18th Annual

CAP LTER All Scientists Meeting and Poster Symposium

Friday, January 15, 2016

SkySong

ASU JULIE ANN WRIGLEY GLOBAL INSTITUTE of SUSTAINABILITY

LTER

NSF

CAP LTER Eighteenth All Scientists Meeting & Annual Poster Symposium

January 15, 2016
ASU SkySong, Synergy I and II
Scottsdale, Arizona

8:00 am Registration, coffee, and tea

8:30 am ***Welcome and Introduction of Keynote Speaker***
Nancy Grimm, Professor, School of Life Sciences & CAP PI/Director

8:40 am ***Baltimore, Phoenix and the Emergence of Long-Term Ecological Research in Cities***
Peter Groffman, Professor, City University of New York Advanced Science Research Center and Brooklyn College

9:40 am ***News from CAP's Affiliated Programs and Partners***

- Kelli Larson, Associate Director, **Decision Center for a Desert City (DCDC)**
- Matei Georgescu, ASU PI, **Urban Water Innovation Network Sustainability Research Network (U-WIN SRN)**
- Charles Redman, co-Director, **Urban Resilience to Extremes Sustainability Research Network (UREx SRN)**
- Anne Reichman, Program Manager, **Sustainable Cities Network (SCN)**
- Corrie Griffith, Executive Director, **Urbanization and Global Environmental Change Project (UGEC)**
- Stacie Beute, Program Coordinator, **Central Arizona Conservation Alliance (CAZCA)**
- Helen Rowe, Director, **McDowell Sonoran Field Institute, McDowell Sonoran Conservancy (MSC)**

11:00 am Poster Session #1

12:30 pm Lunch

1:30 pm ***Tomorrow's Cities: Infrastructure to Enhance Urban Sustainability***
Dan Childers, Professor, School of Sustainability & CAPIV PI/Director

2:30 pm CAP LTER's Annual Service Awards

2:40 pm Poster Session #2

4:10 pm Adjourn for CAPpy Hour; Papago Brewing Company

2016 CAP LTER Symposium

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

Session 1	Session 2
Alvarez Guevara (1)	Harding (2)
Arnett-Romero (3)	Hartnett (4)
Ball (5)	Hester (6)
Beute (9)	Hoffman (8)
Buell (11)	Hutton (10)
Cayetano (13)	Johnson (12)
Chakalian (15)	MacNeille (14)
Chipman (17)	Palta (16)
Colter (19)	Patel (18)
Comeaux (21)	Ramos (20)
Cook (23)	Sampson (22)
Davidson (25)	Sanchez (24)
du Bray (27)	Suchy (26)
Eagar (29)	Suchy (28)
Elser (31)	Upreti (30)
Fan (33)	Burnette (32)
Fang (35)	Weaver (34)
Handler (37)	Wheeler (36)
Hanigan (39)	Zhao (38)

Keynote Speaker Bio

Peter Groffman
Professor, City University of New York Advanced Science Research Center and Brooklyn College

Peter M. Groffman is a Professor at the City University of New York Advanced Science Research Center and Brooklyn College, with research interests in ecosystem, soil, landscape and microbial ecology, with a focus on carbon and nitrogen dynamics. Groffman is chair of the Executive Board of the U.S. National Science Foundation funded Long-Term Ecological Research (LTER) network Science Council and a participant in LTER projects in Baltimore (urban) and New Hampshire (northern hardwood forests). Specific recent research efforts include studies of nitrogen dynamics in urban watersheds, lawns, riparian zones and forests, winter climate change effects on nutrient cycling in forests, calcium/nitrogen/carbon interactions in forests, and the effects of exotic earthworm invasion on soil nitrogen and carbon cycling. Groffman was a Convening Lead Author for the 2013 U.S. National Climate Assessment Chapter on Ecosystems, Biodiversity and Ecosystem Services and a lead author for the Second (Wetlands) and Third (North America) Assessment Reports of the Intergovernmental Program on Climate Change (IPCC).

List of Posters

***Indicates student poster.**

BIOGEOCHEMICAL PATTERNS, PROCESSES, AND HUMAN OUTCOMES

Ball, Becky. A., Sharon J. Hall, and Julie Ripplinger. ***Influence of Climate, Plant Communities, and Land Use on Long-term Patterns of Soil Properties in the CAP LTER Ecosystem.***

Eagar, Jershon D., Pierre Herckes, and Hilairy E. Hartnett.** ***Particle Deposition and Frequency of Haboobs in the CAP LTER.

Handler, Amalia M., Amanda K. Suchy, Nancy B. Grimm, Monica M. Palta, Dan L. Childers, and Juliet C. Stromberg.** ***Microbial Nitrogen Removal in the Salt River Wetlands of Phoenix, Arizona**.**

Hartnett, Hilairy, Maria van Schajik, Monica Palta, Albert Ruhi, and Nancy Grimm. ***Modeling DOC Quantity and Quality in Tempe Town Lake: Time-Series Analysis of a 10-Year Data Set.***

Ramos, Jorge, and Dan Childers.** ***Drying and rewetting periods trigger high pulses of greenhouse gases in wetland mesocosms

Sanchez, Christopher A., Nicholas A. Weller, Dan L. Childers, Laura Turnbull, and R. Upham. ***The Effects of Macrophyte Productivity and Community Composition on the Water and Nutrient Budgets of an Aridland Constructed Treatment Wetland.***

Suchy, Amanda K., Ian Crandall, Emily Sprague, Erin E. Shortlidge and James J. Elser.** ***Nutrient limitation and carbon dioxide fluxes in urban lakes maintained with groundwater and surface water in Tempe, AZ.

CLIMATE, ECOSYSTEMS, AND PEOPLE

Cayetano, Zoe, Ryan Taylor, Christian Monahan, Elijah Campbell, Kelsey O'Brien, Rebecca Lydford, and Amy Dicker.** ***The Influence of Vegetation and Built Environments on Midday Summer Thermal Comfort.

Chipman, Danielle, Kelli Larson, and Amber Wutich.** ***Calculated Risk: Comparing Perceptions of Climate Change Impacts and Responsibilities.

du Bray, Margaret, Amber Wutich, Rhian Stotts, and Alex Brewis.** ***Hope, Fear, and Worry: Emotional Geographies of Communities Affected by Climate Change.

Upreti, Ruby, Zhihua H. Wang, and Jiachuan Yang.** ***Assessing Impact of Landscape Characteristics on Urban Hydroclimate.

Zhao, Qunshan, Soe W. Myint, Elizabeth A. Wentz, and Chao Fan.** ***Rooftop Surface Temperature Analysis in an Urban Residential Environment.

EDUCATION, OUTREACH AND CO-CREATION OF KNOWLEDGE

Beute, Stacie, Cass Blodgett, Wendy Hodgson, Kim McCue, Ken Vonderscher, and Susanne Rothwell. ***Co-Creating Citizen Science in the Phoenix Mountains Preserve: The North Mountain Plant Inventory Project.***

Comeaux, Victoria.** ***Performing Environmental Education Outreach with Preschool to Middle School Age Children in the Phoenix Metropolitan Area.

Elser, Monica, Marcia Nation, and Stevan Earl. ***Engaging Non-Scientists in Urban Ecology: Lessons Learned from Designing, Implementing, and Sustaining Three Place-Based Citizen Science Projects.***

Suchy, Amanda K., James J. Elser, Sara E. Brownell, Nancy B. Grimm, and Erin E. Shortlidge.** ***Students in a Pilot Course-Based Undergraduate Research Experience (CURE) Collect Novel Data on CO_2 Emissions and Nutrient Limitation in Six Urban Lakes in Tempe, AZ.

HUMAN DECISIONS AND BIODIVERSITY

Alvarez Guevara, Jessica, Becky Ball, and Sharon J. Hall.** ***Urbanization Alters Terrestrial Herbivore Composition but not Abundance.

Arnett-Romero, Sky, Bridgett Harding, Dan Allen, and Albert Ruhi.** ***Drought Modifies Land-Use Effects on Arthropod Communities in an Urban Desert Ecosystem.

