New Ideas for Nebraska Green Roof Ecosystems

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A green roof should not be thought of as a flower bed in the sky, but an anthropogenic ecosystem of balanced, but reduced inputs and outputs.
• Use native plants from a stressed community template
  – What templates?
  – What plants?
  – How implemented?

• Glades with shallow soil

Lancaster Co., Ne
Sandstone Prairie
• Glades with shallow soil
• Sand prairies

Thomas Co., NE  
Sandhills Blowout

Lancaster Co., Ne  
Sandstone Prairie
• Glades with shallow soil
• Sand prairies
• Shortgrass prairies
Functionally shallow soils due to:

Underlying Dakota Sandstone
Sandhills Prairie Template

Droughty & sandy soils

Wind abrasion
Shortgrass Prairie Template

Functionally shallow soils due to:

\[ \checkmark \text{Low rainfall} \ < 400 \text{ mm} \]
\[ (17 \text{ inches}) \]

\[ \checkmark \text{High PET} \ > 1300 \text{ mm} \]
\[ (55 \text{ inches}) \]
Shortgrass Prairie Template

• After water, nitrogen becomes the next limiting factor.
• Soil microbial pathways aid turnover of nitrogen & other minerals.
Shortgrass Prairie Template

• Bacteria represent key trophic pathways

• Mycorrhizal fungi utilize root’s sugars & increase access to moisture & nutrients

Photo Credit IVAM Univ. of West Virginia
Investigating the Green Roof Ecosystem Concept: Cooperating Green Roof Research Venues 2007-2013
Pioneers Park Nature Center Green Roof
Cooperative Test Plot 2007, Lincoln, NE

• Extensive (3” to 3-1/2”)
• 800 sf:
• Biomass/cover

• Long-term fertility

Dynamic growth and visual interest in two and one-half growing seasons at PPNC green roof planted June 2007—never fertilized

Dr. Richard Sutton, FASLA GRP
Arbor Day Foundation Green Roof
Cooperative Test Plot 2010, Lincoln, NE

- Ultra-extensive (1-1/2 to 2”)
- 400 sf plot
- Side-by-side w/ Sedum
- Seeded (fall & spring); plugged 72’s
Arbor Day Foundation Green Roof
Cooperative Test Plot 2010, Lincoln, NE

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Sandhills Publishing Green Roof Cooperative Test Plot 2011, Lincoln, NE

- Semi-extensive (5”-6”)

- 2000 sf plot testing:
  Seeding methods & rates
  Adapted & native perennials trials

- Potential germplasm specifically for green roof use:
  - Blue grama  USDA/Ag Research Service
  - Sun sedge  South Dakota State University
  - Hairy grama  UNL
Larson Building/Parkhaus Green Roof Cooperative Test Plot 2012, Lincoln, NE

- Semi-extensive (4”-8”)
- 6000 sf plot testing:
  - Seeding methods & rates
  - Installation costs
  - Maintenance protocols
Prevailing Wisdom

✓ Shallow substrate may not be suitable for many prairie plants
✓ Impossible to recreate microbial and nutrient balance for native plants
✓ Fire impractical to use on green roofs for removing excess biomass

--*Green Roof Plants* -- Snodgrass and Snodgrass 2006
Shallow substrate may not be suitable for many prairie plants
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**Conclusion from 2007-2013 Studies:**
Carefully selected native plants work perfectly well on extensive and semi-extensive green roof ecosystems.
Reducing Green Roof Plant and Planting Costs
“To become more widely used green roofs must become a commodity, not an oddity” —Peter MacDonagh

Landscape Architect & Director of Design
Kestrel Design Group
Green Roof Costs
$20/ sf?
Green Roof Costs

$20/ sf

$10/ sf ?
Green Roof Costs

$20/sf

$10/sf

$6/sf ?
Green Roof Costs

$20/ sf
$10/ sf
$6 / sf  ?  Attaining this in Portland
Example Estimated Per Square Foot Green Roof Cost

- Drainage Layer: $2.36
- Media & install: $1.46
- Plants & Planting: $1.40
- Maintenance: $1.20
- OH & Profit: $5.50

Total Square Foot Costs: $11.92
How to get to $5.00 / sf installation cost and reduce maintenance costs?
1) Using monolithic media layer (i.e., no trays)
Depths should be around 6-9 inches
Rule of thumb: 
Saturated media loading 
Weighs about 7+ lbs/sf for each 1” of media depth
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* 6 to 9 inch depth  =  45 to 75 lbs/sf loading
2) Seeding native grasses versus planting sedum

Slow, backbreaking work to plant raw, native grass seeds by hand but . . .

