CAP LTER IV
2017 ANNUAL REPORT

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Report to the National Science Foundation

CAP LTER IV
2017 Annual Report

REPORT TO THE NATIONAL SCIENCE FOUNDATION

GOALS OF CAP LTER IV:

- To foster interdisciplinary social-ecological urban research aimed at understanding these complex systems using a holistic, ecology of cities perspective, while contributing to an ecology for cities to enhance urban sustainability through transdisciplinary partnerships with city practitioners.
- To use our long-term observations and datasets to articulate new questions that require a long-term perspective.
- To develop and use various models and scenarios to address our research questions.
- To apply our broad use of existing urban ecological theory, while contributing new theory from our knowledge-generating endeavor.
- To build and use transdisciplinary partnerships to foster resilience and enhance sustainability in urban ecosystems while contributing to the education and well-being of urban dwellers of all ages and experiences.

KEY RESEARCH ACTIVITIES DURING 2017

Long-term monitoring and experimentation: Ecosystem Response to Urban Atmospheric Deposition (DesFert, formerly CNDep)

- 15 sites: 5 west of urban area in desert parks, 5 east of urban area in desert parks, 5 in urban core in desert remnant parks.
- Treatment plots fertilized with ammonium nitrate and phosphate—winter and spring, all fifteen sites.
- Atmospheric deposition collection—collected and analyzed quarterly, six sites.
- PRS™ probes (Western Ag Innovations Inc., Saskatoon, Canada) deployed for rainy season and analyzed for NO3-N and NH4+N—winter and summer (monsoon) seasons, nine sites.
- *Larrea tridentate* (creosote) growth measured—spring and fall, nine sites.
- *Larrea tridentate* (creosote) leaves collected for CHN analysis—spring and fall, nine sites.
- Percent composition of annuals recorded for subplots, aboveground material harvested from different subplots, and aboveground dry mass determined for harvested material—spring, all fifteen sites.

Long-term monitoring: Arthropods

- Temporary reduction to twelve sites, maintaining long-term desert sites (open desert and desert remnant) and residential sites (mesic and xeric yards) that coincide with birding locations.
- Sites at commercial properties, on agricultural land, at North Desert Village, and with no concurrent bird site deleted in anticipation of adding sites that coincide with CAP IV question-driven research.
- Ten pitfall traps per site.
- Traps are set quarterly and collected 72 hours after setting.

- Arthropods stored in ethanol (one jar for each trap) for identification in the lab.

Long-term monitoring: Bird Monitoring—Core

- 70 points monitored in winter and spring at residential, desert, desert park, and riparian (Salt River) locations.
- 36 of these points located in Phoenix Area Social Survey (PASS) neighborhoods (three per neighborhood).
- Point count surveys by professional bird surveyors—all birds recorded that are seen and heard within a 15-minute window.
- Each point visited independently by three different surveyors during each season.

Long-term monitoring: Bird Monitoring—Salt River Biodiversity Project

- 7 sites monitored quarterly—winter, spring, summer, and fall.
- Each site monitored at six points.
- Point count surveys by professional bird surveyor—all birds recorded that are seen and heard within a 15-minute window.

Long-term monitoring: Herpetofauna Monitoring—Salt River Biodiversity Project

- 7 sites monitored three times a year—spring, summer, and fall.
- Nine 10 m x 20 m plots per site.
- Two surveyors concurrently survey each plot for presence of herpetofauna.

Long-term monitoring: Atmospheric Deposition

- Atmospheric deposition buckets collected from one urban location.
- Dry bucket collected monthly, wet bucket collected after precipitation events.

Long-term monitoring: Stormwater—Water Quality Analysis

- Water collected from ISCO stormwater samplers at single location at the outflow of Indian Bend Wash and three locations along the Salt River where stormwater drains create "accidental wetlands".
- Discrete, time-weighted sampling of runoff-producing storms.
- Water analyzed for organic matter, total nitrogen, total phosphorus, dissolved organic carbon, total dissolved nitrogen, cations, and anions.

Long-term monitoring: Impact of haboob events (dust storms) on Tempe Town Lake geochemistry

- Development of a haboob classification based on meteorological and air quality measurements.
- Climatological and statistical analysis of Haboobs and dust storms for the Phoenix LTER area for the time period 2005-2014
- Modeling of deposition fluxes from haboobs and evaluation of their contribution to overall dry deposition of material to a location within the CAP LTER network.
- Evaluation of the impact of Haboob dust storms on Tempe town lake chemistry by comparing deposition dataset to long-term Tempe Town Lake chemistry dataset

Long-term monitoring: Water Quality (Taste and Odor) Analysis

- Water collected monthly at 5 locations at major influent and effluent lake systems.
- Water analyzed in lab for nutrients, major cations and anions, pH, temperature, specific conductance, DOC, taste and odor compounds, and particulate matter.

Long-term monitoring: Eddy Covariance Tower

- One tower located in urban area. Tower houses sonic anemometer, infra-red gas analyzer, and temperature/humidity sensor to measure high-frequency (10 Hz) 3-D wind, CO_2 (flux), temperature (flux), and moisture (flux)
- 30 minute block averaged data is streamed daily. 10 Hz data is downloaded monthly.

Long-term monitoring: Microclimate Towers

- Two 10-m towers, one located in desert remnant park within urban area, other located in outlying desert. Towers house sensors to measure temperature/relative humidity, horizontal wind speed and direction, incoming solar radiation, and precipitation. Data downloaded quarterly and archived.

Long-term Monitoring: Earth Networks Weather Station and Greenhouse Gas Analyzer

- CAP LTER hosts system on eighth-floor roof of ISTB IV building at Arizona State University.
- Weather station provides real-time weather observations for 27 parameters, including temperature, relative humidity (dew point calculated), barometric pressure, wind speed and direction, and precipitation.
- 360-degree weather camera provides weather-related shots to Earth Networks website and local news station.
- Picarro greenhouse gas analyzer provides real-time measurements of carbon dioxide and methane.

Long-term monitoring: Tres Rios Constructed Wetlands

- Bi-monthly field visits with several trips taken to the site in each field month to collect samples and data.
- Measurements and samples are taken along two gradients representing the two hydraulic pathways of the treatment cell: whole-system, from inflow to outflow, and within the vegetated marsh proper, from the open water-marsh interface to the shoreline.
- Conduct monitoring on above- and below-ground primary productivity (biomass), foliar and soil nutrient content, water quality, transpiration, and evaporation.

Long-term monitoring: Tempe Town Lake biogeochemistry

- Water samples taken every two weeks and after rain events.
- Measure: Temperature, conductivity, dissolved oxygen, pH, DOC concentration, and DOC fluorescence
- Finalized ARIMA time-series model to assess effects of external (rainfall, water flow, antecedent conditions) and internal (oxygen saturation state, a proxy for primary production) drivers on the concentration and composition of dissolved organic carbon in TTL
- Drafted manuscript describing model results and implications for oxygen saturation and organic carbon dynamics in the lake. Submission planned for Fall 2017.

