13th Annual CAP LTER Poster Symposium

Wednesday-Thursday
January 12-13, 2011

LTER

ASU Global Institute of Sustainability
Arizona State University

NSF

CAP LTER Thirteenth Annual Poster Symposium and All Scientists Meeting January 12-13, 2010 Arizona Ballroom, Memorial Union

January 12, 2011
Urban Sustainability: Phoenix and Beyond

2:00 pm **Welcome**
Rick Shangraw
Director, Global Institute of Sustainability, and Senior Vice President for Knowledge Enterprise Development

2:15 pm **CAP3 Overview and Introduction to the Urban Sustainability Intercity Initiative (USII)**
Dan Childers
Lead PI and Director of CAP LTER; Professor, School of Sustainability

3:00 pm **BES3 Overview and Ideas for the USII**
Steward Pickett
Lead PI, Baltimore Ecosystem Study LTER, Cary Institute of Ecosystem Studies, Milbrook, NY

3:30 pm **Urban Ecology in Miami and Ideas for the USII**
Laura Ogden
Lead PI, Florida Coastal Everglades LTER; Assistant Professor, Florida International University, Miami

4:00 pm **Discussion**

4:30 pm **Celebration and Awards: 13 Years of CAP LTER**

5:00 pm **Adjournment for CAPpy Hour**

January 13, 2011
Poster Symposium

8:45 am **Opening Remarks**
Dan Childers
Lead PI and Director, CAP LTER; Professor, School of Sustainability

9:00 am **1st Interactive Poster Session – Urban Spatial Dynamics**

10:15 am ***Break***

10:45 am **2nd Interactive Poster Session – Urban and Non-urban Habitats**

12:00 pm ***Lunch on your own***

1:30 pm **3rd Interactive Poster Session – Urban Energetics and Cycles**

2:45 pm ***Break***

3:15 pm **4th Interactive Poster Session – Urban Heat Island and Water**

4:30 pm **Closing Remarks**

5:00 pm **Adjournment to CAPpy Hour**

2011 CAP LTER Symposium

Posters are listed alphabetically by first author with poster location number in parentheses.

Poster Session #1 – 9:00-10:15 am **Urban Spatial Dynamics**	**Poster Session #2 – 10:45 am-Noon** **Urban and Non-urban Habitats**
Bleasdale et al. (1)	Banville and Bateman (10)
Crouch et al. (2)	Davies and Deviche (11)
Frisk and Larson (3)	Gade (12)
Hale, A., and Talen (4)	Johnson et al. (13)
Kim and Wentz (5)	Johnson et al. (14)
Sayles et al. (6)	Lerman et al. (15)
Sovick (7)	Lettsome and Bateman (16)
Taylor (8)	Ripplinger and Franklin (17)
Zhang, C., et al. (9)	Shoumaker et al. (18)
	Trubl et al. (19)
	Zhang, S. (20)
Poster Session #3 – 1:30-2:45 pm **Urban Energetics and Cycles**	**Poster Session #4 – 3:15-4:30 pm** **Urban Heat Island and Water**
Chapman and Warner (21)	Ackley (29)
Frijia et al. (22)	Elser et al. (30)
Gifford and Westerhoff (23)	Middell et al. (31)
Hale, R., et al. (24)	Ruddell et al. (32)
Hamilton and Hartnett (25)	Sampson and Sailor (33)
Metson et al. (26)	Tuccillo (34)
Turnbull et al. (27)	Wutich et al. (35)
Warner et al. (28)	

Speaker Bios

Steward Pickett is a Distinguished Senior Scientist and plant ecologist at the Institute of Ecosystem Studies, in Millbrook, New York. He was awarded the PhD by the University of Illinois in 1977. He directs the Baltimore Ecosystem Study Long-Term Ecological Research program. His research focuses on the ecological structure of urban areas and the temporal dynamics of vegetation. He has written books on ecological heterogeneity, humans as components of ecosystems, conservation, and the philosophy of ecology.

Laura Ogden is an Associate Professor of Anthropology in the Department of Global & Sociocultural Studies at Florida International University. Her research focuses on the political ecology of environmental change and restoration in the Florida Everglades. She is serving as Interim PI for the Florida Coastal Everglades Long-Term Ecological Research program. Her book, *Swamplife: People, Gators and Mangroves Entangled in the Everglades*, is forthcoming (Spring 2011, University of Minnesota Press).

List of Posters

URBAN SPATIAL DYNAMICS

Bleasdale Thomas, Carolyn Crouch, and Sharon Harlan. ***Community gardening in disadvantaged neighborhoods in Phoenix, Arizona: Aligning programs with perceptions.***

Crouch, Carolyn, Phoenix Revitalization Corporation, and Sharon Harlan. ***Community food resource mapping in central city south, Phoenix: An exploratory study of community capacity building.***

Frisk, Erin, and Kelli Larson. ***Developing and implementing sustainability education through the integration of behavioral science.***

Hale, Anne, and Emily Talen. ***Analysis of zoning changes–Phoenix AZ.***

Kim, Won Kyung, and Elizabeth A. Wentz. ***Re-examining the definition of urban open space using fuzzy set theory.***

Sayles, Jessie S., Elizabeth M. Cook, Kelli L. Larson, and Sharon J. Hall. ***The influence of environmental values, urban structure, and neighborhood context on household-level biodiversity and plant composition.***

Sovik, Brian R. ***A spatial-temporal representation of land subsidence in the northwest Phoenix valley, Arizona.***

Taylor, Carissa. ***Participation in and accessibility of Arizona's urban farmers' markets: An institutional analysis of farmers' market sustainability.***

Zhang, Chi, Nancy Grimm, J. Wu, Melissa McHale, Xiaoli Dong, and Yun Ouyang. ***Modeling the structure and functions of human-dominated terrestrial ecosystems with a hierarchical patch dynamics approach.***

URBAN AND NONURBAN HABITATS

Banville, Melanie, and Heather Bateman. ***Herpetofauna and microhabitat characteristics of urban and wildland reaches along the Salt River, Arizona.***

Davies, Scott, and Pierre Deviche. ***Does urbanization influence the timing of seasonal breeding and the effect of stress on the reproductive physiology of a Sonoran Desert songbird?***

Gade, Kris. ***Roadside maintenance practices influence plant migration along freeways.***

Johnson, J. Chadwick, Gina M. Hupton, Dianna Bonney, and Monica Elser. ***The web of inquiry: Urban black widow behavior as a tool to teach the scientific process.***

Johnson, J. Chadwick, Meghan Still, and Theresa Gburek. ***Conspecific silk cues shape the habitat preferences of black widows.***

Lerman, Susanne B., V. Kelly Turner, and Christofer Bang. ***Linking homeowners associations with biodiversity: A case study in Phoenix, AZ.***

Lettsome, Olivia, and Heather Bateman. ***Avian communities from urban and non-urban riparian habitats.***

Ripplinger, Julie, and Janet Franklin. ***Spatiotemporal patterns of dominant plant species in CAP LTER.***

Shoumaker, Tracy C., Jianguo Wu, Carol Chambers, and Andrew Smith. ***Effects of urbanization on bat community structure in the Phoenix metropolitan region: A multi-scale perspective.***

