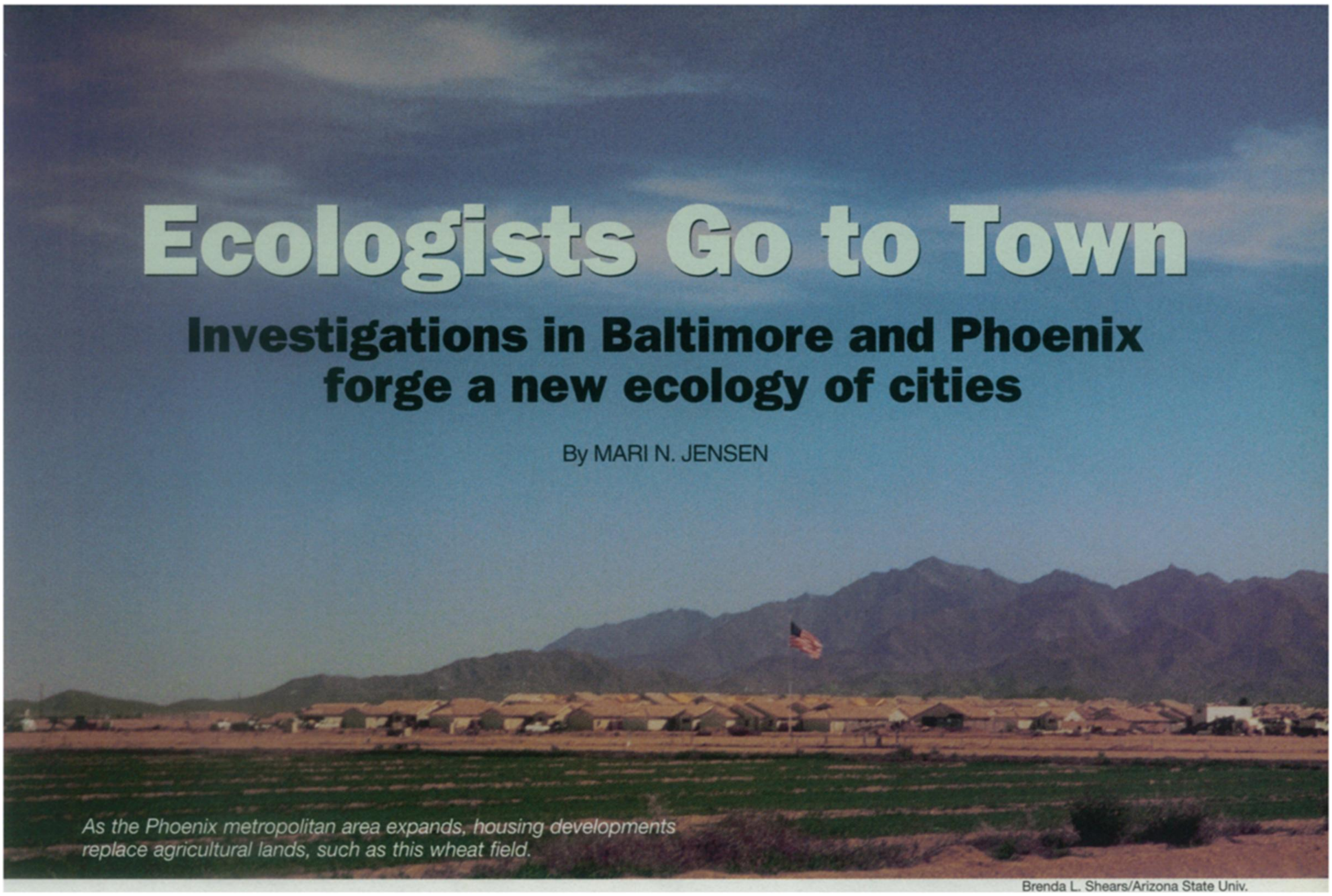


Ecologists Go to Town

Investigations in Baltimore and Phoenix forge a new ecology of cities

By MARI N. JENSEN

As the Phoenix metropolitan area expands, housing developments replace agricultural lands, such as this wheat field.