Harding, Bridget, Sky Arnett-Romero, Dan Allen, Albert Ruhi, and Heather Bateman.** ***Drought and Time Modify Land-Use Effects on Bird Community Structure in an Urban Desert Ecosystem.

Hutton, Pierre, and Kevin J. McGraw.** ***Coping with Light Pollution: Sleep, Stress, and Sickness in City Songbirds.

Johnson, Chad, Dale Stevens, Annika Vannan, Allison Maney, and Javier Urcuyo. ***Urban Pests on an Urban Heat Island: Black Widow Behavioral Plasticity to Elevated Nighttime Temperatures.***

MacNeille, Benjamin, Dan L. Childers, and Ferran Garcia-Pichel.** ***Microbial Biodiversity in Phoenix's Public Phyllosphere.

Weaver, Melinda, and Kevin McGraw.** ***Bold Urbanites and Shy Hillbillies? Variation in Novel Environment Exploration in **Haemorhous mexicanus.**

LAND USE, LAND COVER, LAND ARCHITECTURE, AND ECOSYSTEM SERVICES

Burnette, Riley, Paige Warren, Susannah Lerman, Heather L. Bateman, Kelli Larson, and Jessica Hoffmann. *Linking Residential Landscape, Socioeconomic Status, and Perceptions to Bird Diversity.

Cook, Elizabeth M., and Olga Barbosa. *Maximizing Urban Services in the Future of Valdivia, Chile with Green and Gray Infrastructure.*

***Fan, Chao, S. J. Rey, Soe W. Myint, and Winwin Li. *A Continuous Approach to Evaluating Vegetation and Built-Up Dynamics in a Fast Growing Desert City*.**

Hoffman, Jessica, Kelli Larson, Marcia Nation, and Riley Burnette. *Residential Landscape Changes: Results from PASS 2006 to 2011.

Palta, Monica M., Margaret V. du Bray, Rhian Stotts, Amber Wutich, and Amanda Wolf. *Urban "Accidental" Wetlands Mediate Water Quality and Heat Exposure For Homeless Populations in a Desert City.*

Wheeler, Megan M., Jennifer Learned, Hannah Heavenrich, and Sharon J. Hall. *Regional Patterns and Homogenization of Residential Yard Soil Moisture in US Cities.

SUSTAINABLE FUTURES

Chakalian, Paul. *Robustness Analysis of Phoenix, AZ Heat as a Social Ecological System.

***Colter, Kaylee R., and Chris A Martin. *Evaluating Sustainable Landscapes in the Arid Southwest*.**

Davidson, Melissa, David Iwaniec, Elizabeth Cook, and Nancy Grimm. *Co-development of Sustainable Future Scenarios for the Central-Arizona Phoenix Region*.

Sampson, David A., David Iwaniec, and Melissa Davidson. *The Adaptive Sustainable Scenario Future as Simulated using WaterSim.*

WATER DYNAMICS IN A DESERT CITY

Buell, Andrew, Matt Sokolowski, and Peter Fox. *An Investigation of Factors Affecting the Spread of* D. bugensis *in Arizona's Reservoirs.

Fang, Lei, Enrique R. Vivoni, and Giuseppe Mascaro.** ***Regional Assessment of Observed Rainfall-Runoff Relations in Maricopa County and Its Hydrologic Modeling for Selected Areas.

Hanigan, David, Robert Reed, Yu Yang, Sungyan Lee, and Paul Westerhoff. ***Measuring Nanoparticulate and Dissolved Titanium in Urban Recreational Waterways near Phoenix, AZ.***

Hester, Cyrus M., and Kelli L. Larson.** ***The Effects of Population, Policy, and Economic Change on Water Use in Tucson and Phoenix, Arizona 1990–2014.

Patel, Sarah, Jacelyn Rice, Rhian Stotts, Amber Wutich, and Alexandra Brewis.** ***Cross-Cultural Perceptions of Health Implications from Wastewater Reuse in Fiji, Guatemala, New Zealand, and Spain: Results of the 2013 Global Ethnohydrology Study.

Abstracts

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

Alvarez Guevara, J.[1], B. Ball[1], and S. J. Hall[2]. *Urbanization Alters Terrestrial Herbivore Composition but not Abundance.

Desert ecosystems are one of the fastest urbanizing areas on the planet. This rapid shift has the potential to alter the abundances and species richness of herbivore and plant communities. Herbivores, for example, are expected to be more abundant in cities due to the concentration of food resources and reduction in carnivore populations. Despite this assumption, previous research conducted in urban Phoenix has shown that top-down herbivory led to equally reduced biomass. Since there are no published data reporting the abundance and density of herbivores within and outside Phoenix, it is unclear if this insignificant difference in herbivory at rural and urban sites is due to unaltered herbivore populations, or altered activity levels that counteract abundance differences. Vertebrate herbivore populations were surveyed at four sites inside and four sites outside of the city core during fall 2014 and spring 2015 in order to determine whether abundances and diversity differ significantly between urban and rural sites. Results suggest that the commonly assumed effect of urbanization on herbivore abundances does not apply to small rodent herbivore populations in a desert city. Surprisingly, the data indicates that small rodent abundances were statistically similar inside and outside of the city. A significant difference between small rodent genera diversity, however, was observed and highlights the fact that certain genera of small rodents dominate urban sites. This significant difference was not found at the species level. Additionally, certain species were identified at all of the sites while others were only found in rural or urban parks suggesting that species have different levels of urban tolerance.

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Arnett-Romero, S.[1], B. Harding[2], D. Allen[1], and A. Ruhi[3]. *Drought Modifies Land-Use Effects on Arthropod Communities in an Urban Desert Ecosystem.

CAP LTER has surveyed ground-dwelling arthropod communities inhabiting different types of land-use areas throughout the greater Phoenix metropolitan area since the late 1990s. Here we investigate arthropod pitfall traps surveyed from 2002-2014 across desert, agriculture, mesic urban, mesic/xeric mixed urban, and xeric urban areas. Effects of land use and time Abundance and species richness were explored using General Linear Mixed Models (GLMMs). We found significant land-use X time interactions for both arthropod abundance and richness, indicating that the effects of land use on arthropod communities were not consistent over time. Accordingly, we investigated variation in land-use effect sizes (as measured using Cohen's d) might be affected by drought and time, but effects drought and time did not explain significant variation in land use effect sizes. However, further analyses did indicate that the effects of droughts on arthropod abundance and species richness differed depending on land use type. Drought had strong effects on arthropod abundance in desert land uses, but weaker effects on arthropod abundance in agriculture and urban land uses. For arthropod richness, droughts explained more variation for mesic

sites than others. Future work on this project will be to investigate the long-term effects of land use on beta diversity patterns and community structure of arthropod communities.

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Ball, B. A.[1], S. J. Hall[2], J. Ripplinger[2,3]. *Influence of Climate, Plant Communities, and Land Use on Long-term Patterns of Soil Properties in the CAP LTER Ecosystem.*

In urban ecosystems, enhanced nutrient inputs alter ecosystem processes such as rates of soil nutrient turnover and transformations among pools. Additionally, scholars have illustrated the role of both climate and irrigation as drivers of regional primary productivity and diversity. Therefore, it is likely that changes in climate, plant community diversity, and land use over the last 15 years will have significant impacts on soil properties and stoichiometry in the CAP LTER ecosystem. Numerous papers have explored the relationship between soil properties and land-use in the CAP LTER ecosystem using data from 2000, the initial year of the Survey 200. However, no studies have yet explored the rate of change in soil properties through time, or linked long-term changes in soil properties to plant communities and climate.

We synthesized the 2000, 2005 and 2010 Survey 200 soil, plant, land-use, and climate datasets to answer the questions: (1) How do soil physical properties and chemistry change over time across different land-uses in the CAP ecosystem? (2) Are patterns in soil properties related to plant communities, and do these relationships depend on land-use?

