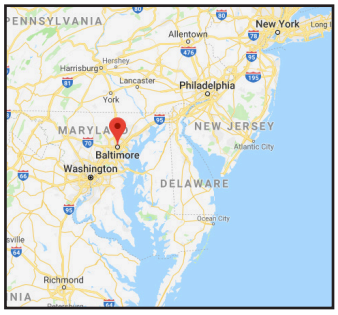
Baltimore Ecosystem Study LTER

Since 1998, the Baltimore Ecosystem Study (BES) LTER has worked to advance the understanding of urban areas by asking three key questions: 1) What is the spatial and temporal patch structure of ecological, physical, and socio-economic factors in the urban ecosystem? 2) What are the fluxes of energy, matter, and populations in patches of the urban ecosystem? 3) What are the choices people and organizations make that affect the urban ecosystem?



Baltimore LTER researchers have pioneered new theory and methods for characterizing urban ecosystems. Watershed biogeochemistry, ecological communities and sentinel species, and human environmental perceptions and behaviors have been the measurements of focus. The research team has established long term records of urban watershed hydrology and biogeochemistry, developed and applied novel instruments for urban social survey, and characterized change in multiple dimensions of urban biodiversity. Baltimore LTER educators and scientists work extensively with students and schools in Baltimore to help bring science into the classroom.

Between 2008-2018:

92 investigators

37 institutions represented

162 graduate students

Urban

Principal Investigator:

Emma J. Rosi

Cary Institute of Ecosystem Studies

Est. 1998

Funding Cycle:

LTER IV

NSF Program:

Division of Environmental Biology / Ecosystem Science

Key Findings

Pioneering urban system science. Researchers at BES LTER developed new theory [Product 2] and methods [5] for characterizing the multidimensional, multidisciplinary nature of urban ecosystems. This work sparked the development of a new "urban systems science" which has become a key component of sustainability science across the globe [7].

Understanding urban watersheds. Baltimore LTER research showed that nutrient cycling and retention in urban watersheds are driven by complex dynamics, with surprisingly high nitrogen retention, climate sensitivity, and surface water-groundwater interactions [1, 8]. These studies have been a foundation for novel analyses of how ecosystems are affected by contaminants of emerging concern [10].

Recognizing social feedbacks. The BES LTER Household Telephone Survey provided information on environmental knowledge, perceptions, values, and behaviors of residents, their influence on ecosystem structure and function, and the ways that ecosystem structure and function may affect residents' physical activity, social cohesion, perception of neighborhood desirability, and willingness to relocate [3].

Unexpected urban biodiversity. Baltimore LTER research has helped challenge the assumption that urban biodiversity is low by showing that biological communities in urban environments are diverse and dynamic. This diversity ultimately affects human well-being, and fluxes of water, energy, carbon, and nutrients [6, 9, 4].

Photo credit: Laura Templeton (above); BES LTER (3 right)

Synthesis

Urban homogenization. Baltimore LTER has a long history of collaboration with its sister site Central Arizona-Phoenix (CAP) LTER, including over 50 co-authored publications. Coordinated data collection (telephone survey, plant diversity, soil processes, microclimate, hydrography, plant and soil C and isotopes) began as part of two projects funded by the NSF Macrosystems Biology program on "urban homogenization." This work is ongoing, and has produced a series of direct comparisons between Baltimore and Phoenix, as well as comparisons with four other major U.S. cities: Boston, Miami, Minneapolis-St. Paul, and Los Angeles [6].

Partnerships

U.S. Forest Service, Baltimore Urban Field Station | University of Maryland, Baltimore County