Brenda L. Shears/Arizona State Univ.

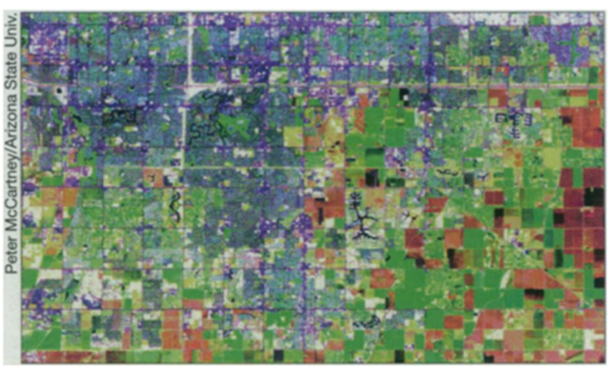
It was a typical field trip. A group of ecologists inside a Chevy Suburban worked on a laptop computer and talked as they bounced along the gravel road that would end up 14 hours later at a small field station in northern Alaska. As they traveled, they discussed what areas to add to the Long-Term Ecological Research (LTER) network—the exclusive list of sites selected for prolonged scrutiny by U.S. ecologists.

The traditional choice would have been a virtually untarnished spot—one that had thus far managed to escape much human interference.

"The draw for ecologists has been the natural environment," says James R. Gosz, an ecologist at the University of New Mexico in Albuquerque who heads the committee overseeing the LTER network. But Gosz and the others riding through the Alaskan wilderness to the Toolik Lake LTER site 8 years ago recognized that people are part of the environment and that ecologists needed to start examining the landscape most influenced by people—the city.

Those conversations in the wilderness, Gosz says, ultimately resulted in the November 1997 addition of Baltimore, Md., and Phoenix, Ariz., sites to the LTER network.

These choices mark a new direction in ecology. "Ecology is the science of the relationship among organisms and their environment. What could be more ecological than studying humans and their environment? For a large number of people in this world, that means humans in the context of cities," says James A. MacMahon, an ecologist at Utah State University in Logan and president of the Ecological Society of America.



Peter McCartney/Arizona State Univ.

Landsat image shows how agricultural land grades into housing developments in a 125-mile square area in the Phoenix suburbs of Chandler and Gilbert. Starting this summer, scientists will receive similar images every 2 weeks, allowing them to monitor land-use changes in the fast-growing regions. Cultivated fields show up as bright green, fallow fields are orange-red, and asphalt and water are dark. Squiggly dark shapes are artificial lakes.

The new sites join a network of research areas designed to answer questions about ecological processes that occur over long periods. The National Science Foundation (NSF) began the LTER program in 1980 with six sites representing such ecosystems as lakes, forests, and prairies. Now, with the addition of Baltimore and Phoenix, the network has expanded to 20 sites.

Part of every LTER site's research program is designed to answer five core questions, Gosz says. What controls the growth of plants? What causes plant and animal populations to vary over time? What happens to the organic matter that plants produce? How do inorganic nutrients move through soil and water? How do disturbances such as fires, drought, or timber cutting affect the biology of the system?

"Research at these long-term sites is challenging long-held perceptions about ecological systems," says ecologist Scott L. Collins, who oversees the LTER program for NSF. For example, he says, researchers at the Harvard Forest LTER station in Massachusetts have shown that dramatic disturbances, such as hurricanes, may have little long-term effect, whereas subtle, human-induced changes in the nitrogen cycle are altering the basic ecosystem processes in the forest.