May 25, 2011
2) Seeding native grasses versus planting sedum

Slow, backbreaking work to plant raw, native grass seeds by hand...
Reduce costs by increasing ease of seed handling:

Small, hirsute seeds $\rightarrow$ encrusted or pelletized $\rightarrow$ spreader
Traditional, dense lawn seeding techniques bring severe competition and require plant fertilization.
Seeding pelletized native grasses with precision spacing using a simple garden seeder
Cost Comparisons

Example: Planting sedum versus seeding native grasses

Timed Production Rate:
1-person-hour 468.5 sf

Sedum:

Plant 1000 sf with 72 plugs at 6” OC
Labor + burden $30/hr = $0.07/hr/sf
Material $5.00/sf
Total $5.07/SF
Seeding native grasses versus planting sedum

Timed Production Rate:
1-person-hour 780 sf

Pelletized native grass seed:

Seed 1000 sf with pellets in 6” rows
Labor + burden  $30/hr = $0.04 /hr/sf
Pelletized seed  $0.75/sf
Total  $0.79/SF

About 6 times less than plugging sedum !!
Green Roof Ecosystem Pitfalls:

Erosion and Grow-in

Maintenance
  Irrigation
  Weeding
  Fertility
  Fire
3) Erosion control accomplished with PAM

Linear polyacrylamides (WSPAMs)

When wet, these polymers are “watered out” of the granule to help stabilize surrounding soil and help bind soil particles. They reduce wind erosion and transport by surface water.
Grow-in to meet the 80% cover and no gaps > 5”
Irrigation protocols honed at PPNC from 2007-2010

Based on 4” depth, high inorganic media

1st Year Establishment Phase
Apply 1/4”-1/2”of water every 7 days
Rainfall not taken into account

Second Year Establishment Phase
Apply 1/4”-1/2”of water every 7 days
Only if no rain greater than 1/4”-inches during that period

Third Year Establishment Phase
Apply 1/4”-1/2”of water every 10 days
Only if no rain greater than 1/4”-inches during that period
Irrigation protocols honed at PPNC from 2007-2010

Year 4 Onward: Maintenance Phase
Apply 1/4”-1/2” of water every 10 days April 1 to October 15.
Only if no rain greater than 1/4”-inches during that period.
Irrigation protocols honed at PPNC from 2007-2010

Year 4 Onward: Maintenance Phase
Apply 1/4”-1/2” of water every 10 days April 1 to October 15. Only if no rain greater than 1/4”-inches during that period.

AND

For every daytime with a maximum temperature above 99° F, or night-time with a minimum above 77° F, subtract one day from the cycle.
Irrigation protocols honed at PPNC from 2007-2010

**Year 4 Onward: Maintenance Phase**

Apply 1/4”-1/2” of water every 10 days April 1 to October 15.

Only if no rain greater than 1/4”-inches during that period.

AND

For every daytime with a maximum temperature above 99° F, or night-time with a minimum above 77° F, subtract one day from the cycle.

AND

For each inch of media depth below 4” subtract 1 day from the cycle.
Irrigation protocols honed at PPNC from 2007-2010

During heat and drought periods:

At least every other day visual and physical inspection of the green roof planting and media dryness.

Always check the moistness of the substrate at several locations before irrigating.
Weeding

• Begins with weed free media.

• Look for weed germination 6-10 days after media placement.

• Continually check any live plant balls for weeds.

• Check entire media area for weeds, insects and disease every week to week and a half during growing season.

• Never let weeds go to seed !!

• Estimate $0.50/sf/year for first 2 years
Fertility

• Fertilizing a must with Sedum to keep healthy and blooming

• Perform a media test and then only use slow release fertilizer

• Not so necessary with non-accessible roofs planted to native grasses and forbs.

• Perhaps lightly top-dress with compost every 5-6 years
Fire and Biomass Removal

- ANSI VF-1 fire standards
- Must remove dead biomass
- Must keep plantings healthy
Fire and Biomass Removal

- Media actually protects roof membrane from fire
Future Research

- Can we reduce the cost of green roofs by using local recycled media ingredients

Crushed, recycled brick

Municipal compost
Thanks to:

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