Putting the Green in Green Infrastructure

Shannon Currey, Hoffman Nursery, Inc.
Debbie Hamrick, North Carolina Farm Bureau

NC DEQ WOW! Stormwater Series

1. The benefits of plants
2. It’s about the right plants for your project
3. Working with the plant industry: Tips for securing plants
4. When it all comes together

Where we’re going today

OVERVIEW

Photo courtesy of Living Roofs

Why green matters

THE BENEFITS OF PLANTS

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GI Works!

Just *one* tree
reduced runoff 60% compared to the tarmac in summer or winter.

Figure 2: Effect of surface type and season on the runoff coefficients of the experimental plots. Mean and standard error shown for all types, n = 9

From: *Trees People and the Built Environment* Proceedings

Atlanta's 4th Ward Park

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Economic benefits

Public funding totaled about $63.8 million ($50 million for the park itself). Private investment around the once blighted asphalt covered site is about $750 million. That's an 11.7 to 1 return back to the city.

Philadelphia

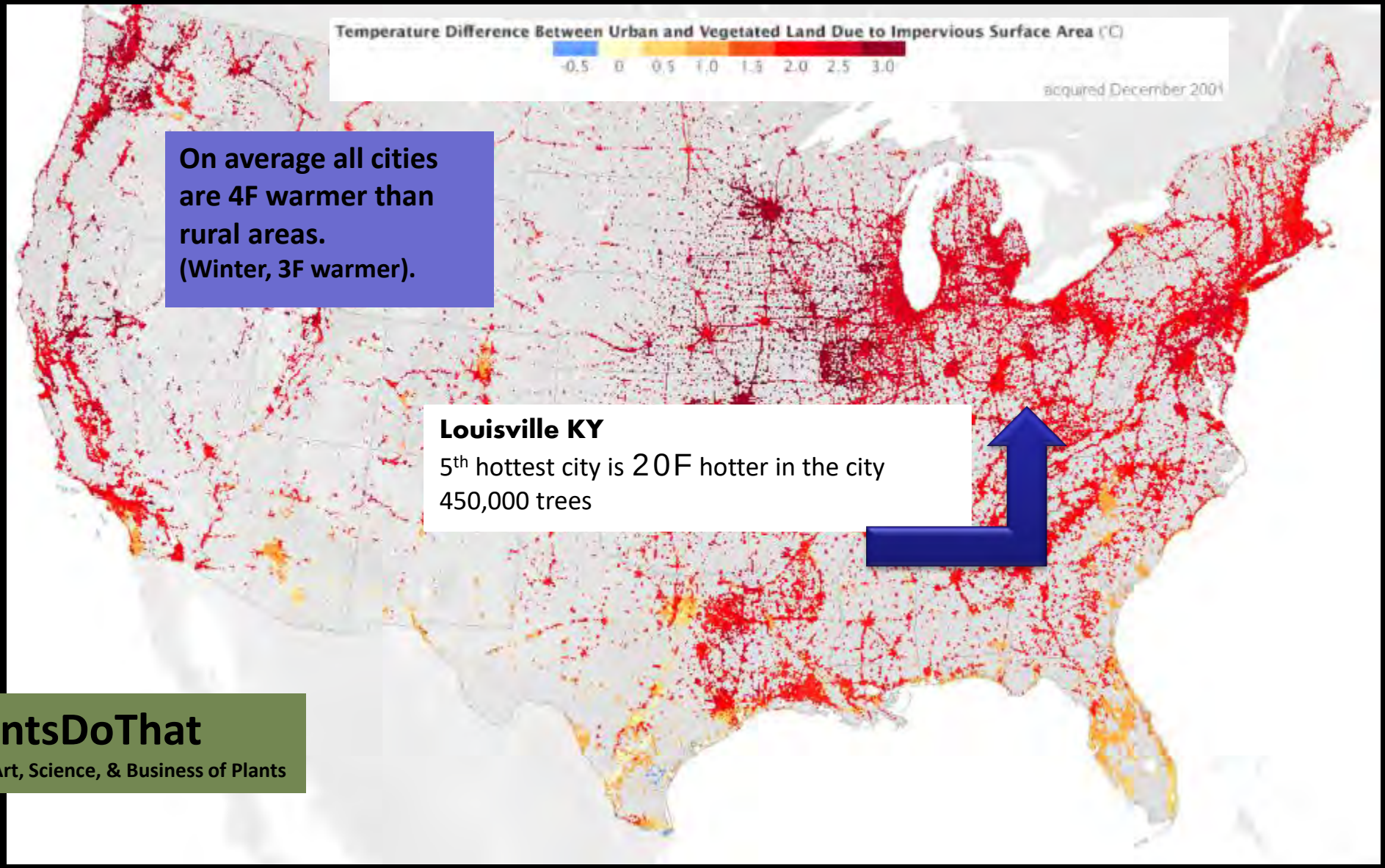
- Green Stormwater Infrastructure Partners member firms showed year-over-year revenue increases of 14% from 2013 to 2014; up $35 million.