- Began sample collection to measure $N_2/O_2/Ar$ saturation states in the lake to assess thermal vs. biological supersaturation of oxygen.

Ecological Survey of Central Arizona (ESCA, formerly Survey 200)

- Soil analyses completed.
- Identification of arthropods collected by sweep net completed.

Sustainable Futures

- Completed final workshops and translating models scenario outputs, visualizations, and narratives into web material, due to be released this fall. The Phase I scenarios were co-developed with city, county, state, and federal partners, community organizations, and NGOs at the regional scale.

SIGNIFICANT RESULTS

Project: Urban water insecurity (DeMyers et al. 2017)

- Barriers to water access include: exposure to extreme heat and the financial barriers to coping with it; increasing physical and social isolation as a product of encampment raiding; inconsistent and uncertain access to water fountains and water trucks
- Sources of water vary across the economic sectors of the population and water sources become more unconventional the more socially marginalized a group is.
- Bottled water is a common source of water that plays a role as both a driver for and an inhibitor of water access.
- There are several health impacts that are associated with water insecurity—coupled with extreme heat—that may lead to a cycle of homelessness or water insecurity.

Project: Tracking urban bird community change within a socioecological framework in Phoenix, AZ (2006 -2011) (Burnette et al. 2016; Lerman et al. 2016; Warren et al. in progress)

- The number of people satisfied with bird variety in their neighborhood, actual bird richness, and bird occupancy all decreased between 2006 and 2011.
- Trends persisted between the two time periods, namely that desert specialists increased in abundance in neighborhoods with desert landscaping, whilst invasive and generalist species increased in abundance in neighborhoods landscaped with exotic plants. However, overall, the total number of desert specialists decreased significantly between the two time.

Project: Measuring urban personal heat exposure (Kuras et al. 2017)

- Collaboratively produced definition: "personal heat exposure is realized contact between a person and an indoor or outdoor environment in which the combination of temperature, humidity, airspeed, and radiative load pose a risk of increases in core temperature or perceived discomfort."
- The first statistical moment of personal heat exposure data is likely an insufficient metric for assessing health risk.

Project: Influence of climate, plant communities, and land-use on long-term patterns of soil properties in the CAP LTER ecosystem (Ball et al. in progress)

- Data support the hypothesis that soil properties in deserts vary less over time compared to managed ecosystems that experience human decision-making
- Land use and land cover have a significant impact on all of the measured soil properties, suggesting that the replacement of desert and agriculture by urban and residential land covers since 2000 is associated with fundamental changes in the biophysical functioning of the CAP LTER ecosystem.
- However, land use alone does not explain all of the variation in soil properties, and we will next explore the relationship between soil properties, land use, and vegetation communities that have also shifted since 2000.

Project: Landscape affinities in the Phoenix oasis (Larson et al. 2017)

- Trends reveal that average age of housing in neighborhoods tends to dominate actual landscape types more than preferences, especially for public areas of front yards.
- Meanwhile, acculturation to the Phoenix oasis—in the form of residents living more of their lives in the Valley—affects both actual and preferred landscapes across front and back yards, although the effect is strongest for actual backyards.
- Altogether, these findings suggest a legacy effect in which older homes and longer-term residents tend to prefer and cultivate the grassy landscapes that have been the historic tradition in the Phoenix oasis. Moreover, the age of development has a stronger impact on front years, whereas time in the region has a stronger effect on back.

Project: Governance dynamics in social-ecological systems (Locke et al. 2017; York and Kane 2017; York et al. 2017)

- Cross-site comparison between Baltimore and Phoenix.
- Citizen support of development fees depended on sociodemographics.
- Patterns of local ecological knowledge and support for policy in CAP and BES differ; age and race explain Phoenician variation, while income and education are predictors in Baltimore.
- Annexation, agricultural and housing prices, and distances to highways help to determine the timing of residential development.

Project: Urban arthropod hydration (McCluney et al. 2017)

- The average water content of arthropods varied with urbanization in three cities (Phoenix, Orlando, Raleigh).
- At certain times of year, mean arthropod water content converges between cities (urban arthropods in Phoenix and Orlando become more similar to urban arthropods in Raleigh).

KEY OUTCOMES OR OTHER ACHIEVEMENTS

CAP LTER is a leader in urban socioecological research:

- Thus far in 2017, we have published 36 peer-reviewed journal articles with 11 in review and one in press.

Faculty collaboration leads to additional grant funding for socioecological research:

- We have leveraged $1.5 million in grant funding since December 2016 (inception of this grant cycle) for a total of over $84.5 million since CAP's inception in 1997.
- Leveraged grants include a $4.2 million NSF Macrosystems Biology grant: "Alternative Futures for the American Residential Macrosystems," based at Research Foundation CUNY - Advanced Science Research Center with CAP Scientists Sharon Hall and Kelli Larson as co-PIs for the ASU sub contract ($646,176), and a $450,000 NSF Civil, Mechanical, and Manufacturing Innovation grant: "A Simulation Platform to Enhance Infrastructure and Community Resilience to Extreme Heat Events," based at ASU with CAP Scientist Mikhail Chester as PI, and Ariane Middel and David Hondula as co-PIs.

Undergraduate and graduate students contribute to a knowledge of urban socioecological systems:

- In 2017, students were authors on 11 publications and were first authors on seven of these.
- Ph.D. degrees were granted to three CAP graduate students in 2017.

CAP engages in knowledge exchange across institutional boundaries:

- CAP's future scenarios project has engaged expert stakeholders from county, state, and federal agencies, municipal departments, non-profits, academic institutions, the regional council of governments, and a tribal association in workshops visioning the future of greater Phoenix.
- CAP is an active partner in the Central Arizona Conservation Alliance, the Sustainable Cities Network, and the McDowell-Sonoran Conservancy's Field Institute where we share research findings, learn from our community partners and collaborate on research, education, and outreach.
- CAP's Regional Water Quality project involves collaboration with the Salt River Project (local utility responsible for water supply) and shares information with local water authorities and managers about quality of all major surface supplies for the metro area through a monthly newsletter and annual workshops.

TRAINING AND PROFESSIONAL DEVELOPMENT

- CAP's activities in the area of training and professional development are three-fold: We actively promote and encourage training and professional development for faculty, staff, and students; we work with the Julie Ann Wrigley Global Institute of Sustainability, the LTER Network Communication Office, and others to design and deliver training and professional development activities that our CAP community can access; and we design and deliver training and professional development for various external stakeholder groups, including teachers. We detail some of these activities under Impact on Human Resources.
- We have encouraged staff to identify training and professional development opportunities that are relevant to their roles and responsibilities in the CAP program. In October, CAP site Manager, Sally Wittlinger and CAP Program Manager Mark Watkins took part multiple training workshops hosted

by the ASU Commission on the Status of Women. Information Manager, Stevan Earl has attended professional development workshops on data and information management. CAP Education Manager Lisa Herrmann attended the Ecology Society of America's annual meeting in Portland, Oregon and participated in professional development activities while there. Other staff members have attended sessions held by ASU on a variety of topics from how to use specialized software packages to effective communication strategies.