Trubl, Patricia, Theresa Gburek, Lindsay Miles, and J. Chadwick Johnson. ***Black widows in an urban desert: Population variation in an urban pest across metropolitan Phoenix.***

Zhang, Sainan, Christopher G. Boone, and Abigail M. York. ***Impacts of land fragmentation on biodiversity in the Phoenix metropolitan region.***

URBAN ENERGETICS AND CYCLES

Chapman, Eric, and Benjamin Warner. ***Foreseeing critical phosphorus cycle transitions in constructed wetlands: Applied to the new Tres Rios arid-land constructed wetlands with the City of Phoenix.***

Frijia, Stephanie, Eric Williams, Subhrajit Guhathakurta, and Ariane Middel. ***Scaling behavior of the life cycle energy of residential building and impacts on greenhouse gas emissions.***

Gifford, J. Mac, and P. K. Westerhoff. ***Making biofuel renewable: Recovering phosphorus from residual biomass.***

Hale, Rebecca, Laura Turnbull, Stevan Earl, and Nancy Grimm. ***Effects of urban stormwater infrastructure and spatial scale on nutrient export and runoff from semi-arid urban catchments.***

Hamilton, Alex, and Hilairy Hartnett. ***Chemical structure and functionality of black carbon in central Arizona soil.***

Metson, Genevieve, Jessica Corman, Elizabeth Cook, Rebecca Hale, David Iwaniec, and Christopher Galletti. ***Nutrient movements in human environment interactions: Phosphorus in Phoenix.***

Turnbull, Laura, Daniel L. Childers, Rebecca Hale, Enrique Vivoni, Stevan Earl, and Nancy B. Grimm. ***Ecosystem structure and hydrologic function of urban deserts.***

Warner, Benjamin, Daniel Childers, and Laura Turnbull. **Hydrology versus ecology: The *effectiveness of constructed wetlands for wastewater treatment in a semi-arid climate.***

URBAN HEAT ISLAND AND WATER

Ackley, J. W. ***Off the sand and onto the asphalt: Does the urban heat island impact desert lizards?***

Elser, Monica, Tirupalavanam Ganesh, Sharon Harlan, Gina Hupton, Dulce Medina, and Elena Ortiz. ***Creating a cross-disciplinary unit for middle school children on the urban heat island.***

Middel, Ariane, Anthony Brazel, Patricia Gober, Soe Myint, Heejun Chang, and Jiunn-Der Duh. ***Impacts of weather variability on turbulent heat fluxes in Phoenix, AZ and Portland, OR.***

Ruddell, Darren M., Anthony Brazel, Juan Declet, P. Grady Dixon, Patricia Gober, Susanne Grossman-Clarke, Sharon L. Harlan, Scott Kelley, and Elizabeth Wentz. ***Environmental Tradeoffs in a desert city: An investigation of water use, energy consumption, and local air temperature in Phoenix, AZ.***

Sampson, David, and David Sailor. ***Coupled energy and water use in the Phoenix Metro Area as influenced by drought and climate change; empirical observations and simulation analyses.***

Tuccillo, Joseph. ***Water allocation and settlement pattern morphologies in the early Salt River Project, 1902-1968.***

Wutich, Amber, Alexandra Brewis, Sveinn Sigurdsson, Rhian Stotts, and Abigail York. ***Fairness and the human right to water: A preliminary cross-cultural theory.***

Abstracts

All abstracts are listed alphabetically by first author. * indicates student poster.

Ackley, J. W.** ***Off the sand and onto the asphalt: Does the urban heat island impact desert lizards?

Climate change has dire implications for many ectotherms. Lizards prefer a narrow range of the environmental temperature distribution in most habitats; this limits their activity in space and time. In winter, global warming could benefit lizards by allowing for shorter hibernations. But in summer, an increase of 1-2°C can greatly restrict daily lizard activity, often below a threshold required to obtain enough energy for survival and reproduction. As a result, climate change may drive 40% of lizard populations extinct by 2080. This assumes lizards will not adapt by dispersing to cooler areas or shifting their activity time to cooler seasons. Such assumptions can be tested in cities like Phoenix, AZ. Here, roads limit dispersal and contribute to a spatially and temporally heterogeneous urban heat island (UHI) effect, which averages +4°C and can locally exceed +10°C at night. I will integrate ecology, physiology, behavior, and climatology to achieve a better understanding how lizards adapt to Phoenix's existing UHI. This will also help us predict the future consequences of climate change for the distribution and abundance of organisms.

Goals of Proposed Research: (1) Measure the spatial and temporal structure of the UHI at scales relevant to thermoregulating lizards. (2) Identify how elevated temperature impacts behavior, population dynamics, and community structure. (3) Determine the relative significance of non-thermal urban variables. (4) Collect data and disseminate management implications with the help of local herpetology clubs and Arizona Game and Fish.

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Banville, M., and H. Bateman.** ***Herpetofauna and microhabitat characteristics of urban and wildland reaches along the Salt River, Arizona.

Urbanization can alter vegetation structure and composition, affecting habitat suitability for many wildlife species. Herpetofauna can be good indicators of structural changes occurring in the environment. We evaluated herpetofauna abundance, species richness, and diversity as well as microhabitat characteristics from three reaches along the Salt River, Arizona. The wildland reach is located in the Tonto National Forest and two urban reaches are located within the greater Phoenix area. One urban reach has been recently rehabilitated and the second is highly disturbed. We predict that more structural diversity of microhabitat and lower urbanization will favor herpetofauna abundance, richness, and diversity. At each reach, we performed visual surveys for herpetofauna along eight transects (n=24) to determine species presence and relative abundance. Microhabitat characteristics such as ground substrate, vegetative cover, woody debris, and plant species richness were quantified along each transect and preliminary results show significant differences among reaches. Preliminary results also show significant differences for herpetofauna species richness among all reaches with wildland reach having the highest species richness and urban disturbed reach the lowest. The Shannon-Wiener diversity index was significantly greater at the wildland reach; whereas, diversity along the two urban reaches did not differ. Abundance of herpetofauna was approximately six times lower along the urban disturbed reach compared to the wildland and urban rehabilitated reaches, which did not differ. Further analyses will identify correlations among microhabitat characteristics and herpetofauna community-level variables. Preliminary results suggest that rehabilitation

efforts may be beneficial for herpetofauna abundance and that urbanization may negatively influence herpetofauna diversity.

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***Bleasdale T.[1], C. Crouch[2], and S. Harlan[1]. *Community gardening in disadvantaged neighborhoods in Phoenix, Arizona: Aligning programs with perceptions*.**

This study examines a struggling community gardening program in an economically disadvantaged minority area of south-central Phoenix, Arizona. The gardening program exists within a larger resident-driven local food initiative. The goals of the local food initiative are to create a sustainable source of food, income, and social cohesion within the community. The objective of the study is to determine what factors are inhibiting the success of the gardening program. We used informal and semi-structured interviews and participant observation to design an exploratory survey, which was administered to 149 residents at a community fair in March 2010. The survey allowed us to analyze neighborhood perceptions of benefits and burdens associated with maintaining the community gardens. We compared perceptions of gardening among three groups of survey respondents: neighborhood residents who are currently engaged in gardening, residents who have gardened but are no longer active, and those who are interested in community gardening but have not participated in the program (potential gardeners). Results indicate these groups of residents do not conceptualize community gardens similarly to each other and that their perceptions of the benefits of gardening differ from the goals of the larger local food initiative in some important ways. If community gardens and local food initiatives are to succeed, they must align themselves with neighborhood perceptions or align the residents with the program's goals through education.