We hypothesize that nutrient content of agricultural and urban soils will exhibit high temporal variability between the three survey years compared to unmanaged desert soils; whereas, nutrient content of desert soils will be more strongly related to seasonal precipitation. Also, we expect desert soil nutrients will be more closely related to plant composition than on agricultural or urban soils. By contributing to understanding human impacts on soil structure and function, this study explores important soil ecosystem services, which in turn aids in understanding the consequences of alterations in these important services.

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Beute, S.[1], C. Blodgett[2], W. Hodgson[1], K. McCue[1], K. Vonderscher[3], and S. Rothwell[4]. *Co-Creating Citizen Science in the Phoenix Mountains Preserve: The North Mountain Plant Inventory Project.*

Public participation in scientific research (PPSR), commonly called citizen science, has the potential to gather scientific data at large spatial and temporal scale, advance scientific literacy in participants, facilitate communication between scientists and stakeholders, and grow the capacity for science-informed policy and management. However, research suggests many projects fail to capitalize on the potential created by public participation. Capturing desired scientific, individual, and socio-ecological outcomes in a PPRS project is linked to the level of public participation in the research process and the degree to which the project is relevant to and meets the needs and interests of its volunteer participants. In an effort to realize a suite of these potential outcomes for citizen science, in early 2012,

members from several Central Arizona Conservation Alliance organizations convened a series of public meetings, forums, and informational sessions in an effort to align interests and goals toward the co-creation of a citizen science-based research project in the North Mountain/Shaw Butte section of the Phoenix Mountains Preserve. Using deliberate design methods, the team successfully aligned scientific and public interests to co-create the North Mountain Plant Inventory Project.

The Project launched in December of 2012 and is still in operation today. While official evaluation is pending, evidence suggests the Project has been successful in achieving intended outcomes by design. Additionally, the Project has produced a series of unintended, positive outcomes generated by public participants. We demonstrate that when seeking a suite of scientific, individual, and socio-ecological outcomes, a deliberate design process inclusive of the diversity of stakeholders' interests is an effective strategy.

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Buell, A., M. Sokolowski, and P. Fox. *An Investigation of Factors Affecting the Spread of* D. bugensis *in Arizona's Reservoirs.

Dreissena bugensis, known commonly as the Quagga mussel, has inhabited several Arizona Reservoirs since 2007-2008 including Lake Mead, Lake Havasu, and Lake Pleasant. Despite high volumes of recreational watercraft travel between these reservoirs and other reservoirs on the Salt River/Verde River systems, *D. bugensis* has been unable to spread to them. This research focuses on determining the factors that are limiting the infestation. Preliminary laboratory investigations have determined that survival of adult specimens introduced into water sampled from Saguaro Lake, Bartlett Lake, and SRP canals is not negatively affected by differences in water chemistry. Turbidity spikes up to 20 NTU were also tested but did not negatively impact survival. Predation by Calanoid copepods has also been ruled out as they have been detected in Lake Pleasant (infested) but not Saguaro Lake or Bartlett Lake (non-infested). The underlying cause appears to be differences in temperature and dissolved oxygen profiles, which are influenced by the trophic structure of the reservoirs. Data from the Regional Water Quality Samping Project was examined to observe seasonal trends. Non-infested reservoirs show dissolved oxygen concentrations well below survivable minimums for *D. bugensis* while infested reservoirs remain oxygenated enough to maintain populations. Future research will investigate the impacts of this phenomenon on spawning as well as duplicate environmental conditions in a laboratory setting to observe survival rates in adult specimens.

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Burnette, R.[1], P. Warren[2], S. Lerman[3], H. L. Bateman[1], K. Larson[4, 5], and J. Hoffmann[4]. *Linking Residential Landscape, Socioeconomic Status, and Perceptions to Bird Diversity

Cities are a patchwork of landscape design and social attributes, both of which have the potential to impact biodiversity outcomes and human interactions with wildlife. We used data from the Phoenix Area Social Survey (PASS) to connect landscape choices, neighborhood demographics, and perceptions of bird variety with field measurements of

the bird community between PASS 2 (2006) and PASS 3 (2011). We defined residential parcels as Mesic, Oasis, and Xeric based on respondent's selection of the landscape type that resembled their front and back yard. Bird richness and occupancy decreased. The percentage of respondents satisfied with bird variety was positively correlated with native bird richness and decreased by more than 10% from PASS 2. A redundancy analysis showed that desert specialist species decreased in neighborhoods with a higher percent of renters and Hispanic descent; and increased in neighborhoods with a higher per capita income. Yard type was an important element for explaining the bird community in Phoenix. The majority of desert specialists were positively associated with xeric landscaping, indicating that desert species increased in abundance with greater amounts of drought tolerant, desert vegetation and gravel ground cover. Non-native species were positively associated with neighborhoods containing mesic yards. Community assemblage patterns were consistent between PASS 2 and PASS 3. Our study provides longitudinal insight into how yard composition and socioeconomic variables structure bird communities. By understanding what neighborhood factors are important for biodiversity we can manage cities in a way that is beneficial for native biota and human well-being.

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Cayetano, Z.[1,4,5,6], R. Taylor[1,6], C. Monahan[2,6], E. Campbell[1,6], K. O'Brien[5,6], R. Lydford[1,6], and A. Dicker[1,3,6]. *The Influence of Vegetation and Built Environments on Midday Summer Thermal Comfort.

The current study assesses the ability of vegetation to improve thermal comfort during desert summers. Microclimate data and fish-eye photos were collected at nine sites throughout a single section of Arizona State University campus (Tempe, Arizona) from September 18 to September 29, 2015, when thermal discomfort is at its peak intensity. Between sites, vegetation varied from desert grasses to nearly full overhead canopy. Other components of urban form, such as proximity to buildings, were controlled between sites but often varied as well. Using the air temperature, humidity and wind speed observations, the RayMan model calculated Physiologically Equivalent Temperature. The model was evaluated and validated using Mean Radiant Temperature data derived from observations of globe temperature. A t-test confirmed that the PET levels of the sun-exposed sites were significantly higher than those of shaded sites by 7.7 °C regardless of the type of shade. Furthermore, the variation in vegetation did not influence humidity between sites, and thus did not impact thermal comfort between the same. Sky View Factor was calculated as the percentage of visible sky in each site's fish-eye photo. Midday PET levels only loosely correlated with Sky View Factor, indicating a stronger dependency on momentary than diurnal shading.

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Chakalian, P.** ***Robustness Analysis of Phoenix, AZ Heat as a Social Ecological System.

This project proposes a framework for analyzing the robustness of the Phoenix urban area extreme heat infrastructure using an institutional analysis and development design. Cities have a finite capacity to dissipate heat into the environment; I consider this a resource that Phoenix residents use within a resource system. This resource can be amplified or attenuated by human-made public and private infrastructure, which can include, public green spaces and building codes, or private net-heat-generating air conditioning and automobiles. The common pool resource dilemma is the potential for under investment in public infrastructure and over appropriation of the resource. The institutions in the Phoenix case study create a public goods style social dilemma, whereby no individual will pay enough for the non-excludable and more symmetrical benefits of public cooling infrastructure, leading to private cooling behaviors at the expense of optimal aggregate cooling capacity. The resource system is vulnerable to exogenous shocks: to the resource through climactic and weather changes, to the public infrastructure through disasters and natural entropic processes, to the public infrastructure providers through political and economic variability, and to resource users from variable finances and mobility. Resource users are also vulnerable to endogenous shocks from personal decision-making about for example, hydration and attire. Framing the problem this way exposes specific governance challenges: measuring the city's capacity to dissipate heat, determining an equitable distribution of that resource, monitoring and sanctioning that distribution, and building institutions that are robust to shocks.

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Chipman, D.[1], K. Larson[1,2], and A. Wutich[3].** ***Calculated Risk: Comparing Perceptions of Climate Change Impacts and Responsibilities.

