Feature Article

Small-scale Green Roofs

by Louise Clark

Green roofs have a long history in human civilization, the first being perhaps the Hanging Gardens of Babylon. One of the Seven Wonders of the Ancient World, it is thought the garden was a stepped pyramid, watered from top to bottom by pumped water and gravity flow. Imagine traveling through the scorching Iraqi desert and happening upon this man-made paradise. Surely weary travelers were awestruck by Nebuchadnezzar II's creation, constructed around 500 BC.

In more recent times, sod has been used to cover roofs, from Scandinavia to America's prairies, as it provides insulation, as well as grazing for livestock. Modern green roofs have their "roots" in ancient models, but today's technologies have made them more efficient, as well as more expensive.

The contemporary green roof renaissance developed in Germany in the 1960s and has spread worldwide. Although not yet as common as in Europe, green roofs are being constructed in the United States as their benefits are quantified. Cities including Portland (Oregon), Chicago, and Philadelphia are leading the country's green infrastructure movement. The ecological advantages green roofs confer include reducing energy consumption, decreasing urban heat island effects, filtering acid rain and air pollutants, lessening the burden on aging sewer systems, dampening noise in cities, habitat creation, and the healthful benefits of viewing nature—all of which have been quantitatively proven. Green roofs contribute points to construction projects seeking LEED certification from the U.S. Green Building Council.

Modern green roofs are composed of layers that provide waterproofing, insulation, water retention, a root barrier, and lightweight, soilless medium to support plant growth. The growing medium depth can vary from extensive, at 3", to over 18" on an intensive roof, and can support vegetation from low-growing sedums to shrubs and small trees. All of the benefits of green roofs can be realized with a shallow sedum roof, with most commercial applications in the U.S. using this model. The Morris Arboretum in Philadelphia has two roofs which I tend—one extensive, which is populated with sedums and small bulbs, and the other, an intensive roof with 8" medium depth, which allows me to experiment with a broad range of plants from bulbs to perennials and shrubs. The roofs contributed points to the platinum LEED certification achieved by the Arboretum's Horticulture Center project completed in 2010.

photo ©Louise Clark

A Peterson green roof nest box from a class author led at Morris Arboretum.

Because of engineering challenges, most of us cannot incorporate green roofs onto our houses without significant expense. Alternatively, we can incorporate small-scale green roof projects into our properties.

A favorite example of mine is green roof nest boxes. Kits are available for purchase, or can be constructed from readily available plans, in pine or preferably rot-resistant cedar. Preassembled nest boxes can be easily modified by attaching lath or milled cedar strips screwed, nailed, or stapled onto the existing roof. A waterproofing layer will extend roof life. The existing roof can be flat, like a Peterson bluebird

box*, or peaked like an A-frame chalet. Small drainage holes drilled in the lath at the lower roof edge will ensure heavy rain doesn't pool. A scant 3" depth of a gravelly medium will support hardy sedums. A deeper rooftop can support tough perennials like armeria, dianthus, alliums, and of course sedums. Newly planted roofs will need water to establish, but, once settled, will need little supplemental water unless the weather is hot and droughty for an extended period. Of the many Peterson bluebird boxes scattered throughout Morris Arboretum's 65-acre Bloomfield Farm, the green roof nest box located close to the Horticulture Center's pedestrian path was the one occupied. Curb appeal works for birds, too!

photo ©Jim Bobb

Bee hive with green roof.

Do you keep bees? Bee hives provide an ideal, underused green roof location. Again, a waterproofing layer will protect the roof from water damage, and lath or untreated dimensional lumber can be used to make the raised growing area. A 2009 Swiss/U.K. green roof study observed bees and found that roofs planted with a mix of wildflowers and sedums were foraged throughout the season, providing pollen for bee larvae and nectar for adults. The Swiss study also found that established green roofs often develop mosses, which bees use as a drinking water source, even when nearby water is available. Sedum-only roofs naturally attracted bees only when plants were blooming. Hives adorned with green roofs should enjoy some cooling and insulating effects from the vegetation and soil atop them, and the added weight could discourage mammalian predation. Those located in urban centers planted with a long-season blooming mix of species can host "bee-ins"—local sweet spots for nectar and pollen sources.

photo ©C.L. Fornari

Green roof chicken coop.

While your domicile probably isn't engineered to hold the weight of a green roof, your canine companion's outdoor abode can be designed for the extra load. The weight of saturated green roof medium is estimated to be about 6¾ pounds per square foot for each inch of depth. That means a shallow roof of 3" will exert almost 20 pounds per square foot, while a roof of 5" depth weighs about 34 pounds per square foot. Knowing that, the roof rafters of a dog house can be spaced more closely to provide the additional support a green roof requires. This is especially important if you use heavy mineral soils, as opposed to harder-to-find lightweight green roof media. Depending on the

What is LEED?