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Chapman, E.[1], and B. Warner[2]. *Foreseeing critical phosphorus cycle transitions in constructed wetlands: Applied to the new Tres Rios arid-land constructed wetlands with the City of Phoenix.

Constructed wetland ecosystem design and management plans often do not provide the necessary insight into phosphorus (P) cycle dynamics to allow regulatory and management agencies to foresee and adapt to system changes in order to maintain P removal rates as required by law. Insights into critical transitions in wetlands to steady-state P cycling incorporate complexity and will add useful focus into constructed wetland management plans. These insights will allow for better design and management of constructed wetland ecosystems. Three objectives exist within the scope of this project: (1) the results of a dynamic systems model (the Kadlec-Knight K-C* Dynamic Model) will be compared to sample data from the new City of Phoenix Tres Rios constructed wetland system to understand the relationship between nutrient uptake and nutrient release by biomass decay, specifically the rate of a modeled 'critical slow down' in state variables will be compared against sample results; (2) the relationship between the CAP LTER community and the City of Phoenix Water Department will be developed through the co-production of research, in line with CAP LTER III objectives; and (3) a working database will be created to synthesize wetland sample data collected by the City of Phoenix Water Department over the past decade to compare experimental results to a larger temporal scale. The City of Phoenix Water Department recently constructed the Tres Rios wetland system to improve the

performance of their 91st Avenue Wastewater Treatment Plant and meet new water quality standards issued by the Arizona Department of Environmental Quality.

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Crouch, C.[1], Phoenix Revitalization Corporation[2], and S. Harlan[3].** ***Community food resource mapping in central city south, Phoenix: An exploratory study of community capacity building.

Access to healthy food in the US is unevenly distributed. Supermarkets and other fresh food retailers are less likely to be located in low-income minority communities, where convenience and dollar stores are more prevalent grocery options. In south-central Phoenix, Arizona, a group of predominantly Hispanic, low-income neighborhoods have established community goals for healthy eating and living. Arizona State University researchers have formed a partnership with a community development organization to enhance this community's capacity to meet its health goals by co-producing place-based, community-specific interventions that improve access to healthy food. Consequently, there is high ownership of the project and its outcomes on the part of community members. Project objectives are to: 1) map the community food resources available to residents, 2) analyze the quality of the community food environment, and 3) increase community capacity to improve access to healthy food. This presentation illustrates progress on mapping the location and type of available food resources (including stores, restaurants, community gardens, and food-box programs) and measuring the availability and quality of food in community food stores using the Nutritional Environment Measurement Survey protocol. Analyzing the distribution and characteristics of community food resources can equip and empower communities to identify strategic, targeted interventions to improve access to healthy food to meet health goals.

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Davies, S., and P. Deviche.** ***Does urbanization influence the timing of seasonal breeding and the effect of stress on the reproductive physiology of a Sonoran Desert songbird?

For seasonally breeding animals, such as birds, correctly timing reproductive activity is crucial. To optimize the timing of breeding, birds track environmental cues that predict future conditions favorable for reproduction. The timing of seasonal reproduction is, therefore, considered one of the major life history traits reflecting the adaptation of birds to local environmental characteristics. Once breeding has been initiated, it is crucial that birds maintain reproductive activity even in the face of unfavorable conditions. Using free-living Abert's Towhees (*Melozone aberti*) caught during June - the end of their breeding season - from urban and rural localities, we investigated the influence of urbanization on (1) breeding condition and (2) the resilience of reproductive physiology to acute stress. To quantify breeding condition we measured cloacal protuberance width, which is enlarged during breeding and regressed outside of this season. We measured the blood concentration of testosterone of males sampled in the field to quantify the resilience to acute stress. We then transferred these birds into captivity to monitor their reproductive status and examine the resilience of reproductive physiology to chronic stress. The plasma testosterone concentration of urban and rural birds did not differ in its resilience to acute stress. On the other hand, urban towhees in the field were in better breeding condition than rural birds and

this disparity persisted in captivity. Chronic stress had no influence on testosterone. Thus, urbanization prolongs seasonal breeding in urban Abert's Towhees, which suggests that urbanization may influence the environmental cues used by birds to time their seasonal reproduction.

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Elser, M.[1], T. Ganesh[2], S. Harlan[3], G. Hupton[1], D. Medina[4], and E. Ortiz[5]. *Creating a cross-disciplinary unit for middle school children on the urban heat island.*

We will present our efforts to create and implement a 7/8th grade unit focusing on the Urban Heat Island that involved input from natural scientists associated with CAP LTER, social scientists associated with the NSF-funded Urban Vulnerability to Climate Change project, and engineering education faculty associated with an NSF-funded Innovative Technology Experiences for Students and Teachers grant. Various components of the unit were tested in after-school programs and in the Junior Ace program of Phoenix College.

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Frijia, S., E. Williams[1], S. Guhathakurta[2], and A. Middel[3]. *Scaling behavior of the life cycle energy of residential building and impacts on greenhouse gas emissions.

Environmental life cycle assessment (LCA) has been increasingly used in studies examining sustainable urban forms to evaluate impacts of urbanization on resources and on the environment. Typically LCA for residential buildings includes the total energy consumed "within a building," which is considered the operational energy use phase, and energy used during the construction energy use phase. The anthropogenic operational phase of residential buildings is significantly higher than the construction phases as a source of environmental impacts. However, the scalability of life cycle energy as a function of building size has not been analyzed systematically so far. Our case study investigates the scaling behavior of the life cycle assessment as a function of building size and number of stories for detached single family and multi-family residential homes within a unified modeling framework. We use an economic hybrid life cycle assessment to estimate construction impacts on energy consumption and greenhouse gas emissions. This approach combines a breakdown of producer prices of individual construction material assemblies with an economic input-output analysis. Results suggest that energy use for the construction phase scales more slowly as a function of size than the operation phase. Thus, the share of the construction phase in the life cycle is smaller for larger homes. The energy scaling behavior for residential houses can be integrated into a larger model to assess the environmental impacts of different urban form on greenhouse gas emission and energy use.

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Frisk, E.[1], and K. Larson[1,2]. *Developing and implementing sustainability education through the integration of behavioral science.

As the urgency to address environmental, social, and economic challenges increases, education continues to be seen as a central part of the solution. In 1997, UNESCO issued a report declaring: "education is the most effective means that society possesses for confronting the challenges of the future. Indeed, education will shape the world of tomorrow" (1997:17). In order for education to be a fundamental part of the solution, educational practices must motivate behavioral change. Therefore, the driving question for this research is: How can we motivate sustainable behavioral change through educational programs?