Climate change is a global problem, but perceptions of its severity and impacts have been shown to vary by a person's location. To begin to characterize and compare how climate change risk perceptions vary around the world, we evaluate various dimensions of risk perceptions, including types of risk, location and scale of risk, and individual versus collective responsibility for addressing climate change, from six cities around the world, including Phoenix, Arizona. Data for this analysis comes from the 2012 Global Ethnohydrology Study, conducted in association with Arizona State University's Decision Center for a Desert City. The study consisted of in-person surveys with open-ended and close-ended questions about climate change uncertainty. This analysis considers responses from six cities, drawing comparisons among individual sites and between developed versus developing contexts. The developing sites surveyed were located in China, Fiji, and Mexico, while the developed sites included were in Australia, New Zealand, and the United States. The results show that residents in less developed sites tend to have higher perceptions of risk, and they also believe that the impacts of climate change will occur sooner than residents of more developed sites. Respondents from developing locations also tend to have a stronger belief in their own ability to reduce climate change by changing their behavior. All respondents overwhelmingly indicate that their country has a responsibility to deal with climate change, but that their government is currently not doing enough. Overall, residents in developing and developed contexts exhibit significant differences in their perceptions of climate change risk. Understanding these differences can help policymakers develop place-specific strategies for climate change mitigation.

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Colter, K. R., and C. A Martin.** ***Evaluating Sustainable Landscapes in the Arid Southwest.

More methods need to be developed to evaluate the performance of sustainable strategies in designed landscapes. Doing so will help to articulate the benefits such projects provide and establish best practices for designers to implement. Programs such as the Sustainable Sites Initiative (SITES) have started this process by providing the first set guidelines strictly for sustainable landscape projects, but even that comprehensive program cannot capture all of beneficial aspects of a well-designed space. During summer 2014, a case study investigation pairing researchers with practitioners was conducted to document performance benefits provided by two Phoenix metropolitan area parks, George “Doc” Cavalliere Park, Scottsdale, AZ and Civic Space Park, Phoenix, AZ. “Doc” park is a 13.8-Hectare, peri-urban public park designed to provide traditional park amenities without infringing on existing desert habitat. Civic Space Park is a 1.0-Hectare urban park, designed to provide a cool-island in the downtown core. Utilizing resources from the project designers along with original research, sustainable design strategies were evaluated and performance benefits unique to each project were developed. Benefits spanned economic, social, and environmental categories to target: stormwater management, water use, energy conservation, habitat creation, microclimate modification, tree health, and park use. These results showed the importance of tailoring sustainable practices to each specific project site. Experiences gained from this case study investigation revealed challenges associated with quantifying the benefits of sustainable-designed public landscape spaces.

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Comeaux, V.** ***Performing Environmental Education Outreach with Preschool to Middle School Age Children in the Phoenix Metropolitan Area.

Funded by the Central Arizona-Phoenix Long Term Ecological Research program, Ecology Explorers seeks to improve the scientific literacy of Arizona’s citizens and to shape a better community by giving students, teachers, and community members the opportunity to study the ecology of our desert cities and the real-world issues they face. Ecology Explorers focuses its educational efforts within the environmental and social aspects of sustainability. The program desires to create environmental awareness and positive behavior change by educating the individuals who impact the earth. Particularly, the program focuses on children, who make up the future generation which will eventually be tasked with addressing the sustainability issues created and perpetuated by past and present generations. The program addresses environmental sustainability by teaching lessons on ecological concepts relevant to both the environment of central Arizona and the global environment. It addresses social sustainability by working directly with the social systems who affect and are affected by the environment, and by incorporating the concept of human-environmental relationships and impacts within the lessons.

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Cook, E.M., and O. Barbosa. ***Maximizing Urban Services in the Future of Valdivia, Chile with Green and Gray Infrastructure.***

Urban social-ecological systems are increasingly threatened by changing climate and extreme events. Cities in developing countries, such as in Latin America, are particularly vulnerable to extreme events due to outdated infrastructure with increasing upkeep costs and decreasing efficiency. Green infrastructure (e.g., wetlands) is an economically feasible alternative to built gray infrastructure (e.g., drainage pipes). In addition, green infrastructure provides a multi-functional set of ecosystem services, such as flood and temperature mitigation that contribute to the future resilience of cities. We examined the potential for green and gray infrastructure to provide complementary solutions to regulate flooding and temperature in Valdivia, Chile by modeling spatially explicit indicators of ecosystem services (e.g., runoff and surface thermal emissions). Valdivia is a unique Latin American case study. Valdivia receives >1800mm annual precipitation and has a high proportion of wetlands within the urban boundary that are important for flood regulation. However, a lack of development regulations is leading to significant loss of wetlands due to rapid development. As a decision support tool, we assessed tradeoffs in three future scenarios of Valdivia based on existing development strategies (e.g. business as usual development) and future sustainability goals from municipal planning documents (e.g. protecting wetlands and "smart city" growth). For example, flood mitigation from a combination of the natural and built environment was stronger in a scenario to protect wetlands than a smart growth scenario. We expand the existing framework of ecosystem services in cities by incorporating services provided by green infrastructure, as well as gray infrastructure and combinations ('hybrids') of green and gray infrastructure.

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Davidson, M.[1], D. Iwaniec[1], E. Cook[3], and N. B. Grimm[1,2]. ***Co-development of Sustainable Future Scenarios for the Central-Arizona Phoenix Region*****.**

Urban sustainability and resilience are increasingly important guiding visions for cities. Complex and changing interactions between people, infrastructure, land, water, food, energy, and climate present an array of challenges for sustainability and resilience planning. Urban ecology can bring useful knowledge and perspectives on the future development of cities, but requires collaborative approaches to address city planning and management needs. We present our framework for co-developing scenarios to explore alternative social-ecological-technological futures that embrace the complexity and changing interactions characteristic of urban environments. We used three scenario approaches: adaptive, strategic, and transformative futures. Adaptive futures were developed to capture responses to extreme events. Strategic futures were projected forward using existing municipal goals and targets. Transformative futures were back-casted from radically transformed visions of sustainability. The framework highlights methods to integrate plausibility-based futures (what is most likely to happen) and desirability-based futures (what we would like to happen). Through a series of collaborative workshops with local community, municipal, and academic stakeholders, we identified key priorities and strategies that decision makers are using to frame development for urban, agricultural, and desert systems in central Arizona, and to address weather-related extreme events (i.e., flood, drought, and heat). We also identified systems and normative conflicts and trade-offs within the distinct future pathways. This project demonstrates how scenario construction can enhance the utility of CAP LTER research to decision-making capacity for long-range sustainability planning.

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du Bray, M., A. Wutich, R. Stotts, and A. Brewis.** ***Hope, Fear, and Worry: Emotional Geographies of Communities Affected by Climate Change.

The changing climate in the American West increasingly represents a threat to individuals and communities who live and depend on resources from the land. For many people living in the West, there is a strong sense of attachment to their landscapes; these areas often become central in emotional understandings of the way the climate is changing, and the effects that people may feel as a result. The 2014 Global Ethnohydrology Study explored the relationships between climate change, local ecological knowledge, and distress in three communities: Phoenix, Arizona, Kodiak, Alaska, and the Gulf Coast of Alabama. To better understand the relationship between the domains of climate change, local knowledge, and distress, we paired structured open-ended questions with close-ended survey questions. Using a Key Words in Context Analysis, we have explored the variability in emotional distress across the three sites. Results from this work will contribute to knowledge on how communities affected by climate change respond emotionally.

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Eagar, J. D.[1], P. Herckes[1], and H. E. Hartnett[1,2].** ***Particle Deposition and Frequency of Haboobs in the CAP LTER.

In the CAP region summer monsoons foster intense dust storms, i.e., haboobs. In these events, thunderstorms produce convective outflows that lift dust hundreds of meters into the air into what appears as a billowing wall of dust. There has been increased interest in haboobs in social media and in the press during the last several years with speculation that haboobs have become more intense and more frequent in recent years. This poster presents basic statistics of CAP haboobs from 2005 to 2014. The dry deposition of all suspended particles (TSP) was predicted to be orders of magnitude larger than that of particles with aerodynamic diameters less than 10 µm (PM10). Annual TSP deposition varied substantially from year to year, ranging from 320–4000 kg ha-[1]. There is little clear evidence for changes in Tempe Town Lake water chemistry that are coincident with haboob events. This may be due to the fact that haboobs generate large-sized dust which may settle rapidly or dissolve slowly in the lake. Future research is warranted to identify the chemical impact of haboobs on other systems in the CAP urban ecosystem.

