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Green roofs are growing up

Native plants key in quest for low-maintenance, self-sustaining groups of drought tolerant plants

By Christine Thuring

A dream of the future

After centuries of habitat destruction, who would have thought that humankind would get its act together so elegantly. By the year 2031, with a population increase of 800,000 since 2006, aerial views of the GVRD show a landscape that is mostly vegetated, the footprint of its population of three million hidden beneath (GVRD 2006).

The first progressive development policy for vegetated rooftops appeared in late 2006 in Port Coquitlam, soon followed by incentive programs by other municipalities. Further to such development programs, existing habitats at grade were given more rigorous protection.

As in other parts of the modern world, vegetated rooftops became important tools for urban planning in the GVRD. Once these municipalities had accepted that development patterns of the last 50 years were no longer appropriate, they began investing into the greening of municipal infrastructure as a form of 'reconciliation ecology' (Miller 2005), including financial support for green roof implementation. Further to target benefits of energy conservation, air quality improvements and stormwater mitigation, the use of indigenous plants would support biodiversity and link patches of existing habitat and migratory corridors.

What is a green roof?

Many names describe the systems that are vegetated rooftops, such as green roof, living roof or ecoroof. Unlike roof gardens that support large features like trees and ponds, this article focuses on shallow extensive green roofs, which are covered by a continuous layer of low-lying plants in 7-15 cm of lightweight substrate. Whereas roof gardens require intensive maintenance, extensive green roofs support low-maintenance, self-

See Living roofs p.4

photo Andrea Martinello, NATS Nursery Ltd.

***Sedum spathulifolium* (broad-leaved stonecrop) has what it takes to withstand the challenging conditions of the rooftop environment.**

What's inside

photo illustration courtesy VCCEP Ltd.

The 5.5 acre Vancouver Convention Centre Expansion Project will be planted and seeded with plants native to the Pacific Northwest. The building will serve as the communication centre for the 2010 Olympics.

Living roofs for the Pacific Northwest

from page 1

sustaining assemblages of drought tolerant plants (Kolb and Schwarz 1999), and are generally functional rather than recreational.

Based on the concept of sod roofs, extensive green roofs were developed in Germany during the oil crisis of the 1970s as a strategy for conserving energy. Since the early 1990s, a number of North American cities have begun sponsoring this technology for their benefits, primarily as a best management practice for decentralized storm-water mitigation. Cities with bylaws and incentives promoting green roof implementation include Chicago, Portland, New York, Toronto, Waterloo, and recently Port Coquitlam (see *PoCo goes green*).

The making of a green roof

Extensive green roofs comprise a system of layers on top of conventional roofing, and are generally specified for low-sloped roofs (0º to 30º) (Johnston and Newton 1993). The basic layers on top of the waterproofing may include a drainage layer, a filter cloth, and the growing medium for the plants . While conventional roofs are often covered with gravel to protect the membrane from wind uplift and UV rays, green roofs can replace that ballast, sometimes without the need for structural adjustments (Scholz-Barth 2001), while also providing better protection and providing many other benefits (see *Green roof benefits*).

Every green roof is unique, designed to match the capacities of a structure to the desired functions of the roof. The weight of the growing medium at