Feel wealthier or feel 7 years younger

- Having 10 more trees in a city block improves health perception in ways comparable to an increase in annual personal income of $10,000 ***AND*** moving to a neighborhood with $10,000 higher median income ***OR*** being 7 years younger.
- Toronto, based on health records of 30,000 residents.

Neighborhood greenspace and health in a large urban center by Omid Kardan, Peter Gozdyra, Bratislav Misic, Faisal Moola, Lyle J. Palmer, Tomáš Paus and Marc G. Berman in *Scientific Reports* , Article number: 11610 (2015) doi:10.1038/srep11610.

NASA: Vegetation is an essential factor in limiting urban heating



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Plants Reduce Air Pollution

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- EarthSense Systems and the University of Leicester
- Direct link between air pollution and green infrastructure, with trees and grass cover contributing to a reduction in concentrations of fine particulate matter (PM2.5).
- The aerodynamic dispersive effect of trees results in a **9% reduction in PM 2.5** concentrations.
- A **decrease of PM 2.5, by 2.8% owing to deposition on trees and 0.6% owing to deposition on grass,** was also observed.

Modelling the effectiveness of urban trees and grass on PM2.5 reduction via dispersion and deposition at a city scale by Antoine Jeanjean, Paul Monks and Roland Leigh in the Atmospheric Environment Journal. http://www.sciencedirect.com/science/article/pii/S1352231016307336

We are learning about plants…

CO^2 **sequestration**

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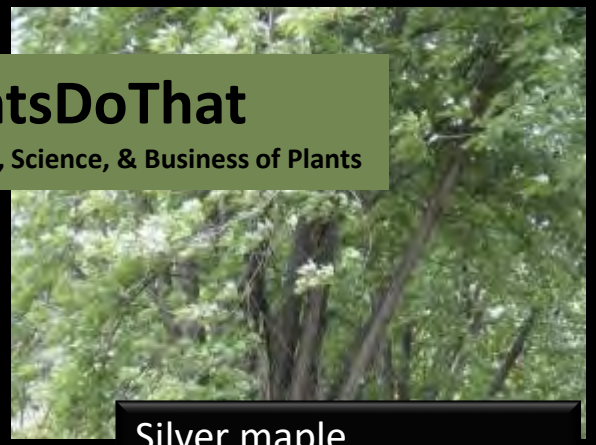

Silver maple

Sweet gum

Southern magnolia

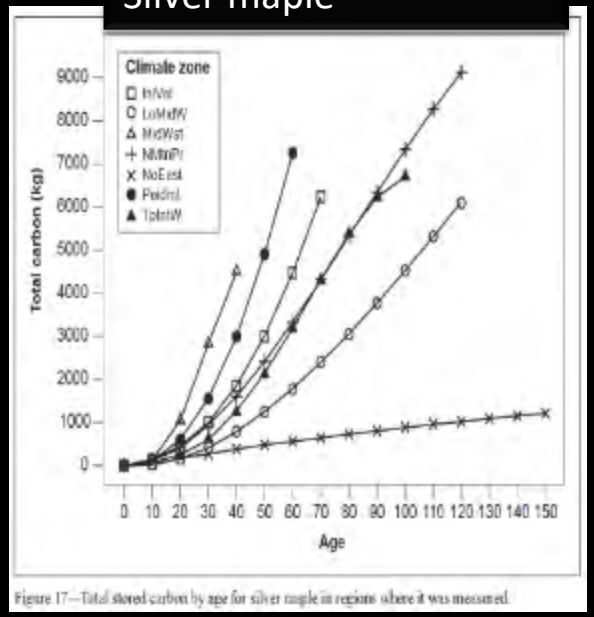

Figure 17—Total stored carbon by age for silver maple in regions where it was measured.

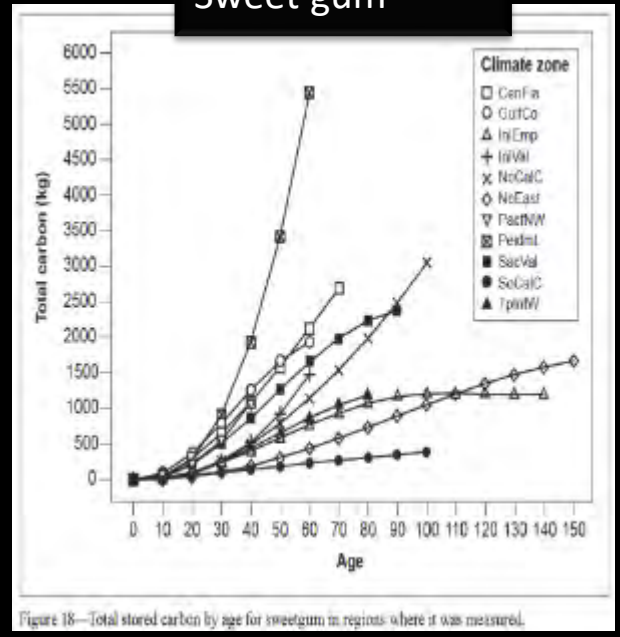

Figure 18—Total stored carbon by age for sweetgum in regions where it was measured.