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Elser, M., M. Nation, and S. Earl. ***Engaging Non-Scientists in Urban Ecology: Lessons Learned from Designing, Implementing, and Sustaining Three Place-Based Citizen Science Projects.***

The Central Arizona-Phoenix Long-Term Ecological Research (CAP LTER) program has been involved in several citizen science initiatives over its 17-year history. In this poster, we examine several of these initiatives of varying durations: The Ecology Explorers program (15 years-old) and the McDowell Sonoran Conservancy Partnership (3 years old) involve

replicating CAP LTER protocols with non-scientists (k-grey). Other initiatives such as the Urban Tree Community Science initiative and the Phoenix Phenology Trail involve community partners interested in collecting urban ecological data but not linked directly with CAP LTER protocols.

We examine issues of participant recruitment, engagement and retention; technology use in program delivery; and the challenges of channeling resources to citizen science ventures. We reflect on how our ideas about effective strategies for engaging citizen scientists have changed over time, and how we have tried to make these changes in our more recent programming. Designing, implementing, and sustaining effective place-based citizen science programs requires more than just a good idea; these require dedicated human and fiscal resources and clear implementation plans.

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***Fan, C., S.J. Rey, S.W. Myint, and W. Li. *A Continuous Approach to Evaluating Vegetation and Built-Up Dynamics in a Fast Growing Desert City*.**

Human impacts on the natural environment has been a central topic over the last two decades. Urban growth, from regional sprawl to global urbanization, is the most rapid, drastic, and irreversible form of human modification of the Earth's surface. Accurate and updated knowledge of the spatiotemporal pattern of urbanization is an important step in understanding the impacts of urbanization on the socio-ecological processes. Our study builds on previous efforts on urban landscape pattern mapping and integrates long image time series, continuous spatial indices, and non-parametric methods in a spatiotemporal study of vegetation and built-up dynamics. Two local indicators of spatial association are utilized to measure the concentration and spatial arrangement of two important urban land use types—vegetation and built-up areas over the Phoenix metropolitan area. We employed the Mann-Kendall test to detect the monotonic trends in the quantity and pattern of vegetation and manmade features over the last two decades. Our preliminary results show that 16.15% and 28.02% of the urban area in 2010 has a significant increasing and decreasing trend in the quantity of vegetation, respectively. Comparatively, 15.41% and 22.06% of the urbanized land in 2010 indicates a significantly growing and declining pattern in the concentration of built-up areas. Findings from this study improve our understanding of the human impacts on the natural environment, which is of paramount importance for sustainable urban development in the context of rapid global change.

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Fang, L.[1], E. R. Vivoni[2], and G. Mascaro[3]. *Regional Assessment of Observed Rainfall-Runoff Relations in Maricopa County and Its Hydrologic Modeling for Selected Areas.

The U.S. Geological Survey and the Flood Control District of Maricopa County have been collecting long-term, high-resolution rainfall and runoff data for the purposes of emergency alerts and flood hazard assessments. Nevertheless, these observations have been generally underutilized for the purposes of regional hydrologic analyses and modeling. In this study, we conduct an assessment of the regional rainfall-runoff relations obtained from a large set of urban and rural watershed in Maricopa County, illustrating the variations in the watershed responses according to season and urbanization extent. From this analysis, a

subset of watersheds was selected to perform modeling activities using the HEC Hydrologic Modeling System (HMS) at the scale of individual storm and flood events. We discuss the selection of relevant hydrologic data, processes and parameters and the practical application of the model using ArcGIS, HEC-GeoHMS and HEC-HMS tools. Using the modeling system, we conduct model calibration and testing activities and discuss the differential response of urban and rural watersheds to storm events in the region. This study is a first step toward the development of regional hydrologic modeling tools that can help a wide range of stakeholders interested in flood control, hydrologic design and hazard assessments.

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***Handler, A. M.[1], A. K. Suchy[1], N. B. Grimm[1], M. M. Palta[2], D. L. Childers[3], and J. C. Stromberg[1]. *Microbial Nitrogen Removal in the Salt River Wetlands of Phoenix, Arizona*.**

Wetlands have emerged in the urban Salt River channel of Phoenix, Arizona, due to urban runoff draining into the formerly dry river channel. Water delivered by storm drains is enriched in nitrogen, particularly nitrate, which is a groundwater pollutant in Arizona. Microbially-mediated nitrate removal requires low oxygen and high organic carbon availability, conditions common in wetland soils. Wetlands in the bed of the Salt River therefore potentially have the ability to significantly increase water quality in surface and, eventually, groundwater in Phoenix. We investigated the chemical characteristics of the Salt River wetlands and conducted soil incubation experiments to evaluate potential for nitrogen attenuation by two microbial nitrate transformations: denitrification and dissimilatory nitrate reduction to ammonium (DNRA). We found that subsurface sediment porewater had significantly lower nitrate concentrations (5.5 ± 2.0 µg L^{-1}) than surface water (47.9 ± 8.5 µg L^{-1}). Soil porewater had significantly lower dissolved oxygen (1.8 ± 0.1 mg L^{-1}) than surface water (4.4 ± 0.5 mg L^{-1}) and high dissolved organic carbon concentrations (6.3 ± 0.2 mg L^{-1}), indicating conditions conducive to microbial nitrate reduction. In incubations, soils were treated with nitrate concentrations similar to either storm or baseflow concentrations of nitrate observed in the Salt. Nitrate declined exponentially throughout the incubation in both treatments ($p<0.001$). Ammonium concentrations increased linearly over the incubation time ($p<0.01$), indicating that DNRA may contribute to nitrate removal in the Salt River wetlands. Total decrease in nitrate exceeded ammonium accumulation, suggesting that the Salt River wetlands may provide a net ecosystem benefit by removing excess inorganic nitrogen.

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Hanigan, D., R. Reed, Y. Yang, S. Lee, and P. Westerhoff. *Measuring Nanoparticulate and Dissolved Titanium in Urban Recreational Waterways near Phoenix, AZ.*

Use of engineered TiO_2 nanoparticles (NPs) in products such as sunscreen, paints, and foods is leading to concern they may enter the environment, with potentially harmful effects. Predicted surface water concentrations in the ng/L to µg/L range make detection and quantification of these particles difficult without pre-concentration techniques and/or sensitive spICP-MS methods. Water samples were collected from swimming pools and the Salt River near Phoenix, Arizona during summer. TiO_2 NPs were detected in river water using cloud point extraction and subsequent analysis by transmission electron microscopy with energy dispersive X-ray analysis, and compared with NPs found in sunscreen. Diurnal measurements of river water were made using single particle inductively coupled plasma mass spectrometry and showed an 80% Ti-containing particle concentration increase in the afternoon, from $1.5x10^4$ L^{-1} to $2.7x10^4$ particles/L, which paralleled changes in an active organic sunscreen additive.

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Harding, B.[1], S. Arnett-Romero[2], D. Allen[2], A. Ruhi[3], and H. Bateman[2]. *Drought and Time Modify Land-Use Effects on Bird Community Structure in an Urban Desert Ecosystem.

