

Accidental urban oases

As some cities struggle with population declines, vacant lots are proliferating. Can these derelict spaces contribute to conservation?

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The bumblebees of southeast Michigan are wary of downtown living. Certainly, they buzz around city gardens and nature reserves—but numerous buildings and concrete structures nearby these green spaces typically mean fewer bumblebees and bumblebee species.

Except, that is, in Detroit. In the state’s biggest city, bees seem relatively unfazed by urbanization. One downtown garden site boasts nearly as many bumblebees as a

nature reserve in a rural area (1). “We see this huge bounce-back in the abundance and diversity of these important pollinators,” says ecologist Paul Glauam at the University of Michigan in Ann Arbor, MI, who was part of the bee survey behind this counterintuitive discovery.

What is so special about Detroit? The city is filled with vacant residential properties, where houses sit empty or have been demolished. Partly because of the decline of US car manufacturing, Detroit’s population



When it comes to vacant urban lots, some see blight, others havens of conservation. Researchers found that vacant Baltimore lots are home to 60 bird species, including American robins (*Turdus migratorius*). Image courtesy of Christine Brodsky.

fell from about 1.8 million people in 1950 to less than 675,000 in 2016. Departing residents left behind yards that became overgrown. When Glaum walked around the city in 2014 and 2015, he saw wildflowers thriving in many of these vacant lots, perhaps because city workers mowed infrequently and didn't apply herbicides to the sites. But where some might see a mess of unkempt weeds, Glaum sees a vital refuge for bees.

Other studies, too, suggest a surprising amount of biodiversity in abandoned urban spaces. Researchers have found that vacant lots—ranging from the yards of unoccupied homes to old industrial sites—can harbor rich communities of plants, insects, and birds. The sites provide other environmental advantages as well, including new wetlands that enhance pollution clean-up.

Such unplanned green spaces have become increasingly common in cities that are shrinking because of deindustrialization, falling birth rates, residents fleeing to suburbs, and other factors. From 1950 to 2000, more than 350 cities around the world shrank (2). Some urban areas are pockmarked with tens of thousands of vacant lots covering thousands of acres. In a recent study, researchers reported that an average of 17% of the land in US cities was vacant; in some cities, that figure exceeded 25% (3).

Researchers are now trying to better understand how these abandoned plots contribute to conservation. Although vacant lots collectively cover a significant amount of land, they remain less studied than landscapes such as national and urban parks. "I think they have the potential to be ecologically important," says Emily Minor, an ecologist at the University of Illinois at Chicago. The sites also offer opportunities to test conservation strategies on a large scale. "These urban vacant lots create a huge outdoor laboratory to do replicate field experiments," says Mary Gardiner, an entomologist at The Ohio State University in Columbus.

But ecologists studying vacant lots must grapple with social implications. From an environmental perspective, letting plots grow unchecked might be ideal for wildlife. But where researchers see the potential for ecological oases, residents often see blight: crime-prone areas choked with weeds and scattered with trash. Vacant lots are often located in poor neighborhoods, where tall, unkempt shrubs and trees can make the sites feel unsafe. One recent study in Philadelphia found that drug sales were common in front of vacant lots, and some sites became gathering spots for heroin and cocaine users (4). Some community members simply consider the overgrown plants ugly. "The social issues are just as big, if not bigger than, the ecological ones," Minor says.

As the amount of vacant land in shrinking cities increases, so too does the need to figure out management solutions for these sites. "What you're seeing is a collision of serious academic and scientific interest with a real societal problem," says Christopher Swan, an ecologist at the University of Maryland, Baltimore County.



One study found that although bumblebees tend to be sparser in urbanized areas, Detroit—a city with many vacant lots—had an unexpectedly high bee abundance and diversity, even at sites surrounded by buildings and concrete. Image courtesy of Paul Glaum.

Wilderness in the City

Shrinking cities often share similar histories. First, an industry dies out, and people leave to seek work elsewhere. In areas with high vacancy rates, property values fall and crime can rise. This drives out even more people, leaving fewer tax-paying residents to help maintain the city. Populations have waned in cities from North America to Asia and Australia (5), says Karina Pallagst, an urban development researcher at Technische Universität Kaiserslautern in Germany, who is part of an international team that's studied the issue since the early 2000s.