- During summer 2017, CAP partnered with the Urban Resilience to Extremes (UREx) Sustainability Research Network and the Urban Water Innovation Network (UWIN) SRN to continue the Summer Research Experience for Undergraduates (REU) program that began in 2016. This brought 10 undergraduate research students (three funded by CAP) together in bi-monthly seminars to share their research and engage in discussions about interdisciplinary research, career and graduate school planning, and science communication. We involved graduate students in these sessions when possible to promote peer-to-peer learning and engagement. Plans to continue and expand this program in 2018 are already being discussed, including a possible a formal REU Symposium at the end of the summer.
- CAP Student Representative Megan Wheeler, with support from the CAP management team, has begun a CAP Student Group. She, along with a small group of officers, have organized multiple events with the goal of increasing networking opportunities for ASU students interested in CAP LTER-related work. These events included a kick-off meeting in which members of the CAP Leadership Team were invited to speak about their research, as well as a presentation on data management given by CAP Information Manager Stevan Earl. This group is already planning events for 2018.
- CAP is highly integrated into Childers' Wetland Ecosystem Ecology Lab (WEEL), which spearheads our research in the Tres Rios Constructed Wetlands. The City of Phoenix built these wetlands as an alternative to traditional wastewater treatment, and now, Tres Rios has become a living laboratory for high school, undergraduate, and graduate students who seek to understand how the constructed wetlands treat wastewater in an arid environment by investigating the function of wetland plants and soils as well as nutrient and water budgets. Last year, WEEL hosted a research scientist from the Chinese Academy of Sciences (CAS), Dr. Yufen Ren, and a Ph.D. student from the CAS (Yanying Yang), both of whom worked with CAP to learn urban ecology field and lab techniques. In 2018 the WEEL and CAP will host another CAS Ph.D. student (Xiaofang Hu).
- CAP encourages students, staff, and faculty to participate in research conferences and symposia as part of their professional development. Each year, CAP funds several students and faculty research presenters to attend the Ecological Society of America's conference and the American Geophysical Union's annual meeting, as well as other research meetings and events. Other conferences that included presentations on CAP research include Resilience 2017 in Stockholm, Sweden, and the International Long-Term Ecological Research Network's 1st Open Science Meeting in Skukuza, South Africa. CAP's annual symposium in January 2017 attracted over 120 participants, including 39 poster presenters.
- Ecology Explorers, in partnership with the McDowell Sonoran Conservancy (MSC), was awarded funds to enable the use of Ecology Explorer educator training to develop four ASU student interns and six MSC volunteers, who will then visit 48 Title I classrooms with Ecology Explorer lessons this spring. These funds will also be used to train 20 MSC volunteers in leading field trips.

DISSEMINATION

- In 2017, CAP students and scientists published a total of 36 peer-reviewed journal articles with 11 in review and one in press. Our journal publications span the biological, physical, engineering, health, and social sciences as well as landscape architecture and urban planning and include journals such as *Journal of Arid Environments, Landscape and Urban Planning, Weather, Climate and Society, Ecosphere, Applied Energy, Behavioral Ecology and Sociobiology, Environmental Justice, Environmental and Resource Economics, Ecosystem Health and Sustainability, and Nature: Ecology and Evolution*..
- CAP joined the social media world in 2010 with its Twitter account @CAPLTER, which focuses on promoting urban socioecological research and practice. We currently have posted a total of 1723 Tweets and have 1156 followers, of whom the majority are scientists, scientific organizations and programs, and environmental and urban-focused non-profits.
- During 2016-2017, CAP scientists have been included in multiple local and national news items, including:
    - Pierre Heckes was quoted in ABC 15's article on the impact that Haboobs have on increasing the risk of Valley Fever in Arizona.
    - The Los Angeles Times quoted David Hondula in their article on climate change and its impact the building boom in Phoenix.
- As noted earlier under Opportunities for Training and Professional Development, CAP actively supports students, staff, and faculty to attend professional meetings and research symposia to present CAP research. In addition to the 39 poster presentations at the January 2017 CAP All Scientists Meeting, CAP scientists and students have made around 20 other presentations during this reporting period.
- Starting with CAP3, we have held our annual All Scientists Meeting and Poster Symposium (ASM) off-campus at ASU's SkySong facility in Scottsdale, which has allowed us to attract more community partners to this all-day event. Our office location in Wrigley Hall is easily assessable to visitors traveling to campus either by car, light rail, bus, or bicycle. Wrigley Hall includes facilities for large and small meetings, most of which have large screens that allow us to connect with our collaborators remotely. We will continue this tradition for our 20th ASM on January 5, 2018.
- In Fall 2017, we launched three co-production service-learning courses to support designed experiments at The Design School at ASU. As part of the course, we are conducting a pre-post survey, follow-up interviews, and focus groups to measure outcomes of the co-production processes. The goals of the research are to:
    - Assess the potentially unique challenges and opportunities associated with co-production in the context of urban ecological design projects;
    - Identify pathways to create more useful CAP LTER science through co-production between scientists, designers, residents, developers, and agency decision-makers involved with urban ecological design projects; and
    - Develop social learning feedback mechanisms between students, researchers, and practitioners for CAP LTER's designed experiment projects and to serve as the foundation of a CAP Co-production Framework

PLANS FOR 2018

- The CAPIV proposal details a number of changes to our long-term monitoring program, including those to more closely tie our monitoring sites together spatially, which will enable us to ecologically characterize neighborhoods and other sites of ecological interest, such as the Salt River and mountain parks. While our monitoring schemes will retain some urban-desert gradient features, we feel that we

have answered many of the questions that we had on ecologies across such gradients. For example, we will eliminate our bird monitoring sites in agricultural and commercial areas while retaining the core residential and Salt River sites and adding sites to the PASS neighborhoods and mountain parks. We will continue to work with our scientists and staff to design and implement changes to our long-term monitoring sites.