Over the last 15 years, Central Arizona-Phoenix Long-term Ecological Research (CAP LTER) teams have collected data on land-use and bird sightings on 46 sites across the Greater Phoenix Area. We investigated how land-use effects on bird community species richness abundance varied over time. We used General Linear Mixed Models (GLMMs) to with land use and time as crossed fixed effects. Results showed a significant land-use by time interaction on both species richness and abundance, indicating that land-use effects were not consistent over time. Further analyses indicated that show that the magnitude of land use effect sizes on bird abundance were predicted to the occurrence of droughts (as measured by Palmer Drought Severity Index, PDSI), with effect sizes being largest during dry periods one year prior to and during the survey. Land use effect sizes on bird species richness were also influenced by droughts, with larger effects during dry periods one year prior to and wet periods during the survey; however land use effect sizes on bird species richness also increased over time. In fact, a priori planned contrasts indicated that significant differences between land uses were not observed until 2013 and 2014. Thus, variation effects of land use on bird abundance and species richness were related to time-lag and current effects of drought, and land effect use effect size on species richness also is growing over time. Future work on this project will be to investigate the long-term effects of land use on beta diversity patterns and community structure of bird communities.

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Hartnett, H.[1,2], M. van Schajik[3], M. Palta[1], A. Ruhi[4], and N. Grimm[4]. *Modeling DOC Quantity and Quality in Tempe Town Lake: Time-Series Analysis of a 10-Year Data Set.*

Tempe Town Lake (TTL) is a man-made lake in Tempe, AZ. It provides flood mitigation and recreation to the region and provides a unique test-bed for studying urban

biogeochemistry. TTL receives inputs from rainfall, storm flow, and upstream river discharge. We used ARIMA time-series modeling to evaluate drivers of change in dissolved organic carbon (DOC) concentration and quality over the last three years. Carbon quality is represented by fluorescence characteristics (fluorescence index, humification index, Freshness) corresponding to carbon source and reactivity.

Model comparisons of bi-weekly DOC measurements vs. monthly averages suggest monthly averages are insufficient to capture high-resolution temporal dynamics induced by external and internal drivers. Significant seasonality was observed in all DOC quantity and quality parameters. Algal production appeared to be the strongest driver of DOC quantity, since oxygen (O_2) saturation yielded the best-fit model for DOC quantity. However, external drivers (rainfall, dry periods, overland flow) were important determinants of DOC quality. It appears that dry periods allow carbon to accumulate on land surfaces, which is then delivered to the lake via rainfall. Dissolved O_2 is supersaturated over 70% of the 10-y time-series, strongly suggesting the lake is predominantly autotrophic. The decommissioning, in 2012, of a treated-effluent outfall into the lake also appears to have fundamentally shifted DOC input and carbon dynamics. We are comparing findings from the last three years to other periods in the 10-year dataset, to test whether driver-DOC relationships are robust, and how longer-scale changes in lake management and climate have driven changes in DOC over time.

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Hester, C.M.,[1] and K. L. Larson[1,2]. *The Effects of Population, Policy, and Economic Change on Water Use in Tucson and Phoenix, Arizona 1990–2014.

Managing water resources in an arid climate during rapid urbanization is one of the major sustainability challenges of the 21st century. Despite growing populations, many American cities have seen reduced per capita water usage over the last quarter of a century. Arizona's largest cities, Phoenix and Tucson, are no exception. Both cities have benefited from declining rates of per capita water use despite very different approaches. This study first conducts a breakpoint analysis to identify key periods of change in the water use of each city. It then employs a structural decomposition analysis to estimate the degree to which policy tools, drought, and economic restructuring can account for sector-level water trends. In so doing, we may gain a better understanding of how the urban metabolism of water is transforming and what this means for the resilience of arid cities in a century of change.

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Hoffman, J.[1], K. Larson[1,2], M. Nation[3], and R. Burnette[4]. *Residential Landscape Changes: Results from PASS 2006 to 2011.

We sought to understand how the landscapes of the houses and residents we surveyed have changed from 2006 to 2011 for the importance of understanding urban ecology and sustainability. There is a strong connection between water consumption and landscape about 70% of Arizona residential water consumption is used outdoors. The 2011 Phoenix

Area Social Survey (PASS) surveyed 806 houses, 365 of the responses came from the same address in 2006. Of the 365 repeat houses, 196 individuals were the same participant in 2011 and 2006. For the purposes of this study, responses from repeat houses (n=365) as well as repeat individuals (n=196) have been analyzed. The patterns in landscape change were analyzed with cross-tabulations. The survey question involved asked respondents which of the following types of landscapes resembles their front and back yards separately: Mesic – a yard with grass, some shrubs and leafy trees, Oasis – a yard with some grass and some crushed stone with plants, shrubs and trees, Xeric – a yard with crushed stone and native desert plants and trees, Patio – a yard with large areas of hard surface, such as flagstone or finished concrete, and plants and shrubs in containers, and Other – all other types of landscape. Overall, the majority of yards in our samples did not change landscape types between 2006 and 2011. In the front, the aggregate shift in residential landscapes has been away from mesic and oasis toward oasis and xeric landscapes. For both samples, the most common shift for front yards was from oasis to xeric; for the back, yards changed from oasis, and less so mesic and xeric, to more mesic and oasis yards.

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Hutton, P., and K. J. McGraw.** ***Coping with Light Pollution: Sleep, Stress, and Sickness in City Songbirds.

Animals have evolved to time their biological rhythms with the predictable rise and fall of the sun. Contemporary increases in light exposure, such as in urban environments, may therefore introduce a strong selection pressure for individuals, species, populations and communities of animals. Using house finches (*Haemorhous mexicanus*) in Phoenix, we tested the hypothesis that urban finches, which are exposed to light throughout night, are more resilient to its effects than rural finches, which are further removed from its influence. Specifically, we predicted that under constant light rural finches have increased stress and disease progression, and reduced sleep compared to urban birds. Overall, our results suggest that birds may rapidly develop resistance to the negative effects of shifting photoperiods. Additionally, we underscore how important these mechanisms (or lack thereof) are for conserving global biodiversity due to the broad geographic reach of light pollution.

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Johnson, C., D. Stevens, A. Vannan, A. Maney, and J. Urcuyo. ***Urban Pests on an Urban Heat Island: Black Widow Behavioral Plasticity to Elevated Nighttime Temperatures.***

Urbanization results in dramatic changes to the natural landscape, including habitat fragmentation and loss of natural habitat. Certain species, termed 'urban exploiters', flourish in urban centers, sometimes outcompeting, and thus reducing, native biodiversity. However, the mechanism by which urban exploiters are able to dominate in urban ecosystems is not yet well understood. The black widow spider, *Latrodectus hesperus*, is a super-abundant urban pest species native to the desert Southwest. My laboratory has been actively testing the hypothesis that behavioral plasticity allows this urban pest to thrive following urbanization. Here we examine the effect of elevated temperatures on the

behavioral repertoire of black widows. In particular, the urban heat island (UHI) in Phoenix, AZ has resulted in elevated nighttime temperatures. Specifically, with past CAP support, we have used ibuttons to show that urban black widows experience a four degree Celsius elevation in nighttime temperature relative to their desert counterparts. Thus, we test the hypothesis that the UHI affects the behavioral repertoire (e.g. courtship, cannibalism, web building, foraging success) of black widows.

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MacNeille, B.[1], D. L. Childers[1], and F. Garcia-Pichel[2]. *Microbial Biodiversity in Phoenix's Public Phyllosphere.

Urban areas worldwide are experiencing an influx of human population resulting in multi-scalar environmental changes, including diminished air quality. Motor vehicle transportation is a major contributor to air pollution in urban areas, especially to fine particles (PM 2.5), which are associated with adverse health effects and mortality. One strategy employed by the City of Phoenix to improve air quality is by planting trees near roadsides to intercept and trap air pollutants. This project focuses on the microbial colonizers of the surfaces of plant tissues (i.e. the phyllosphere) that may play an important role in urban biogeochemical cycling in the presence of pollutants.

The objective of this project is to: 1) characterize the composition and biogeochemical function of microbial communities inhabiting the urban phyllosphere of city trees in Phoenix; 2) evaluate community variation due to differences in exposure to motor vehicle pollutants. I use molecular techniques to quantify the density, community composition, and prevalence of select functional genes within microbial communities inhabiting leaf surfaces. My ultimate goals are to create ecological knowledge about this "new" urban environment and to inform strategic tree planting and management of the Phoenix urban forest.

