

CAP LTER V 2024 ANNUAL REPORT TO THE NATIONAL SCIENCE FOUNDATION



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Report to the National Science
Foundation

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CAP LTER V

2024 Annual Report to the National Science Foundation

REPORT TO THE NATIONAL SCIENCE FOUNDATION

GOALS OF CAP LTER V

- Use field ecological and social observations and experiments requiring long-term perspectives;
- Develop and use models and scenarios through participatory, community-based strategies;
- Advance urban ecological theory while contributing new theory derived from our transdisciplinary research;
- Promote and strengthen environmental justice using broadly inclusive approaches to CAP science and outreach;
- 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 types, ages, and experiences; and
- Adaptively manage our research and how we frame our work with communities of practice. CAP V research will be organized around five interdisciplinary questions that will use and build on 19 long-term datasets and experiments in a fully integrated and synthetic research platform.

KEY RESEARCH ACTIVITIES

Long-term Observations and Experimentations

Ecosystem Response to Urban Atmospheric Deposition (DesFert experiment)

- 15 sites: Five west of urban area in desert parks, five east of urban area in desert parks, and five in urban core in desert remnant parks.
- Treatment plots fertilized with nitrogen (as ammonium nitrate) and/or phosphorus (as triple super phosphate)—winter and spring, all fifteen sites since 2006.
- Atmospheric deposition collection—collected and analyzed quarterly at six sites.

- PRS™ probes (Western Ag Innovations Inc., Saskatoon, Canada) deployed in rainy season and analyzed for NO₃⁻ and NH₄⁺—winter and summer (monsoon) seasons at nine sites.
- *Larrea tridentate* (creosote) growth measured during spring and fall at nine sites.
- *Larrea tridentate* (creosote) leaves collected for CHN analysis—spring and fall at nine sites.
- Percent composition of annuals recorded for subplots; above ground material harvested from different subplots, and aboveground dry mass determined for harvested material—spring at nine sites.

Arthropods

- Twelve sites, including long-term desert sites (open desert and desert remnant) and residential sites (mesic and xeric yards) that coincide with birding locations.
- Eight additional sites at McDowell Sonoran Preserve, a citizen science partner.
- Ten pitfall traps per site.
- Traps are set quarterly and collected 72 hours after setting. McDowell Sonoran Preserve sites will be collected during the summer starting in 2024.
- Arthropods stored in 70% ethanol (one jar for each trap) and identified in the lab.

Bird Monitoring

- 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.

Bird Monitoring—Salt River Biodiversity Project

- 7 sites monitored quarterly, with 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.

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.

Atmospheric Deposition

- Atmospheric deposition buckets were collected from one urban location; Dry bucket collected monthly, wet bucket collected after precipitation events.
- Project terminated in summer 2023.

Stormwater

- Water collected from ISCO stormwater samplers at three locations along Indian Bend Wash (IBW): one long-term site at the southern outflow of IBW and at two sites further upstream in the IBW watershed.
- 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.
- Fluxes calculated by combining concentration and water flow data.

Regional Drinking Water Quality Analysis

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

Eddy Covariance Tower

- Two towers, one located the Maryvale Neighborhood, the other at the Desert Botanical Garden.
- The Botanical Garden Tower houses sonic anemometer, infra-red gas analyzer, and temperature/humidity sensor to measure high-frequency (10 Hz) 3-D wind, CO₂ (flux), temperature (flux), and moisture (flux).
- New sensors for the Maryvale tower were purchased by the Southwest Urban Corridor Integrated Field Laboratory.
- 10 Hz data is downloaded monthly in person, with a wireless data transfer system currently in production.
- Data is currently being retrieved and processed by the Vivoni Lab.

Microclimate Towers

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

Earth Networks Weather Station and Greenhouse Gas Analyzer

- CAP LTER hosts this system on eighth-floor roof of ISTB4 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 photos to Earth Networks website and local news station.
- Previously, a Picarro greenhouse gas analyzer provided real-time measurements of carbon dioxide and methane (removed in April 2023).

Tres Rios Constructed Wetlands

- Bi-monthly field visits.
- 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, along 10 permanent transects.
- Measure aboveground primary productivity (biomass) of marsh vegetation, foliar and soil nutrient content, and water quality to produce whole system nutrient budgets, and transpiration and evaporation to produce whole system water budgets.