Unlike most ecological research projects, which are funded for only 3 years, LTER programs are initially funded for 5 or 6 years, at the end of which the funding is usually renewed. As a result, scientists now have more than 18 years' worth of information on some of the oldest LTER sites. To kick off the Baltimore Urban LTER project and the Central Arizona–Phoenix Urban LTER project, NSF provided each with $875,000 for the first year and $700,000 for each of the succeeding 5 years.

"The long term really gives you a different way of thinking about your project," says Collins. "You can do more risky experiments."

He adds, "Long-term research allows you to understand surprises. If you get a surprise year—double the amount of rain, or half the amount of rain, or an outbreak of grasshoppers—if you don't have a lot of time, you don't get to follow that very well."

M.N. Jensen

Bits of the natural world persist in Baltimore's 6,900 vacant lots. However, the trash dumped there can leak pollutants into ground- and surface waters. Researchers plan to investigate how setting up microbusinesses, such as nurseries or specialty vegetable gardens, in the vacant lots will affect the flow of energy, nutrients, and money through the city's ecosystem.

To organize their inquiries about cities, the investigators at both urban LTER sites plan to use a popular method for figuring out how ecosystems vary from place to place and over time.

In the past, while studying an ecosystem such as a forest or field, ecologists drew a boundary around it and assumed the region inside was uniform, says Steward T.A. Pickett, project director for the Baltimore site and an ecologist at the Institute of Ecosystem Studies in Millbrook, N.Y. However, over the last two decades, he has promoted a different model.

Spatial Analysis Laboratory/Univ. of Maryland Baltimore County

After measuring individual trees, researchers in Baltimore map the sizes and locations onto aerial photos. The scientists will use the information to calculate how the city's variable tree canopy affects ecological factors such as stormwater runoff and urban wildlife habitat.

Ecosystems aren't really homogeneous, he says. When ecologists look at an ecosystem close up or over the long term, they find variation.

"It's like a quilt," he says.

At every scale, from the hands-and-knees viewpoint of a small child to the continentwide view of a satellite image, the scientists see patches. They also see patches within patches.

This patchiness "means something about how the system is built, how it works, how it changes through time," Pickett says. Different types of ecosystems are made up of different types of patches. A meadow may have a distinct set of plants that grows only in the lowest, wettest parts. In a forest, a patch may be a gap left by a fallen tree where light-loving plants can thrive. Ecologists use a computer model to explore how the different types of patches shift around in space and in time—and why.

"Because we don't know ecologically how metropolitan areas function," says Pickett, "we need an organized approach that will let us take them apart and put them back together."

However, ecologists are not used to studying the patches within patches that make up cities. "We don't have a theory that was built for cities," he says, "and we don't have the kinds of data sets that you have to have to understand cities." Therefore, Pickett has teamed up with 35 other researchers to understand the patches that make up the Baltimore city ecosystem. The team includes ecologists, sociologists, educators, geographers, and economists, many of whom have conducted research in the region for years. Recently, a similar group led by Charles L. Redman and Nancy B. Grimm of Arizona State University in Tempe have taken up the challenge in Phoenix.

The interdisciplinary teams will collect information in a way that is new for both the ecologists and the social scientists. Imagine, Pickett suggests, the team going out to investigate an area where rows of new townhouses are marching up a hillside near Owings Mills, Md. Not long ago, the whole region was agricultural land. Today, the grassy remnants of pastures, still surround the relatively treeless development.

"Traditionally, the social scientists would go to the built part and ask what the people were doing, how they made their decisions, and the ecologists would go over to the green spots and count the bugs," he says. "Now, we have to ask how people's decisions influence the green spots, and how the green spots influence people's decisions."

Once the researchers do that, he says, they will have defined a new kind of patch, one where the parking lot, buildings, and small green strips are all considered together. "Now," he says, "you can ask how that new patch functions, how sustainable its social processes are, and how it affects ecological processes [outside the patch]."