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Palta, M.M.[1], M. V. du Bray[2], R. Stotts[2], A. Wutich[2], and A. Wolf[3]. *Urban "Accidental" Wetlands Mediate Water Quality and Heat Exposure For Homeless Populations in a Desert City.*

In urban settings where humans interact in complex ways with ecosystems, there may be hidden or unanticipated benefits (services) or harm (disservices) conferred by the built environment. We examined interactions of a highly vulnerable population, the homeless, with urban waterways and wetlands in Phoenix, Arizona. Urban wetlands that are created "accidentally" (by water pooling in abandoned areas of the landscape) have many structural (e.g., soils and hydrology) and functional (e.g., high denitrification) elements that could provide services similar to natural, unaltered aquatic systems. We used a mixed-method socio-ecological approach to examine wetland ecosystem functions and the ways in which homeless populations utilize Salt River wetlands for ecosystem services. Interviews and trash surveys indicated that homeless people are accessing and utilizing the wetlands as a source of running water, for sanitary and heat mitigation services, and for recreation and habitation. Environmental monitoring demonstrated that the wetlands can provide a reliable source of running water, nutrient and pathogen removal, heat mitigation, and privacy, but they may also pose a health risk to individuals coming in contact with the water through drinking or bathing. Whether wetlands provided a net benefit vs. harm varied according to

site, season, and particular service, and several tradeoffs were identified. For example, heat is highest during the summer storm season, when pathogen loading is also high at most sites. These wetlands and waterways are not maintained and managed for ecosystem functions or services; our research suggests that accidental systems should be further examined to determine how they might be utilized and sustained by urban populations, particularly those who are socially vulnerable.

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Patel, S.[1], J. Rice[2], R. Stotts[2], A. Wutich[2], and A. Brewis[2]. *Cross-Cultural Perceptions of Health Implications from Wastewater Reuse in Fiji, Guatemala, New Zealand, and Spain: Results of the 2013 Global Ethnohydrology Study.

The relationship between humans and wastewater is one that has many direct social and health impacts on communities at large. In reaction to global limitations of freshwater, wastewater serves as a valuable resource to tap into. This research examines the cross-cultural public health concerns about treated wastewater in order to draw conclusions that can aid in strategic implementation of advocacy and public education about wastewater reuse. While technological advances have made water recycling a viable option in some locations, the negative perception of wastewater reclamation and reuse has limited the implementation of this process in many communities. Focusing on four sites representing varied levels of socio-economic and political development (Fiji, Guatemala, New Zealand, and Spain), the 2013 Global Ethnohydrology Survey employed ethnographic methods to assess levels of understanding of wastewater treatment and reuse. Using visual content analysis, schematic representations of how participants thought wastewater should be treated to become drinkable again were coded for a variety of treatment levels and specific treatment processes. Additionally, using close-ended questions, we examined willingness to use, levels of disgust associated with, and health concerns linked to a variety of potential uses of reclaimed wastewater. Our overall goal is to contribute to the literature on the social acceptability of treated wastewater reuse.

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Ramos, J.[1] and D. Childers[1]. *Drying and rewetting periods trigger high pulses of greenhouse gases in wetland mesocosms

The concept of wastewater treatment by wetland ecosystems evolved from the fact that wetlands include both aerobic and anaerobic environments, which enhances N removal through the combination of several biogeochemical processes. When constructed treatment wetlands (CTW) are built for the purpose of polishing nitrogen from wastewater but with a permanently flooded hydrological regime, they may generate appropriate conditions for the production of greenhouse gases such as nitrous oxide (N_2O) and methane (CH_4) production. We studied the effect of three different hydrological regimes (2, 7, and 14 day-dry periods before re-wetting again) on the rates of nitrous oxide and methane production in mesocosms from a permanently flooded CTW. Preliminary results of the experiment showed that methane emissions were higher in all treatments after the first exposure to their dry periods. Immediately after the re-wetting periods, high methane emissions were released from the 2-day treatment mesocosms. Methane emissions from the 14-day and 7-day

treatments were similar before and after applying the dry period to the mesocosms. In the control mesocosms, nitrous oxide emissions were greater at the initial part of the experiment. Compared to the control and other treatments, emissions decreased and increased during the drying and re-wetting period (respectively) in the 2-day treatment mesocosms. These preliminary results show that applying a drying and rewetting hydrological regime to mesocosms from a permanently flooded constructed wetland, can trigger unexpected greenhouse gas emissions.

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Sampson, D. A., D. Iwaniec, and M. Davidson. *The Adaptive Sustainable Scenario Future as Simulated using WaterSim.*

There are multiple paths to a sustainable water future, and each path represents a unique perspective (with unique challenges and opportunities). The Sustainable Futures Scenarios Initiative has embarked on a journey to bring together a diverse group of decision-makers in an attempt to forge multiple, potential water futures based on current and potential future water policy and infrastructure decisions. Each water future contains rational policy choices–some choices may be more expensive than others while some may be more or less aggressive, but all are plausible (some more than others)–that create a specific future envisioned. Although there are nine distinct scenario futures defined in the project we focused on the Adaptive Drought Scenario for 2060; as a proof-of-concept exercise we parameterized the WaterSim 5 model to accommodate many of the Adaptive Drought Scenario strategies to examine the water delivery and use outcomes from the suite of policy decisions embedded in this particular scenario description. This process required us to add some components into the model to accommodate particular themes of interest, such as the capture and use of storm water runoff, and rainwater harvesting, to name two. We compared results from this scenario with a business as usual test case to demonstrate the effects of the various policies on water use dynamics for the Phoenix Metropolitan Area.

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Sanchez, C. A.[1], N. A. Weller[1], D. L. Childers[1], L. Turnbull[2], and R. Upham[3]. *The Effects of Macrophyte Productivity and Community Composition on the Water and Nutrient Budgets of an Aridland Constructed Treatment Wetland.*

Constructed treatment wetlands (CTWs) have been well established as effective and sustainable solutions to the problem of urban water treatment and reuse. However, treatment wetlands located in aridland cities may be subject to unique hydrological and ecological conditions, relative to their more mesic counterparts, that challenge their ability to deliver ecosystem services. In hot, dry climates large water losses via evaporation and plant transpiration may potentially alter the ability of these systems to perform intended functions – namely nitrogen (N) retention and processing. In addition, emergent macrophytes play an important role in nutrient removal, particularly nitrogen (N) removal, in CTWs. However, the role of plant community composition in nutrient removal is less clear.

Our two primary objectives were to 1) develop robust water and N budgets to evaluate the impact of an arid climate on CTW N removal and 2) quantify macrophyte community composition and develop estimates of species-specific contribution to the N and water

budgets at a 42 ha CTW in arid Phoenix, Arizona. We found that total water losses via evapotranspiration peaked at 300,000 m^3 $month^{-1}$ and peak aboveground biomass, dominated by Typha spp., ranged from 1586±179 to 2666±164 gdw m^{-2} in the hot, dry summer months. Contrary to our expectations, large transpirative water losses and diverse plant communities appeared to enhance N treatment efficacy relative to humid, mesic systems by drawing large volumes of replacement water into the marsh via a "biological tide," providing more opportunities for vegetation and soil microbes to process effluent.

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Suchy, A.K[1]., I. Crandall[1], E. Sprague[1], E.E. Shortlidge[2] and J.J. Elser[1].** ***Nutrient limitation and carbon dioxide fluxes in urban lakes maintained with groundwater and surface water in Tempe, AZ.

Urban lakes are important amenities for city life. However, they are frequently subject to increased nutrient loads from fertilizer applications or nitrogen deposition, which can affect water quality and amenity value. Management decisions, such as which water source supplies urban lakes, can also determine nutrient concentrations. In Arizona, manmade urban lakes can be supplied with groundwater or surface water, which often have different concentrations and ratios of inorganic nitrogen and phosphorus. To determine if water source has an impact on ecosystem processes in urban lakes, we examined nutrient limitation of primary production (pelagic and benthic) and carbon dioxide (CO_2) flux from six urban lakes in Tempe, AZ.