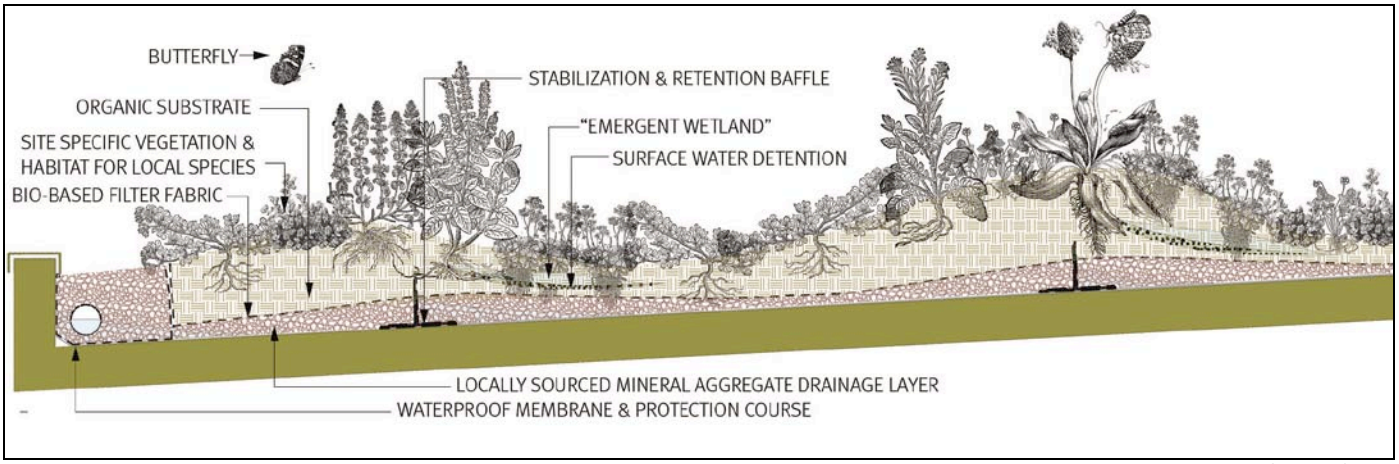


Image courtesy of Rana Creek

Extensive green roofs comprise a system of layers on top of conventional roofing materials. The basic layers include a waterproof membrane, a drainage layer, filter cloth and a substrate for plant growth.

Green roof benefits

Stormwater mitigation: Stormwater runoff from buildings can be delayed and retained by green roofs. Evaporation and transpiration (evapotranspiration) by the plants and substrate returns moisture to the atmosphere instead of the sewers (Scholz-Barth 2001).

Air quality improvement: Foliage traps airborne particles, evapotranspiration lowers ambient temperatures, reducing related health issues and mortalities (Curriero *et al.* 2002).

Reduce urban heat island effect: Built surfaces trap and radiate heat, so planting these surfaces allows for evapotranspirative cooling and shade, thereby reducing microclimate temperatures and improving living conditions in the urban environment (Dimoudi and Nikolopoulou 2003).

Noise attenuation: Vegetated surfaces deflect high frequency sounds, and green roofs can attenuate low frequency noise by 40 decibels (Peck *et al.* 1999).

Thermal insulation: Since less air conditioning is required in the summer, buildings can conserve energy and reduce greenhouse gas emissions. (Peck *et al*. 1999)

Extend lifespan of waterproofing: Green roofs protect the membrane from UV rays and moderate the thermal stress of temperature fluctuations, which can extend membrane life two or threefold. (Scholz-Barth 2001)

Cost savings: Conserve energy, waterproofing materials, stormwater management fees, public health issues, etc (Peck *et al.* 1999).

Ecological compensation: Potential to create habitat and refuge for flora and fauna (Brenneisen 2004).

photo courtesy NATS Nursery Ltd.

NATS Nursery in Langley set up its green roof testing facility in 2004 to determine the plant species most amenable to B.C. rooftop environments.

saturation, for example, will only be as heavy as the building's structural capacity permits. Waterproofing will often be newly renovated to ensure decades worth of uncompromised protection. In the hospitable climate of the Pacific Northwest, spontaneous living roofs frequently occur when moss and volatile seeds colonize a roof.

Rather than natural topsoil, lightweight media are usually used for extensive green roofs because they are durable (resist compression, stable pore volume, inert) drain well and retain moisture. These substrates are often made with volcanic or expanded aggregates and typically contain less than 20 percent organic matter. This large mineral to organic ratio minimizes weed establishment to only the hardiest of volunteers (keeping maintenance costs down), and promotes drainage while absorbing and retaining enough water for the selected plant species (Kolb *et al*. 1982).

