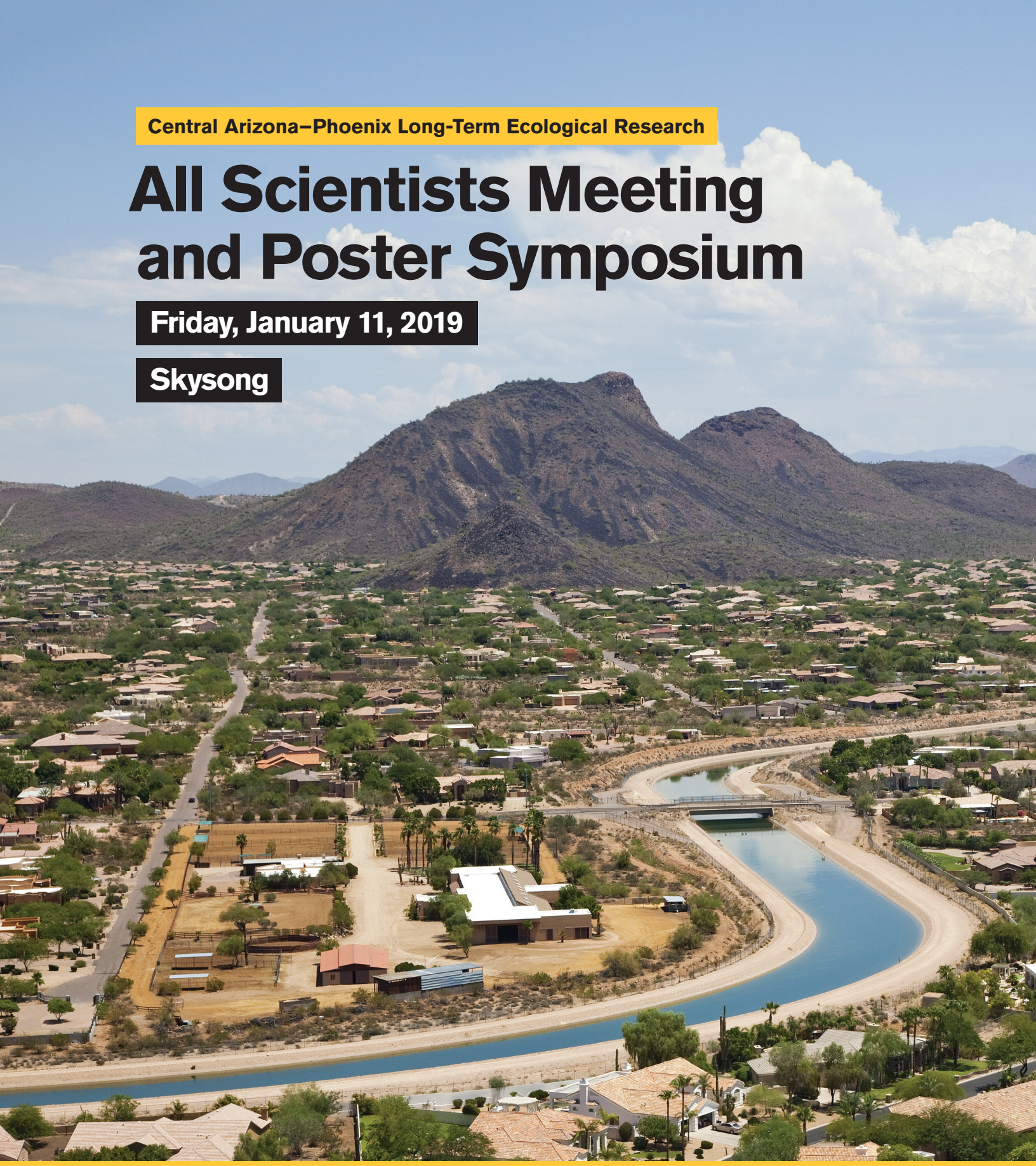
Central Arizona–Phoenix Long-Term Ecological Research

All Scientists Meeting and Poster Symposium

Friday, January 11, 2019

Skysong



Central Arizona-Phoenix Long-Term Ecological Research
CAP LTER

ASU Julie Ann Wrigley Global Institute of Sustainability
Arizona State University

LTER NETWORK

NSF

CAP LTER Twenty-first All Scientists Meeting
and Poster Symposium
January 11, 2019
Synergy I and II, Building 3
Skysong, Scottsdale, Arizona

8:00 a.m. Registration, poster setup; coffee and tea

8:30 a.m. **State of the Program Address & CAP Service Awards**
Dan Childers, Director, CAP LTER and Professor, School of Sustainability

9:00 a.m. **Keynote Presentation: The Evolution of Life in the Urban Jungle**
Marc T. J. Johnson, Associate Professor, University of Toronto-Mississauga, the Canadian Research Chair for Urban Environmental Science, and the Director of the Centre for Urban Environments

10:15 a.m. **Interdisciplinary Research Theme (IRT) Updates #1**

Scenarios and Futures
David Iwaniec, Assistant Professor, Georgia State University

Urban Design
Paul Coseo, Assistant Professor, Herberger Institute for Design & the Arts

Governance and Institutions
Abigail York, Associate Professor, College of Liberal Arts and Sciences

Residential Landscapes and Neighborhoods
Riley Andrade, PhD Student, School of Geographical Sciences and Urban Planning
Megan Wheeler, PhD Student, School of Life Sciences

11:00 a.m. **Poster Session #1**

12:00 p.m. **Lunch**

1:00 p.m. **Interdisciplinary Research Theme Meetings – #1: Scenarios and Futures, Governance and Institutions, Urban Design, and Residential Landscapes and Neighborhoods.**

1:45 p.m. **Interdisciplinary Research Theme Updates #2**

Adapting to City Life
Kevin McGraw, Professor, School of Life Sciences

Climate and Heat
David Hondula, Assistant Professor, School of Geographical Sciences and Urban Planning

Parks and Rivers
Heather Bateman, Associate Professor, College of Integrative Science and Arts

Water and Fluxes
Becky Ball, Associate Professor, School of Mathematical and Natural Sciences

2:30 p.m. **Interdisciplinary Research Theme Meetings – #2: Adapting to City Life, Climate and Heat, Parks and Rivers, and Water and Fluxes**

3:15 p.m. **Poster Session #2**

4:45 p.m. **Closing Statement / Announcements**

5:00 p.m. **Adjourn, CAPpy Hour at Bitters**

2019 CAP LTER Poster Symposium

Posters are listed alphabetically by first author with poster location number in parentheses.
*Indicates a student poster.

Poster Session #1	Poster Session #2
*Baur et al. (1)	*Andrade et al.(2)
Berbés-Blázquez et al. (3)	*Basile et al. (4)
*Boehme and de Albuquerque (5)	*Bergman et al. (6)
Brewis et al. (7)	*Boehme et al. (8)
Cook et al. (9)	*Clark and Johnson (10)
Coseo et al. (11)	*Coker et al. (12)
*Dwyer and Lewis (13)	*de Tranaltes et al. (14)
*Dzyuban, Hondula, et al. (15)	*Dzyuban, Messerschmidt, et al. (16)
*Grade et al. (17)	Earl (18)
Grimm et al. (19)	*Elser and Grimm (20)
*Hallmark et al. (21)	*Fisher et al. (22)
Herckes et al. (23)	*Fleeger et al (24)
*Kazenel et al. (25)	*Helmrich et al. (26)
Kim et al. (27)	*Hutton et al. (28)
Lewis and Prince (29)	*Juarez Rivera and Harnett (30)
Muenich et al. (31)	*Lauck and Grimm (32)
*McLaughlin et al. (33)	*Nguyen and Westerhoff (34)
*Ohlert and Collins (35)	Reichman et al. (36)
Reichman and Fields-Austin (37)	*Sanchez et al. (38)
Sampson (39)	*Stuhlenmacher et al. (40)
Sullivan et al. (41 – presenter Grace Pyon)	*Weiss et al. (42)
*Wang and Wang (43)	*Weller et al. (44)
Zhang et al. (45)	*Wright et al. (46)
Zhao et al. (47)	

Speaker Bio

Marc T. J. Johnson

Marc Johnson is an associate professor at University of Toronto Mississauga, the Canadian Research Chair for Urban Environmental Science, and the Director of the Centre for Urban Environments. He obtained his PhD from the University of Toronto in 2007, after which he conducted an NSERC Post-doctoral Fellowship at Duke University, and was an assistant professor at North Carolina State University before returning to the University of Toronto in 2011. His research takes an interdisciplinary approach to address a broad array of problems in evolution and ecology, including coevolutionary biology, eco-evolutionary dynamics, the evolution of sex, and how urban environments affect the evolution of life around us. He has received numerous awards for his research, including the American Society of Naturalists Young Investigator Prize, the Canadian Society of Ecology and Evolution Early Career Award and the Governor General's Gold Medal. He is presently an Associate Editor with Evolutionary Applications and Proc B, and is active in the community as a Director of The Riverwood Conservancy and as the co-founder of the Riverwood Young Naturalist club.

The evolution of life in the urban jungle

Urban areas represent the fastest growing ecosystem on earth, in which urban development creates novel ecosystems by dramatically altering the biotic and abiotic environment. Despite the importance of urbanization and large advances in our understanding of the ecology of cities, we have little understanding of how urbanization affects the evolution of life in urban areas. In this talk, I will review our current knowledge of the effects of urbanization on multiple evolutionary processes, including mutation, gene flow, genetic drift and natural selection. I will then describe our work examining how these evolutionary processes affect the ability of plants to genetically adapt to urban environments. I will conclude with a discussion of existing gaps in our knowledge and a description of the first global study of urban evolution – The Global Urban Evolution project (GLUE).

List of Posters

***Indicates student poster.**

ADAPTING TO CITY LIFE

Basile, Anthony J., William Clark, Xiaojian Shi, Haiwei Gu, Pierre Deviche, and Karen L. Sweazea. *Mourning Doves,* Zenaida macroura*, are resistant to metabolic effects of a mammalian diabetogenic refined carbohydrate diet.

***Boehme, Cameron S., and Fabio S. de Albuquerque. *Environmental predictors of bird abundance and richness*.**

***Clark, Ryan C., and J. Chadwick Johnson. *Urban vs desert: Behavioral syndrome differences in the western black widow*.**

***Dwyer, Jessie M., and Jesse S. Lewis. *Bat habitat use across the gradient of urbanization in the Phoenix metropolitan area*.**

***Dzyuban, Yuliya, David Hondula, Charles Redman, and Ariane Middel. *Analyzing transit-based heat exposure and behaviors to enhance urban climate adaptation and mitigation strategies in the southwest USA*.**

***Fleeger, Melissa, Kelli L. Larson, Megan M. Wheeler, Riley Andrade, and Sharon J. Hall. *Attitudes toward pollinators in residential landscapes of metropolitan Phoenix, Arizona*.**

Grade, Aaron M., Susannah B. Lerman, and Paige S. Warren. *Do anthropogenic resources buffer avian species against environmental stressors in residential landscapes?

Hutton, Pierce, C. D. Wright, Dale F. DeNardo, and Kevin J. McGraw. *No effect of human presence at night on disease, body mass, or metabolism in rural and urban house finches (*Haemorhous mexicanus*).

Lewis, Jesse S., and Aaron J. Prince. *The effects of urbanization on the wildlife community across the Phoenix Valley*.