Tempe Town Lake Biogeochemistry

- Water samples collected every two weeks and after rain events and analyzed for temperature, conductivity, dissolved oxygen, pH, chlorophyll a, inorganic nutrient and DOC concentrations, and DOC fluorescence.
- Eureka Manta+35 multiprobe datasonde deployed in Tempe Town Lake in June 2018. Sensors measure temperature, conductivity, turbidity, pH, dissolved oxygen, chlorophyll a, DOC concentration, and CDOM/fDOM at 30-minute intervals. Datasonde is removed monthly from TTL and brought back to lab for cleaning, data download, and sensor calibration.

Charismatic Megafauna in Cities

- Wildlife cameras deployed at 50 sites in CAP study area in proximity to ESCA, DesFert, and Salt River sites. Data are downloaded monthly. This project was concluded in August 2020. With the pilot project completed, the cameras will now be relocated to 35 sites along the Salt River.

Drought-Net

- Two sites, each with seven rainout shelter plots and seven control plots.
- Desert annuals and soil samples collected for analysis each spring.
- Sites situated at DesFert sites, one west and one east.
- Project is in collaboration with researchers from Sevilleta LTER.
- Drought-Net infrastructure was removed in spring 2023, but plots will continue to be surveyed through spring 2024.

TRAINING AND PROFESSIONAL DEVELOPMENT

- CAP's activities in the area of training and professional development are three-fold: 1) We actively promote and encourage training and professional development for faculty, staff, and students; 2) we work with the Julie Ann Wrigley Global Institute of Sustainability and Innovation, the LTER Network Communication Office, and others to design and deliver training and professional development activities to the CAP community; and 3) we design and deliver training and professional development for various stakeholder groups, including teachers, citizen scientists, and practitioner partners.

- During summer 2023, CAP continued our Integrated Summer Research Experience for Undergraduates (REU). This year, we brought seven REU students 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 near-peer mentoring, learning, and engagement.
- In 2023, the CAP Student welcomed a new leader, Luke Ramsey-Wiegmann, a PhD student in the School of Sustainability. He continued to build and develop the CAP LTER Student Group, picking up where Jeffrey Haight left off. They have also organized events to increase networking opportunities for ASU students interested in CAP LTER-related work, including a monthly CAP coffee hour that coincides with the CAP JEDI committee's Equity Circle.
- ASU's Wetland Ecosystem Ecology Lab (WEEL) is highly integrated into CAP. The WEEL spearheads our research at the Tres Rios Constructed Treatment Wetlands and in other urban wetland systems. The City of Phoenix built these wetlands as an alternative to traditional wastewater treatment, and Tres Rios has become a living laboratory for high school, undergraduate, and graduate students who want to experience urban field and lab research for the first time. All field work at Tres Rios in the eight and a half years of the WEEL lab has been done by student volunteers.
- 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 to present their research findings at the Ecological Society of America's conference, the American Geophysical Union's annual meeting, as well as other conferences and events. Other conferences and events where CAP researchers presented their findings in 2023 included the Urban Ecosystem Research Consortium and The Joint Annual Meeting of Wildlife and Fisheries Societies.
- CAP's annual All Scientist Meeting in January 2024 attracted over 100 participants, including 30 poster presenters, and we anticipate similar attendance and participation in January 2025.

DISSEMINATION

- In 2023-24, CAP students and scientists published a total of 18 peer-reviewed journal articles with 16 in review and three 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: Urban Ecosystems, Sustainability, Landscape and Urban Planning, The Journal of Ornithology, Frontiers in Ecology and Evolution, and PLOS One.
- CAP joined the social media world in 2009 with its Twitter account @CAPLTER, which focuses on promoting urban social-ecological research and practice. We currently have 1849 followers, of whom the majority are scientists, scientific organizations and programs,

or environmental and urban-focused non-profits.