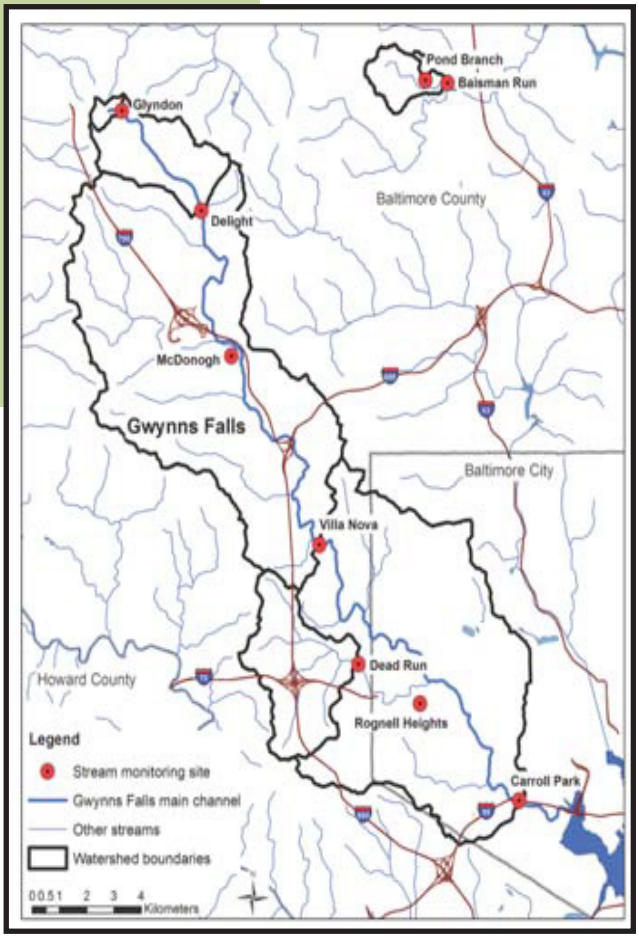
Photo credit: BES LTER

Data Accessibility

Baltimore LTER watershed data are the focus of outreach to local municipalities grappling with water quality regulations for the Chesapeake Bay via the Baltimore Urban Waters Partnership; these data along with the Baltimore LTER physical sample archive have attracted outside investigators to pursue new analyses. Core long term datasets on trace gases [8], biodiversity, and community perception surveys have facilitated cross-LTER site analyses [8] and research on urban homogenization [6].

Broader Impacts

Reaching urban schools. Since 2009, BES LTER has worked with 135 Baltimore teachers on a variety of education programs. One such project – Pathways to Environmental Science Literacy – involved 4 other LTER sites. Main outcomes included: 1) reaching thousands of students in Baltimore County and Baltimore City Public Schools (ca. 50% and 90% underrepresented minorities, respectively), 2) research on teaching and student learning, and 3) curricular modules on carbon, water, biodiversity, and citizenship.



Improving urban quality of life. Educators, researchers, and outreach specialists partner with government agencies, non-governmental organizations, communities, and neighborhoods to improve environmental quality and human health and well-being across the city using scientific reasearch.

Engaging diverse youth in urban ecology. Since 2015, BES LTER has partnered with Parks and People Foundations every summer to immerse a team of high school students in long term research through the BRANCHES Young Environmental Scientist Program.

Environmental Justice. Studies at BES LTER identified long term and institutionalized systems in Baltimore that perpetuate inequities over time. These findings inform the city's equity planning and serve as models for other U.S. cities.

High-resolution landcover mapping at BES LTER and urban tree canopy (UTC) data have contributed to national and international standards for urban landcover mapping. These data are required by the Maryland State Legislature for tracking canopy loss. They are also used by the City of Baltimore to analyze change and drivers of canopy change.

Photo credits: BES LTER (above map and cover photo)

Top Products

1. Bettez, N et al. 2015. Climate variation overwhelms efforts to reduce nitrogen delivery to coastal waters. **Ecosystems.** doi: 10.1007/s10021-015-9902-9
2. Grove, M et al. 2015. The Baltimore School of Urban Ecology: Space, Scale, and Time for the Study of Cities. **Yale University Press**, New Haven.
3. Hager, GW et al. 2013. Socio-ecological revitalization of an urban watershed. **Frontiers in Ecology and the Environment.** doi: 10.1890/120069
4. Swan, SM et al. 2017. Differential organization of taxonomic and functional diversity in an urban woody plant metacommunity. **Applied Vegetation Science.** doi: 10.1111/avsc.12266
5. Pickett, STA et al. 2017. Dynamic heterogeneity: a framework to promote ecological integration and hypothesis generation in urban systems. **Urban Ecosystems.** doi: 10.1007/s11252-016-0574-9
6. Groffman, PM et al. 2017a. Ecological homogenization of residential macrosystems. **Nature Ecology & Evolution.** doi: 10.1038/s41559-017-0191
7. Groffman, PM et al. 2017b. Moving towards a new Urban Systems Science. **Ecosystems.** doi: 10.1007/s10021-016-0053-4
8. Ni, X and PM Groffman. 2018. Declines in methane uptake in forest soils. **PNAS.** doi: 10.1073/pnas.1807377115
9. Schmidt, DJ et al. 2017. Urbanization erodes ectomycorrhizal fungal diversity and may cause microbial communities to converge. **Nature Ecology & Evolution.** doi: 10.1038/s41559-017-0123
10. Rosi-Marshall, E and T Royer. 2012. Pharmaceutical compounds and ecosystem function: An emerging research challenge for aquatic ecologists. **Ecosystems.** doi: 10.1007/s10021-012-9553-z