Two neighborhoods might have the same area, equal amounts of lawn, and the same total number of trees and buildings yet function very differently ecologically, says Alan R. Berkowitz, a team member from the Institute for Ecosystem Studies. Those neighborhoods would represent two different patch types, he says, if one had houses clustered together near a small woodland park and the other had buildings and trees spread evenly over the landscape, with bits of lawn in between. "Somehow we want to come up with a way of defining those [patches] that embraces their difference," he says, "not just say they both have the same number of trees."

In Baltimore, the first place the team will define new patches is the 17,150-hectare watershed drained by a stream called Gwynns Falls. The watershed starts in the forested and agricultural areas near Reisterstown, Md., and runs southeast, ending in concrete-covered inner-city Baltimore. The researchers want to understand how the watershed's patchiness works ecologically as the landscape grades from farms and forests into suburban housing developments and terminates in the city.

Pickett says that, unlike many metropolitan areas, Baltimore still has much of its native topography. The city government is beginning to organize its park management around watersheds, a natural landscape feature. That's unusual, he says, because most governments manage pieces of land defined by drawing some straight lines on a map, and "that doesn't have much to do with how nature moves things around."

Ecologists, hydrologists, and other natural scientists often use watershed boundaries to delineate their research sites. Therefore, Pickett says, organizing the LTER site's initial research around a watershed provides a good conceptual tool for the research team and connects the researchers with citizens' groups and city managers and planners.

Forging links with community members is a special aspect of the urban LTER projects. "Part of this LTER is to bring in the public to monitor and interpret the environment where they live," says social ecologist William R. Burch Jr., a team member from Yale University who has been working with citizens in Baltimore since 1989. He has run inner-city revitalization projects, such as offering science education and cleaning up vacant lots. "We can have training programs to help ordinary citizens map and monitor what's going on where their children play or in the air they breathe."

One such effort will recruit kids to plot the location, identity, and size of trees onto maps of city neighborhoods. Those maps will help researchers interpret satellite images of the city. In return, research results from the LTER project will help Baltimore's Parks and People Foundation focus its efforts to protect the urban forest, says Jacqueline M. Carrera, an LTER team member and the foundation's director.

Researchers at the Baltimore site plan to share both the research process and its results with the people of Baltimore. "It's not that we're studying people—we are conducting research with people," says team member J. Morgan Grove of the U.S. Forest Service in Burlington, Vt.

Some social science researchers question whether the urban LTER programs represent a true collaboration between social scientists and natural scientists, as program supporters have advertised.

"It has a hard-core ecology focus—which is both a boon and a bane," says geographer B.L. Turner II of Clark University in Worcester, Mass. "Because the stimulus first came so much from the ecological community, it was not truly a 50-50 split in defining what's important."

Turner acknowledges that the social sciences do not have the spatial analysis models needed for such research projects. What's more, he says, urban LTER projects offer the potential for much greater collaboration between social scientists and natural scientists than most universities or institutions have ever provided.

Redman says that forging a truly interdisciplinary perspective is a tremendous hurdle. "I think when we look back on it, in a real sense, that will be the hardest part . . . getting people to speak meaningfully to each other and consider each other's approaches."

Cross-disciplinary collaboration is a necessary part of working on a frontier, says Grimm. "I'm really interested in whether it's possible to bring some of the social science models for how human decisions work and how humans drive land-use changes and integrate those [models] with our ecological understanding," she says. "I think that there will be new ecological theory. . . . I'm not sure how that will be done. It's really daunting, actually."

Like Grimm, Pickett says he finds himself looking onto a new frontier. He feels a kinship with the zoologists and botanists of 100 years ago, who envisioned a novel way of looking at the natural world by integrating the studies of organisms and their environment. That approach would come to be known as ecology.

"They developed a new perspective," he says. "That's the kind of opportunity we have presented to us now. It's really hard to say exactly how it's going to look . . . to combine with the economists and social scientists and civil engineers and ask not just How does it affect the green spots? but How does the whole thing work?" □