***McLaughlin, Jade E., Karen M. Wright, Jennifer A. Rudgers, Melanie R. Kazenel, and Julieta Bettinelli. *Long-term pollinator monitoring study in the Chihuahuan Desert at the Sevilleta LTER, New Mexico*.**

Reichman, Anne, Steven Russell, and Lexie Fields-Austin. *ASU Project Cities.*

***Weiss, Katherine C. B., Courtenay A. Ray, J. Schipper, and Sharon J. Hall. *Conceptual methods for the definition of mammalian functional traits in urban landscapes*.**

CLIMATE AND HEAT

Baur, Lauren E., Scott L. Collins, Alan K. Knapp, and Melinda D. Smith. *Chronic drought severely alters plant species composition in arid grasslands.

Boehme, Cameron S., Chelsea Stratton, and Fabio S. de Albuquerque. *Energy, water and habitat diversity as predictors of vegetation cover in urban areas.

***Coker, Keaton M., Jennifer Hackney-Price, J. Chadwick Johnson, and Claire Moen. *The effect of urban heat-related hormones on the behavior of the western black widow spider*.**

***de Tranaltes, Christopher D., and J. Chadwick Johnson. *Urban heat island effects on the cannibalistic behavior of desert and urban lineages of black widow spiders* (Latrodectus hesperus).**

Dzyuban, Yuliya, David Hondula, Charles Redman, and Ariane Middel. *Analyzing transit-based heat exposure and behaviors to enhance urban climate adaptation and mitigation strategies in the southwest USA.

***Dzyuban, Yuliya, Maggie Messerschmidt, Heather Fischer, Angela Ellsworth, Patricia Solis, Jennifer Vanos, Ariane Middel, and David Hondula. *Mapping thermal comfort in Edison Eastlake Neighborhood with citizen scientists*.**

Elser, Stephen R., and Nancy B. Grimm. *Modeling water use to achieve 25% canopy cover in Phoenix, Arizona.

Hallmark, Alesia J., Jennifer A. Rudgers, Scott Collins, Doug Moore, and Stephanie Baker. *Optimizing plant size:biomass allometric relationships at the Sevilleta LTER.

Helmrich, Alysha M., Erica J. Gilrein, Mikhail V. Chester, and Samuel A. Markolf. *The past, present, and future of design storms.

***Kazenel, Melanie R., Karen W. Wright, Terry L. Griswold, Julieta Bettinelli, Jennifer A. Rudgers, and Kenneth D. Whitney. *Native bees exhibit species- and ecosystem-specific changes in abundance with aridity*.**

***McLaughlin, Jade E., Karen M. Wright, Jennifer A. Rudgers, Melanie R. Kazenel, and Julieta Bettinelli. *Long-term pollinator monitoring study in the Chihuahuan Desert at the Sevilleta LTER, New Mexico*.**

Ohlert, Timothy J., and Scott L. Collins. *A collaborative approach to desert plant community research.

Stuhlmacher, Michelle F., Riley Andrade, and Billie L. Turner II. *The ecological outcomes of land system architecture change: A case study of riverfront redevelopment in Tempe, Arizona.

Wang, Chenghao, and Zhi-Hua Wang. *A statistical view of the Phoenix urban heat island during the past 86 years (1933–2018).

Wright, Mary K., David M. Hondula, Paul C. Chakalian, Kelli L. Larson, Lance E. Watkins, and Liza C. Kurtz. *Heat surveys in hot places: Predictors of heat illness events in Phoenix, Arizona.

Zhang, Yujia, Ariane Middel, and B.L. Turner II. *Evaluating the effect of 3D urban form on neighborhood land surface temperature using Google Street View.*

Zhao, Qunshan, Dhrumil Shah, Ziqi Li, Heather Fischer, Wei Luo, Patricia Solis, and Elizabeth A. Wentz. *ActivityLog – HeatMappers: A novel research data collection tool for logging human activities, locations and environment data.*

EDUCATION AND MANAGEMENT

Earl, Stevan R. *CAP LTER informatics: Data management for project investigators and the scientific community*.

Muenich, Rebecca, Otakuye Conroy-Ben, Clinton Williams, and Peter Conden. *The nexus of agricultural and urban trade-offs: Enhancing*

interdisciplinary education and research to create emerging opportunities in urban agriculture.

GOVERNANCE AND INSTITUTIONS

Brewis, Alexandra, Amber Wutich, Margaret V. du Bray, Jonathan Maupin, Roseanne C. Schuster, and Matthew M. Gervais. *Community hygiene norm violators are consistently stigmatized: Evidence from four global sites and implications for sanitation interventions.*

Reichman, Anne, and Lexie Fields-Austin. *The Sustainable Cities Network*.

Reichman, Anne, Steven Russell, and Lexie Fields-Austin. *ASU Project Cities.*

Sanchez, Christopher A., Chingwen Cheng, Dan Childers, and Abigail York. *Designing and implementing ecological monitoring of Urban Ecological Infrastructure (UEI): A case-study.

Stuhlmacher, Michelle F., Riley Andrade, and Billie L. Turner II. *The ecological outcomes of land system architecture change: A case study of riverfront redevelopment in Tempe, Arizona.

PARKS AND RIVERS

***Boehme, Cameron S., and Fabio S. de Albuquerque. *Environmental predictors of bird abundance and richness*.**

Grimm, Nancy B., Amalia M. Handler, Marina D. Lauck, Monica M. Palta, and Amanda K. Suchy. *A most valuable accident: Accidental wetlands provide ecosystem services in an aridland city.*

Lauck, Marina, and Nancy B. Grimm. *Effects of variable inundation patterns on wetland plant communities and nitrogen uptake in the Salt River wetlands.

Lewis, Jesse S., and Aaron J. Prince. *The effects of urbanization on the wildlife community across the Phoenix Valley*.

Stuhlmacher, Michelle F., Riley Andrade, and Billie L. Turner II. *The ecological outcomes of land system architecture change: A case study of riverfront redevelopment in Tempe, Arizona.

RESIDENTIAL LANDSCAPES AND NEIGHBORHOODS

Andrade, Riley, Kelli L. Larson, Janet Franklin, and Christopher Swan. *Land management and household characteristics mediate species assemblages in residential landscapes.

Bergman, Dena N., Megan M. Wheeler, Kelli L. Larson, and Sharon J. Hall. *Do attitudes towards native flora predict landscaping choices in privately managed urban landscapes?

***Fleeger, Melissa, Kelli L. Larson, Megan M. Wheeler, Riley Andrade, and Sharon J. Hall. *Attitudes toward pollinators in residential landscapes of metropolitan Phoenix, Arizona*.**

Reichman, Anne, and Lexie Fields-Austin. *The Sustainable Cities Network*.

Reichman, Anne, Steven Russell, and Lexie Fields-Austin. *ASU Project Cities.*

Zhang, Yujia, Ariane Middel, and Billie L. Turner II. *Evaluating the effect of 3D urban form on neighborhood land surface temperature using Google Street View.*

SCENARIOS AND FUTURES

Berbés-Blázquez, Marta, David Iwaniec, Elizabeth Cook, Melissa Davidson, Nancy Grimm, Tischa Muñoz-Erickson, and Darin Wahl. *Assessing scenario visions: Resilience ,equity, and sustainability of the future of South Phoenix.*

Coseo, Paul, Marta Berbés-Blázquez, Yuliya Dzyuban, Nancy B. Grimm, Allyce Hargrove, and Yeowon Kim. *Scenario design through interdisciplinary community-research-teaching collaborations.*

Elser, Stephen R., and Nancy B. Grimm. *Modeling water use to achieve 25% canopy cover in Phoenix, Arizona.

Kim, Yeowon, Jason Sauer, Bernice Rosenzwieg, and Nancy Grimm. *New methods for examining pluvial flood exposure and social sensitivity in Central Arizona-Phoenix*.

Reichman, Anne, Steven Russell, and Lexie Fields-Austin. *ASU Project Cities.*

Sampson, David Arthur. *Influence of water supply (including rainwater and gray water) and demand management on meeting outdoor water demand in the Phoenix metropolitan area*.

Sullivan, Abigail, Alexandra Brewis, and Amber Wutich (presenter Grace Pyon). *Studying children's cultural knowledge and behaviors related to environment, health, and food: Methods for ethnoecological research with children*.

***Weller, Nicholas, David Sittenfeld, Emily Hostetler, and Katie Todd. *Mapping public values about climate adaptation and resilience using deliberative forums*.**

URBAN DESIGN

Coseo, Paul, Marta Berbés-Blázquez, Yuliya Dzyuban, Nancy B. Grimm, Allyce Hargrove, and Yeowon Kim. *Scenario design through interdisciplinary community-research-teaching collaborations.*

***Dzyuban, Yuliya, David Hondula, Charles Redman, and Ariane Middel. *Analyzing transit-based heat exposure and behaviors to enhance urban climate adaptation and mitigation strategies in the southwest USA*.**

***Dzyuban, Yuliya, Maggie Messerschmidt, Heather Fischer, Angela Ellsworth, Patricia Solis, Jennifer Vanos, Ariane Middel, and David Hondula. *Mapping thermal comfort in Edison Eastlake Neighborhood with citizen scientists*.**

Elser, Stephen R., and Nancy B. Grimm. *Modeling water use to achieve 25% canopy cover in Phoenix, Arizona.

Helmrich, Alysha M., Erica J. Gilrein, Mikhail V. Chester, and Samuel A. Markolf. *The past, present, and future of design storms.

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Reichman, Anne, and Lexie Fields-Austin. *The Sustainable Cities Network*.

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***Sanchez, Christopher A., Chingwen Cheng, Daniel L. Childers, and Abigail York. *Designing and implementing ecological monitoring of Urban Ecological Infrastructure (UEI): A case study*.**

Stuhlmacher, Michelle F., Riley Andrade, and Billie L. Turner II. *The ecological outcomes of land system architecture change: A case study of riverfront redevelopment in Tempe, Arizona.

Zhang, Yujia, Ariane Middel, and Billie L. Turner II. *Evaluating the effect of 3D urban form on neighborhood land surface temperature using Google Street View.*

WATER AND FLUXES

Boehme, Cameron S., Chelsea Stratton, and Fabio S. de Albuquerque. *Energy, water and habitat diversity as predictors of vegetation cover in urban areas.

Cook, Elizabeth M., Pamela E. Padgett, and Sharon J. Hall. *Long-term community composition shift of desert annual vegetation correlated to co-occurring pollutants in urban ecological airshed*.

Elser, Stephen R., and Nancy B. Grimm. *Modeling water use to achieve 25% canopy cover in Phoenix, Arizona.

Fisher, Theresa, Sally Wittlinger, Roy Erickson, and Hilairy E. Hartnett. *High-resolution temporal monitoring of an arid, urban lake: Preliminary results.

Grimm, Nancy B., Amalia M. Handler, Marina D. Lauck, Monica M. Palta, and Amanda K. Suchy. *A most valuable accident: Accidental wetlands provide ecosystem services in an aridland city.*

Hallmark, Alesia J., Jennifer A. Rudgers, Scott Collins, Doug Moore, and Stephanie Baker. *Optimizing plant size:biomass allometric relationships at the Sevilleta LTER.

Helmrich, Alysha M., Erica J. Gilrein, Mikhail V. Chester, and Samuel A. Markolf. *The past, present, and future of design storms.