As these cities hollowed out, vacant lots blossomed. An early investigation into their ecology came in the aftermath of World War II, which split Berlin into western and eastern sectors that were surrounded by Soviet Union-controlled East Germany. Fearing that Soviet forces would eventually occupy the entire city, large companies and others fled Berlin. The economy declined, and many of the city's bombed buildings were not rebuilt. Ingo Kowarik, an urban ecologist at the Technical University of Berlin, recalls seeing vacant lots in the 1980s that had metamorphosed into forest. "What I saw was absolutely fascinating," he says. "It was a patchwork of wilderness in the city." He and his colleagues discovered that these sites contained a mix of native and non-native plant species—herbs, grasses, shrubs, and trees—observations they reported in 1980 and 1986 studies (6, 7).

Later work in other regions mirrored these findings. From 2001 to 2005, French scientists surveyed plants at 986 sites in the greater Paris area, including abandoned lots they called "wastelands." Because these lots experienced little disturbance, the plants naturally progressed from pioneer species to grasses to trees. "There is no human pressure to stop this succession," explains study coauthor Audrey Muratet, an ecologist



Researchers found that accidental wetlands such as this one, located in the Salt River bed in Phoenix, removed phosphate pollution coming from lawn fertilizer and other sources. Image courtesy of Amanda Suchy (City University of New York, New York).

at the Regional Agency for Biodiversity of Île-de-France, a nonprofit in Paris. Her team found that the wastelands contained 58% of the area's plant diversity, more than gardens and parks, although Muratet acknowledges that some of that diversity came from non-native species (8).

More recent studies suggest that abandoned sites can support animals as well as plants. In 2013, Christine Brodsky, an urban ecologist now at Pittsburg State University in Kansas, began studying birds in vacant lots in Baltimore, where the human population has fallen by about one-third over the past seven decades. "Going into it, I honestly had really low expectations," Brodsky says. But her team identified 60 bird species in abandoned plots (9). These included "species I would never have thought in a million years would use these lots," she says, such as northern parulas and black-and-white warblers, which typically prefer forests.

Trees and shrubs in the vacant lots may also provide rest areas for birds during long journeys. Brodsky observed migrating species such as Wilson's warbler and blackburnian warbler in the lots of Baltimore, a stopover point on a major migration route. "They are little islands of green in a sea of grey," she says.

Accidental Wetlands

Their roles as havens for flora and fauna aside, abandoned sites can serve an important remediation function, especially once flooded. Wetlands are not common in urban areas, but these soggy ecosystems might play an important role in cleaning up a city.

Take Liberty State Park in New Jersey, a former railroad yard. Part of the park was fenced off from the public in the 1970s, allowing forest and marsh plants to grow. Now the area contains what Monica Palta, an urban ecologist at Pace University in New York City, calls "accidental wetlands."

Palta wondered if the wetlands could alleviate nitrogen pollution. Fossil fuel combustion, fertilizer use, and old wastewater infrastructure all release nitrate, or nitrate precursors. When this pollutant reaches coastal waters, it can trigger algal blooms that threaten marine species. But in wetland conditions, microbes often consume nitrate and produce nitrogen gas, a cleaning process called denitrification.

The ground at Liberty State Park consisted largely of rocks and coal fragments, so Palta didn't expect to find much microbial activity. But her analysis of soil samples showed that bacteria were actually removing nitrate fast enough to keep up with deposition of the pollutant from the atmosphere (10). "I always love hard-luck cases," she says. "People really perceived these areas as just having no ecological value whatsoever."

In another study, Palta assessed whether two accidental wetlands in Phoenix reduced phosphate pollution. The phosphate, which came mainly from lawn fertilizer, could end up in the Gulf of California and cause algal blooms. She measured levels of phosphate passing through upstream and downstream sites per day and estimated that the wetlands removed 21–28% of the pollutant (11).

Value in Weeds

Despite their benefits, vacant lots also raise some tough environmental questions. If the microbes in accidental wetlands don't complete their denitrification process, for example, they may end up producing nitrous oxide, a greenhouse gas. These sites can also become breeding grounds for disease-carrying mosquitoes.

Meanwhile, many vacant lots are overrun with exotic species that originated in different regions or continents and may not support native animals. In some cases, exotic species can turn invasive, spread from urban areas to more pristine locales outside cities, and take over large swaths of habitat. These invasive species could push out native counterparts and even drive them to extinction.

To determine vacant lots' true conservation value, researchers need to understand the balance of benefits and problems that they bring. For example, Christopher Riley, an ecologist on Gardiner's team, wanted to know if exotic plants were actually doing some good. After all, both native and non-native species can provide ecosystem services, such as sequestering carbon, absorbing storm-water runoff, and reducing air pollution.

