Ni, Co, Cu, Zn, Ag, Cd, Sn, Sb, Ce, Pr, Nd, Eu, Gd, Tb, Sc, Dy, Ho, Er, Tm, Yb, Lu, Au and Pb via inductively coupled plasma mass spectrometry (ICP-MS). Patterns were elucidated in part by cluster and principal component analysis, as well as spatial maps based on ArcView. With the exception of the Phoenix metropolitan area, mining regions near Wickenburg and smelting operations near Ajo, elemental concentrations were generally comparable to unpolluted regions. Copper deposition patterns were indicative of both mining and smelting activities. Secondarily Pb, Sb and Zn were associated with mining. Lead was, of course, associated with high vehicular traffic densities in urban areas, where elevated levels of Cd, Sb and Zn were also found. The occurrence of the rare earth elements reflected the influence of blowing dust and in the NE part of the county a special geological deposit resulted in high levels of Co, Cr, Ni and Sc. Over the 30+ year period, Pb decreased by 71%, a pattern that reflects the switch to unleaded gasolines. Similarly the closure of the Ajo smelter has resulted in a substantial reduction of Cu, particularly in southern Maricopa County. In contrast, Zn has increased as much as 246% over the same period in metropolitan areas.

**NOTES**