Herckes, Pierre, Denise Napolitano, Aurelie R. Marcotte, Jershon Eagar, and Matt Fraser. *Characterization of haboob dust storms in Phoenix, AZ*.

Juarez Rivera, Marisol, and Hilairy E. Hartnett. *Is oxygen supersaturation in Tempe Town Lake mainly driven by abiotic processes?

Lauck, Marina, and Nancy B. Grimm. *Effects of variable inundation patterns on wetland plant communities and nitrogen uptake in the Salt River wetlands.

***Nguyen, Thuy, and Paul Westerhoff. *Modeled de facto reuse in surface water sources in the Colorado River Basin*.**

Abstracts

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

Andrade, R.[1], K. L. Larson[1, 2], J. Franklin[3], and C. Swan[4]. *Land management and household characteristics mediate species assemblages in residential landscapes.

Ecological communities in cities are assembled through processes such as intraspecific interactions, dispersal, and resource dynamics, but also through interactions with people. Metacommunity theory offers a framework to explore such mechanisms by incorporating human-environment interactions into our understanding of community ecology. Here, our goal is to test the application of metacommunity theory in urban ecosystems by connecting biodiversity outcomes to local environmental heterogeneity and regional spatial processes. Using tree, insect, and bird community data collected from Phoenix neighborhoods as part CAP LTER's long-term ecological and social monitoring program we answered the following questions. (1) What are the relative influences of environmental versus spatial processes on ecological community structure in residential landscapes? (2) Do differences in household characteristics and the resulting land management decisions change the relationship between community structure with local and regional processes? We found that spatially structured environmental processes were strongly associated with bird community assemblages, whereas the tree community in Phoenix was related to the local environment. The insect community was weakly associated with both local environmental and regional spatial processes. Environmental characteristics of the landscape were more important for determining differences in tree, insect and bird community assemblages in older neighborhoods with lower socioeconomic status then in newer, wealthier neighborhoods with a higher proportion of property owners. This suggests that ecological communities in neighborhoods with lower socioeconomic status are structured by environmental filtering. Conversely, species in neighborhoods with higher socioeconomic status readily disperse between patches of relatively equal resources, following the theory of patch dynamics. Overall, our findings advance urban ecosystems theory, and more specifically, how human-environment interactions mediate biodiversity and community assemblages.

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Basile, A. J.[1], W. Clark[1], X. Shi[2], H. Gu[2], P. Deviche[1], K. L. Sweazea*1,2*. *Mourning Doves,* Zenaida macroura*, are resistant to metabolic and vascular effects of a mammalian diabetogenic refined carbohydrate diet.

Granivorous urban birds often consume human foods typical of a Western diet that are provided through waste or recreational feeding. Whole wheat seeds are a choice food for Mourning Doves, but it is unknown how these birds would respond to a refined wheat/bread diet. We hypothesized that feeding adult Mourning Doves a refined carbohydrate diet (white bread: WB; n=6) for four weeks would result in diabetes-like pathologies including hyperglycemia, endothelial dysfunction, and altered metabolic profiles when compared to birds receiving a nutritionally balanced diet (bird seeds: SD; n=8). Following the four-week long diets, we euthanized birds with an overdose of sodium pentobarbital and collected cardiac blood, liver, kidney, and pectoralis muscles for metabolomics analyses and biochemical assays. We also dissected cranial tibial arteries to measure acetylcholine-mediated vasodilation. Contrary to the hypothesis, doves fed WB developed few changes in metabolite concentrations compared to control doves (number of altered metabolites: 9 of 123 in plasma, 7 of 92 in liver, and 6 of 91 in pectoralis muscle; $p<0.05$). Moreover, pathway analyses revealed only three significantly altered pathways (liver: glutathione metabolism and histidine metabolism; pectoralis muscle: glyoxylate and dicarboxylate metabolism; $p<0.05$). Plasma glucose, uric acid, insulin, liver triglyceride, glycogen, and pectoralis muscle glycogen concentrations did not differ between groups, but liver glycogen was increased (2.12-fold) in the WB group ($p=0.015$). Diet type had no significant effect on vasodilation. However, compared to results from a prior study on wild-caught doves, captivity improved vasodilation (WB vs wild birds: $p=0.002$; SD vs wild birds: $p=0.022$). In conclusion, a four-week long diet consisting of white bread increased liver glycogen but did not instigate symptoms of diabetes.

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Baur, L.E.[1], S. L. Collins[1], A. K. Knapp[2], and M. D. Smith[2]. *Chronic drought severely alters plant species composition in arid grasslands.

Global climate change is projected to cause droughts of increased frequency, duration and severity in North America. Grassland regions that differ in productivity may also differ in their response to drought. EDGE (Extreme Drought in Grasslands Experiment) used identical infrastructure to impose rainfall reductions at six sites spanning desert grassland, shortgrass steppe, mixed grass prairie, and tallgrass prairie. A chronic drought treatment consisting of 66% rainfall reduction throughout the growing season was imposed for four years. Nonlinear regression indicated a negative relationship between the mean annual precipitation of the sites and the magnitude of drought effects on the plant dominant species. This pattern was largely driven by the two driest sites, located at the Sevilleta Long Term Ecological Research site in New Mexico. Plant species composition between chronic drought and control treatments diverged rapidly at the Sevilleta sites, showing a significant difference in the first year of treatment, while all the other sites took two to three years to diverge. At the Sevilleta sites, chronic drought caused an extreme drop in abundance of the dominant C4 grass species, followed by temporary booms in annual forbs. In the third year of treatment, the magnitude of the effect of drought (expressed as Cohen's D) on relative cover of the dominant species at the Sevilleta sites was approximately 2x the effect size at the wettest site. In the fourth year, the magnitude of the drought effect at one of the Sevilleta sites was over 13x the effect at the wettest site. Our results indicate that arid desert grasslands may be particularly vulnerable to extreme drought under future climate change.

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Berbés-Blázquez, M.[1], D. M. Iwaniec[2], E. M. Cook[3], M. Davidson[1], N. B. Grimm[1], T. Muñoz-Erickson[4], and D. Wahl[5]. *Assessing scenario visions: Resilience, equity, and sustainability of the future of South Phoenix.*

Current and projected climatic trends highlight the need for transformative change to stay within a safe operating space for humanity. In the absence of strong international agreements, municipal governments are leading the charge to build resilience to climate change in general and to extreme weather events in particular. However, it is notoriously difficult to guide and activate processes of change in complex adaptive systems such as cities. Participatory scenario planning with city professionals and members of civil society provides an opportunity to co-produce positive visions of the future. Yet, not all visions are created equal. Our work introduce a

framework for characterizing resilience, equity, and sustainability of alternative scenario visions. We then apply the framework to analyze scenario visions created in participatory workshops at the regional and village level in Phoenix. Our analysis allows us to compare not just alternative visions, but also key pathways (and potential obstacles) toward stated future goals, as well as implicit and explicit tradeoffs.

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Bergman, D. N.[1], M. M. Wheeler[1], K. L. Larson[2], and S. J. Hall[1]. *Do attitudes towards native flora predict landscaping choices in privately managed urban landscapes?

Urban landscaping choices have a significant influence over local biodiversity, ecosystem functioning, and ecosystem services. Understanding the plant composition of urban landscapes and the motivation for landscaping choices is integral for guiding the future of ecosystem service provision in cities. Native plant species are likely more important for supporting sensitive native animal communities than non-native plants. Socioeconomic and normative pressures as well as preferences for various plant attributes have been studied as drivers for landscaping choices. However, few studies have explored the drivers behind private land owners' decisions to landscape with native flora specifically. We set out to understand what predicts individuals' decisions to include native plant species in privately managed front yards, using Phoenix, AZ as a case study. We hypothesized that people's attitudes toward native plants and attitudes towards the desert would be related to the abundance of native species in their yards. We also hypothesized that yards with desert-like landscaping would have more native plants than yards with grassy landscaping. We found that neither attitudes toward native plants nor attitudes towards the desert predicted the proportion of native plant species found in yards, indicating that individual attitudes are not driving native plant abundance in these yards. However, as expected, desert-landscaped yards contained a higher percentage of native species than lawn-dominated yards. Further work will explore how resident demographic characteristics, resident knowledge about native plants, and native plant availability for purchase influence native plant inclusion in residential landscapes. Understanding what determines the use of native plants in residential landscaping will be an important tool for increasing and supporting conservation of native biodiversity in human-dominated ecosystems.

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***Boehme, C. S., and F. S. de Albuquerque. *Environmental predictors of bird abundance and richness*.**

Previous studies conducted in the Phoenix metropolitan area have documented declines of abundance and richness of birds in riparian habitats. Herein, we investigated environmental predictors that contribute to bird abundance and richness in the Phoenix metropolitan area. Specifically, we documented, for the first time, (1) how species richness and abundance vary across years annually throughout the urban area, and (2) what environmental variables account for the variation seen in annual bird abundance and richness. We used bird census surveys collected over a 16-year period throughout the Phoenix urban area from 2000 to 2016 and conducted general linear model tests to determine significance of each environmental variable to richness and abundance. Our results showed that winter precipitation, seasonality indicators, and soil characteristics are the largest drivers of abundance and richness of birds throughout the Phoenix metropolitan area over a 16-year period. The results of this study are necessary to better understand the composition of future bird communities as climate continues to change.

Science and Mathematics, College of Integrative Sciences and Arts, Arizona State University, 7271 E Sonoran Arroyo Mall Suite 233, Mesa, AZ 85212

Boehme, C. S., C. Stratton, and F. S. de Albuquerque. *Energy, water and habitat diversity as predictors of vegetation cover in urban areas.

Maricopa County has grown substantially in the past two decades and there is increasing interest in the quantification of vegetation cover in urban areas. We used the Normalized Difference Vegetation Index (NDVI) to quantify the changes in vegetation cover and to investigate the direct and indirect impacts of climate and urbanization processes on vegetation cover at many urban sites within the Central Arizona-Phoenix Long-Term Ecological Research (CAP LTER) sites. NDVI is an important variable for measuring plant biomass and to measure changes in vegetation cover. Specifically, we documented (1) the key abiotic drivers affecting vegetation cover, (2) interactions among abiotic drivers, and (3) the shapes of the relationships between abiotic variables and vegetation. We generated a regional dataset that encompasses temperature, precipitation, NDVI values. We ran cluster analysis utilizing R on a comprehensive set of variables that we found to influence the distribution of NDVI values in the study area. We then ran random forest models on the remaining variables to determine the contribution of the variable to NDVI. Finally, we completed Partial Dependency Plots (PDP) to determine the influence of each variable. Our

results reflect mean diurnal range, precipitation of the driest quarter, soil diversity, soil-organic matter, sun range hours, aspect, and sun hour average to be the key drivers affecting vegetation cover in the Phoenix metropolitan area. This study is necessary to compare annual changes in vegetation cover as they are related to changes in climate and urbanization processes on NDVI in the Phoenix metropolitan area.

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Brewis, A.[1], A. Wutich[1], M. du Bray[2], J. Maupin[1], R. Schuster[1], and M. Gervais[3]. *Community hygiene norm violators are consistently stigmatized: Evidence from four global sites and implications for sanitation interventions*.