- **L**eadership in **E**nergy & **E**nvironmental **D**esign
- U.S. Green Building Council rating system
- Three tiers based on points achieved: silver, gold, platinum
- Provides third-party verification of design/build strategies that improve performance:
  - Energy savings
  - Water efficiency
  - CO_2 emissions reduction
  - Improved indoor environmental quality
  - Stewardship of resources (recycling, repurposing materials)

* Designed by Dick Peterson. For more information and plans of the bluebird nest box, visit www.nysbs.org/handouts/ThePetersonBox.pdf.

roof's slope, horizontal battens might have to be installed to keep the growing medium from sliding. Any slope of 30°, or a 7:12 pitch, requires some method of soil stabilization to prevent a landslide. Once established, plant roots knit together in the medium to form a matrix that stabilizes the soil. Grasses, with their fine fibrous roots, do an excellent job.

If bluebirds find green roofs attractive, can chickens be far behind? While you wouldn't want hens scratchin' on a green roof, their coop roof can do double duty by providing extra growing space for green roof plants, or as a raised bed for small vegetable crops like herbs, spinach, lettuce, or radishes. You could provide forage for bees with flowering plants, or harvest fresh, organic ingredients for delectable spinach omelettes. Chicken manure makes great fertilizer, which could be incorporated into the rooftop soil for vegetable growing. Search online for "green roof chicken coop" and you'll be amazed by what some very creative poultry growers have devised.

Your storage shed roof might be the final frontier of gardening real estate. With proper planning for new construction or a retrofit of your existing shed, growing opportunities are just above your head. Shallow, lightweight plantings of hardy sedums can soften the building outline and help absorb rainfall, while offering habitat. A rain barrel could even be employed to harvest rain water that slowly seeps from the roof. Nigel Dunnett's *Small Green Roofs: Low-tech Options for Green Living* (Timber Press, 2011) offers inspiration and expert guidance on design and construction techniques and showcases many residential projects, from green roof car ports, to bicycle sheds, and more.

While commercial green roofing supplies are hard to come by for homeowners, you can repurpose materials and find supplies at DIY stores. For example, green roof growing medium can be approximated by combining 5–10% aged compost with graded gravel from fines to pea gravel, which varies from ⅛" to ⅜" particles. Pumice, heat expanded shale, or expanded clay can also be used if available. Flexible, long-lasting waterproofing membranes, such as EPDM (ethylene propylene diene monomer), can be purchased from roofing suppliers, or pond liners can be found at lower prices, especially if you'll need only a small amount. Pressure-treated lumber or rot-resistant woods, like black locust and cedar, all work—with the caveat that pressure treated lumber shouldn't be used if you're planning to grow crops for consumption.

Some of my go-to, tough-as-nails perennials that grow well on the Morris Arboretum's intensive green roof include *Allium cernuum* and *A. schoenoprasum, Aquilegia canadensis, Asclepias tuberosa, Dianthus gratianopolitanus,* sedums, opuntias, yuccas, and numerous small bulbs, including species crocus and tulips, grape hyacinth, and western camas.

photo ©Louise Clark

Green roof kildeer nest.

Besides providing pleasant views of greenery, the best part of green roof gardening is no pests. Deer, groundhogs, chipmunks, skunks, opossums, and neighborhood cats cannot disturb roof top plantings. Welcome visitors such as birds and insects enjoy the security of aerial gardens. If your roof is gravelly with low growing plants, it might attract nesting kildeer, a species of plover, as the Morris Arboretum roofs have.

By incorporating a small-scale green roof into your premises, you can provide ecological services including habitat creation for birds and insects, pollinator sustenance, and enjoy pest-free gardening while moving toward more sustainable living. Your small efforts combined with those of others in your community can contribute these environmental advantages while conferring health benefits to you.

Louise Clarke *is a degreed horticulturist at The Morris Arboretum in Philadelphia, Pennsylvania. She stewards the 74-acre Bloomfield Farm property, which includes more than 1,200 accessioned woody plants, as well as two green roofs, on which she conducts plant hardiness trials to establish a regionally appropriate plant palette. As a regional director of GWA, the Association of Garden Communicators, and self-proclaimed plant geek, she enjoys sharing her avidity for plants by teaching and writing for* Seasons*, the Arboretum's newsletter, as well as* Washington Gardener Magazine.

Ed Note: A full-color version of this article can be found on the HPS website. Or, better yet, visit Morris Arboretum to view the rooftop boxes and gardens in person.