This research will provide insights to three fields of literature (and practice) which are seldom considered concurrently – educational pedagogy, behavioral change, and sustainability science – through the development of educational principles and practices that promote sustainable change. The framework we develop will be applied to (1) an extensive survey of high school students regarding their declarative, procedural, effectiveness, and social knowledge as its relates to urban sustainability; (2) an intensive program for high school students that utilizes the knowledge domains to educate for sustainable change. The program will be held in collaboration with SOS, GK-12, and STEM College-for-Kids program, and Phoenix Metropolitan K-12 teachers (summer 2011) and will focus on issues of urban sustainability.

This research will further CAP-LTER's goals of bringing "ecology into sustainability education" while also raising awareness of sustainability challenges among students and teachers.

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Gade, K. *Roadside maintenance practices influence plant migration along freeways.*

General ecological thought regarding plant biology and urban areas has rested on two potentially contradictory assumptions. The first is that non-native plants spread easily from human developments to "pristine" areas. The second is that native plants cannot disperse through developed areas. Both assume anthropogenic changes to ecosystems create conditions that favor non-native plants and hinder native species. However, it is likely that anthropogenic alterations of habitats will favor groups of plant species with similar functional traits, whether native or not.

Migration of plants can be divided into the following stages: dispersal, germination, establishment, reproduction and spread. Functional traits of species determine which are most successful at each of the stages of invasion or range enlargement. I studied the traits that allow both native and non-native plant species to disperse into freeway corridors, germinate, establish, reproduce, and then disperse along those corridors in Phoenix, Arizona. Field methods included seed bank sample collection and germination, vegetation surveys, and seed trapping. I also evaluated concentrations of plant-available nitrate as a result of localized nitrogen deposition. While many plant species found on the roadsides are either landscape varieties or typical weedy species, some uncommon native species and unexpected non-native species were also encountered. Maintenance regimes greatly influence the amount of vegetative cover and species composition along roadsides. Understanding which traits permit success at various stages of the invasion process indicates whether it is native, non-native, or species with particular traits that are likely to move through the city and establish in the desert.

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Gifford, J. M., and P. K. Westerhoff.** ***Making biofuel renewable: Recovering phosphorus from residual biomass**.**

Current energy consumption practices deplete fossil fuels, create greenhouse gases, and contribute to global warming. Biofuel from phototrophic microbes like algae and bacteria provides a viable substitute. Lipids and fatty acids are produced from microorganisms, but are typically less than 40% of the biomass. Residual biomass includes nutrients, like phosphorus, which can be recycled in four steps to increase overall sustainability. First, cellular digestion converts organic phosphorus into inorganic species. Step two separates, captures, and concentrates it. Third, phosphorus is supplied to a new biomass crop. Finally lipids are extracted for biofuel. This poster presents research which improves biofuel sustainability by refining nutrient recycling focused on the first two steps.

The digestion step will be enhanced by laboratory testing various methods on biomass samples of the same composition. The separation step refinement might include development of an ion exchange filter. Resins with specific affinity have shown great promise in wastewater nutrient recovery, but have yet to be examined for biomass applications. The inputs, wastes, and rate of recovery from each digestion and separation method will be measured, ensuring overall sustainability improvement.

Nutrient recovery has additional applications in wastewater treatment and fertilizer production. Global phosphorus reserves are depleting. Wastewater treatment plant sludge may be a renewable source of nutrients for fertilizer if they can adequately be captured, increasing food availability across the globe. Improved recovery techniques may also result in reduced agriculture runoff, thereby reducing eutrophication of downstream water bodies and maintaining quality of natural water resources.

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Hale, A.[1], and E. Talen[2].** ***Analysis of zoning changes–Phoenix AZ.

The intention of this research project was to document zoning changes in Phoenix over time. The project documents these changes in ten year intervals, beginning with a map of the 1930 zoning districts and ending with a present day (2008) map of zoning districts. By process, these maps were transcribed from hard copies into ArcGIS, a mapping and geographical analysis computer program.

Phoenix's original city boundary line from 1930 was the parameter for sampling the cities zoning changes in these ten year intervals. Although the city has since grown in size from its original 1930's form, this area proved to be a good sample of change, land development patterns, and the complexity of zoning codes and reforms in Phoenix. This is exemplified in the contrast between various historic images which document on the ground behavior related to the research site.

As anticipated, the zoning changes moved from less complex zoning districts in the 1930's (i.e., residential, commercial, and industrial) to multi-layered complex zoning districts in 2008 (i.e., residential infill that uses underlying zoning, planned community districts, historic preservation overlays, etc). This shift towards complexity is also expressed within Phoenix's building ordinances documents.

Several limitations and set backs were experienced in this research project. The City of Phoenix has not preserved or documented historically the progression of its own zoning changing and or decisions. In addition, a zoning map from the 1950's is not available to be added to the research and data sets. Likewise, locating pictures that show the same scene throughout the various decades has proven to be difficult.

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Hale, R.[1], L. Turnbull[2], S. Earl[2], and N. Grimm[1]. *Effects of urban stormwater infrastructure and spatial scale on nutrient export and runoff from semi-arid urban catchments.

The modification of the land surface and hydrologic networks due to urbanization has driven changes in stormwater runoff processes and nutrient export to downstream systems. Previous research has focused on the effects of impervious areas and land cover, but the role of urban drainage infrastructure (engineered hydrologic networks) and spatial scale in stormwater hydrology and biogeochemistry is largely unstudied. We measured rainfall and discharge, and sampled stormwater runoff from 8 urban catchments with similar land use (urban residential) but differing drainage infrastructure (primarily surface runoff, pipes, washes, or retention basins), across eight spatial scales from 5 to 21,000 ha. We sampled 9 storms during the 2010 summer monsoon season, for a total of 27 storm x catchment events. We analyzed stormwater samples for dissolved nitrogen, phosphorus, organic carbon, and chloride. We found that patterns of nutrient export and discharge vary strongly within catchments due to storm characteristics, and between catchments due to infrastructure type. Results show that the transport of dissolved and particulate N, P and C are governed primarily by flow characteristics, which vary depending on the extent and type of stormwater infrastructure. Thus, changes in ecosystem structure resulting from urbanization exert a major control over the dynamics of nutrient redistribution within these catchments.

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Hamilton, A.[1], and H. Hartnett[1,2]. *Chemical structure and functionality of black carbon in central Arizona soil.

Black carbon (BC) is the product of incomplete combustion of fossil fuels and biomass. The amount of BC has been well quantified in aerosols and ocean sediments, however; little is known about BC in a terrestrial urban setting. Since the BC global budget is unbalanced with respect to sources and sinks, we propose that BC is undergoing bio-, chemical-, or photo-degradation in soil. Since it is also known that BC is a significant portion of the organic carbon in central Arizona soils (31%), it could play a major role in organic biogeochemical processes in this area. In an attempt to understand the reactive nature of BC in soil, solid- and liquid-state nuclear magnetic resonance (NMR) is utilized to identify chemical functional groups of soil black and organic carbon. Preliminary results show that BC is primarily aromatic (ring structure); however, there are indications that other functionality, such as carbonyl (C=O) and alkene (C=C) groups, exists. Black carbon solubility experiments were also completed using acid and aqueous soil extractions. Organic and black carbon was detected in extraction media using a total organic carbon (TOC) analyzer. Results indicate that a portion of the BC in soil is water-soluble and therefore, could be more involved in biogeochemical processes than previously thought.