Community sanitation interventions increasingly leverage presumed innate human disgust emotions and desire for social acceptance to change hygiene norms. While often effective at reducing open defecation and encouraging handwashing, there are growing indications from ethnographic studies that this strategy might create collateral damage, such as reinforcing stigmatized identities in ways that can drive social or economic marginalization. To test fundamental ethnographic propositions regarding the connections between hygiene norm violations and stigmatized social identities, we conducted 267 interviews in four distinct global sites (in Guatemala, Fiji, New Zealand, USA) between May 2015 and March 2016. Based on 148 initial codes applied to 23,278 interview segments, text-based analyses show that stigmatizing labels and other indices of contempt readily and immediately attach to imagined hygiene violators in these diverse social settings. Moral concerns are much more salient at all sites than disease/contagion ones, and hygiene violators are extended little empathy. Contrary to statistical predictions, however, non-empathetic moral reactions to women hygiene violators are no harsher than those of male violators. This improved evidentiary base illuminates why disgust- and shame-based sanitation interventions can so easily create unintended social damage: hygiene norm violations and stigmatizing social devaluations are consistently cognitively connected.

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***Clark, R. C.[1], and J. C. Johnson[2]. *Urban vs desert: Behavioral syndrome differences in the western black widow*.**

Urbanization leads to a massive reduction in species diversity throughout the world, extirpating many taxa from large sections of their natural range. Be that as it may, there are a handful of species that thrive in these novel ecosystems. Animal behavior is possibly one facet of phenotype that may be explaining why some thrive in this environment and others fail to exist. In this research we look at a few behavioral differences between individuals of a species found in both urbanized and undisturbed Sonoran Desert near central Arizona. Widow spiders are often found within the city creating dense aggregations, in contrast to their desert counterpart where they are typically settled in very low densities. Here, we will follow and document 26 individuals in the adult phase of the cobweb producing spider, the North American western black widow, *Latrodectus hesperus*. The investigation will show what role site origination (urban vs. desert) has on the expression of conspecific cannibalism, boldness and aggressiveness toward prey. We hypothesis that there will be a clear difference in all three behaviors. Our prediction is 1) latency to cannibalize will be longer in the urban individuals, 2) urban spiders will be bolder than the desert lineage and 3) aggressiveness toward prey will be higher in the desert individuals.

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Coker K., J. Hackney-Price J., J. C. Johnson, and C. Moen. *The effect of urban heat related hormones on the behavior of the western black widow spider.

Behavioral ecology addresses the evolutionary changes in an organism's behavior shaped by environmental variation, and as such is a field that lends itself to understanding how rapid human alterations to the landscape (e.g., urbanization) affect biodiversity. A model species for research in this regard is the western black widow spider (*Latrodectus hesperus*), with populations inhabiting both urban Phoenix and Sonoran Desert habitats. In particular, we have shown that 1) urban black widows experience a 6^{o}C urban heat island (UHI) effect (27 vs 33^{o}C) relative to their desert counterparts, and that in early spiderlings this difference 2) slows development, 3) reduces mass, and 4) heightens foraging voracity and propensity for sibling cannibalism. Underlying these life history effects, we have shown that this UHI temperature differential is accompanied by toxic levels of Ecdysone (20E), the steroid hormone known to underlie the molting process in arthropods. In this study, we look to experimentally test the connection between elevated 20E and spider behavior in a dosage-controlled setting. Preliminary dosing trials suggest that a dose of 0.125 ng of hormone per milligram of

spider mass is a nonlethal dosage. As elevated ecdysone levels have already been indicated to be correlated to stress reactions, we hypothesize that ecdysone-dosed *L. hesperus* will exhibit elevated levels of foraging voracity and cannibalism to compensate for the stress-related nutritional demands excessive levels of ecdysone may induce. Studies like these that identify the mechanism underlying the effects of urbanization on urban pests are required to allow urban evolutionary ecologists to better predict how organisms will respond to such global change.

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Cook, E. M.[1], P. E. Padgett[2], and S. J. Hall[3]. *Long-term community composition shift of desert annual vegetation correlated to co-occurring pollutants in urban ecological airshed*.

Plants and ecosystems are rarely exposed to a single pollutant, where ozone (O_3), carbon dioxide (CO_2), and nitrogen (N) deposition are elevated in and around cities. Despite the ecological relevance of O_3, CO_2, and N in the "urban ecological airshed" as both stressors and resources for primary producers, their combined and long-term impacts are unknown. We examined the net effect of the urban ecological airshed on the dominant Sonoran Desert winter herbaceous vegetation in a long-term multi-factor field experiment (15 sites, urban-rural gradient, 2008-2017) and a controlled multi-factor dose-response greenhouse experiment (full factorial O_3, N, and CO_2, current and future projected levels). Across Phoenix, winter O_3 concentrations—during the desert herbaceous growing season—are increasing over time, following a west-east precipitation gradient. We expected *S. arabicus*—a non-native grass with a high relative growth rate and low water-use efficiency—to be more sensitive to higher O_3 concentrations because of its greater stomatal conductance in comparison to the dominant native forb, *Pectocarya* spp. However, in the long-term field experiment, we found a shift in species composition from *Pectocarya* to the non-native *S. arabicus*—particularly in the outlying sites to the east of the city where O_3 concentrations have increased most. To further examine the unexpected success of *S. arabicus* under higher O_3 stress, we conducted a multi-factor greenhouse experiment. We found that while both species declined when exposed to elevated O_3 — alone, in combination with elevated CO_2, the negative effects of O_3 exposure were mitigated for the non-native *S. arabicus*. However, CO_2 had minimal protective effect against high O_3 concentrations for the native forb. The synergistic results highlight the long-term consequences of exposure to multiple pollutants in the urban ecological airshed, and the importance of examining the net effect of co-occurring

exposure to predict shifting community composition in protected ecosystems.

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Coseo, P.[1], M. Berbés-Blázquez[2], Y. Dzyuban[2], N. B. Grimm[2], A. Hargrove[1], and Y. Kim[2]. *Scenario design through interdisciplinary community-research-teaching collaborations.*

Scenario planning results in nuanced, multidimensional visions of the future. In order to capture the richness of these visions, visual depictions of a desirable future state are valuable because they connect easily with a variety of audiences. In this poster, we present the process of co-creating design vignettes for scenario visions created with city and community leaders in South Mountain Village (SMV), Phoenix, around the themes of heat resilience, eco-hydrological connectivity, social connectivity, equity, and circumventing green gentrification processes. A design studio was engaged to further develop the five scenario visions into landscape designs for SMV. This process of scenario development is unique in that it involved the collaboration between researchers from the Central Arizona-Phoenix Long-term Ecological Research (CAP LTER) project, Urban Resilience to Extreme Sustainability Research Network (UREx SRN) and an upper level landscape architecture studio in a process that combined hands-on and experiential pedagogical approaches, research and community outreach. UREx Fellows presented their research work and participated in weekly group discussions and one-on-one interactions with design students to enrich their perspectives on resilience, environmental and social justice and facilitate translation of complex concepts into visual and physical forms. Using this model, students benefited from access to expertise, data, and future scenarios for South Mountain Village's social-ecological-technological system. Researchers benefited from an infusion of new ideas, deepening of scenario vision narratives, and visualization development. The outputs of the collaborative studio feed back into future CAP LTER and URExSRN scenario workshops, informing participants on how the alternative futures of SMV might turn out, and also train designers to actively participate in scenario workshops more broadly.

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***de Tranaltes, C. D.[1], and J. C. Johnson[1, 2]. *Urban heat island effects on the cannibalistic behavior of desert and urban lineages of black widow spiders* (Latrodectus hesperus).**

Global climate change is a ubiquitous human disturbance affecting nearly every ecosystem on the planet. Urban heat island (UHI) effects in heavily urbanized cities may provide an opportunity to examine the resulting shifts in animal behavior as this disturbance worsens. We examined the rate of cannibalism and mortality in urban and desert juvenile black widows (*Latrodectus hesperus*) exposed to UHI temperatures. We replicated realistic sibling cannibalism conditions within six urban and seven desert lineages beginning day 31 of development. Each replicate consisted of five siblings housed together at either elevated urban heat temperatures (33°C) or native Sonoran desert temperatures (27°C). The number of individuals cannibalized, verified by the presence of silk wrapping, was recorded daily until all spiders perished. ANOVA showed that family of origin had a statistically significant impact on cannibalism measures, thus we restricted our analyses to family averages. Desert lineages proved to be significantly quicker to cannibalize siblings than urban lineages, though this effect weakened as the number of days at temperature treatment grew (and the number of live spiderlings declined), such that urban heat conditions proved to be the main driver heightening cannibalism later in the experiment. If urban black widow populations are less cannibalistic (i.e., more socially tolerant) than their desert counterparts, this may provide a behavioral explanation for their troublesome success in urban disturbed ecosystems. Understanding this urban pest's population growth may aid in the development of safer and more effective pest control measures.

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***Dwyer, J. M., and J. S. Lewis. *Bat habitat use across the gradient of urbanization in the Phoenix metropolitan area*.**

The response of bats to urbanization is species-specific and shapes the distribution and composition of bat communities. Species can be classified as urban avoiders, urban adapters, or urban exploiters based on where their relative density is the highest along a gradient of urbanization. Urban avoiders are sensitive to urbanization and reach their highest densities in wildland areas, whereas urban exploiters, such as the Mexican-free tailed bat, peak in density in highly urban areas. Arizona exhibits the highest richness of bats in the Western US, and also includes one of the fastest growing metropolitan areas in the United States. The goal of our study is to understand the effect of urbanization on the distribution of bats in an arid region. To achieve this, we will deploy acoustic monitors at 50 sites across

the Phoenix metropolitan area in locations with varying levels of urbanization, from non-urban wildland habitat to highly urban cityscape. Here we present an overview of project objectives, methodology, and proposed analyses. Field work will begin in January 2019 and continue for one year. We will then evaluate the spatial and temporal patterns of bat species and communities across the gradient of urbanization. These results will provide more information on Arizona bats that will assist wildlife managers in creating and implementing regional conservation plans. This information will also add to the CAP LTER effort to understand the urban socioecological systems in the arid, and rapidly growing, Phoenix metropolitan area.

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Dzyuban, Y.[1]*, D. Hondula[2], C. Redman[1], and A. Middel[3]. *Analyzing transit-based heat exposure and behaviors to enhance urban climate adaptation and mitigation strategies in the southwest USA.

Public transportation systems represent an intersecting point between urban climate change adaptation and mitigation strategies. Increasing the use of public transit systems can help cities meet a wide range of sustainability and health goals including reductions in greenhouse gas emissions. Simultaneously, public transit use typically necessitates exposure to outdoor weather. In extreme climates, uncomfortable or dangerous weather conditions may suppress public transportation system without sufficient infrastructure to moderate exposure. We will present results from an ongoing research project in the hot desert city of Phoenix, Arizona, that aims to understand and improve public transit riders' experiences and resilience to heat. Researchers used environmental measurements and surveys to assess environments, conditions, and the behaviors and perceptions of public transit riders. Survey data revealed key behaviors and perceptions that should influence transit stop design strategies: stops that are perceived more beautiful and pleasant are also rated as more thermally comfortable; riders identified infrastructure elements and coping behaviors that make them feel cooler. Findings also showed that current infrastructure standards and material choices for bus stops are not ideal for providing thermal comfort and can contribute to hotter microclimates. As cities in warming climates shift toward increasing the use of public transit, continued attention to the experiences and preferences of transit riders—especially during the summer months—will improve the likelihood that they can meet or exceed public transportation and sustainability goals.