- We are adding two ISCO autosamplers higher up in the Indian Bend Wash watershed to allow us to spatially expand our work on urban stormwater.
- We intend to deploy a sensor on a buoy in Tempe Town Lake to collect data on DOC, pH, temperature, conductivity, and dissolved O2.
- For our REU program in summer 2018, we will recruit at least one SEEDS SPUR fellow and up to two more REU students from groups underrepresented in STEM. After another successful run in summer 2017, we will be continuing to collaborate with the UREx SRN and other urban-focused programs on campus on a summer REU program with more seminars and activities planned.
- We are continuing a review of our online data and metadata and making necessary changes to enable users to download and use these data more effectively. We will be working closely with Ecology Explorers to create special datasets from our long-term data that can be easily used in classroom and outreach settings.
- We will continue pursuing collaborative research opportunities with the Decision Center for a Desert City (DCDC) in the areas of governance, green infrastructure, the urban heat island, and landscape design for ecosystem services. The PI of DCDC, Dave White, and two of the co-PIs, Amber Wutich and Kelli Larson, are on the new CAP leadership team, which will enhance our collaboration.
- In addition, we will continue our work with the Sustainability Research Network based at ASU, UREx SRN, which has former CAP co-director Nancy Grimm as a co-director with CAP's former co-director Chuck Redman.
- The Future Scenarios group has created a website based on the work they did during CAP3. It will go live in late 2017/early 2018. They will also be collaborating with the UREx SRN researcher and practitioner team to develop village scale (i.e. South Mountain Village, Phoenix) future scenarios.
- We will be continuing our efforts to communicate science from our research in mountain parks in collaboration with our partners the McDowell Sonoran Conservancy's Field Institute and the Central Arizona Conservation Alliance (see below). We will be working with the Field Institute on how to expand our citizen science activities beyond arthropod monitoring on Conservancy land to other monitoring activities and to transfer this successful citizen science model to other mountain parks.
- The Ecology Explorers program will hold a teacher workshop in summer 2017 on a CAP research topic to be determined. Ecology Explorers is leveraging its collaborations with other environmental education programs in the Global Institute of Sustainability and in other ASU units to expand its reach. In addition, it will continue to work with non-profits and programs across the Phoenix area, including the South Mountain Environmental Education Center, the McDowell-Sonoran Conservancy's Field Institute, the Central Arizona Conservation Alliance, and the Desert Discovery Center.
- The CAP LTER Managerial Team, along with members of the Executive Committee, Leadership Team, and other researchers will attend the next LTER All Scientists Meeting in Fall 2018 in Monterey, California.

IMPACTS

Impact on Principal Discipline

Early on in CAP, we along with our colleagues in the BES were initiators of a conceptual shift in urban ecology from examining ecology in the city to a more systems-oriented approach of understanding the ecology of the city (Grimm et al. 2000). CAP continues to have a large impact on the theory and practice of urban ecology as evidenced by our publication record. The CAP program has published 562 journal articles, 10 books, and 102 book chapters since 1998. Edited volumes on urban ecology that have been published over the past ten years (e.g., Douglas et al. 2011; Elmqvist et al. 2013; Gaston 2010; Lepczyk and Warren 2012; Marzluff et al. 2008; McDonnell et al. 2009; Niemela et al. 2012; Pickett and Cadenasso 2013) copiously cite CAP publications, and many have CAP associated scientists as chapter authors. Recent textbooks on urban ecology also discuss CAP's work in the Phoenix region (Adler and Tanner 2013; Douglas and James 2015; Francis, Millington, and Chadwich 2016; Forman 2014; Parris 2016).

Our other major contributions to date for this grant cycle are:

- Warren et al.'s research provides longitudinal trends of birds in urban neighborhoods, especially linking how landscaping choices and sociodemographic characteristics are associated with long-term bird community trends.
- Larson et al.'s study shows a strong legacy effect in which the age of housing, as well as time spent in the Phoenix oasis, renders residential landscapes more mesic (grassy) than xeric (desert-like). This work is important since many people assume newcomers to the Valley—who are often from the Midwest or more mesic climates)—are bringing grassy landscapes. Not only is this a false assumption, but the legacy effect of historical landscaping trends persists in both the preferences and actual landscapes of residents, potentially making a shift toward lower water-use, more drought-tolerant yards more difficult in older neighborhoods as well as among long-term residents.
- Andrade et al. increases our understanding of the complex linkages in socio-ecological systems and connects the Great Recession and other social processes to ecological outcomes including available habitat and arthropod community structure.

Impact on Other Disciplines

While CAP remains a fundamentally ecological research program, we are an inherently interdisciplinary endeavor, and thus have contributed to shaping urban ecology as a collaborative discipline that includes perspectives, theories, and research from across the natural, physical, social, and engineering sciences to investigate the complexity of processes in urban areas (as illustrated by the contents of the edited urban ecology volumes cited above). During the 2016-2017 reporting period, we had 46 faculty members, 10 graduate student researchers, and four undergraduate researchers actively engaged in CAP research from 12 different academic units/disciplines.

As such, CAP's contributions outside of urban socioecological research are often at the interface between disciplines. Examples include:

- The dataset on haboob (dust storm) occurrence and biogeochemistry contributes to meteorology, atmospheric sciences, and geological sciences.

- Research on the behavioral and physiological impacts on birds from urbanization contributes to work in ecology, physiology, animal behavior, immunology, and neuroendocrinology because the questions being investigated have rarely been asked in the context of urbanization.
- Work on the Great Recession and urban vegetation diversity contributes to bodies of literature in ecology, biogeography, and urban planning.
- Our stormwater research, including work on accidental wetlands, cuts across civil and water resources engineering, ecology, geography, and anthropology.

Impact on Development of Human Resources

- For our summer 2017 REU program, we targeted students from groups underrepresented in STEM. We worked with the Ecological Society of America's SEEDS SPUR fellowship program and recruited one student to join three other faculty-recruited students (also from underrepresented groups) in our summer REU program. These four students bring the total number of REU students supported under NSF funding to 37 since 1998. Several of these students have gone onto graduate school in traditional STEM fields and the in new field of sustainability, and many others have entered STEM-related careers.
- We piloted a set of seminars during summer 2016 to provide REU students with information and experiences beyond what they gain through working with a faculty member. After a resounding success, we continued that program in 2017 and once again partnered with the UREx and U-WIN SRNs to get a critical mass of students together to share research across traditional academic boundaries. The 12 participating students (two of whom participated mainly via Vidyo) came together for five breakfast meetings covering topics such as interdisciplinary research, post-graduate career and education planning, and science communication. The final luncheon meeting involved each student giving a short presentation on learning from the summer's research experience. Feedback from students afterwards indicated that they had appreciated these meetings and that the REU experience had shaped their thinking about post-graduation academic work and careers.
- For many students, this was the first time that they had conducted research and the first time that they had engaged in research-related discussions across disciplinary boundaries. The seminar conveners from CAP and UREx noted the fascination that students had with research very different from theirs: the stream ecology student asking questions of the UREx student researching urban protest movements in Mexico City; the landscape architecture student explaining his rendering of CAP scenarios to the pre-med student; and everyone's questions about the black widow spider in the plastic container that was an illustration for a presentation on black widow spider behavior. Other feedback from students and faculty will assist us in planning for summer 2018.
- REU students are expected to give poster presentations on their work at CAP's annual All Scientists Meeting. Many students end up publishing their research with others in the lab where they were a REU student.
- In 2017, our graduate grants program competitively granted $35,925 to support the research of ten graduate students:
    - Melissa Davidson & Yeowon Kim: "Alternative Futures for Phoenix Neighborhoods: A downscaling approach to scenario development"
    - Cyrus Hester: "Developing a Novel Paleoecological Approach for Studying Long-term, Heavy Metal Pollution in the Greater Phoenix Area"
    - Megan Wheeler: "Effects of nutrient enrichment on annual plant community composition in the northern Sonoran Desert"
    - Qunshan Zhao: "Impact of tree locations and arrangements on outdoor microclimate and human thermal comfort in a compact urban residential environment"

