Central Arizona-Phoenix Long-Term Ecological Research
CAP LTER

Central Arizona–Phoenix LTER

As one of two sites in the LTER Network at the urban-wildland interface, understanding urban ecosystems has always been central to the Central Arizona–Phoenix (CAP) LTER enterprise. The 6,400 km^2 study site includes both the Phoenix Metropolitan Area and the outlying Sonoran desert. The central question at CAP LTER is focused on the interconnectedness of human and environment interactions: How do the ecosystem services provided by Urban Ecological Infrastructure (UEI) affect human outcomes and behavior, and how do human actions affect patterns of urban ecosystem structure and function and, ultimately, urban sustainability and resilience? For 22 years, CAP LTER researchers have explored social-ecological frontiers in interdisciplinary urban ecology through the study of residential landscapes, urban water bodies, desert parks and preserves, the flora, fauna, and climate of a riparianized desert city, and urban design and governance. Broader impacts of CAP LTER's work include convergence research, with a theoretical focus on the nexus of ecology and design to enhance urban sustainability and resilience. A new theoretical focus for CAP LTER is UEI – a critical bridge between the system's biophysical and human/social domains. The dynamics of UEI will guide research and activities for the next 5-10 years.

Between 2008-2018:

93 investigators

12 institutions represented

92 graduate students

Urban

Principal Investigator:

Daniel L. Childers

Arizona State University

Est. 1997

Funding Cycle:

LTER IV

NSF Program:

Biological Sciences / Division of Environmental Biology

Key Findings

Effects of the 2008 Great Recession on plant communities in residential landscapes. Widespread loss of management (irrigation, weeding, planting, fertilizing) occurred when people were forced to leave their homes, driving an increase in post-recession plant species richness and community homogeneity as abandoned yards were taken over by weedy annual species [Product 7].

Urban Heat Island (UHI) research. Urban heat affects human health and well-being in many ways. Related impacts on human well-being will increase under most climate change scenarios. Researchers at CAP LTER visualized spatial disparities in human-health impacts and environmental perceptions by combining remotely sensed temperature and land cover data at parcel and neighborhood scales with Phoenix Area Social Survey data [6].

Determining optimal irrigation regimes for mesic and xeric residential landscapes. Soil moisture dynamics were modeled using soil moisture data from the long term experimental landscapes at our North Desert Village experimental neighborhood. The relationship between irrigation schedules and plant stress differed by landscape type, which has implications for optimal irrigation regimes [9].

Plant mediated control of surface hydrology in a constructed wetland. Plants at the Tres Rios constructed wastewater treatment wetland were found to be highly productive, transpiring large volumes of water, particularly in the hot, dry summer. A plant driven “biological tide” brings new water and nutrients into the marshes to replace these transpiration losses, making a treatment wetland more effective than if it were located in a cooler or more mesic environment [2].

Exploring the mechanisms that drive urbanization and its impacts on biotic diversity. An experiment that manipulated food resources and predation showed that different factors regulate plant-associated arthropod communities in desert and urban habitats. Bottom up factors were most influential in desert habitats, while urban arthropods responded to a complex set of relationships among climate, plant growth, and predation. Long term research at 12 riparian sites showed that engineered sites supported more generalists while native desert sites supported more specialists. Bird abundance, species richness, and diversity decreased across all riparian types from 2001-2015, and the riparian bird community is shifting towards one characteristic of more engineered sites with less water [1].

Synthesis

Urban homogenization. Central Arizona–Phoenix LTER is working with four other LTER sites to understand how urbanization tends to reduce the unique character of plant and animal communities in each location, making distant cities more biotically similar to each other.

Sharing and comparing with Baltimore Ecosystem Study LTER. There is a long history of collaboration and collegiality between CAP LTER and its companion urban LTER program in Baltimore, especially in the areas of scenarios research and ecology design nexus. Comparing results of the Phoenix Area Social Survey with the Baltimore Phone Survey, researchers at the two sites have related long term change in these social data to patterns of land cover change using high resolution (0.8 m) land use and land cover change data and socio-economic data from both cities.

Urban climatic extremes. The Urban Resilience to Extremes Sustainability Research Network (UREx SRN) integrates social, ecological, and technological systems to devise, analyze, and support urban infrastructure decisions in the face of climatic uncertainty. The foundation established by CAP LTER research was a key factor in basing this international network at Arizona State University.

Data Accessibility

Information management at CAP LTER is well developed; datasets are up to date and archived with the Environmental Data Initiative, documented, and publicly accessible. Central Arizona–Phoenix LTER is an active contributor to the LTER Network Information Management Committee. The Information Manager at CAP LTER works with scientists, students, and staff to address data management throughout the knowledge generating enterprise – from research design to data publication, including teaching a research data management methods course through ASU's School of Sustainability.

Broader Impacts

Convergence research. Transdisciplinary and translational questions are an important component of the core research effort for CAP LTER. Social-ecological science – especially in cities – is particularly suited for this approach. Key goals include: 1) raising awareness of cities as social-ecological platforms for solving sustainability challenges and 2) co-producing knowledge with decision makers.

Education outreach at all levels. K-12 education through an award-winning Ecology Explorers program; 39 undergraduate students supported through a REU program; 58 graduate students funded since 2010 through our novel Grad Grants program; several postdocs funded.

Spatially explicit, long term database on social-ecological variables. Researchers, city managers, and the public have access to CAP LTER's comprehensive database.

Partnerships

Arizona State University Decision Center for a Desert City (ASU DCDC) | Central Arizona Conservation Alliance | McDowell Sonoran Conservancy | The Nature Conservancy

Top Products

1. Bang, C et al. 2012. Control of arthropod abundances, richness and composition in a heterogeneous desert city. **Ecological Monographs.** doi: 10.1890/11-0828.1
2. Bois, P et al. 2017. Confirming a plant-mediated "Biological Tide" in an aridland constructed treatment wetland. **Ecosphere.** doi: 10.1002/ecs2.1756
3. Cook, EM et al. 2012. Residential landscapes as social-ecological systems: a synthesis of multi-scalar interactions between people and their home environment. **Urban Ecosystems.** doi: 10.1007/s11252-011-0197-0
4. Hale, RL et al. 2015. Stormwater infrastructure controls runoff and dissolved material export from arid urban watersheds. **Ecosystems.** doi: 10.1007/s10021-014-9812-2
5. Hall, J et al. 2011. Ecosystem response to nutrient enrichment across an urban airshed in the Sonoran Desert. **Ecological Applications.** doi: 10.1890/10-0758.1
6. Jenerette, GD et al. 2016. Micro-scale urban surface temperatures are related to land-cover features and residential heat related health impacts in Phoenix, AZ USA. **Landscape Ecology.** doi:10.1007/s10980-015-0284-3
7. Ripplinger, J et l. 2017. Boom-bust economics and vegetation dynamics in a desert city: How strong is the link? **Ecosphere.** doi: 10.1002/ecs2.1826
8. Shrestha, M et al. 2012. Land fragmentation due to rapid urbanization in the Phoenix Metropolitan Area: Analyzing the spatiotemporal patterns and drivers. **Applied Geography.** doi: 10.1016/j.apgeog.2011.04.004
9. Volo, TJ et al. 2014. Modeling soil moisture, water partitioning, and plant water stress under irrigated conditions in desert urban areas. **Ecohydrology.** doi:10.1002/eco.1457
10. Zhang, C et al. 2013. A hierarchical patch mosaic ecosystem model for urban landscapes: Model development and evaluation. **Ecological Modelling.** doi: 10.1016/j.ecolmodel.2012.09.020

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