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Dzyuban, Y.[1]*, M. Messerschmidt[2], H. Fischer[3], A. Ellsworth[4], P. Solis[5], J. Vanos[1,6], A. Middel[7], and D. Hondula[6].** ***Mapping thermal comfort in Edison Eastlake Neighborhood with citizen scientists.

The Heat Mappers walk was a community effort to establish a baseline for thermal comfort in Edison-Eastlake Neighborhood near downtown Phoenix. At the walk, two dozen volunteer participants provided an assessment of thermal conditions along strategic walking routes and bus stop locations slated for shade and other improvements. The walk was organized by The Nature Conservancy in Arizona in partnership with Museum of Walking, Phoenix Revitalization Corporation, and Arizona State University, and took place in the afternoon of September 29th, 2018.

Edison-Eastlake is a focal point for ASU and CAP LTER research because the neighborhood will undergo significant renovation under a Housing and Urban Development "Choice Neighborhoods Implementation Grant". Assessing and improving the neighborhood resilience to extreme heat is one factor being considered during this reshaping process. During the Heat Mappers event, volunteers walked a predetermined 3 mile loop, and filled out a field guide questionnaire which asked them to record their thermal comfort and other perceptions at a series of stops. Twelve of the participants wore GPS devices, along with heart rate, air temperature, and ultraviolet radiation exposure monitors. This select group of volunteers also participated in walking interviews. These data will complement ongoing data collection in the neighborhood, including weather information from the six weather stations that CAP researchers recently installed in the area and micrometeorological data taken with a mobile microclimate cart. Combining the environmental, health, and human perception data will allow the project partners to better understand the heat exposure and drivers of thermal (dis)comfort in the neighborhood prior to the reshaping process. We will present the methodology for the Heat Mapper event that we intend to repeat in future years to track progress in meeting community goals related to heat and thermal comfort.

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Earl, S. R. *CAP LTER informatics: Data management for project investigators and the scientific community*.

The CAP LTER addresses the challenges of curating and disseminating research data with a robust Information Management System (IMS) that benefits CAP LTER investigators and the broader scientific community. The CAP LTER IMS facilitates the ingestion of research data and metadata from the project's long-term monitoring programs and project investigators. CAP LTER data are archived with the Environmental Data Initiative, which provides long-term storage and access to research data. Research data are also cataloged by the DataONE federation, which greatly enhances their discoverability. Through these resources, data from the CAP LTER's long-term monitoring programs and project investigators are available to the community as building blocks for future research efforts. For project investigators, submitting data through the CAP LTER meets the data publishing requirements set by funders and publishers, and each data set is given a citation with a Digital Object Identifier (DOI) that a data provider may reference. The CAP LTER Information Manager and the GIOS Informatics Team are available to assist with the data publishing process, data management plans, and generally to provide guidance regarding effective approaches to managing research data.

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Elser, S. R., and N. B. Grimm. *Modeling water use to achieve 25% canopy cover in Phoenix, Arizona.

Chief among the present and future concerns for the city of Phoenix are heat and water use. In 2017 alone, 155 people died from heat-related ailments in Maricopa County, but vegetation has been cited as a protective factor against human heat stress in the city. To help address concerns of heat the city of Phoenix published in 2010 their Tree and Shade Master Plan (TSMP) in which they outline a plan to achieve 25% canopy cover by 2030. While this many trees would assuredly provide many ecosystem services including heat mitigation, the disservices associated with watering them is also important to consider given the city's limited water resources. We ask, how will water use change based on the prioritization of certain trees over others? Using the 2010 Survey 200 (ESCA) vegetation data set, we assess the state of the urban forest when the TSMP was published along with water use data to determine how much water was needed to support that amount of canopy. We then modeled how much water it would take to achieve 25% canopy cover under 4 different scenarios for 2030: Business as Usual (BAU), Sonoran Natives (SN), Fewest Trees (FT), and Water Minimization Optimum (WMO). We found that the SN and WMO scenarios required less water than

the BAU scenario to achieve 25%, but that the FT scenario required the most water of all. These findings illustrate the importance of selecting trees to balance tradeoffs between services and disservices to achieve desirable outcomes.

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Fisher, T.[1], S. Wittlinger[2], R. Erickson[2], and H. E. Hartnett[1]. *High-resolution temporal monitoring of an arid, urban lake: Preliminary results.

Tempe Town Lake, found in Tempe, AZ, has been the site of long-term ecological monitoring since 2005. However, this monitoring has only been on the timescale of days or weeks, making it difficult to capture short-term phenomena. Given the importance of pulse events to arid ecosystem, further analysis of the ecosystem required observations on a shorter timescale. In response to this need, a datasonde was installed on the lake in June of 2018, which allowed continuous monitoring of pH, dissolved oxygen, temperature, conductivity, chlorophyll, turbidity, and colored dissolved organic matter (CDOM) on a half-hourly basis. Monitoring was conducted during from June through August, followed by an interruption due to technical issues, and resuming in October. Initial results indicate that CDOM levels undergo a diel cycle (peaking at night, declining during the day) during the summer months. This pattern becomes less distinct during the fall and winter. CDOM also shows a negative correlation with temperature during the summer, but a positive one during the winter. Discharge events due to rainfall also appear to increase the level of CDOM in Tempe Town Lake, though the magnitude of the increase varies considerably. This type of high temporal resolution geochemical data will aid in understanding the biogeochemical behavior of the lake, and influence possible future water policy and ecosystem management decision.

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***Fleeger, M.[1], K. L. Larson[1,2], M. M. Wheeler[3], R. Andrade[2], and S. J. Hall[3]. *Attitudes toward pollinators in residential landscapes of metropolitan Phoenix, Arizona*.**

Pollinators provide essential ecosystem services since they assist in plant reproduction and the maintenance of biodiversity. Pollinators are not only crucial for the health of vegetation worldwide, but also for crop yields and agricultural productivity that directly benefit people. Multiple factors, including land development and urbanization, pose threats to pollinators and

the ecosystem services they provide. The ability of pollinators to thrive in urban landscapes, and therefore impact agriculture and plant communities, relies on land management decisions that support pollinator habitat and health. In this poster, we present data from the 2017 Phoenix Area Social Survey on residents' attitudes toward pollinators. Specifically, we asked Phoenix residents: to what extent do you like or dislike bees, bats, butterflies, and hummingbirds? We found that butterflies and hummingbirds were viewed very favorably, while bees and bats were viewed negatively by many survey respondents. In addition, we analyzed the relationship between attitudes toward pollinators and specific demographic variables including Latino/Hispanic ethnicity, gender, age, income, and education. The results indicate that residents who identify as Hispanic and/or Latino significantly dislike both bats and bees compared to other residents, while people with higher education favored bats and bees more. We also found that women dislike bats, but like butterflies, at a higher rate than men. Age did not influence attitudes towards pollinators, but more affluent residents liked bats more than did those of lower incomes. This is just the beginning of a closer look at the relationship between humans and pollinators, and what this means for the future of pollinators as a whole.

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Grade, A. M.[1], S. B. Lerman[2], and P. S. Warren[3]. *Do anthropogenic resources buffer avian species against environmental stressors in residential landscapes?

Birds in residential landscapes often take advantage of anthropogenic resources, such as bird feeders, pollinator gardens, and water features. In fact, anthropogenic resources can play a role in patterns of avian species composition and abundance in residential landscapes. Availability of these resources is often relatively consistent across time within residential yards and decoupled from environmental stressors such as drought, which typically drive resource availability in natural systems. We suggest that these anthropogenic resources may act as a buffer from environmental stressors for urban-dwelling birds, and that species life history traits (e.g., dietary preferences) determine the strength of these buffer effects. We present here work in progress that will test anthropogenic resource buffer effects on 10 bird species that occupy residential yards in the Central Area-Phoenix Long-Term Ecological Research (CAP LTER) study system that were part of the Phoenix Area Social Survey (PASS) neighborhoods. We will select these 10 bird species for variation in traits based on a matrix of life history traits, as well as their presence at PASS locations. We will use bird census data from PASS along with anthropogenic resource metrics collected as part of the

Ecological Survey of Central Arizona (ESCA) to develop species distribution models (SDMs) for 2011 and 2016. We predict that if there is a buffer effect on a species, there will be a greater influence of anthropogenic resources on species distributions in SDMs from 2011, a severe drought year, than in SDMs from 2016. We also predict that species life history traits will have an influence on the presence of a buffer effect, as well as what anthropogenic resources are included in the SDMs. The results of this study will provide more insight into how species life history traits influence reliance on anthropogenic resources as a buffer during stressful environmental events.

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Grimm, N. B.[1], A. M. Handler[1], M. D. Lauck[1], M. M. Palta[2], and A. K. Suchy[3]. *A most valuable accident: accidental wetlands provide ecosystem services in an aridland city*.

Accidental wetlands are unique urban habitats resulting from human activities but not designed or managed for any specific purpose. These understudied wetlands likely provide ecosystem services. The Salt River channel in Phoenix supports several accidental wetlands maintained by storm drains discharging urban baseflow and stormwater into the dry river bed with its compacted sediments. CAP studies have examined the ecosystem services provided, especially related to nutrient cycling. Findings suggest that reduction of nitrate, a potentially problematic nutrient in these wetlands, is occurring without active restoration and management. However, nitrate removal could be augmented through hydrologic management of these accidental wetlands.

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Hallmark, A. J.[1], J. Rudgers[1], S. Collins[1], D. Moore[1], and S. Baker[2]. *Optimizing plant size:biomass allometric relationships at the Sevilleta LTER.

Accurately estimating primary production is a core research theme of all Long-Term Ecological Research (LTER) sites. Non-destructive methods of measuring productivity are preferable in areas like arid grasslands or forests where plants recover slowly from disturbance. Allometric equations allow researchers to relate non-destructive measurements such as plant height or cover to plant biomass. In order to create species-specific plant allometries, we have harvested over 22,000 individual plants representing nearly 200

unique species over the course of two decades at the Sevilleta LTER site in central New Mexico. Here, we present the updated workflow used to generate each species' allometric equation. A series of model comparison tests were used to assess the effects of fire, collection year, collection site, and climate (seasonal temperature, rainfall, and aridity) on the linear relationship between plant volume (cover x height) and dry weight. Species-specific or aggregated plant functional type allometric equations were then applied to the Sevilleta LTER's core biomass dataset. We found that individual plant cover rather than plant volume best related to plant biomass in our system. This exciting finding may allow us to reduce field efforts, has allowed for the conversion of "cover-only" datasets, and has implications for the use of aerial drone photography in estimating biomass in the future. In order to make Sevilleta LTER data as understandable and transparent as possible, all analyses for this updated workflow are conducted in R, a free and open-source software, and code is made publicly available on a GitHub account.

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Helmrich, A. M.[1] E. J. Gilrein[1], M. V. Chester[1], and S. A. Markolf[2]. *The past, present, and future of design storms.