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Johnson, J. C.[1], G. M. Hupton[2], D. Bonney[3], and M. Elser[2]. *The web of inquiry: Urban black widow behavior as a tool to teach the scientific process.*

Hands-on inquiry is a major emphasis in K-12 science education, but how often do students design and conduct tests of their own ideas in the classroom? Here we present a collaborative effort between a CAP LTER research program and a middle school science classroom. Specifically, students were introduced to the behavior and urban ecology of black widow spiders and encouraged to use their observations of black widow behavior to ask questions and formulate a testable hypothesis. This stage of hypothesis development can be the greatest challenge for teachers and students. We facilitated this by encouraging students to build on their initial questions by further exploring the underlying independent variables and refining their original question into a testable explanation. Students were excited to focus intensively across an entire month on this engaging study species leading us to conclude that partnerships between K-12 classrooms and academic researchers can jump-start genuine inquiry projects. Lastly, it should be emphasized that the curriculum we present here is not unique to black widows, and can be implemented with any organism teachers are able to bring into the classroom.

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Johnson, J. C., M. Still, and T. Gburek. *Conspecific silk cues shape the habitat preferences of black widows.*

The Western Black widow spider (*Latrodectus hesperus*) is a common pest that thrives in disturbed, urban habitat including the Phoenix metropolitan area. Widow spiders are both a species of medical importance owing to the danger their venom presents to human victims, and a common urban, agricultural and invasive pest species. However, relatively little is known about the ecology of black widows. For example, habitat choices of web-building spiders like the black widow are critical as web construction is an energetically costly behavior. While our lab has previously demonstrated that urban infestations of black widows arise, in part, because spiders prefer to settle near chemical cues from prey, it's unclear what other factors promote high-density infestations of widow spiders in urban areas. Here, we indirectly tested the hypothesis that infestations are, in fact, aggregations of close relatives by predicting that spiders would prefer to build webs in the presence of silk from a full sister. Instead, we found that, given the choice of related silk, unrelated silk, and no silk, black widows significantly preferred to settle where unrelated chemical cues were present. Thus, we found no evidence to support the contention that infestations are made up of family groups, and instead found widow spiders to actively avoid chemical cues of siblings. We discuss the alternative hypothesis that benefits of urban family groups may be outweighed by costs (e.g. increased risk of competing/cannibalizing a full sister). We also discuss the anecdotal observation that abiotic factors, specifically the worst hail storm in 75 years, led the majority of spiders to leave their web and settle in areas that were best sheltered from heavy winds.

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Kim, W. K., and E. A. Wentz.** ***Re-examining the definition of urban open space using fuzzy set theory.

Urban open space is a key infrastructure to the quality of the urban environment and sustainable living in cities. Extensive research on urban open space shows that there are environmental, social, and economic benefits. Nevertheless, there is no standard definition for urban open space. Various factors, such as size, shape, diversity, greenness, facilities, and distribution, as well as the design and management of urban open spaces play a decisive role in defining urban open space and its function. This research suggests the new approach to define urban open space to satisfy the demand for better understanding urban open space with different characteristics. Fuzzy set theory can be a solution to delineate many phenomena, which are difficult to delineate because of vague definition and meaning. We develop a theoretical perspective of urban open space typology based on how their attributes and elements of a configuration are connected to open space benefits. The data used in this research include Quickbird satellite images and parcel data. Sample sites in Phoenix, Arizona are empirically investigated to test new theoretical concept for urban open space. Multiple-factors representation is implemented to compare the approaches of binary and fuzzy sets. Examining for a solution to mitigate urban heat island is complex because many variables of urban environment interact. The new definition of open spaces can be applied to solve this problem. Our findings show how the theoretical perspective developed in this study allows for detailed and appropriate analyses for urban open space research.

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Lerman, S. B.[1], V. K. Turner[2], and C. Bang[3].** ***Linking homeowners associations with biodiversity: A case study in Phoenix, AZ.

Residential yards and gardens have the potential to mitigate the loss of urban biodiversity if they can provide habitat for native wildlife. The approach humans employ to manage yards and gardens is often at odds with natural processes and ecological function. For example, weed removal and pest control could have negative implications for ground-dwelling arthropods and insectivorous birds. Homeowners' Associations (HOA) manage a significant proportion of residential landscapes in the Phoenix Metropolitan area through the authority of official Covenants, Conditions and Restrictions (CCR). The active management of the yards might prove beneficial for native wildlife. We calculated native bird species diversity, insect diversity, and plant diversity at 39 PASS neighborhoods. Half of these neighborhoods belong to an HOA. We then compared plant, bird, and insect diversity between neighborhoods with and without an HOA. Neighborhoods belonging to an HOA had significantly greater bird and plant diversity, though insect diversity did not differ. For the neighborhoods belonging to an HOA, we analyzed landscape form and management practices based on the CCR. We link these features with ecological function and suggest how to modify these management practices in ways to help improve conditions for native wildlife. We conclude with suggestions on how HOAs can incorporate strategies from the Sustainable Sites Initiative in order to help promote biodiversity in current and future HOA neighborhoods.

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Lettsome, O., and H. Bateman.** ***Avian communities from urban and non-urban riparian habitats.

Riparian ecosystems are important habitats to bird species by providing water, shade, food, and nesting sites. As urbanization increases, the quality and extent of the riparian areas will likely decrease. Some urban ecosystems may be rehabilitated by planting native vegetation. We were interested in how urbanization and rehabilitation affects bird communities. The purpose of our research is to compare avian diversity, abundance, species richness and microhabitat at three types of urban and non-urban riparian habitats. We tested the null hypothesis that bird diversity of an urbanized riparian area was similar to a wildland riparian area. I counted birds at eight point-count stations six times during the spring of 2010 at three locations: Salt River (SR, wildland riparian), Rio Salado (RS, rehabilitated urban riparian), and Boyce Thompson Arboretum (BTA, non-native and non-urban riparian). Avian diversity and species richness did not differ among locations. However, avian abundance was 30% greater at SR compared to RS and BTA. Among avian guilds, aquatic species were four times more abundant at SR compared to the other two sites. Microhabitat characteristics were similar among the locations except for canopy cover was greatest at BTA. These results suggest that our urban and non-urban locations were similar in avian diversity and vegetation characteristics, with some differences in avian abundance. By comparing habitat of rehabilitated and non-rehabilitated riparian ecosystems, this work can provide information to resource managers on how urbanization and rehabilitation impact avian communities.

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Metson, G.[1,2], J. Corman[1,3], E. Cook[1,3], R. Hale[1,3], D. Iwaniec[1,3], and C. Galletti[1,4].** ***Nutrient movements in human environment interactions: Phosphorus in Phoenix.