So Riley and his colleagues studied trees at 163 sites in and around Cleveland. Some sites were vacant, and others were occupied urban and suburban lots containing single-family homes with yards. The team then used software called i-Tree Eco, available from the US Forest Service and its partners, to estimate the dollar value of ecosystem services provided by trees on each lot.

Employing various economic models, the software estimated, for example, the value of storm-water runoff reduction—calculating the monetary costs incurred when managing that storm water via traditional

methods such as drains. Because vacant lots contained an average of three times as many trees as occupied sites, their additional greenery boosted the value of their services (12). Overall, vacant lots provided an average of \$2,931 worth of ecosystem services per hectare, compared with only \$1,320 and \$861 per hectare for inner-city and suburban residential lots, respectively. About half of the value of vacant lots' services came from exotic species, such as white mulberry and tree-of-heaven. These results challenge the view, held by some ecologists, that exotics are inherently bad, Riley says. They're "providing a fair chunk of the value," he asserts.

People should accept that novel ecosystems will emerge in cities, says Kowarik. Too often, he argues, the reason given for removing exotic plants is overly simplistic. "They are exotic; therefore, they are bad," he says. "This is not convincing for me." If exotics invade pristine areas and displace native species, however, "it's time to intervene."

Riley acknowledges that his team assessed only a subset of ecosystem services. When considering other functions such as providing habitats, he says, exotic plants in vacant lots might perform worse than native species. If that leads city authorities to replace the exotics in their vacant lots, managers do have some recourse. Swan's team has shown that native species can be established fairly quickly by planting a mix of native plants with diverse traits. "If you wanted to move in the direction of natives, it's not as hard as we think," Swan says.

Pocket Prairies

As researchers begin to paint a more nuanced picture of the value of vacant lots, they are moving past merely cataloguing the species that live at these sites. Some are now studying how well organisms thrive in these urban wildernesses. "Just knowing what's there is not enough," Gardiner says.

For instance, researchers don't fully understand how lead contamination in vacant lots might harm the animals that live there. That information could help managers determine if they need to test the soil's lead levels and steer species away from certain sites, whether by mowing contaminated lots to deter insects from settling there or by planting attractive flowers in uncontaminated lots to offer the insects an alternative home. "But first we have to understand if it's even an issue," Gardiner says.

Gardiner's team recently studied how bees interact with sunflowers grown in lead-polluted soil. Bees visited the lead-exposed sunflowers as often as "clean" ones, but the visits were three to five times shorter (13). She speculates that the lead-exposed flowers might have produced less nectar or lower-quality nectar, and her team is now exploring how contaminated soils affect bee reproduction.

Ultimately, researchers need to consult with communities to determine the best management solutions for vacant lots. "They don't exist in isolation," says Kirsten Schwarz, an urban ecologist at Northern Kentucky University in Highland Heights, KY. "They're embedded in communities."

Residents may want vacant lots tidied up to reduce crime. In the Philadelphia study, researchers monitored areas where a horticultural society had cleared trash in vacant lots, leveled the land, planted new grass and trees, and added fences. Residents felt safer, and crimes such as gun assaults and burglaries dropped (4).

Although the authors of the Philadelphia study say the makeovers were inexpensive, some municipalities may lack the money to clean and maintain many vacant lots. So urban planners have devised other ways to spruce up the sites. Detroit residents can buy a lot next to their home for \$100 and use it for purposes such as gardens or play areas. The "Re-Imagining A More Sustainable Cleveland" program invited community members to propose new uses for the sites.

"Just knowing what's there is not enough."

—Mary Gardiner

Gardiner is investigating conservation strategies that could make vacant lots more attractive to local communities while also boosting their insect-habitat potential. Her team is testing different combinations of planting and mowing frequencies at 64 vacant lots in Cleveland; they aim to monitor how the resulting vegetation in these flower-filled "pocket prairies" affect processes such as bee foraging and prey consumption. But she does acknowledge that while some people enjoy native wildflowers, others think they "look like a weedy mess."

Researchers still need to study how wildlife populations fare long term at these sites. But it's already clear that such research programs and community schemes are set to become more important as cities keep evolving. By all indications, the same lot-proliferating trends are likely to continue. Many Latin American cities, for example, are expected to shrink because of declining birth rates, Pallagst notes. Around the world, airports near urban cores are being relocated outside cities, leaving new green spaces behind. And as fragments of habitat vanish outside the city, studying the ecology of urban vacant lots could become increasingly vital for conservation efforts. "In many other places, there's less and less space where you can do any type of conservation," Gardiner says. With vacant lots, "there's real potential."

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