Design storms, typically defined as the amount of rainfall distributed over space and time used to determine design standards, are a vital component of stormwater infrastructure development that allows engineers to assess risk. The assumption of a stationary climate within design storm methodology is undermined by climate change, where extreme weather events are intensifying in frequency and magnitude. This research, supported by the Urban Resilience to Extremes Sustainability Research Network, has two primary objectives: 1) expand and evaluate the definition of design storms in the context of all infrastructure systems and all environmental hazards, and 2) propose new ways of considering these environmental hazards to infrastructure that go beyond risk and extend the resiliency of these systems. First, the authors argue that design storms encompass multiple extreme weather events—not only rainfall—and their impacts on all critical infrastructure. Therefore, a definition of design storms is proposed as 'the acceptable level of probability, from any environmental hazard(s), for the process of the design of hard infrastructure, including transportation, power, water, and buildings.' Secondly, consideration of these hazards must go beyond historical information on risks (climate or otherwise) to be able to manage an ever-changing future. This work proposes a more robust consideration of risk and resilience in design storm methodology, and suggests changes to that methodology, to increase

reliability of critical infrastructure design standards within a non-stationary climate by reviewing existing academic literature and design standards. Furthermore, this work revolutionizes the way in which design storms are defined in literature and creates a uniform approach to assessing extreme weather events and their impacts on infrastructure as a collective whole.

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Herckes, P.[1], D. Napolitano[1], A. R. Marcotte[1], J. Eagar[1], and M. Fraser[2]. *Characterization of haboob dust storms in Phoenix, AZ*.

During the summer monsoon season Arizona, very intense dust storms, or haboobs, can occur. These dust storms, characterized by a clear moving front can last from minutes to hours and can substantially impact the local air quality by a sharp increase in particulate matter (PM) and bring an influx of PM material from other locations, impacting local deposition fluxes. During the monsoons seasons 2013 and 2014, background urban PM samples and the PM of haboob events (PM2.5 and PM>2.5) were collected on the Arizona State University Tempe campus. Samples were analyzed for trace metals, organic and elemental carbon as well organic molecular marker species such as polycyclic aromatic hydrocarbons (PAH) or sugars.
The PM10 concentrations in these dust storms are typically on the order of 100s μg/m^3 and can go above 1,000 μg/m^3, although for short amounts of times. PM2.5 concentrations also increase typically by a factor 5-10 compared to pre-haboob conditions.

The chemical characterization shows that the dominant component of these dust storms in mineral dust, consistent with the formation mechanism of these storms, kicking up desert soil in monsoon storm outflows. However chemical analysis also shows a general increase of all species, not only crustal component. In fact elements associated with a anthropogenic activities, such as lead, cadmium, antimony are also substantially increased in the fine particles during these events. This suggests a strong resuspension of urban and street dust. The latter is consistent with organic molecular marker species which show also a substantial increases (e.g. factor of 5 for PAH in PM2.5). The composition data will be further discussed relative to non-haboob dust events and background urban PM.

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Hutton, P., C. D. Wright, D. F. DeNardo, and K. J. McGraw. *No effect of human presence at night on disease, body mass, or metabolism in rural and urban house finches (*Haemorhous mexicanus*).

Global urban development is accelerating and has various effects on wildlife. Most studies of anthropogenic impacts on animals have focused on effects like habitat change or pollution, however there may also be direct effects of physical human presence and on wildlife stress. Additionally, most studies on how human presence affects wildlife have focused on the active, daytime phase of diurnal animals, rarely considering effects of our night-time activities. We hypothesized that, if night- time human presence is a stressor for wildlife that are not commonly exposed to humans, night-disturbed rural animals would show elevated stress compared to urban individuals. Specifically, we experimentally investigated the effects of human presence at night (HPAN) on disease, body mass, and mass-specific metabolic rates in urban- and rural-caught captive house finches (*Haemorhous mexicanus*). Our HPAN treatment consisted of a human entering the housing room of the birds and briefly jostling the home cages of each finch as the person on five randomly selected nights per week for three minutes. Compared with a control (night-undisturbed) group, we found that HPAN greatly increased the odds finches were awake for approximately 33 min post-disturbance, but that chronic HPAN treatment did not alter body mass, parasitic infection by coccidian endoparasites, or mass-specific basal metabolic rates. Additionally, urban and rural finches did not differ in their response to the treatment. Overall, our results are consistent with those showing that brief but regular human disturbances can have acute negative effects on wildlife, but carry little long-term metabolic or disease-related costs.

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Juarez Rivera, M., and H. E. Hartnett. *Is oxygen supersaturation in Tempe Town Lake mainly driven by abiotic processes?

Dissolved oxygen concentrations for the past decade show that Tempe Town Lake (TTL) is supersaturated with respect to O_2 for approximately 70% of the year with 30% of the data equal to or greater than 120% saturation. This data may suggest that biological production of O_2 exceeds its consumption during respiration. However, abiotic processes such as bubble injection or thermal warming can also shift the oxygen concentration from equilibrium. Faster rates of water warming relative to water-atmosphere gas exchange rates result in oxygen supersaturations, while faster cooling rates result in oxygen undersaturation. TTL experiences warming of +3.2°C/month during spring-winter and cooling of -4.2°C/month during fall and winter. For

this research project we ask, what is the dominant process driving oxygen super saturation at TTL? We collected seventeen surface water samples over the course of a year. Using Membrane Inlet Mass Spectrometry we measured argon:oxygen ratios for each sample and determined the oxygen and argon saturation states for each sampling day. Argon was used as a tracer for abiotic contributions of oxygen because it has similar solubility as oxygen and is biologically inert. Our time series shows that Ar saturations track those of O_2 closely. Saturation anomalies (deviations from equilibrium) for argon and oxygen range between +75.63±1.05% and -14.09±0.10% and between +75.07±0.04% and -18.49±0.07%, respectively. Eleven of the 17 sampling days differ by ≤5% and the largest percent difference is 19.50%. These results show that abiotic processes are the main drivers of the observed O_2 saturation at Tempe Town Lake. This work should be continued in lakes of the Southwest to determine how regional climate is affecting their oxygen balance.

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Kazenel, M. R.[1], K. W. Wright[2], T. L. Griswold[3], J. Bettinelli[1], J. A. Rudgers[1], and K. D. Whitney[1]. ***Native bees exhibit species- and ecosystem-specific changes in abundance with aridity.***

Although there is widespread concern about pollinator declines, evidence of potential climate change effects on bee communities is scarce. Bees may be susceptible to changes in both climate mean and variability, including frequency of extreme weather events such as drought, but little work has examined this topic. We studied relationships between native bee abundance and climate at the Sevilleta National Wildlife Refuge in New Mexico, USA, where multiple dryland ecosystem types converge and climate-induced ecosystem state transitions are predicted. We asked: 1) Does native bee abundance vary with level of aridity (drought)? 2) Do bee abundance relationships with aridity differ among three ecosystem types (Chihuahuan Desert grassland, Chihuahuan Desert shrubland, and Great Plains grassland)? and 3) Are bee abundances better predicted by present or past year's aridity? We used Buchmann funnel traps to sample bees between March and October from 2002 through 2014, gathered climate data from co-located weather stations, and focused our analyses on the five most abundant bee species collected. Bee species had differing relationships with aridity among ecosystem types, and trends varied among species. Abundance relationships with increasing aridity ranged from linear (positive and negative) to quadratic and cubic. All species had nonlinear relationships with aridity in one or more ecosystems, suggesting that species could be differentially affected by changes in climate mean and variance. Both past and present year's aridity were significant predictors of bee abundance.

Understanding climate change effects on bees will thus require attention to bee species identity, ecosystem types and transitions, and both past and present climate conditions.

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Kim, Y.[1], J. Sauer, [2], B. Rosenzweig[3], and N. Grimm[2]. *Integrated modeling approach for examining pluvial flood exposure and social sensitivity in Central Arizona-Phoenix.*

Human and infrastructure losses due to extreme precipitation may increase in the future if cities cannot estimate the locations and populations most likely to be impacted by these events. A potential increase in the likelihood of cloudburst events, i.e., short-duration, intense rainfall events, in Central Arizona-Phoenix (CAP) has in turn elevated the need to estimate the areas of CAP most likely to experience pluvial flooding, as well as an evaluation of the stormwater management system's ability to manage these extreme events. In this research, we use a new form of topographic analysis, called 'blue spot modeling' to map areas of the city where substantial surface flooding is likely to occur as a result of extreme cloudburst events. Additionally, we use EPA Stormwater Management Model (SWMM) and the city's official model to estimate regions of the stormwater management network where flooding is likely to occur. We overlay these flood exposure maps with sensitivity variables in order to generate a combined vulnerability index, which allows for the relative comparison of less and more vulnerable areas of CAP. Our results show a great deal of spatial heterogeneity in combined vulnerability; however, we also find substantial pluvial flooding co-occurs in areas where the stormwater management system also experiences flooding, thereby exacerbating the exposure of sensitive populations in the city. Our maps should aid resilience planners in CAP in targeting their attention in particular areas of the city, and provide them with the information to design a suite of location-specific strategies to reduce flood vulnerability.

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Lauck, M., and N. B. Grimm. *Effects of variable inundation patterns on wetland plant communities and nitrogen uptake in the Salt River wetlands.

Nitrogen pollution from urban runoff is a concern that affects the health of people and ecosystems. In addition to numerous valuable ecosystem services, including provision of habitat that promotes biodiversity and heat mitigation, arid urban wetlands remove nitrogen from runoff through denitrification and plant uptake. However, nitrogen removal efficiency of wetlands varies. Several factors contribute to this variation – including environmental conditions, stoichiometry, plant diversity, and functional traits. Plant communities vary as a function of competitive interactions and environmental conditions, such as water availability, which varies dramatically within and between years in arid systems. While the dependence of wetland plant community composition on water availability has been established, the effect of communities on total nitrate removal is less understood. Recent work found species-specific differences in denitrification rate, nitrogen retention, and biomass accumulation that varied over time and as a function of species interactions. This suggests nitrogen removal may be dependent on complex interactions between community functional composition and environmental conditions. In this study, I ask, how do plant community interactions vary as a function of water conditions in an arid urban wetland, and how does this variation affect nitrogen uptake? I will approach these complex interactions between environmental context, plant community, and nitrogen removal using a combination of field observations, plant tissue chemistry, and greenhouse experiments. Data from this study will inform urban water management and stream restoration decisions on how to minimize tradeoffs between sustainability goals to maximize ecosystem benefits, while contributing to long-term data on arid urban wetland ecosystems.

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Lewis, J. S., and A. J. Prince. *The effects of urbanization on the wildlife community across the Phoenix Valley*.

Urbanization can shape species distributions and community assemblies of mammals. Urban exploiters, such as coyote and javelina, can adapt and cause human-wildlife conflict, whereas urban avoiders, such as mountain lions, are more sensitive to urbanization. Mammals are important for maintaining community integrity and this group of wildlife is of great interest to the public and policy makers. Although mammals are important to ecosystems and people in the Phoenix Valley, this group of wildlife is in need of further study to better understand mammal-urban relationships. To evaluate how the wildlife community responds to varying levels of

urbanization, we are collaborating with private and public partners at city, county, state, and federal levels. Using data from wildlife cameras set up along a gradient of urbanization, we will evaluate the spatial and temporal patterns of mammals across the gradient of urbanization. Here we present an overview of project objectives, methodology, and proposed analyses. Fieldwork will begin in January 2019 and continue for one year. Ultimately, information from this project will be used to create predictive maps of important habitat for wildlife species and potential human-wildlife conflict zones. These results can be used to enhance conservation and reduce conflict across the gradient of urbanization within the CAP LTER.