- 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 29 poster presentations at the January 2024 CAP All Scientists Meeting, CAP scientists and students have made 39 other presentations during this reporting period.
- As part of our NSF virtual site visit in May 2021, we created a series of virtual site visits that allowed our reviewers to experience learn about the work we do at different sites across the CAP area. Link: https://www.youtube.com/playlist?list=PLmV7x-JlhKmqbrOVClY_cGZpaa8HC34-h
- Every year, we hold our annual All Scientists Meeting and Poster Symposium (ASM) off-campus at ASU's Skysong facility in Scottsdale, which is located north of the ASU Tempe campus. We will continued this tradition for our 26th ASM on January 12, 2024. Our ASM's agenda includes a "State of the Program" update from Dan Childers. He also gives out CAP Service Awards to individuals who have made great contributions to CAP LTER. Last year, we honored:
 - Dr. Jeffrey Haight, in appreciation of his leadership of the CAP LTER student group.
 - Dr. Michelle Hale, in appreciation of her outreach efforts with local indigenous communities on behalf of CAP.
 - Dr. Charles Redman, in appreciation of his decades of leadership and contributions to CAP LTER and the science community.
 - Mark Watkins, in appreciation of his program management efforts.
- Our staff has offices in The Wrigley Center for Planetary Health and the Goldwater Center on ASU's Tempe campus. Both include facilities for large and small meetings, most of which have large screens that allow us to connect with our collaborators remotely.

PLANS FOR 2024

- We will continue our work based on the goals of CAPV. In particular, to expand our urban air quality and environmental justice work and our work with underserved communities in South and West Phoenix, and to expand our work with local Indigenous communities.
- The next CAP LTER All Scientists Meeting and Poster Symposium, our 27th, will be held at ASU Skysong in January 2025.
- The CAP LTER Justice, Equity, Diversity, and Inclusion committee will continue to hold regular meetings, monthly Equity Circles, and work toward the goals outlined in the Impacts on in Human Resources section.

IMPACTS

Impact on Main Discipline

Early on in CAP, we along with our colleagues at the BES LTER Program were initiators of a conceptual expansion of urban ecology from a discipline examining ecology *in* the city to a more holistic approach of understanding the ecology *of* the city (Pickett et al. 1997; Grimm et al. 2000). CAP continues to contribute significantly to the theory and practice of urban ecology as evidenced by our publication record. The CAP program has published 681 journal articles, 13 books, and 117 book chapters since 1998. CAP research is copiously cited in numerous 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), and many have CAP 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). CAP scientists have published papers that expand urban ecological theory into the realm of a transdisciplinary and translational ecology for cities (Childers et al. 2014, 2015; Pickett et al. 2016), into linking urban ecosystem services to urban resilience (e.g., Grimm et al. 2016; 2018), and on the concept of urban ecological infrastructure as a social-ecological bridge for translational urban ecology (Childers et al. 2019).

Impact on Other Disciplines

While CAP remains a fundamentally ecological research program, CAP research has always been an inherently interdisciplinary endeavor, and thus have contributed to shaping urban ecology as a collaborative field that includes perspectives, theories, and research from across the natural, physical, social, design, and engineering sciences to investigate the complexity of social-ecological processes in urban areas. During the 2022-2023 reporting period, we had over 50 faculty members, and 60 student researchers actively engaged in CAP research from 12 different academic units/disciplines at ASU and at 12 institutions beyond ASU: University of California-Berkeley, University of California-Davis, University of Massachusetts at Amherst, Bowling Green University, Georgia State University, University of Georgia, University of Oklahoma, Barnard College, University of New Mexico, Pace University, and Northern Arizona University.

As such, CAP's contributions outside of urban social-ecological research are often at interfaces among disciplines. In fact, most of CAP's contributions to urban systems science are beyond the disciplines of ecology and urban ecology.

Impact on Development of Human Resources

At the end of Summer 2023, our Lab Manager, Marisa Masles, retired after more than 10 years with CAP. We replaced Marisa with Yi Ren, an ASU undergraduate who recently completed his MS degree in environmental chemistry. Yi is responsible for all of CAP's analytical and lab work.

CAP LTER Justice, Equity, Diversity, and Inclusion (JEDI) Committee

In 2020, Elizabeth Cook (Barnard College, NY) and Quincy Stewart (CAP Site Manager) co-founded the CAP LTER Justice, Equity, Diversity, and Inclusion (JEDI) Committee. The JEDI Committee is guided by an evolving set of responsibilities and goals. The goals and initiatives of the committee,

as currently stated, have evolved from ongoing discussions with current CAP community members, the CAP Executive Committee and Leadership Team, and the LTER Network Diversity Committee. Our JEDI Committee's current goals are to lead initiatives to:

- Actively foster and support diversity within the CAP community and STEM more broadly;
- Enhance representation and support of underrepresented minorities in STEM career advancement through CAP initiatives;
- Proactively review and promote anti-racist policies and initiatives related to CAP research, programming, and hiring practices; and
- Build awareness in the CAP community about the multiple facets of JEDI encountered in the Greater Phoenix region every day.