  - Pierce Hutton & Emily Webb: "Urban Impacts on Life History Strategy in a Common Desert Songbird"
  - Eli Perez-Ruiz: "Evaluation of the Net Ecosystem Exchange across different landscapes in Phoenix, Arizona"
  - Ivan Lopez-Castrillo: "Regional Urban Ecohydrological Assessment of Rainfall-Runoff Relations and their Hydrologic Modeling"
  - Jazmine Russell: "Utilizing remotely sensed data to monitor algal blooms and water quality in Arizona reservoirs."
- The impact of the graduate grants program goes beyond money for research. Previous recipients of graduate grants form a panel, run like a NSF proposal review panel, to recommend the next year's graduate student applicants for funding. This model is how CAP trains the next generation of academic and agency scientists on writing effective proposals through hands-on experience with proposal review. The response to this process has been overwhelmingly positive.
- Sixteen teachers from the CAP LTER area were selected through a competitive application process to participate in an intense, week-long summer professional development workshop through the Ecology Explorers program. During this week, teachers learned about the LTER and CAP LTER research work and participated in the lessons and field studies of the Ecology Explorers curriculum. This focus of this workshop was ecology of the McDowell Sonoran Region, and teachers and included a field experience in that Preserve. The teachers will report back later in the school year on classroom implementations of their summer learning experience.
- Additionally, two educators from the McDowell Sonoran Conservancy attended the summer training with plans to develop more robust learning experiences for students attending field trips to the Preserve. Following this training, MSC secured funding for additional trainings through Ecology Explorers for its entire field trip facilitator staff for 2018.
- Eight teachers from the CAP LTER area participated in a joint professional development workshop on water in the environment that featured Ecology Explorers lessons for a portion of one day. The collaborative development and delivery of this workshop with Arizona Project WET is leading to ongoing projects with this organization.
- Eighteen teachers from the Leona Charter School District attended a 2-hour workshop introducing them to the CAP LTER program and Ecology Explorers resources.
- The Ecology Explorers team worked with the Arizona Center for Nature Conservation to develop a 10-lesson unit for the Roosevelt School District's after school program. 3 ACNC educator staff were trained for joint facilitation of this program.
- Three undergraduate student interns and one undergraduate student worker worked with the Ecology Explorers program in spring and fall semesters of 2017. These students learned basics of pedagogy for both classroom and non-formal education settings. They also contributed to the development of teaching materials and lesson plans. Students teamed together to implement learning experiences for schools, community events, and afterschool programs, including a unique afterschool program for families in transition. One student intern will be presenting her two years of work developing contributions to the Ecology Explorer curriculum as her honors thesis this spring.
- One graduate student worker assisted the summer 2016 teacher professional development workshop. This student produced presentations for the teachers on his research areas of expertise, and also facilitated aspects of the workshop related to these areas. It was evident through both observation and in post-workshop surveys that tremendous value was added for the participating teachers through engagement with this student.

Impact on Physical Resources that Form Infrastructure

- As our field area is large, covering the Phoenix metropolitan area and surrounding desert, CAP's provision of field vehicles for research has been essential for the collection of long-term data and student investigations in the urban and peri-urban areas. CAP Site Manager Sally Wittlinger is in charge of insuring that the vehicles are maintained, that researchers undergo the appropriate training to use the vehicles per ASU rules, and that vehicles are checked out and returned properly.
- Shared instrumentation in the Goldwater Environmental Laboratory (GEL) allows CAP researchers access to equipment and training to conduct analyses. The GEL webpages provide a list of equipment http://rts.clas.asu.edu/gel. Some of CAP's part-time laboratory personnel are also employed by GEL, and CAP contributes to equipment purchases on a case-by-case basis.
- CAP maintains the below field infrastructure. During this reporting period (2016-2017), we focused on routine maintenance, instrument calibration, dealing with the vandalism inherent in urban areas, and engaging faculty and students in using the long-term data from these monitoring efforts as well as in locating short-term investigations at these sites.
    - A retractable, 22.1m, four-section eddy flux tower, located in a suburban Phoenix neighborhood comprised of single-story housing. The eddy flux tower measures 3-D wind, CO2, temperature, and moisture, and fluxes are calculated using standing eddy-correlation techniques. The following instrumentation is located on the tower: 3D sonic anemometer, infrared gas analyzer, temperature–relative humidity sensor, and net radiometer.
    - An Earth Networks weather station on the roof of the ISTB4 building (ASU Tempe campus) that measures temperature, humidity, wind speed, precipitation, air pressure and dew point and includes a greenhouse gas analyzer. CAP also maintains a video camera attached to the same tower that the local Channel 3 weather team uses in broadcasts.
    - At each of the DesFert sites, five permanently marked 20m x 20m plots, two unfertilized controls and three receiving fertilizer additions (N, P, or N+P) twice per year. Each plot also contains permanently marked quadrats for biomass and community composition of annual plants and marked creosote bush shrubs for stem elongation measurements.
    - At the Desert Botanical Garden and Lost Dutchman State Park DesFert sites, micrometeorological stations measure temperature, humidity, wind speed, precipitation, air pressure, and dew point. For measurement of atmospheric deposition, CAP has installed resin-based bulk deposition and through fall collectors at each DesFert site. Atmospheric deposition work also includes deposition collectors (wet/dry collector, resin-based bulk collector) on the roof of the Life Sciences A building at the ASU Tempe campus.
    - ISCO automated samplers at Indian Bend Wash and in three stormwater outfalls to the Salt River.

Impact on Institutional Resources

- CAP LTER's grant from NSF in 1997 was the catalyst for the formation of the Julie Ann Wrigley Global Institute of Sustainability at ASU and the sustainability research efforts at ASU. It remains an important research platform for work on urban socioecological systems at ASU and is included on the ASU Office of Knowledge Enterprise Development (OKED) timeline, "A Legacy of Discovery" https://research.asu.edu/ .
- One reason why CAP has stimulated so much research on urban socio-ecological systems is the openness of CAP's leadership to new investigators and students who can contribute novel perspectives

on our long-term work. Furthermore, our collaboration model has led to numerous research initiatives outside of CAP as evidenced by the considerable amount of research funding leveraged from CAP.