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***McLaughlin, J.[1], K. Wright[2], J. Rudgers[1], M. Kazenel[1], and J. Bettinelli[1]. *Long-term pollinator monitoring study in the Chihuahuan Desert at the Sevilleta LTER, New Mexico*.**

The bee monitoring study was created to examine community and population fluctuations in native bees over a long period of time. With its origin in 2001, the study has now accumulated 17 years worth of continuous data making it one of the longest running bee data sets in the world. Comprised of more than 300 species, this data is an excellent representation of the bee diversity that can be found in the Chihuahuan Desert grass and shrublands. The methodology for this study is fairly simple and requires low maintenance making it a good candidate for modification and implementation in other ecosystems. Bees are collected in funnel traps at three different sites on the Sevilleta National Wildlife Refuge. Collected bees are then curated in an arthropod lab at the University of New Mexico, identified to species, and entered into the data set. This data, paired with any multitude of accessible Sevilleta LTER data sets, allows for analyses to address inquiries on a multitude of subjects including but not limited to: climate sensitivity, community variation, spatial and temporal patterns, phenological relationships, and specialist vs generalist dynamics. The application of this type of study in other ecosystems, including urban environments, may reveal answers to similar questions.

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Muenich R. L.[1], O. Conroy-Ben[1], C. Williams[2], and P. Conden[3]. *The nexus of agricultural and urban trade-offs: Enhancing interdisciplinary education and research to create emerging opportunities in urban agriculture.*

The Phoenix, Arizona metropolitan area has been experiencing the loss of agricultural lands due to urban expansion for decades. In Maricopa County alone, urban areas expanded from 3% of the total area in 1955 to 20% in 2001. Given the climate of the area is semi-arid, with a mean temperature of 15-30°C and average annual precipitation of 190 mm, the region is particularly vulnerable to climate risks. The Phoenix area supports over 4 million residents and is a major agricultural food and fiber exporter, therefore disruptions and decreases to its productivity could have impacts beyond Phoenix and Arizona. There are serious concerns in the Phoenix area as to whether or not water supplies will be sufficient to support the growing urban population, let alone the extant agricultural production in the area. With a grant from the United States Department of Agriculture (USDA) National Institute of Food and Agriculture, we are working to enhance Arizona State University's (ASU) ability to perform agricultural research and education through the topic of trade-offs and opportunities between urban and agricultural lands management. Our three-year project has three main foci: (1) Education, (2) Research, and (3) Engagement. To enhance agricultural education at ASU, we are currently developing an experiential learning course for undergraduate students at ASU and students at Mesa Community College to increase their exposure to urban agriculture-related research and careers. To increase agricultural research at ASU, we're establishing two MS student projects co-advised by ASU researchers and research scientist at USDA's Arid Lands Agricultural Research Center. Finally, we are establishing a stakeholder advisory group and hosting conferences and webinars to engage the broader urban and agricultural communities in Phoenix, in Arizona, and in other communities dealing with competition between urban and agricultural lands.

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Nguyen, T., and P. Westerhoff. *Modeled de facto reuse in surface water sources in the Colorado River Basin.

De facto potable reuse occurs when treated wastewater is discharged into the upstream of drinking water treatment plants (DWTPs). Due to concern about impacts of contaminants of emerging concerns (CECs) at downstream DWTPs, a recent study on the occurrence of de facto potable reuse has been assessed at national scale, but it is limited to the DWTPs serving greater

than 10,000 people. The Colorado River Basin is one of the most critical water sources in the western United States which supplies water for seven states including Arizona, California, Colorado, New Mexico, Nevada, Utah and Wyoming. This study will look at all-sized DWTPs in the Colorado River Basin for potential impacts of upstream treated wastewater discharging to surface waters by using "De Facto Reuse in our Nations Consumable Supply (DRINCS)" model. The goals of the study are to: (i) estimate the percentage of treated wastewater present at a particular DWTP's intake; and (ii) analyze the spatial distribution and magnitude of the de facto potable reuse under varied flow conditions. The modeled results show high occurrence of DFR (associated CECs) at downstream drinking water intakes during droughts, which is the design condition for WWTP effluents. More of small DWTPs are likely impacted by CECs in the Colorado River Basin. Analysis using DRINCS could help investigate DWTPs at higher risk of de facto potable reuse of municipal wastewater and supports monitoring efforts by identifying highly impacted areas.

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***Ohlert, T. J., and S. L. Collins. *A collaborative approach to desert plant community research*.**

Over the last century, climate change has led to increases in drought intensity through escalating both the severity and duration of droughts. Droughts are becoming longer and drier and this trend is expected to continue well into the 21st century. Regional studies have shown that drier ecosystems are more sensitive to drought than wetter ecosystems. Thus, the southwestern United States, as one of the driest regions in North America, is extremely susceptible to intensified effects of drought. Since a vast proportion of plant ecology research is conducted in mesic ecosystems, like tallgrass prairie and deciduous forest, there is an opportunity to progress the field of plant ecology through detailed study of drought response in the deserts of the Southwest.

The objective of our study is to compare drought responses between Arizona's Sonoran Desert and New Mexico's Chihuahuan Desert, using the resources of the CAP LTER and Sevilleta LTER, respectively. To accomplish this goal, we are instituting a rainfall manipulation experiment that decreases precipitation to plant communities by 66% for four years, simulating an extreme drought event. These two deserts have distinct botanical compositions and community structures, the Sonoran dominated by shrubs, cactus, and winter ephemerals and the Chihuahuan dominated by perennial grasses. The responses of these contrasting community structures will provide insight into the drivers of desert response to drought.

Additionally, this research collaboration is contributing data to the Drought Network, an international collaborative of drought scientists.

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Reichman, A., and L. Fields-Austin. *The Sustainable Cities Network*.

The Sustainable Cities Network, an award winning outreach and education program within the Julie Ann Wrigley Global Institute of Sustainability, convenes communities across Arizona to further urban sustainability. The Network serves as a bridge between Arizona State University's multi-disciplinary research and technical capabilities and the front-line challenges facing local communities. Created in 2008 to strengthen regional sustainability efforts, SCN is a voluntary, no-cost network that includes hundreds of practitioners from cities and towns, counties, tribal communities, and many nonprofit organization partners from the Phoenix Metro area and throughout Arizona. Member communities share knowledge, resources, and solutions to make sustainability a core value in community planning, operations, and policy development. To do this, the Network hosts educational workgroups, regional meetings, training workshops, events and activities, partnership projects, and ASU engagements to facilitate information sharing and collaborative activities and outcomes. Additionally, the Sustainable Cities Network is spearheading a university-community partnership program, Project Cities, to improve educational opportunity for ASU students while providing needed technical assistance to neighboring cities. Now in its second year, Project Cities allows ASU classes across academic disciplines to work on city projects such as strategic plans, economic development, or environmental conservation, providing both professional experience to students and additional assistance for city staff and departments. This poster is an overview of the Network and includes information about Project Cities.

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Reichman, A., S. Russell, and L. Fields-Austin. *ASU Project Cities*.

ASU Project Cities is a university-community program connecting Arizona State University students and faculty in select academic courses with projects and sustainability needs and/or challenges of a local community partner. Over the course of a 12-24 month program cycle, students from multiple disciplines and courses research difficult problems selected by the city. At the end of each semester, students present innovative solutions, designs, recommendations, and/or strategies to city staff, which are then

used by the community to make more informed decisions to move projects, planning, and community sustainability efforts forward.

Project Cities involves a broad range of ASU academic disciplines and departments including, but not limited to, sustainability, public policy, tourism, urban planning, design, landscape architecture, engineering, business, journalism, and environmental management. Through this applied "real-world" experiential-style program, students have the opportunity to influence a local community's decision making and planning capacity; thus, having a lasting impact on the community's economic, social and environmental future. This poster is an overview of the ASU Project Cities program.

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Sampson, D. A. *Rainwater and gray water potential for meeting outdoor water demand in the Phoenix metropolitan area*.

The Phoenix metropolitan area (hereafter "Phoenix") is prone to high drought risk and climate change. High uncertainty in future water supplies, and an uncertain future population for Phoenix, coupled with land-cover land-use (LCLU) change, dictates the need for proactive water supply and demand management. A collaborative working group of water managers, stakeholders, and academics developed adaptive and transformative scenarios—sustainable water futures—that incorporate standard and novel water policies and proposed LCLU change for Phoenix for 2060. I adapted an existing water policy and planning model, and parameterized it to explore spatial and temporal differences in water supply and demand for the "strategic" (business as usual) scenario out to 2060. In this contribution I focus on: 1) water use efficiency and growth management, and 2) the influence of the adoption rate and time to implementation of rainwater harvesting and gray water policies on the regional groundwater aquifer and potential for meeting outdoor water demand in Phoenix. I observed decreased reliance on surface water supplies and on groundwater use with increased use of non-potable water sources (grey water and rainwater harvested). Water demand decreased overtime; marked differences in the temporal changes in housing density distributions resulted in dramatically different water use profiles For the strategic scenario, by 2060 alternative supplies from non-potable sources combined could offset, on average, 30% of total outdoor water demand with maximum estimates approaching 90%, depending on the community examined and the rainfall received.

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Sanchez, C. A.[1], C. Cheng[2], D. L. Childers[1], and A. York[3]. *Designing and implementing ecological monitoring of Urban Ecological Infrastructure (UEI): A case study.

Cities are increasingly using nature-based approaches to address urban sustainability challenges. These solutions leverage the ecological processes associated with existing or newly constructed Urban Ecological Infrastructure (UEI) to address issues through ecosystem services (e.g., stormwater retention or treatment). The growing use of UEI to address urban sustainability challenges necessitates transdisciplinary co-production of UEI design, monitoring and maintenance among teams of urban researchers and practitioners. However, how this co-production process unfolds specifically in UEI-based projects has not been studied in the Phoenix metro area.

I examine several components of a co-produced design process and related project outcomes associated with a small-scale UEI project – bioswales installed at the ASU Orange Mall and Student Pavilion in Tempe, AZ. Specifically, I explore the social design process and ecological outcomes associated with development of an ecohydrological monitoring protocol for assessing post-construction landscape performance of this site. The design process was documented using participant observation of collaborative project meetings, and semi-structured interviews with key researchers and practitioners. Throughout this process, researchers and practitioners co-produced a suite of ecological and hydrological metrics to monitor the performance of the bioswales (UEI) constructed at Orange Mall, with an emphasis on understanding stormwater dynamics. I then installed and operated monitoring equipment throughout fall 2018 to generate data that can be used to assess system performance with respect to the co-identified performance metrics.

Here I present preliminary results of landscape performance from storm events in fall 2018, as well as key themes and insights related to the design process of this project. More broadly, this research will provide insights into improving the monitoring, evaluation, and performance efficacy associated with collaborative stormwater UEI projects in arid cities.

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Stuhlmacher, M., R. Andrade, and B. L. Turner II. *The ecological outcomes of land system architecture change: A case study of riverfront redevelopment in Tempe, Arizona.