Humans alter urban biogeochemistry by deliberately changing inputs and outputs of materials into a city, by inadvertently altering air, water, and soil conditions, and by changing the location where materials accumulate. Urban biogeochemistry can affect human activity by controlling city-wide policy regulations (i.e., pollution control), by regulating costs of manufacturing, agriculture, and transportation, and by affecting individual health and quality of life. The feedbacks between human activity and biogeochemistry are influenced by the relationships between elements, e.g., carbon (C) and phosphorus (P), in the system components (e.g. building materials, foods, fuels, biota, soil). The relative amounts of elements in each component may have a unique elemental signature or stoichiometry. As technologies, regulations, built structures, values, preferences and economies change and develop, so does the stoichiometry of the city.

Here we present our work constructing an urban phosphorus budget for the Metropolitan region of Phoenix, using the Central–Arizona Phoenix ecosystem as our boundary. In this budget we take into account the built environment, which is often overlooked as a nutrient stock. We also calculated other major stocks, including vegetation soil, humans, pets and livestock. The major flows in the CAP ecosystem include fertilizer to agricultural soils, human waste, food to humans and livestock and wastewater. This P budget was created in order to couple it with two other biogeochemically important elements: C and N to create the first stoichiometric budget of an urban system.

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Middel, A.[1], A. Brazel[2], P. Gober[1,2], S. Myint[2], H. Chang[3], and J. Duh[3]. *Impacts of weather variability on turbulent heat fluxes in Phoenix, AZ and Portland, OR.*

This local-scale study examines the effects of historic weather extremes on the summer daytime surface energy balance in Phoenix, AZ and Portland, OR, two cities with distinct climates, but warm and dry summers. We use the Local-Scale Urban Meteorological Parameterization Scheme (LUMPS, after Grimmond and Oke, 2002) to estimate the surface energy balance based on land cover fractions derived from Quickbird imagery (2.5 m resolution) and historic hourly weather observations. The study area comprises ca. 200 block groups (length scale 0.5 km), ranging from dry to wet neighborhoods in and around the core of the two cities where UHI mitigation might be considered important. In our analysis, we particularly focus on the turbulent latent and sensible heat fluxes, which correlate to outdoor water use and temperatures. Results show that latent heat increases almost linearly with respect to equivalent vegetative surface area and Bowen ratios (sensible ÷ latent heat) vary inversely with vegetation fraction between and within cities. Impervious surface cover is positively correlated to the available energy that is partitioned into sensible heat. Cumulative evapotranspiration is similar for average weather conditions across medium wet sites in Phoenix and Portland, but varies more in Portland under extreme weather conditions. Results suggest that land cover manipulation could offset influences of deleterious weather extremes on evapotranspiration in Portland to a certain degree, but not in Phoenix. Further research will combine historic weather variability with IPCC climate change scenarios to investigate future outdoor water use and temperatures under climatic uncertainties.

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Ripplinger, J.[1], and J. Franklin[2]. *Spatiotemporal patterns of dominant plant species in CAP LTER.

We are exploring spatiotemporal dynamics of plant communities in urban and surrounding desert sites of the rapidly urbanizing Phoenix metropolitan area. Our efforts build on theoretical work developed primarily in 'natural' systems as well as considerable efforts by Central-Arizona Phoenix Long-Term Ecological Research (CAP LTER) projects. Data for the CAP LTER Survey 200 project was collected at 204 randomly located sample plots. Previous analyses of these data detected associations between both environmental and socioeconomic factors (e.g., land use) and plant diversity and composition based on single survey years. We have detected changes in species frequency and abundance between 2000 and 2005. For example, dominant cactus species decrease in frequency from 2000 to 2005, while frequency of dominant tree and shrub species remain relatively constant. We hypothesize that changes in relationships are related to environmental and socioeconomic factors but that their relative impact differs between urban, desert, and agricultural sites. This work is a preliminary step to identifying thresholds of change and discerning the applicability of ecological resilience theory in urban landscapes, which will contribute to our understanding of threshold behaviors in coupled human-natural systems.

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Ruddell, D. M.[1], A. Brazel[2], J. Declet[3], P. G. Dixon[4], P. Gober[2], S. Grossman-Clarke[1], S. L. Harlan[3], S. Kelley[5], and Elizabeth Wentz[2]. ***Environmental Tradeoffs in a desert city: An investigation of water use, energy consumption, and local air temperature in Phoenix, AZ.***

Three environmental challenges in an urban desert environment are temperature regulation, water scarcity, and energy demands. The rapid urban growth of Phoenix, AZ over the last fifty years has strained environmental systems and raised the importance of water resource management. For instance, the urban heat island (UHI) effect observes higher nighttime temperatures in the urban corridor threaten human health and well-being. A second challenge is water scarcity, and research shows that the temperature variability within metropolitan Phoenix is strongly correlated with vegetation cover. Water intensive landscapes, such as turf grasses and trees, mitigate against warm temperatures through evapotransportation in some areas of Phoenix, while soils of drought resistant landscaping store heat, exacerbating high temperatures in other areas. A third challenge is energy demand to provide electricity for indoor cooling which is water intensive. This study examines 16 diverse census blocks groups within the city of Phoenix to investigate the complex relationship between water consumption, energy use, and local air temperature. Research hypotheses are: 1) neighborhoods composed of drought-resistant landscapes use more energy and at higher demands compared to irrigated landscapes; and 2) neighborhoods with irrigated landscapes use water more efficiently than drought-resistant yards when considering the indirect costs of energy generation, transmission, and consumption. This study utilizes four datasets for the year 2005 at the census block group level, which are: monthly water consumption; monthly residential energy use; vegetation fraction; and simulated air temperature.

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Sampson, D.[1], and D. Sailor[2]. ***Coupled energy and water use in the Phoenix metro area as influenced by drought and climate change; empirical observations and simulation analyses.***

We examined current electricity consumption and water availability and use in the Phoenix metropolitan area, and future projections through the year 2100, using daily estimates of temperature and precipitation downscaled from two emission scenarios and four General Circulation Models. Our conceptual framework follows the flow path for electricity production and use and water supply and demand from source to end-use for: 1) water treatment plants, 2) residential and commercial use (in-door and out-), 3) waste water treatment, 4) agricultural irrigation, and 5) power plants. We used empirical estimates of electricity use from the Federal Energy Regulatory Commission to generate relationships between electricity consumption and hourly temperature (load sensitivity). We also used empirical algorithms to model the electrical requirements of conveying and treating surface and groundwater. A variant of the Decision Center for a Desert City's WaterSim provided estimates of water supply for 35 Valley water providers. We estimated water demand using provider-specific estimates of GPCD from the Arizona Department of Water Resources (ADWR) (modeled through 2100) and time series forecasts of population estimates from the Maricopa Association of Governments. ADWR provided estimates of agricultural and Irrigation District pumping. Analyses were aggregated to obtain monthly metropolitan-wide estimates. Results suggest a load sensitivity of 3% per °C increase in temperature which translated as a 7% to 12% increase in summer electricity use by 2100 for current (static)

populations. Water demand, as influenced by temperature alone, may increase five to 15% during summer months by 2100. We present results for future population projections.