- CAP LTER's data management system is the core for a data management system encompassing sustainability research efforts at ASU.
- The on-line Urban Ecology module for educators, developed through the Mary Lou Fulton Teacher's College, is accessible for classroom teachers and non-formal educators throughout the year. https://pll.asu.edu/p/class/orc-ecologyexplorers1
- CAP's Ecology Explorers program provides teachers with professional development training and resources for engaging middle and high school students in learning about urban ecology. Several lesson plans are available on the CAP website. This spring, we collaborated with the Data Nuggets program to disseminate a lesson on the effect of urbanization and habitat restoration on reptiles, such as lizards, to teachers nationally via the Data Nuggets website.
- A new Ecology Explorer protocol, developed in collaboration with CAP LTER researcher David Hondula, has been piloted and various public forums and seen to encourage public participation with data collection. We plan to further expand this citizen science protocol through the new ASU Citizen Science Network and to public venues such as libraries and nature centers throughout the CAP area.
- Two online learning courses, one specific to Urban Ecology and one newly developed, introducing CAP LTER and Ecology Explorers, are accessible for classroom teachers and non-formal educators throughout the year.
- Ecology Explorers worked in collaborative development throughout 2017 with the Desert Discovery Center, the McDowell Sonoran Conservancy, Arizona Center for Nature Conservation, and Arizona Project WET.
- CAP has contributed to the establishment of a citizen science arthropod monitoring program at the McDowell-Sonoran Preserve and is a key partner with the McDowell Sonoran Conservancy. This relationship continues to grow.
- Since 1998, over $84 million in leveraged funding has had a significant impact on institutional resources to support research in the CAP community and beyond, although this report focuses on the results of CAP's direct funding from NSF.

Impact on Information Resources

The CAP LTER added nine new data sets to its publicly available data holdings and another nineteen were revised or updated during the reporting year. New data sets of note include the first publications from the CAP LTER's urban flux tower in the Phoenix area neighborhood of Maryvale, and numerous data sets concerning heat and well-being. All metadata are encoded in the XML-based Ecological Metadata Language (EML), with data and metadata available via both the CAP LTER data catalog on the project website and the LTER Network Information System catalog.

The CAP LTER Information Manager and Julie Ann Wrigley Global Institute of Sustainability (GIOS) informatics team strive continuously to improve the presentation, utility, and management of CAP LTER information resources. Notable improvements for this reporting year include:

- Current CAP Information Manager Stevan Earl and former CAP LTER Information Manager (Phillip Tarrant) taught a course on research data management at Arizona State University in the spring of 2017. This course provided graduate students, including students actively involved with the CAP LTER, with a greater awareness of the importance of data curation, and the skills and tools to more effectively manage their research data. On the heels of strong reviews, S. Earl and P. Tarrant will teach this course again in the spring of 2018.

- The CAP LTER created a GitHub organization to accommodate centralized storage of code and other information resources. Version control provides a linear history of improvements and changes to informatics workflows and resources, and the public repositories may provide helpful contributions to other institutions with similar data-processing requirements.
- The GIOS informatics team transitioned all digital resources from campus-based servers to cloud environments. Servers, and web and informatics resources are now hosted on Amazon, and file-based resources are hosted on Dropbox. These transitions provide greater resilience, utility, and dependability at a reduced cost.
- The formation of an advisory committee consisting of a CAP LTER principal investigator, graduate student, and project staff member to guide the direction and implementation of information management at the CAP LTER. Input from the planned Information Management Advisory Committee (IMAC) is sought to provide (1) insight regarding information management tools and resources that project participants will find most useful and, thus, aid research production, and (2) perspectives from a diversity of backgrounds and areas of expertise to shape data products such that they are maximally discoverable, decipherable, and usable.

The CAP LTER is committed to making a strong contribution to informatics within the LTER network. The CAP LTER Information Manager (S. Earl) participates in all network information meetings and activities. He is an elected officer of the LTER Information Management Executive Committee, chaired the LTER Information Managers Skillset and Training Resources working group, and is a member of a working group tasked with revising the LTER Information Management Committee Terms-of-Reference (by-laws). In addition, S. Earl serves on the Environmental Data Initiative (EDI) Data Checks Committee, which oversees quality control checks implemented in the PASTA+ system (the engine that helps to ensure the integrity of data sets submitted to the LTER and EDI data portals).

Impact on Society beyond Science and Technology

- The Ecology Explorers team has participated in statewide and national meetings and conferences for science and environmental educators. We are participating in the development of initiatives involving the Arizona Association for Environmental Education, the North American Association for Environmental Education, and the Central Arizona Conservation Alliance.
- Our Ecology Explorers program (work described in several sections above) is our major vehicle for engaging with K-12 students, teachers, and the general public. In the current reporting period, we engaged in 39 outreach activities, including the ASU Night of the Open Door, AZ SciTech Festival, and classroom visits, which reached approximately 1664 youth, 702 adults, and 308 teachers. We produced four new Ecology Explorers lessons and engaged in three highly effective multi-day teacher training sessions.
- The Wetland Ecosystem Ecology Lab (WEEL) regularly creates charrettes with the City of Phoenix Water Services Department to assist them with best management practices of the Tres Rios Wetlands ecosystem. They are in the process of scheduling another round of these for mid-December 2017.
- CAP engages with the Sustainable Cities Network, a vehicle for communities in the greater Phoenix region to share knowledge and coordinate efforts to understand and solve sustainability problems. We sit on the Green Infrastructure working group to learn what our issues our city partners are facing and to understand possible synergies with our CAP research.
- Our Scenarios work, described under Activities and Findings, involves many expert stakeholders from across levels of government, the non-profit sector, and the research community. Far from being a purely academic exercise, the Scenarios workshops engage participants in defining future scenarios and understanding the consequences of these designs for water, heat, the urban form, waste, and

food systems through modeling by CAP scientists and visualizations by design students. Development of these scenarios allows us to contrast diverse alternative future pathways and explore interacting strategies for urban sustainability and resilience. This project demonstrates how scenario construction can enhance research and decision-making capacity for long-range sustainability planning and ultimately, we hope this will spark a larger conversation in the greater Phoenix area about future pathways.