During this reporting period:

- The CAP JEDI committee (9 members) has held regular bi-weekly meetings to work toward achieving the initiatives outlined in the CAP JEDI Action Plan.
- The CAP JEDI committee has hosted community 'Equity Circle' discussions to broaden the conversation about the JEDI with CAP following the URGE Curriculum. Two of the Equity Circles have been held in-person at the CAP All Scientists Meetings with participation from a majority of CAP community members.
- In 2022-2023, the CAP JEDI Committee supported the development of the CAP Field Safety Protocol and hosted the CAP Community "Climate" Survey to better learn about the experiences of CAP community members participating in CAP-related activities.
- The CAP JEDI committee has drafted and is currently soliciting feedback on a CAP Community Code of Conduct.
- The CAP JEDI committee is reviewing and revising the application and recruitment recommendations for CAP REU and graduate student summer projects.

CAP LTER Research Experiences for Undergraduates (REU) Program

For our summer REU program, we actively recruit students from groups underrepresented or minoritized in STEM. Our 2023 REU students included:

- Brian Ballantyne: "Using CAP-LTER's arthropod dataset to examine urban evolution within a socio-ecological framework" (Mentor: Chad Johnson)
- Mariah Beltran: "Tres Rios for Two" (Mentors: Dan Childers and Julia Hernandez); "Examining the Opportunities, Constraints, and Contexts for Human-Wildlife Coexistence" (Mentor: Kelli Larson)
- Arshonne Cazares: "Diversifying Visions of the Future with Rural and Urban Indigenous Communities" (Mentors: Michelle Hale and Michele Clark)
- Zoe Gentry: "River Futures: Participatory visioning for an urban river" (Mentors: Nancy Grimm, Liliانا Caughman, and Michelle Hale.)
- Carter Henry: "Examining the Opportunities, Constraints, and Contexts for Human-Wildlife Coexistence" (Mentor: Kelli Larson)
- David Nguyen: "Tres Rios for Two" (Mentors: Dan Childers and Julia Hernandez)
- Nadia Upah: "Birds in a Warming World: An Integrated Physiological Perspective" (Mentor: Pierre Deviche)

These seven students bring the total number of REU students supported with NSF funding since 1998 to 94. Many of these students have gone onto graduate school in traditional STEM fields and the in newer field of sustainability, and others have moved on to STEM-related careers.

CAP held our Integrated Summer REU program for the seventh straight summer in 2023. This program brings together a critical mass of students— seven in total for 2023 — to share research across traditional academic boundaries. The participating students connected in person or remotely via Zoom for five meetings covering topics such as interdisciplinary research, post-graduate career and education planning, and science communication. The final session involved each student giving a short presentation on their research and experiences. Feedback from students afterward indicated that they appreciated these meetings and that the REU experience had left them with very positive impressions about post-graduation academic degrees and STEM 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. Further feedback from students and faculty will assist us in planning for our Integrated Summer 2024 REU program.

CAP LTER Graduate Grants

The long-running CAP Grad Grants Program has been a model structure for supporting graduate student research for many years. Students submit short proposals for funding early in the year, and we convene an NSF-like panel of students who were funded by the program in the previous year and postdocs. The students review the proposals and discuss them in the panel, with the result being recommendations on funding to the Director. This model is one of many ways that CAP trains the next generation of academic and agency scientists on how to write and review proposals effectively. The response to this process by our students has been overwhelmingly positive, and both the CAP Grad Grants Program and this review process have become models across the LTER Network. In 2023, our CAP Grad Grants Program competitively awarded \$19,876 to support the research of four graduate students:

- Timara Crichlow: “Modeling Community Perceptions of Tree Distribution in the Phoenix Region” (Mentor: Paul Coseo)
- Olivia Nguyen: “The effects of the COVID-19 pandemic on human behaviors and wildlife populations across the gradient of urbanization” (Mentors: Jesse Lewis, Dan Childers, and Esther Rubin)
- Peter Price: “Heat Reduction Benefits of a Residential Rooftop Green Space: Perceptions vs. Realities for a Vulnerable Population” (Mentors: Paul Coseo and Ariane Middel)
- Zachary Van Tol: “Mechanisms of Movement: Identifying the factors that decide the spaces people experiencing chronic homelessness occupy and the associated climate exposures” (Mentors: Ariane Middel and Jennifer Vanos)
-

Impact on Teaching and Educational Experiences

Our Ecology Explorers program is our major vehicle for engaging with K-12 students, teachers, and the general public. The Ecology Explorers team has participated in statewide and national meetings and conferences for science and environmental educators to find ways to prioritize pathways for systemically excluded groups.