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Sayles, J. S.[1], *E. M. Cook[2], K. L. Larson[1,3], and S.J. Hall[2]. *The influence of environmental values, urban structure, and neighborhood context on household-level biodiversity and plant composition.

Residential gardens and lawns are a primary setting for many peoples' interactions with their environment. Both individual homeowner's actions and wider societal drivers influence the shape of these landscapes and thus, the suburban and urban environment. A number of studies have investigated how urbanization affects biodiversity at regional scales, but fewer studies have examined biodiversity across households. To address this need we performed field and social surveys across 428 front yards, stratified across four distinctive neighborhoods in the Central Arizona-Phoenix ecosystem. We examined how different domains of environmental values and urban structural components including house age, yard size, and property value, affect plant biodiversity (richness, evenness, Fisher's alpha, and Sorenson's index) and plant community composition across household yards. We find that yard area is significantly associated with wealth, and both appear to drive plant diversity, whereas house age and environmental values are only weakly related to diversity. Our findings suggest that mangers of municipal biodiversity programs should consider urban structure, rather than only prioritizing residents' values.

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Shoumaker, T.[1], J. Wu[1], C. Chambers[2], and A. Smith[1]. *Effects of urbanization on bat community structure in the Phoenix metropolitan region: A multi-scale perspective.

Rapid transformation of habitats into highly urbanized landscapes can affect animal behavior preventing the recruitment of native biodiversity into urban areas even for the most mobile species such as birds and bats. Yet, few studies have considered the multi-scale effects of urbanization on bat community structure, especially in the Southwest. The objective of this study is to examine the relationship between bat community structure and landscape pattern across multiple scales in the Phoenix metropolitan region. Three sites were randomly placed in seven land use land cover (LULC) types: compacted soil, cultivated grass, cultivated vegetation, disturbed commercial/industrial, disturbed residential, undisturbed, and water. Sites were passively monitored from May 1, 2010 - October 31, 2010 using Anabat detectors. To elucidate characteristic scales at which bats perceive their environment, significant variables will be examined across three circular, hierarchically nested scales: local, home range and landscape. This research seeks to address the following research questions: 1) What is the spatial distribution of bat activity across LULC types? 2) How is bat community structure, specifically species richness and foraging activity affected by different degrees of urbanization? and 3) What variables and scales are most important for relative bat habitat use? As a response to declining bat populations, examination of the effects of urbanization on bat community structure across multiple scales will enhance management of essential urban habitats required to maintain bat populations inhabiting urban ecosystems of the West.

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Sovik, B. R.** ***A spatial-temporal representation of land subsidence in the northwest Phoenix valley, Arizona.

A frontier in GIScience is converting objective data of dynamic and complex real world phenomena into spatial-temporal building blocks. This research analyzed objective data for a complex and dynamic phenomena called land subsidence. The analysis focused on the temporal state of land subsidence in the northwest Phoenix metropolitan area. The costs of damage from land subsidence are in the millions of dollars for critical infrastructure in Arizona. Base information was derived from satellite Interferometric Synthetic Aperture (InSAR) data and processing. The research examined query limitations of GIS - both spatially and temporally. Cartographic results were presented to provide improved subjective analysis. Underlying this research, theoretical perspectives from Donna Peuquet's Space-Time Theoretical Framework were applied and analyzed.

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Taylor, C.** ***Participation in and accessibility of Arizona's urban farmers' markets: An Institutional analysis of farmers' market sustainability.

Farmers' markets are a growing trend in the U.S., and are often touted as a solution to many of the environmental, social and economic problems implicated in the conventional U.S. food system. However, there is growing evidence that the benefits of farmers' markets accrue to a small proportion of U.S. farmers and consumers. A mere 6.2% of farmers in the U.S. participate in any form of direct-marketing, and studies repeatedly find that local food outlets such as farmers' markets primarily serve the urban elite, with low-income and ethnically diverse consumers often absent. This calls into question the assumption that farmers' markets are necessarily panaceas for the ills of the conventional food system. While researchers have begun to document lack of participation in farmers' markets, little research has explicitly explored why producers and consumers encounter barriers to participation. In the limited body of (largely unpublished) research exploring the rules and norms which govern farmers' markets, there is some indication that some rules and norms may serve to restrict access to a limited group of users in alignment with the market's particular goals. This study begins to synthesize and analyze the existing literature on consumer and producer barriers to farmers' market participation, farmers' market institutions, and how the rules and norms that govern markets may influence consumer and farmer participation. Specific need for additional research in this area is outlined.

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Trubl, P.[1], T. Gburek[1], L. Miles[1], and J. C. Johnson[2]. *Black widows in an urban desert: population variation in an urban pest across metropolitan Phoenix.

Ecologists are still coming to grips with the effects of urbanization on biodiversity. For example, urban habitats are often characterized by reduced species diversity but increased abundances of a handful of urban specialists. Yet, the reasons why urban specialists thrive while species diversity suffers remains unclear. The Western Black widow spider (*Latrodectus hesperus*) is a common pest that thrives in disturbed, urban habitat including the Phoenix metropolitan area. Widow spiders are both a species of medical importance owing to the danger their venom presents to human victims, and a common urban, agricultural and invasive pest species. Over a 10-week period, during the peak of the breeding season (July-Sept), we followed 10 populations of widows throughout the greater Phoenix area. To examine the extent to which urban populations are distinct from each other, we quantified the degree of among-population variation relative to within-population variation. Variables examined include: average spider mass, population density (males and females), web volume, fecundity (# of egg sacs), prey diversity and density. An appreciation of the variation in these variables across populations of an urban pest species such as black widows can give urban ecologists a greater understanding of how urban specialists exploit disturbed environments. Future work will i) map abiotic variation across these urban sites on top of these biotic data, and ii) compare these urban populations to black widows inhabiting ancestral, relatively undisturbed Sonoran desert habitat.

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Tuccillo, J.[1,2] *Water allocation and settlement pattern morphologies in the early Salt River Project, 1902-1968.

Using GIS to determine the relationship of settlement densities relative to canals and groundwater pumps in the early Salt River Valley Water Users Association, I examine three stages of growth: the collectivization and development of water resources from 1903-1917, the enactment of municipal water privileges in 1937, and contracted water delivery between SRP and municipalities in 1952. Results so far reveal several discrete canal flow regions along the urban peripheries of Phoenix, Mesa, Tempe, and Chandler, with high settlement densities and dependency on minor branches of the canal system. In 1915, for example, such settlement patterns are visible among regions including Lehi, Scottsdale, East Tempe, and South-Central Phoenix. Incorporating decisionmaking policies that led to rapid urban development of peripheral land in the Salt River Valley during the post-World War II population boom, I assess where, and under which circumstances (i.e. industrialization, canal displacement), this settlement type became most vulnerable to urban development.

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Turnbull, L.[1], D. L. Childers[2], R. Hale[3], E. Vivoni[4], S. Earl[1], and N. B. Grimm[4]. *Ecosystem structure and hydrologic function of urban deserts*.