For this study we used six urban lakes within the CAP-LTER; three supplied with groundwater and three with surface water. In each lake we measured pH, conductivity, and concentrations of limiting nutrients (nitrogen and phosphorus). We used bioassays to identify limiting nutrients for phytoplankton and benthic algae. Carbon dioxide flux was measured using floating chambers.

We found marginally significantly higher concentrations of nitrate in lakes supplied with groundwater than lakes supplied with surface water ($p=0.06$). All lakes supplied with groundwater showed evidence of phosphorus-limited phytoplankton growth, while lakes supplied with surface water showed a variety of nutrient limitation regimes. Benthic algae showed no pattern of nutrient limitation among lakes of different water sources. Urban lakes were also not a clear source or sink for CO_2. Further, there was no significant difference in CO_2 flux among groundwater and surface water lakes.

Overall, these data suggest that water source can affect nutrient limitation in urban lakes. However, our small sample size and sampling area prevented more robust and generalizable conclusions. More extensive sampling of lakes in both water source categories will be pursued in coming years.

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Suchy, A.K[1]., J. J. Elser[1], S. E. Brownell[1], N. B. Grimm[1], and E. E. Shortlidge[2].** ***Students in a Pilot Course-Based Undergraduate Research Experience (CURE) Collect Novel Data on CO_2 Emissions and Nutrient Limitation in Six Urban Lakes in Tempe, AZ.

Course-based undergraduate research experiences (CUREs) are courses in which students experience the process of science through addressing novel research questions that have relevance to local and/or scientific communities. CUREs have the potential to amass valuable scientific data while also engaging students in genuine research, ultimately improving student interest and retention in science.

In an effort to understand the potential impacts of a CURE on introductory freshman biology students at Arizona State University, we piloted a CURE where students asked research questions directly related to an ASU faculty's research program. Students examined how differing water sources of urban lakes affects CO2 emissions and nutrient limitation. Three lakes maintained with groundwater and three lakes maintained with surface water were selected within the CAP LTER study area. Students performed both field and lab experiments to address their research questions.

Throughout the course, student assignments focused on relevant writing skills and data analysis. By the end of the project they analyzed their own data and communicated results of their studies in conference-style presentations. Evaluation of cognitive and affective gains for students in the CURE compared to students in the un-changed lab sections are underway. Our preliminary data indicate a positive shift in CURE student attitudes towards science.

This pilot CURE at ASU reveals a viable mechanism for scaling-up student involvement in a locally relevant, long-term ecological research project. The resulting data can be of use to the scientific community while providing significantly more opportunities for students to engage in research than are currently available to biology students at ASU.

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Upreti, R., Z. H. Wang, and J. Yang.** ***Assessing Impact of Landscape Characteristics on Urban Hydroclimate.

The land use and land cover (LULC) changes due to urbanization play a vital role in local as well as regional climate change. The replacement of the natural surfaces with manmade structures modifies the surface energy and water budgets of the environment and is responsible for the urban climate change. To understand the underlying physics of urban climate modeling, in- depth knowledge is needed on the impact of various urban landscape characteristics on the urban climate. In this study, we use one of the fastest growing cities in the U.S. that is, metropolitan Phoenix, Arizona as our testbed. We carried out regional climate modeling using the Weather Research and Forecasting (WRF) model while also incorporating the single-layer Urban Canopy Model (UCM).This advanced WRF-UCM modeling framework is then applied to simulate plausible scenarios of urban expansion in the study area, jointly determined by landscape planners and researchers. The results from the model are validated with the field measurements from ground based meteorological observation. The impact of a range of land surface parameters associated with the LULC changes, including urban morphology, hydrothermal properties and anthropogenic heat input are evaluated based on outputs of numerical simulations. Among these parameters, it is expected that excessive urban warming in the study area is found to depend largely on the areal fraction of built surfaces as well as the urban morphology. The results from this study will help to better adapt and mitigate the influence of climate change on the urban environment.

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***Weaver, M., and K. McGraw. *Bold urbanites and Shy Hillbillies? Variation in Novel Environment Exploration in* Haemorhous mexicanus.**

To survive in human environments, animals must adapt to the presence of anthropogenic structures, noises, vegetation, and introduced species. Thus, urban individuals may be more willing to approach novel objects and novel species than their rural counterparts. Studies on risk taking and neotolerance in urban areas have produced conflicting results, however, as some species tend to be more exploratory in urban areas while others show the opposite trend. Many of these studies test one specific object or situation rather than combining several novel situations that may more closely mimic an urban environment. We tested exploratory behavior of house finches (*Haemorhous mexicanus*) in a novel structural environment and in the presence of novel bird species. Birds from six different sites across an urban gradient were placed into a large aviary cage and we recorded how many novel structures they visited, how long it took to approach each structure, and how long they spent at each. We predict that urban birds will approach novel structures/species more quickly and spend more time feeding from novel structures.

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Wheeler, M. M., J. Learned, H. Heavenrich, and S. J. Hall. *Regional Patterns and Homogenization of Residential Yard Soil Moisture in US Cities.

Similar management practices within urban residential areas across large spatial scales are thought to lead to the homogenization of ecosystem structure and function compared with the diverse natural ecosystems that these systems replaced. At the same time, underlying geological and climatic gradients also have potentially strong influences on residential ecosystems. To consider how human management and large-scale natural gradients influence the soil and hydrology of residential landscapes, we measured soil moisture in yards in seven climatically distinct cities across the country (Baltimore, MD, Boston, MA, Los Angeles, CA, Miami, FL, Minneapolis-St. Paul, MN, Phoenix, AZ, and Salt Lake City, UT) as well as in areas of natural vegetation in each metropolitan area. Probes were placed under the dominant yard cover type (lawn, gravel, or mulch in most cases) and recorded soil moisture measurements every 30 minutes for up to two years. Preliminary analysis shows strikingly different patterns in soil moisture in different cities, with some clear patterns characteristic of certain regions. For example, yards in Phoenix show clear peaks in soil moisture with rapid attenuation year-round, while lawns in Minneapolis-St. Paul show more highly variable soil moisture during the growing season with clear declines in soil moisture levels and variability during the winter months, when lawns are dormant and likely snow-covered. From these data, we can conclude that regional differences are of high importance in determining residential soil moisture dynamics. However, soil moisture tended to be more similar in among residential yards in the cities than in natural areas, providing some evidence for homogenization.

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Zhao, Q.[1], S. W. Myint[2], E. A. Wentz[1], and C. Fan[2]. *Rooftop Surface Temperature Analysis in an Urban Residential Environment.

The urban heat island (UHI) phenomenon is a significant worldwide problem caused by rapid population growth and associated urbanization. The UHI effect exacerbates heat waves during the summer, increases energy and water consumption, and causes the high risk of heat-related morbidity and mortality. UHI mitigation efforts have increasingly relied on wisely designing the urban residential environment such as using high albedo rooftops, green rooftops, and planting trees and shrubs to provide canopy coverage and shading. Thus, strategically designed residential rooftops and their surrounding landscaping have the potential to translate into significant energy, long-term cost savings, and health benefits. Rooftop albedo, material, color, area, slope, height, aspect and nearby landscaping are factors that potentially contribute. To extract, derive, and analyze these rooftop parameters and outdoor landscaping information, high resolution satellite imagery, LIDAR and thermal imagery are necessary. Using data from the City of Tempe AZ, we extracted residential rooftop footprints and rooftop configuration parameters from airborne LIDAR point clouds and QuickBird satellite imagery. Those parameters were analyzed against surface temperature data from the MODIS/ASTER airborne simulator (MASTER). MASTER images provided fine resolution (7 m) surface temperature data for residential areas during daytime and night time. Utilizing these data, ordinary least squares (OLS) regression was used to evaluate the relationships between residential building rooftops and their surface temperature in urban environment. The results showed that daytime rooftop temperature was closely related to rooftop spectral attributes, aspect, slope, and surrounding trees. Night time temperature was only influenced by rooftop spectral attributes and slope.

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