Growing conditions

Plants suited to grow on rooftops must tolerate hostile growing conditions caused by direct exposure to solar radiation, extreme temperature fluctuations, and emissions (Kolb 1987) without guarantee of supplementary irrigation or care. Appropriate plants are those with shallow rooting systems that can compete

Continued on page 6

PoCo goes green

On December 11, 2006, Port Coquitlam passed a bylaw requiring green roofs for all new buildings with footprints greater than 5,000 m^2. This is the first such bylaw in Canada that applies to large-format buildings. The reasons for this policy were to provide habitat and support biodiversity, mitigate the urban heat island effect to slow the rate of global warming, reduce the use of non-renewable energy resources, and lessen the amount of runoff entering stormwater infrastructure (Richard 2006).

from page 5

for limited root space and moisture in shallow, mineral substrates. These plants should be easy to propagate and look good year-round (Dunnett and Kingsbury 2004) and must be competitive but should not behave invasively (Kolb *et al*. 1983). Native plants currently used on green roofs in coastal B.C. are listed in Table 1.

Habitat value of vegetated roofs

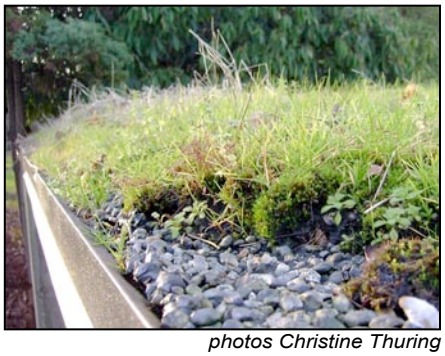
Habitat creation may be cited alongside the benefits of economy, society and environment, but rarely is the type or quality of this habitat defined. Indeed, green roof research typically targets topics of economic magnitude, like thermal efficiency and stormwater retention. Providing more vegetation in a rapidly urbanizing landscape is undeniably an improvement over yesterday's bleak roofscape, but let us nonetheless imagine the full ecological potentials in a modern world where anything is possible.

This article opened with a dream that could come true: human development sustainably tucked beneath a mosaic of naturalized roofscapes; collaborative design teams (including disciplines of architecture, engineering, design, horticulture, ecology, etc.) working together to create site-integrated buildings that ensure human wellness while concurrently restoring links for ecosystem health and function. Self-sustaining, regenerative living roofs with diverse phenologies can support complex food webs, connect nutrient and water cycles, and serve as undisturbed refuges. In imagining this ideal future, let us contemplate what can be done in the present.

Native plants for green roofs

Regions with emerging green roof industries commonly borrow plant lists from regions with mature markets. The climate of coastal B.C. is dramatically different from those origins, however, and as a result plant lists here naturally incorporate the genius loci of species native to this region. These plants bear the qualities necessary for vigor in green roof conditions and derive from plant communities of Garry oak and associated ecosystems, coastal bluffs, high alpine zones, dry rainshadow, and rocky outcrops.

Meanwhile, many native plants are being tested for future use on green roofs (Table 2). Some of these newcomers will cover some of the 5.5



photos Christine Thuring

Many coastal area rooftops have been colonized by mosses, which eventually create conditions for a succession of other volunteer plants. These spontaneous green roofs reflect the species assemblages that can optimize in local environmental conditions, and could serve as design templates for low maintenance, self-sustaining, regenerative living roofs. At left, *Polypodium glycerrhiza* (licorice fern) is one of over 30 species (not all native) colonizing this Granville Island tar and gravel roof.

