(From Widimedia Commons; originally published in Scientific American)

Why Green Roofs Never Work

On a rooftop in New York City's Chelsea neighborhood, two students are collecting soil samples from boxes planted with species from two native plant communities: Hempstead Plains, which are grasses belonging to a prairie community originally found on Long Island, and Rocky Summit grasslands, which grow on the tops of mountains and ridges throughout southern New England and all of New York State. They carefully place the dirt from the soil core into a plastic bag and seal it up to be taken to the lab for analysis.

These two students are part of a research team that is trying to figure out how to maximize the benefits of green roofs. The problem has taken on practical significance as grass and other plants sprout on rooftops all over Manhattan and in other cities. For the past two years, New York City Mayor Michael Bloomberg's PlaNYC initiative has offered tax abatements for green roof construction and grant money for projects to capture storm water. Rooftop gardens have the potential of lowering energy usage for heating and air-conditioning as well as reducing rainwater runoff, but their effectiveness is not well established.

Researchers are trying to identify the best plant species suitable to green roofs, with an eye to designing ones that fulfill their promise. A 2007 study in the journal BioScience found that green roofs can potentially help manage stormwater runoff, reduce urban heat-island effects and regulate building temperature. To deliver these benefits, rooftop vegetation has to be able to

survive the high winds, prolonged UV radiation and unpredictable fluctuations in water availability. To resist these harsh environments, a majority of green roofs are planted with sedum, a non-native species that can survive wind and long periods withoutrainfall. A roof planted with sedum, however, is no greener, from the standpoint of sustainability, than is ordinary tar or asphalt.

Sedum does not absorb water as efficiently as other plant species, according to Scott MacIvor, a PhD student in biology at York University in Toronto who studies bee and wasp habitats on green roofs there, and co-wrote the city's new guidelines for biodiverse green roofs. At certain times of the year, he says sedum actually absorbs heat instead of reflecting it. "The problem is that sedum plants aren't really performing on green roofs," he notes. "They're just there." One of the plant's biggest failings, it turns out, is that it does not encourage biodiversity of plant species on the roof. According to MacIvor's research, green roofs provide the most benefit when they are planted with a diverse group of species that are adapted to local conditions.

Krista McGuire has taken sedum's inadequacy as a challenge. The assistant professor of biological sciences at Barnard College wanted to see if a variety of native plants could survive on green roofs and how well they would deliver the desired benefits. Since 2010, the year Bloomberg announced his green roof initiative, McGuire has been comparing soil samples from 10 roofs planted with native vegetation with soil from five city parks spanning New York's five boroughs, seeking to identify the microbial communities that thrive on green roofs to better to understand how healthy rooftop ecosystems sustain themselves.

Her study, published in PLoS ONE last April, found that green roofs have distinct fungal communities that help plants to thrive in harsh, polluted environments and filter heavy metals. On average, 109 different types of fungi were present on each roof including Pseudallescheria fimeti, a fungus that grows in polluted soils and human-dominated environments. Rooftop soil also contained fungi from the genus Peyronellaea, which live in the tissues of plants to help them take in nutrients.

McGuire hopes her research will be able to help inform green roof companies on planting the best species for each rooftop. Three of the rooftops, which received more intensive sampling, showed that fungal communities are different from one roof to another. Roofs are microclimates, McGuire says. Fungal growth depends on the position of the roof, pollution levels in the area, temperature and how much rainfall it receives. "Plant species are adapting to new environments," she says. "Without the fungi, the plants would not be able to grow and survive."

"In the long term, this information may help individuals decide which types of soil microbes to amend on their green roofs, so that they can maximize plant survival and minimize management," she says.