CAP received supplemental NSF support for a summer RET program, and based on the success of that we received additional support in 2020 for a larger “RET on steroids” program that continued through Summer 2023. In both cases we were able to support research experiences for two K-12 teachers, and both cohorts are from Roosevelt School District, which serves a lower income, predominantly Hispanic population (97% of the students are minority) in South Phoenix. Notably, Roosevelt School District includes one of our PASS neighborhoods (#U18), where 93% of residents are Mexican/Latino, where the median annual household income is less than \$37,000 and where fewer than 4% of residents hold a bachelor’s degree or above (Larson et al. 2017). The district is also part of the City’s South Mountain Village, which is 63% Hispanic and 15% Black. Our four RET educators represent each of these demographic groups. Our 2020 RET educators conducted their collaborative research with scientists from our Climate and Heat IRT, where they are focusing on extreme heat in school playgrounds, how the microclimate of playgrounds affects the health and wellbeing of children, and how UEI may be used to mitigate playground climate extremes while solving other health-related schoolyard challenges.

Impact on Physical Resources that Form Infrastructure

The 6400 km² study area of CAP includes all of the Phoenix metropolitan area as well as surrounding desert. Because of the vast scale of our research endeavor, CAP’s provisioning of field vehicles for research has always been essential for the collection of long-term data, for student research, and for more targeted experiments and investigations in our urban and peri-urban areas. CAP Site Manager Quincy Stewart ensures that the vehicles are maintained that researchers undergo the appropriate ASU training to use the vehicles, and that vehicles are used properly. In 2023 CAP took delivery of the first electric vehicle (a Nissan Leaf) in our fleet.

Shared instrumentation in the Metals, Environmental and Terrestrial Analytical Laboratory (METAL) allows CAP staff and researchers access to equipment and training to conduct analyses. The [METAL webpages](#) provide a list of equipment.

CAP maintains a diversity of field infrastructure. CAP Research Specialists perform routine maintenance, instrument calibration, and deal with the vandalism inherent in urban areas. Along with the CAP Site Manager, they assist faculty and students in locating short-term investigations at CAP 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.
- 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 five marked creosote bush shrubs for stem elongation measurements and permanently marked subplots for biomass collection and surveys of community composition of annual plants.
- For measurement of atmospheric deposition, CAP maintains resin-based bulk deposition and throughfall collectors at six of the DesFert sites.

- At one urban DesFert desert remnant site and one outlying DesFert desert park site, micrometeorological stations measure temperature, relative humidity, wind speed and direction, precipitation, and solar radiation.
- At each of seven sites along the Salt River, CAP maintains nine permanent herpetofauna plots and six birding points.
- CAP maintains ISCO automated samplers at three stormwater sampling sites along Indian Bend Wash.
- A Eureka Manta+35 multiprobe datasonde is deployed in Tempe Town Lake with sensors to measure temperature, conductivity, turbidity, pH, optical dissolved oxygen, chlorophyll A, DOC concentration, and DOC fluorescence.

Impact on Information Resources

Data Resources

The CAP LTER added a revised dataset to its publicly available data holdings during the measurement period. The updated dataset includes the latest observations from the CAP LTER's long-running work exploring the dynamics among elevated nutrient inputs, notably via atmospheric deposition, and Sonoran desert ecosystem structure and function. The CAP LTER has archived 261 project datasets with the Environmental Data Initiative (EDI) as of this writing. All CAP LTER dataset metadata are encoded in the XML-based Ecological Metadata Language (EML) schema, with data and metadata available through the CAP LTER data catalog on the project website, the EDI data portal, and DataONE.

Infrastructure

The CAP LTER Information Manager strives always to improve the presentation, utility, and management of CAP LTER information resources. Notable improvements for this reporting period include:

- Further expansion and refinement of tablet-based data-entry applications that improve the accuracy and efficiency of data acquisition by CAP LTER technicians.
- Continued improvement of a suite of R-based tools that aid the development of EML metadata used to describe research data. In particular, the (1) expanded use of configuration (yaml) files that simultaneously increases the readability of inputs while reducing the amount of R coding required to generate data packages, (2) integration with the [QUDT](#) semantic resource for units, and (3) option to include semantic annotations to selected metadata features to improve dataset interoperability. Though developed by and for the CAP LTER, these tools are generalizable and publicly available.