Table 1. B.C. native plants in use on green roofs

Allium cernuum
Arctostaphylos uva-ursi
Brodiaea hyacinthina
Camassia quamash
Campanula rotundifolia
Festuca idahoensis
Festuca rubra
Fragaria chiloensis
Fragaria virginiana
Sedum divergens
Sedum oreganum
Sedum spathulifolium
Sedum stenopetalum
Sisyrinchium idahoense

Table 2. Native plants being tested for green roof applications

Agrostis pallens
Allium acuminatum
Antennaria microphylla
Armeria maritima
Aster subspicatus
Calamagrostis stricta
Carex inops
Carex pansa
Carex tumulicola
Clarkia amoena
Danthonia californica
Erigeron compositus
Eriophyllum lanatum
Luzula multiflora
Olsynium douglasii
Penstemon davidsonii
Penstemon serrulatus
Phyllodoce empetriformis
Plectritis congesta
Poa secunda
Potentilla anserina
Saxifraga integrifolia
Saxifraga rufidula
Selaginella wallacei
Sisyrinchium spp.

acres on the living roof of the Vancouver Convention Centre Expansion, and are new even to the commercial growing industry. Some plants are being tested on small roofs, like gazebos, garages, and sheds, while others will be rigorously studied in research plots (e.g. B.C. Institute of Technology).

Challenges to roof greening

As with any new and emerging market, barriers must be overcome before green roofs can be widely accepted and implemented. Economically, green roofs will be expensive until quality competition whittles down prices. Government incentive programs are invaluable in getting innovative markets off the ground.

Misconceptions associated with green roofs must be debunked through education and demonstration. Only if the waterproofing is poorly installed will a roof spring a leak (vegetated or not), for instance, and only if the structural engineer has made grave miscalculations would a vegetated roof crash through a ceiling.

Biologically, the roof environment is challenging because it is disconnected from a greater soil profile and because it is exposed to extreme conditions (see *Green roof challenges*). Still, of B.C.'s many plant communities, several of these occur in conditions analogous to those found on extensive green roofs. Just as the early pioneers of German rooftop greening explored their local nutrient-poor, drought-prone habitats, so can we investigate our biotopes for suited flora. With over 2,000 species (Evergreen Foundation 2005) to choose from, certainly we'll find a few.

Green roofs for biodiversity

While stormwater mitigation is the usual driver for green roof policy, endangered species can direct green roof mandates, too. Studies in Switzerland and England have found red-listed invertebrates, spiders and birds using green roofs for habitat (Brenneisen 2004, Gedge and Kadas

Continued on page 8

photos Andrea Martinello, NATS Nursery Ltd.

Clockwise from top: *Camassia quamash* (common camas), *Fragaria chiloensis* (coastal strawberry), *Eriophyllum lanatum* (woolly eriophyllum).

Green roof challenges

- Direct solar radiation
- Frequent drought
- Wind dessication
- Shallow, nutrient-poor, mostly mineral substrate
- Subject to bird curiosity/herbivory/damage

from page 7

2004), and legal protection of these species in combination with committed spokespeople have resulted in policies mandating green roofs for biodiversity. These 'living roofs' have many of the same benefits as extensive green roofs, but their function of supporting biodiversity trumps aesthetics. For example, one of England's rarest birds, the black redstart (*Phoenicurus ochruros*), breeds in the rubble along London's Thames River corridor, an old brownfield site currently in the midst of large-scale redevelopment. The legal protection of this species mandates that its habitat must either be conserved or recreated, so 'rubble roofs' now accompany all development there.

In order to promote biodiversity and create microclimates, living roofs often incorporate random elements like mounds and berms, standing water, and wood debris. Living roofs in Basel, Switzerland are even mandated to include appropriate natural soils from a 50 km radius. These roofs are not even planted, but the seedbank and wind-blown seeds are allowed to accomplish the task.

In closing

Green roofs are just part of the solution to a healthier future on this earth, and cooperation among disciplines is vital for true success. Conservation should remain a fundamental priority, but living roofs may represent a new dimension of ecological opportunity which can help offset the impacts of a building's footprint.