Improving the sustainability of urban areas—home to over 50% of the world's population—can have a dramatic impact on improving global

sustainability. Moreover, because land use/land cover is both a driver and a potential solution to global environmental change, land composition and configuration (i.e., land system architecture) is an important tool for working towards urban sustainability. Research on the interactions between land system architecture and urban ecosystems is in a nascent stage, with most work evaluating separate ecological outcomes such as the urban heat island, surface water run-off, or biota. Here, we use long term CAP LTER data along with satellite imagery for an integrated comparison of surface urban heat island, vegetation, and bird biota in a redeveloped region along the Rio Salado. The riverfront of the Rio Salado in Tempe, Arizona experienced significant redevelopment as part of the Tempe Town Lake development between the early 1990s and 2000. We examined how the land system architecture of the riverfront changed during this period; what the ecological outcomes were in terms of land surface temperature, vegetation presence/health, and bird biota; and which land system architecture changes relate to ecological outcomes. We find that size, shape, connectivity, and distribution of the land system relate to at least one ecological outcome but that the change in connectivity over time is related to both the decline in vegetation presence/health and the increase in land surface temperatures.

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Sullivan, S.[1], A. Brewis[2], and A. Wutich[2] (Presenter Grace Pyon[2]). ***Studying children's cultural knowledge and behaviors related to environment, health, and food: Methods for ethnoecological research with children.***

Children's ethnoecological knowledge and behaviors related to the environment, health, and food can differ significantly from those of the adults around them. It can be difficult to design studies to capture these differences because standard ethnographic methods do not necessarily translate well to fieldwork with children. We review and evaluate the range of tools useful for eliciting children's (birth to age 12) cultural knowledge and behavior across the domains of health, food, and the environment, identifying the characteristics of different methods (e.g., what type of data they produce, their fit with types of research questions, ages with which they have been used, analytical tools, advantages, and disadvantages). Methods examined include systematic observation in situ (time scans or spot observations), focal follows, photo and video elicitation, artwork, photovoice, video diaries, scrapbooking, oral semi-structured interviews, focus groups, written surveys and diaries, object identification and sorting, attribution tasks, and narrative picture book tasks. We find several opportunities to strengthen ethnoecological research with children. These include regularly

disclosing and discussing the challenges and details of using informed consent and conducting new research to understand the impacts of integrating technologies with other methods to collect ethnoecological data with children. Careful consideration of methods is important for rigorous research and this article serves as a tool for researchers working with or considering working with children, to expand the body of research engaging with and analyzing children's unique cultures.

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Wang, C., and Z-H. Wang. *A statistical view of the Phoenix urban heat island during the past 86 years (1933–2018).

The Phoenix metropolitan area has experienced extensive land use and land cover changes from agricultural and natural landscapes to the built environment during the past decades. The use of construction materials and impervious surfaces in the urban area alters the heat and water exchange, leading to the well-known urban heat island (UHI) effect. With the well-developed station network and long-term meteorological records, the Phoenix UHI is among the most-studied urban climates. Most existing literature, however, only focused on relatively short periods that are less than 20 years, while the UHI effect is continuously changing due to the ongoing urbanization process in Phoenix. In this study, we retrieved 86-year (1933–2018) air temperature data observed at 3 meteorological stations in the Phoenix metropolitan area. A 4-step gap filling method was adopted to reconstruct the daily and monthly missing data, which is more realistic than using climatological averages. The change points of monthly temperature series were detected using Pettitt’s test. Results show statistically significant changes of daytime and nocturnal canopy layer UHI effect in Phoenix over time, mainly due to the urban expansion. In addition, the patterns of monthly variability are significantly different before and after the change points. The distinct peaks in the spectral analysis suggest that the most important periodicities for the UHI effect were around 12, 6, and 4 months, primarily owing to the seasonality. This study provides new insights into the Phoenix UHI effect from a statistical point of view. The UHI effect manifests strong dependence on the selection of both representative stations and time series, highlighting the impact of seasonal cycle and dynamic urbanization process.

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Weiss, K. C. B.[1], C. A. Ray[1], J. Schipper[2], and S. J. Hall[1]. *Conceptual methods for the definition of mammalian functional traits in urban landscapes.

By quantifying adaptations, functional trait approaches increase the predictability of urban impacts on biodiversity. Since functional traits reveal feedbacks between organisms and their environment, they are an essential tool to assess how ecological communities impact ecosystem health and processes. Despite their commonality in the field, significant disagreement exists on how to measure and compare functional traits across taxa, especially across mammals. As ecosystem engineers and drivers of food web trophic dynamics, mammals are key determinants of ecosystem health in human-modified systems. Here, we propose and apply a new functional trait framework to urban mammalian systems that standardizes functional trait assessments and allows for cross-taxa comparisons. We hypothesize that urban mammal community composition reflects physiological constraints as defined by functional traits. To test our hypothesis, we will apply our framework along an urban gradient within CAP LTER. Our framework advocates selecting functionally analogous traits that most likely respond to studied phenomena and that relate to community assembly rules (e.g., selection, speciation, drift, and dispersal). For mammals in CAP LTER, we predict that both behavioral and physiological traits influence their ability to adapt to human-dominated environments. These traits include: activity pattern (corresponding with behavioral thermoregulation and human avoidance), body size (corresponding with heat dissipation, human avoidance, and the increase of mesopredators in cities), dentition and nutritional physiology (corresponding with urban resource use), home range plasticity (corresponding with adaptability to changing patch sizes), and behavioral plasticity (corresponding with acclimation to humans and increased species densities in urban areas). Our research supports a novel functional trait approach for the assessment and conservation of urban ecological communities across the US.

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Weller, N.[1], D. Sittenfeld[2], E. Hostetler[2], and K. Todd[2]. *Mapping public values about climate adaptation and resilience using deliberative forums.

Planning for the impacts of climate change forces communities to make difficult decisions bridging scientific assessment and community concerns. For example, a community preparing for future heat waves must address uncertainty about the frequency, severity, and impacts of those heat waves and complex values tradeoffs in deciding how to prepare. While scientists and governments have sought to 'down-scale' climate models and other

scientific tools to better predict climate change impacts, fewer efforts have sought to assess the ideas and opinions of people living in communities that will be affected regarding climate adaptation. Complicating assessments of public values is the technical nature of climate change impacts and adaptation strategies.

We will present an assessment of informed public values about climate resilience stemming from eight deliberative public forums about climate resilience held across the country in 2017 and 2018. We refer to 'informed public values' because participants at these forums learned about 1) the impacts of heat waves, extreme precipitation events, drought, and sea level rise on communities, 2) different strategies communities can take to build resilience to those impacts, and 3) potential uncertainties, tradeoffs, and impacts associated with those strategies. Participants reported their preferred resilience strategies through group and individual voting exercises and provided their own ideas for how specific local resilience planning priorities should be addressed. We used voting exercises and transcripts of participant conversations to assess public values asserted during discussions. We compare responses for extreme heat across 3 US cities: Phoenix, AZ, St. Paul, MN, and Portland, OR.

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***Wright, M. K.[1], D. M. Hondula[1], P. C. Chakalian[2], K. L. Larson[1], L. E. Watkins[1], and L. C. Kurtz[2]. *Heat surveys in hot places: Predictors of heat illness events in Phoenix, Arizona*.**

The determinants of spatial and temporal variability in heat-related and morbidity have been the subject of extensive research in the hot, desert city of Phoenix, Arizona. Most researchers have focused on hospital records and autopsy reports to provide statistics on extreme heat exposure events, yet it is estimated that many more heat illness events go unreported. Social surveys can give us greater insight into the extent and drivers of heat illness, particularly in those events that did not result in formal medical care. Two residential social surveys recently conducted in the Phoenix metropolitan area specifically ask residents about their experience with heat illness, their perceptions of heat in their neighborhood, and their access to and use of cooling resources: the 2017 Phoenix Area Social Survey (n = 497), administered by the Central Arizona Phoenix Long-Term Ecological Research program, and the 3HEAT screening survey (n = 163), administered as part of an NSF-supported three city collaboration within the cities of Phoenix, AZ, Detroit MI, and Atlanta, GA. Survey responses indicate that indoor residential thermal comfort, financial constraints on air conditioning use, neighbor-

hood scale temperature perceptions and land surface temperature observations, and risk perception of extreme heat are significantly correlated with incidence of heat illness. Thermal preference appears to be a more important determinant of indoor conditions and heat experiences than previously understood, and may mediate previously proposed associations between socioeconomic status and heat vulnerability. Our work highlights opportunities to integrate across social surveys to yield more robust insights into associations between behavioral and environmental factors and heat-related health events.

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Zhang, Y.[1], A. Middel[2,3,4], and B. L. Turner II[1]. *Evaluating the effect of 3D urban form on neighborhood land surface temperature using Google Street View.*

Land surface temperature (LST) directly responds to incoming solar radiation and is strongly influenced by vertical urban structures, such as trees and buildings that provide shade. Conventional LST-planar land-cover assessments do not explicitly address the vertical dimension of the "urbanscape" and therefore do not capture the heterogeneity of solar radiation exposure of planar surfaces adequately. To fill this gap, this study compares and integrates novel spherical land-cover fractions derived from Google Streets View (GSV) with the conventional planar land-cover fractions in estimating daytime and nighttime LST variations in the Phoenix, AZ, metropolitan area. The GSV spherical dataset was created using big data and machine learning techniques. The planar land cover was classified from the National Agriculture Imagery Program (NAIP) imagery. Ordinal least square (OLS) and geographically weighted regression (GWR) were used to assess the relationship between LST and urban form (spherical and planar fractions) at the block group level. Social-demographic variables were added provide the most comprehensive assessment of LST. In the result, the GSV spherical fractions provide better LST estimates than the planar land-cover fractions, because they capture the multi-layer tree crown and vertical wall influences that are missing from the bird-eye view imagery. The GWR regression further improves model fit versus the OLS regression (R2 increased from 0.6 to 0.8). Employing GSV and spatial regression approaches, we have improved the specificity of LST identified by neighborhoods in Phoenix by accounting for shading. This place-specific information is critical for optimizing diverse cooling strategies to combat heat in Phoenix and other semi-arid cities.

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Zhao, Q., D. Shah, Z. Li, H. Fischer, W. Luo, P. Solis, and E. A. Wentz. ***ActivityLog-HeatMappers: A novel research data collection tool for logging activities, locations and environment data.***

ActivityLog is a general mobile phone application that helps urban climate researchers and social scientists study spatial-temporal dynamics of human interaction with urban environment. Data collected through ActivityLog are timestamped, geo-referenced, and easily paired up with air temperature and relative humidity such as Kestrel Drop (a Bluetooth enabled environmental data logger). Specifically, ActivityLog - HeatMappers is designed to support the development of HeatMapper Citizen Science project, which attempts to understand the heat vulnerable population in Maricopa County, Arizona. ActivityLog - HeatMappers has five main functionalities. First, it notifies users at every given hour's interval to remind about logging. Secondly, it periodically collects users' locations at a certain pre-defined interval. Thirdly, it can be paired with a Kestrel Drop device to inform users about current temperature, relative humidity and heat stress index. Fourthly, the mobile application contains a link to HeatMapper survey from Qualtric platform. Lastly, all collected data (location, time, temperature, relative humidity, heat stress index, human activity) are synced with a cloud database that can help researchers monitor data collection progress in a real-time manner. The research results help us understand user behaviors for daily log activities. We also evaluate the data quality of activity logs based on various criterions such as locations, activities of the user, etc. The research results can help us better understand how human activities interact with urban thermal environment and inform planning policy development.

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