Urbanization affects the water budget by altering the partitioning of precipitation into evapotranspiration (ET), surface runoff, and groundwater recharge. Modifications in ecosystem structure resulting from urbanization and human decisions about outdoor water use will affect the nature of horizontal hydrological fluxes (surface runoff and stormwater

flow) and vertical hydrological fluxes (ET and infiltration, which may lead to groundwater recharge). To establish the effects of urbanization and future climate stressors on the water balance we need to determine how land use, human decisions about water use, and climate change affect the vertical and horizontal components of the urban water budget. We present a conceptual framework for the study of urban ecohydrological processes that is based on structural-functional interactions and feedbacks. We consider the focal processes in terms of the horizontal versus vertical movement of water, the extent to which they are controlled by human engineering of the built environment and decision-making in the urban ecosystem. Following this conceptual framework, the three primary components of the urban water balance of interest, besides water inputs, are 1) runoff, 2) ET and 3) infiltration and groundwater recharge. We present data on the runoff component of the urban water budget in the Phoenix metropolitan area. Results show that runoff from small (5 ha) basins was characteristically flashy while hydrographs from medium-sized watersheds (100 ha) were more sensitive to stormwater infrastructure type. Ultimately, hydrologic connectivity at larger (1000s of ha) scales significantly dampened stormwater hydrographs, even though a wide mix of infrastructure types characterize this urban watershed.

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Warner, B.[1], D. Childers[1], and L. Turnbull[2]. Hydrology versus ecology: The *effectiveness of constructed wetlands for wastewater treatment in a semi-arid climate.

Urbanization is a major driver of land-use change world-wide, including semi-arid areas of the southwestern USA, such as Phoenix, and is associated with an increase in the volume of municipal wastewater that is tied to the growing human population in the city. Increasingly, wetlands are being constructed for tertiary wastewater treatment (i.e., nutrient removal from effluent). The use of constructed wetlands to improve the quality of wastewater effluent is relatively uncommon in arid ecosystems, however, and lessons learned from their use in more mesic settings may not translate well to dryland settings.

We seek to address two pertinent questions about these aridland wetland treatment ecosystems: 1) Is wetland uptake and transformation of bioactive solutes [by plants and soil microbes] sufficient to counteract the effects of evapoconcentration to yield a net improvement in the quality of wastewater? 2) What are the relative effects of surface water evapoconcentration and soil evapoconcentration on the short and long-term ability of constructed wetlands to improve wastewater quality?

In semi-arid climates, high evaporation rates will concentrate solutes in the water column while high evapotranspiration rates will concentrate solutes in the soils of constructed wetlands. The concentration of bioactive and non-bioactive solutes via these processes may exceed the ability of wetland biological processes to transform and remove bioactive solutes, thus reducing the treatment efficacy of the wetland. These same processes will also concentrate solutes that are not biogeochemically active, particularly in soils, perhaps to the point that wetland plant function and thus treatment efficacy are adversely affected.

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Wutich, A., A. Brewis, S. Sigurdsson, R. Stotts, and A. York. ***Fairness and the human right to water: A preliminary cross-cultural theory.***

Here we attempt to develop a preliminary cross-cultural theory of conceptions of fairness around the right to water. To develop such an elemental theory, our analysis of people's ideas in four ecologically and culturally different sites focuses on three key questions: How are conceptions of fairness in water grounded in local cultures, ecologies, and governance systems? What general factors or conditions might best explain variation in ideas around specific dimensions of fairness in water distribution? Are there general principles of water distribution that people understand as fundamentally fair or unfair cross-culturally?

The central themes identified in each fieldsite resonate with local ecological, economic, and political situations, and our meta-analysis found four key domains – water access, water quantity, the role of government, and equity/equality issues – to be consistent concerns across the four field sites. By contrast, water quality, water cost, water source, water rights and infrastructure turn are only relevant to people in some sites. The distinction between water-rich and water-scarce sites and wealthier versus poorer economies seems to provide much of the contextual explanation of this variation, and as scarcity and costs rise, we would predict that discord around key notions of fairness will increase.

Importantly, our findings can be directly related to the global movement toward defining water as a human right, show that there are shared concerns that are not well developed or represented in current international agreements, and hopefully contribute to a more sophisticated theory of fairness related to the human right to water.

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Zhang, C.[1], N. Grimm[2], J. Wu[2], M. McHale[3], X. Dong[2], and Y. Ouyang[1]. ***Modeling the structure and functions of human-dominated terrestrial ecosystems with a hierarchical patch dynamics approach.***

In order to address the spatial heterogeneity and functional complexity of the human-dominated ecosystems, a Hierarchical Patch Dynamic Ecosystem Model (HPDEM) was developed to simulate the impacts of management and environmental changes on the carbon/water/nitrogen dynamics of the terrestrial ecosystem. Ecosystem was modeled as interrelated subsystems that were in turn composed of their own subsystems, and so on, until the elementary level was reached. At the elementary level of the HPDEM, plant physiological submodels were developed to simulate the ecological processes of individual plants. Above the plant level, five other hierarchical levels (population, landcover, land-use, landscape, and region) were modeled by addressing their dominant processes, drivers, and constraints. After model parameters were fit and validated against intensively studied ecological sites, the model was applied to the Phoenix (AZ) metropolitan area to study the spatiotemporal pattern of ecosystem carbon balance in response to the influence of urban landscape composition, land-use management, and urban-induced environmental changes such as the CO_2 dome-effect, urban heat island, and air pollution. The model simulation estimated total ecosystem carbon storage of Phoenix to be 15.78 Tg (1 T = 10^{12} g), most of which is stored in the desert land-use type. Our results also indicated that in arid cities like Phoenix, human management, especially irrigation, was the most important factor determining the productivity and carbon pool size of the terrestrial ecosystem. Other factors, such as urban-induced environmental changes and alteration of landscape structure, also have important impacts on carbon dynamics of the Phoenix ecosystem.

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Zhang, S.[1], C. G. Boone[1,2], and A. M. York[2]. *Impacts of land fragmentation on biodiversity in the Phoenix metropolitan region.

Land fragmentation, in part a product of land use and land cover changes attributed to urbanization, is regarded as a key driver of declining global biodiversity. Social-ecological systems (SESs) frameworks identify biodiversity loss as a consequence of coupled human-environment dynamics, but it is rarely considered in policy making due to the paucity of monitoring, weak methods and vague indicators. In recent years, biodiversity analysis and evaluation has improved, but little is known about biodiversity dynamics in complex urban settings where interaction with social dynamics is intense. This research explores the impacts of land fragmentation on biodiversity change in the Phoenix metropolitan region to investigate potential drivers of change, and to link patterns and processes.

Biodiversity has three attributes: composition, structure and function. We focus on the composition at the population species level, and apply a suite of biodiversity indices to examine the correlation of land fragmentation with population abundance and species richness. Biodiversity data are drawn from the Central Arizona–Phoenix Long-Term Ecological Research 200-point survey (for years 2005 and 2008). Land fragmentation patterns and metrics are generated from the National Land cover Dataset (NLCD) dataset (for years 1992 and 2001). The primary method is the integration of biological data and remote sensing data using spatial statistic analyses. Results of this study provide empirical evidence of human activity and its impacts on ecosystems in a rapidly urbanizing and arid region.

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