- CAP's involvement with the McDowell-Sonoran Conservancy's Field Institute began with our contribution to their arthropod monitoring program. The Conservancy seeks to understand how the McDowell Mountains are being impacted by human activity. We have engaged an active group of volunteers in pitfall trapping arthropods along eight transects in the McDowell Sonoran Preserve and have trained the volunteers to identify arthropods. During this reporting period, we initiated work with the Field Institute to communicate CAP's monitoring and research conducted in the mountain parks surrounding the Phoenix region to park staff. CAP scientists Sharon Hall and Stevan Earl are members of the Field Institute's Science Advisory Committee and both have been featured in the *Field Institute Insider*, the scientific magazine of the McDowell Sonoran Conservancy, which is distributed to Conservancy members.
- CAP staff, students, and scientists are actively involved in the Central Arizona Conservation Alliance (CAZCA), an organization composed of partners from the non-profit, public, and education sectors focused on research and education toward the conservation of the mountain parks surrounding and within the Phoenix metropolitan area. CAP was one of CAZCA's founding partners in 2010, and we continue to work with the organization on citizen science, education, and research efforts.
- The Desert Discovery Center is a partnership between the City of Scottsdale and ASU to build a world-class research and education facility to improve public understanding of desert ecosystems worldwide and to generate ideas on how to live in a rapidly growing urban area situated within a desert ecosystem. Our work on this initiative to date has mainly involved contributions to planning sessions as well as discussions about the development of curriculum for K-12 schools.
- Discussions with the AZ Chapter of the American Planning Association to co-host workshops and webinars are climate-smart and sustainable landscapes in urban neighborhoods of Phoenix and beyond. This was a part of a SNAPP proposal—led by Susannah Lerman—that is currently under review, the outcome of which would be a series of workshops to advance analyses and knowledge of climate-smart yards across the U.S. and beyond.
- In Fall 2017, CAP Researchers Paul Coseo and Chingwen Cheng launched one CAP Design Forum partnering with the Flood Control District of Maricopa County (FCDMC) to identify a research design strategy for a series of designed experiments. They plan subsequent Design Forums to support the FCDMC – CAP partnership to create a series of designed experiments campus at the FCDMC.

PUBLICATIONS

Andrade, R., H. L. Bateman and Y. Kang. 2017. Seasonality and land cover characteristics drive aphid dynamics in an arid city. *Journal of Arid Environments* 122(Sep):12-20. DOI: 10.1016/j.jaridenv.2017.04.007. (link)

Banville, M. J., H. L. Bateman, S. R. Earl and P. S. Warren. 2017. Decadal declines in bird abundance and diversity in urban riparian zones. *Landscape and Urban Planning* 159(Mar):48-61. DOI: 10.1016/j.landurbplan.2016.09.026. (link)

Berisha, V., D. M. Hondula, M. Roach, J. R. White, B. McKinney, D. Bentz, A. Mohamed, J. Uebelherr and K. Goodin. 2017. Assessing adaptation strategies for extreme heat: A public health evaluation of cooling centers in Maricopa County, Arizona. *Weather, Climate, and Society* 9(1):71-81. DOI: 10.1175/WCAS-D-16-0033.1. (link)

Bois, P., D. L. Childers, T. Corlouer, J. Laurent, A. Massicot, C. A. Sanchez and A. Wanko. 2017. Confirming a plant-mediated "Biological Tide" in an aridland constructed treatment wetland. *Ecosphere* 8(3):e01756. DOI: 10.1002/ecs2.1756. (link)

Burillo, D., M. V. Chester, B. Ruddell and N. Johnson. 2017. Electricity demand planning forecasts should consider climate non-stationarity to maintain reserve margins during heat waves. *Applied Energy* 206(Nov):267-277. DOI: 10.1016/j.apenergy.2017.08.141. (link)

Chapman, E. J., H. Cadillo-Quiroz, D. L. Childers, M. R. Turetsky and M. P. Waldrop. 2017. Soil microbial community composition is correlated to soil carbon processing along a boreal wetland formation gradient. *European Journal of Soil Biology* 82(Sep-Oct):17-26. DOI: 10.1016/j.ejsobi.2017.08.001. (link)

Cook, M. O., M. J. Weaver, P. Hutton and K. McGraw. 2017. The effects of urbanization and human disturbance on problem solving in juvenile house finches (*Haemorhous mexicanus*). *Behavioral Ecology and Sociobiology* 71:Art. 85. DOI: 10.1007/s00265-017-2304-6. (link)

DeMyers, C., C. Warpinski and A. Wutich. 2017. Urban water insecurity: A case study of homelessness in Phoenix, Arizona. *Environmental Justice* 10(3):72-80. DOI: 10.1089/env.2016.0043. (link)

Eagar, J., P. Herckes and H. E. Hartnett. 2017. The characterization of haboobs and the deposition of dust in Tempe, AZ from 2005 to 2014. *Aeolian Research* 24(Feb):81-91. DOI: 10.1016/j.aeolia.2016.11.004. (link)

Fishman, J. and V. K. Smith. 2017. Latent tastes, incomplete stratification, and the plausibility of vertical sorting models. *Environmental and Resource Economics*66(2):339–361. DOI: 10.1007/s10640-015-9952-7. (link)

Fraser, A. M. and M. V. Chester. 2017. Transit system design and vulnerability of riders to heat. *Journal of Transport & Health* 4(Mar):216-225. DOI: 10.1016/j.jth.2016.07.005. (link)

Giraudeau, M., R. Stikeleather, J. McKenna, P. Hutton and K. McGraw. 2017. Plumage micro-organisms and preen gland size in an urbanizing context. *Science of the Total Environment* 580(Feb):425-429. DOI: 10.1016/j.scitotenv.2016.09.224. (link)

Grimm, N. B., S. T. Pickett, R. L. Hale and M. L. Cadenasso. 2017. Does the ecological concept of disturbance have utility in urban social-ecological-technological systems?. *Ecosystem Health and Sustainability* 3(1):e01255. DOI: 10.1002/ehs2.1255. DOI: 10.1002/ehs2.1255. (link)

Groffman, P. M., M. Avolio, J. Cavender-Bares, N. D. Bettez, J. M. Grove, S. J. Hall, S. E. Hobbie, K. L. Larson, S. B. Lerman, D. H. Locke, J. B. Heffernan, J. L. Morse, C. Neill, K. C. Nelson, J. O'Neil-Dunne, D. E. Pataki, C. Polsky, R. Roy Chowdhury and T. L. Trammell. 2017. Ecological homogenization of residential macrosystems. *Nature: Ecology & Evolution* 1:Art. 0191. DOI: 10.1038/s41559-017-0191. (link)

Groffman, P. M., M. L. Cadenasso, J. Cavender-Bares, D. L. Childers, N. B. Grimm, J. M. Grove, S. E. Hobbie, L. R. Hutyra, G. D. Jenerette, P. T. McPhearson, D. E. Pataki, S. T. Pickett, R. V. Pouyat, E. Rosi-Marshall and B. L. Ruddell. 2017. Moving towards a new urban systems science. *Ecosystems* 20(1):38-43. DOI: 10.1007/s10021-016-0053-4. (link)

Hagaman, A. K. and A. Y. Wutich. 2017. How many interviews are enough to identify metathemes in multisited and cross-cultural research? Another perspective on Guest, Bunce, and Johnson's (2006) landmark study. *Field Methods* 29(1):23-41. DOI: 10.1177/1525822X16640447. (link)