Network Participation

The CAP LTER is committed to making a strong contribution to informatics within the LTER Network and the ecological sciences generally. The CAP LTER Information Manager (S. Earl) participates in all Network information management meetings and activities, participates in numerous informatics and scientific conferences, and contributes to publications spanning both the ecological and informatics sciences. S. Earl is a contributor to numerous working groups, including: (1) a joint effort by the LTER and EDI to improve tools and resources to characterize units of measure, (2) a LTREB and NCEAS synthesis working group exploring the impacts of wildfire on the biogeochemistry of flowing waters in

the arid Southwest, and (3) developing ontologies and other resources to improve the discoverability and interoperability of soil chemistry data.

Impact on Society beyond Science and Technology

- Our Education and Engagement committee has focused on building the relationships between historically underserved communities through arts and place-based educational offerings in the community in the form of event vending, workshops, presentations/demonstrations, and resource co-creation.
- To support a sense of place and encourage nature-based thinking, community offerings were held in local underutilized/underserved nature spaces. Learners joined guided Rio Salado river walks and site explorations using Photovoice and storytelling as tools to co-create visions for the future. Sense of place is further supported through the sharing of the Research Experience for Undergraduates (REU) supported 'Living Lands' game in context to river-focused events such as the Walk for the Wild, Tres Rios Nature Festival, and local educational events.
- Land-based learning was extended to include community gardens and agricultural spaces. Traditional land use, practices, and knowledge proved to be a fruitful space for community building, collaboration, and co-creation. Brassica Pláticas (community circles), nature song learning/playing (Son Jarocho), and mini nature camps to explore music, nature, and food were some of the activities.
- Land-based learning allowed us to support relevant cultural knowledge exchange. Tlaxcalli (tortilla) workshops using non-GMO blue corn were used as a tool for discussing history, culture, food, and ecology. Further environmental justice and community history and resiliency were supported through our collaboration with various environmental justice-focused collaborators including work with our Research Experience for Teacher (RET). As a lead for culturally relevant teaching courses (Native, Black, Chicanx Histories) and support for student groups (Mecha - Movimiento Estudiantil Chicano de Aztlán, Black Student Union, and Native Youth Council), we were able to support ecological context to a cultural lens. Activities included using traditional Sonoran Desert native plants to create recipes, school presentations on environmental justice, and visits to local historical sites, led by youth participatory action research.
- Participants were supported in their expression throughout these offerings using arts-based approaches that made communication and discussion accessible. Collaborating with local artists and art spaces, we supported art in ecology work through co-created canvasses, design charrettes, storytelling writing, and data visualization.
- As we continue to navigate the complexities of intentional, respectful community collaboration and engagement, we are participating in the NSF-funded APEAL.
- Our goals are: 1) To continue to strengthen and expand existing relationships with Indigenous communities and groups, including incubating cross-community engagement

(this is current engagement); and 2) to leverage these existing community relationships to begin to engage additional local Indigenous community organizations and tribes (we have identified five of these); we call this future engagement “pre-engagement”. Our framework for how these two goals, their associated activities, and these various communities interact is below.

- A major goal of CAP V is to engage with local Indigenous communities and tribes; this includes graduate and undergraduate students, community members, and knowledge-holders and decision-makers in urban and reservation areas. The engagement effort we propose here will help us begin to build and strengthen these relationships (what we are calling “pre-engagement”) in respectful, strategic, coordinated, and trust-building ways.”

PUBLICATIONS

Students in **Bold**

Journal Articles

Chandrakanthan, Kanchana and Fraser, Matthew P. and Herckes, Pierre. (2023). Microplastics are ubiquitous and increasing in soil of a sprawling urban area, Phoenix (Arizona). *Science of The Total Environment*. 906 (C) . [doi: https://doi.org/10.1016/j.scitotenv.2023.1676...](https://doi.org/10.1016/j.scitotenv.2023.1676...)

Rosales Chavez, Jose-Benito and Larson, Kelli L. and **Morales Guerrero, Jorge** and Clark, Jeffrey A.G.. (2023). Evaluating how varied human-wildlife interactions affect physical, mental, social, and spiritual health. *SSM - Qualitative Research in Health*. 4 (C) . [doi: https://doi.org/10.1016/j.ssmqr.2023.100302](https://doi.org/10.1016/j.ssmqr.2023.100302)