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photos Andrea Martinello, NATS Nursery Ltd.

Left: The fleshy leaves of *Sedum oreganum* (Oregon stonecrop, left) allow it to endure dry conditions. Above: *Sisyrinchium idahoense* (Idaho blue-eyed grass), a member of the Iris family.

Mark your calendar

September 6
Christine Thuring: Living roofs – an archipelago of habitat potential.
Christine will address rooftop refuges and how to integrate ecology into the design and planning of the built environment. This South Coast Native Plant Study Group presentation begins at 7:15 p.m. at the Vancouver Museum. Contact Ron Long (rlphoto@shaw.ca 604-469-1651) for more information.

References cited

Brenneisen, S. 2004. Green roofs: How nature returns to the city. Acta Hort. 643.

City of Port Coquitlam. December 2006. City of Port Coquitlam Sustainability Initiative. (http://www.city.port-coquitlam.bc.ca/__shared/assets/Sustainability_Initiative_Dec_063145.pdf) (accessed February 12 2007)

Curriero, F.Cl, K.S. Heiner, J.M. Samet, S.L. Zeger, L. Strug and J.A. Patz. 2002. Temperature and mortality in 11 cities of the eastern U.S. American Journal of Epidiology 155: 80-87.

Dimoudi, A. and M. Nikolopoulou. 2003. Vegetation in the urban environment: microclimatic analysis and benefits. Energy and buildings 35(1):69-76.

Dunnett, N. and N. Kingsbury. 2004. Planting green roofs and living walls. Timber Press, Portland, OR.

Evergreen Foundation, 2005. Go for green, the active living and environment program: Gardening for life. Fact Sheet #6: Gardening with native plants. (http://www.goforgreen.ca/gardening/Factsheets/Fact6.htm) (accessed Wednesday December 20, 2006)

Gedge, D. and G. Kadas. 2004. Bugs, bees and spiders: Green roof design for rare invertebrates. Proceedings from 2nd International Green Roof Infrastructure Conference, Awards and Trade Show, Greening Rooftops for Sustainable Communities, Portland, OR. June 2004. The Cardinal Group, Toronto.

GVRD, 2006. Livable region strategic plan review: Population growth issues and options, Workshop backgrounder. Greater Vancouver Regional District: Technical Advisory Committee Workshop, March 26, 2006.

Johnston J. and J. Newton. 1993. Building green: A guide for using plants on roofs, walls and pavements. The London Ecology Unit. London, England.

Kolb, W., T. Schwarz and P. Mansourie. 1982. Extensivbegrünung von Dachflächen: Vegetationstechnische Eigenschaften und Kosten von 10 verschiedenen Substraten. Zeitschrift für Vegetationstechnik 5:106-112.

Kolb, W., T. Schwarz and R. Trunk. 1983. Zur begrünung von Kiesdächern. Zeitschrift für Vegetationstechnik 6:143-151.

Kolb, W. 1987. Abflussverhältnisse extensiv begrünter Flachdächer. Teil II: Wirkung des Sättigungsgrades der Vegetationsschicht auf Abflußspenden und Wasserrückhaltung. Zeitschrift für Vegetationstechnik 10:162-165.

Kolb, W. and T. Schwarz. 1999. Dachbegrünung: Intensiv und extensiv. Eugen Ulmer, Stuttgart.

Miller, J.R. 2005. Biodiversity conservation and the extinction of experience. Trends in Ecology and Evolution 20 (8): 430-433.

Peck, S., C. Callaghan, B. Bass, M.E. Kuhn. 1999. Greenbacks from green roofs: Forging a new industry in Canada. Canada Mortgage and Housing Corporation.

Richard, L.L. 2006. Green Roofs: Chapter Two. Planning West. Planning Institute of British Columbia 48 (3): 6.

Scholz-Barth, K. January 2001. Green roofs: Stormwater management from the top down. Environmental Design and Construction. January/February.