Hondula, D. M., R. C. Balling Jr., R. Andrade, S. Krayenhoff, A. Middel, A. Urban, M. Georgescu and D. J. Sailor. 2017. Biometeorology for cities. *International Journal of Biometeorology* 61(Supp. 1):59-69. DOI: 10.1007/s00484-017-1412-3. (link)

Klaiber, H. A., J. K. Abbott and V. K. Smith. 2017. Some like it (less) hot: Extracting tradeoff measures for physically coupled amenities. *Journal of the Association of Environmental and Resource Economics* 4(4): 1053-1079. DOI: 10.1086/692842. (link)

Krause, S., J. Lewandowski, N. B. Grimm, D. M. Hannah, G. Pinay, K. McDonald, E. Marti, A. Argerich, L. Pfister, J. Klaus, T. Battin, S. Larned, J. Schelker, J. Fleckenstein, C. Schmidt, M. O. Rivett, G. Watts, F. Sabater, A. Sorolla and V. Turk. 2017. Ecohydrological interfaces as hotspots of ecosystem processes. *Water Resources Research* 53(8):6359-6376. DOI: 10.1002/2016WR019516. (link)

Kuras, E. R., M. B. Richardson, M. M. Calkins, K. L. Ebi, J. J. Hess, K. W. Kintziger, M. A. Jagger, A. Middel, A. A. Scott, J. T. Spector, C. K. Uejio, J. K. Vanos, B. F. Zaitchik, J. M. Gohlke and D. M. Hondula. 2017. Opportunities and challenges for personal heat exposure research. *Environmental Health Perspectives* 125(8):085001. DOI: 10.1289/EHP556. (link)

Larson, K. L., J. Hoffmann and J. Ripplinger. 2017. Legacy effects and landscape choices in a desert city. *Landscape and Urban Planning* 165:22-29. DOI: 10.1016/j.landurbplan.2017.04.014. (link)

Li, X., Y. Kamarianakis, Y. Ouyang, B. L. Turner II and A. J. Brazel. 2017. On the association between land system architecture and land surface temperatures: Evidence from a desert metropolis -- Phoenix, Arizona. *Landscape and Urban Planning*163(2017):107-120. DOI: 10.1016/j.landurbplan.2017.02.009. (link)

McCluney, K., J. D. Burdine and S. D. Frank. 2017. Variation in arthropod hydration across US cities with distinct climate. *Journal of Urban Ecology* 3(1):1-9. DOI: 10.1093/jue/jux003. (link)

McHale, M. R., S. J. Hall, A. Majumdar and N. B. Grimm. 2017. Carbon lost and carbon gained: A study of vegetation and carbon tradeoffs among diverse land uses in Phoenix, AZ. *Ecological Applications* 27(2):644–661. DOI: 10.1002/eap.1472. (link)

McPhearson, P. T., D. M. Iwaniec and X. Bai. 2017. Positive visions for guiding urban transformations toward sustainable futures. *Current Opinion in Environmental Sustainability* 22:33-40. DOI: 10.1016/j.cosust.2017.04.004. (link)

Palta, M. M., N. B. Grimm and P. M. Groffman. 2017. "Accidential" urban wetlands: Ecosystem functions in unexpected places. *Frontiers in Ecology and the Environment*15(5):248-256. DOI: 10.1002/fee.1494. (link)

Pulford, E., B. A. Polidoro and M. L. Nation. 2017. Uniderstanding the relationships between water quality, recreational fishing practices, and human health in Phoenix, Arizona. *Journal of Environmental Management* 199(2017):242-250. DOI: 10.1016/j.jenvman.2017.05.046. (link)

Rice, J. and P. K. Westerhoff. 2017. High levels of endocrine pollutants in US streams during low flow due to insufficient wastewater dilution. *Nature Geoscience* 10:587-591. DOI: 10.1038/ngeo2984. (link)

Ripplinger, J., S. L. Collins, A. M. York and J. Franklin. 2017. Boom-bust economics and vegetation dynamics in a desert city: How strong is the link?. *Ecosphere* 8(5):e01826. DOI: 10.1002/ecs2.1826. (link)

Smith, V. K., S. L. Harlan, M. McLean, J. Fishman, C. Valcarcel and M. L. Nation. 2017. Does reputation enhance response rates?. *Applied Economic Letters* 24(17):1228-1231. (link)

Song, J., Z. Wang and C. Wang. 2017. Biospheric and anthropogenic contributors to atmospheric CO_2 variability in a residential neighborhood of Phoenix, Arizona. *Journal of Geophysical Research: Atmospheres* 122:3317-3329. DOI: :10.1002/ 2016JD026267. (link)

van Riper, C. J., A. C. Landon, S. Kidd, P. Bitterman, L. A. Fitzgerald, E. F. Granek, S. Ibarra, D. Iwaniec, C. M. Raymond and D. Toledo. 2017. Incorporating sociocultural phenomena into ecosystem service valuation: The importance of critical pluralism. *BioScience*67(3):233-244. DOI: 10.1093/biosci/biw170. (link)

Wang, Z., D. Shao and P. K. Westerhoff. 2017. Wastewater discharge impact on drinking water sources along the Yangtze River (China). *Science of the Total Environment* 599-600(Dec):1399-1407. DOI: 10.1016/j.scitotenv.2017.05.078. (link)

Wheeler, M. M., C. Neill, P. M. Groffman, M. Avolia, N. D. Bettez, J. Cavender-Bares, R. Roy Chowdhury, L. Darling, J. M. Grove, S. J. Hall, J. B. Heffernan, S. E. Hobbie, K. L. Larson, J. L. Morse, K. C. Nelson, L. A. Ogden, W. D. Pearse, J. O'Neil-Dunne, D. E. Pataki, C. Polsky, M. K. Steele and T. L. Trammell. 2017. Continental-scale homogenization of residential lawn plant communities. *Landscape and Urban Planning* 165:54-63. DOI: 10.1016/j.landurbplan.2017.05.004. (link)

York, A. M., K. Kane, C. M. Clark, L. E. Gentile, A. Wutich and S. L. Harlan. 2017. What determines public support for graduated development impact fees?. *State and Local Government Review* 49(1):15-26. DOI: 10.1177/0160323X17716745. (link)

Zhang, Y., A. Murray and B. L. Turner II. 2017. Optimizing green space locations to reduce daytime and nighttime urban heat island effects in Phoenix, Arizona. *Landscape and Urban Planning* 165:162-171. DOI: 10.1016/j.landurbplan.2017.04.009. (link)

Zhao, Q., E. A. Wentz and A. T. Murray. 2017. Tree shade coverage optimization in an urban residential environment. *Building and Environment* 115(Apr):269-280. DOI: 10.1016/j.buildenv.2017.01.036. (link)