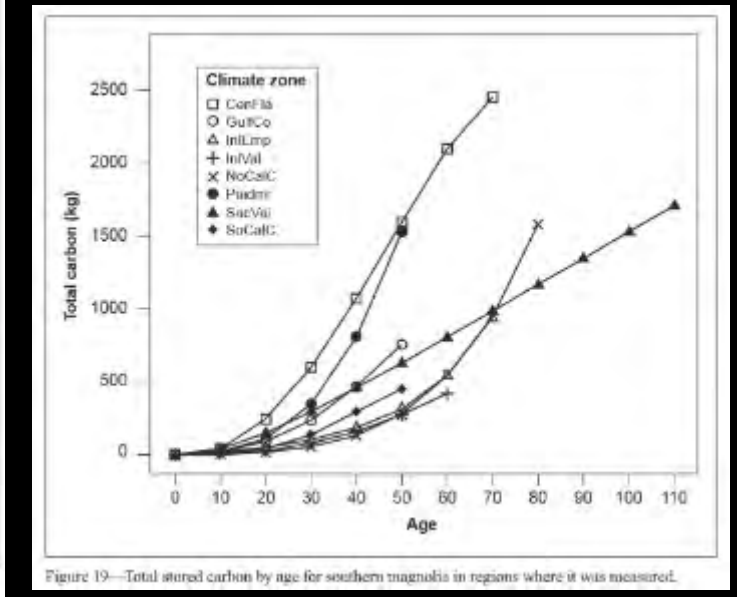

Figure 19—Total stored carbon by age for southern magnolia in regions where it was measured.

Vegetation protects women's health

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- Living in green is good for women's health; the more vegetation the better
- An 8-year study showed that women living in areas with more vegetation had a 12% lower mortality **rate** than women living in areas with the least vegetation.
- It didn't matter where the green exposure was: city or country, east or west, north or south.
- "We observed no threshold at which greater greenness was not associated with lower mortality rates." The main benefits were improved mental health, social connections, exercise and lower air pollution. "Green vegetation has a protective effect …"

More exposure to vegetation linked with lower mortality rates in women Harvard T.H. Chan School of Public Health. Exposure to Greenness and Mortality in a Nationwide Prospective Cohort Study of Women by Peter James, Jaime E. Hart, Rachel F. Banay, and Francine Laden in *Environmental Health Perspectives* DOI:10.1289/ehp.1510363.

Add crime fighting to the list of tree benefits

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- New Haven is home to 32,000 street trees and parks covering 2,200 acres. Approximately 38% of all land is covered by tree canopy
- For every **10% increase in tree canopy cover there was a 15% decrease in the violent crime rate and a 14% decrease the property crime** rate

Figure 1. 2014 land cover in Hartford, Connecticut.

blog post by the study authors: http://blogs.lse.ac.uk/usappblog/2015/11/20/trees-a-new-partner-in-the-fight-against-urban-crime/?utm_content=25407037&utm_medium=social&utm_source=twitter

U.S. COAST GUARD HEADQUARTERS, WASHINGTON D.C.

1.2 million sq. ft. structure

Public demonstration projects

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GSA is the largest green roof owner with 2.5 million sq. ft.

From: Christian Gabriel, GSA

What did we learn from this nature-based approach?

* We learned that the design intercepts and treats 766,294 gallons of stormwater annually, three times (3x) more than what is required statutorily.

* We learned that by leading with ecosystem themed courtyards and forest regeneration areas, that the site now harbors approximately eight times (8x) more native plant material than a traditional project.

* We learned that employing this type of landscape approach, on this scale, sequesters 883,306 pounds of carbon annually. That is equivalent to about twenty four times (24x) the carbon sequestering capacity of a traditional speculative office complex design of equivalent programmatic and geographic size.

* We learned that the project's wide spread deployment of plant material and surface water courses reduces ambient air temperatures on average 10-14 degrees more than that of a traditional office complex. This translates to reduced heat island impacts and reduced energy costs.

From: Christian Gabriel, GSA

GSA

--8,500 facilities
--1.2 million workers
--191 LEED blds.
--18 Sustainable Sites projects

--75-85 capital dev. projects now
--$40 mill to $1.5 billion

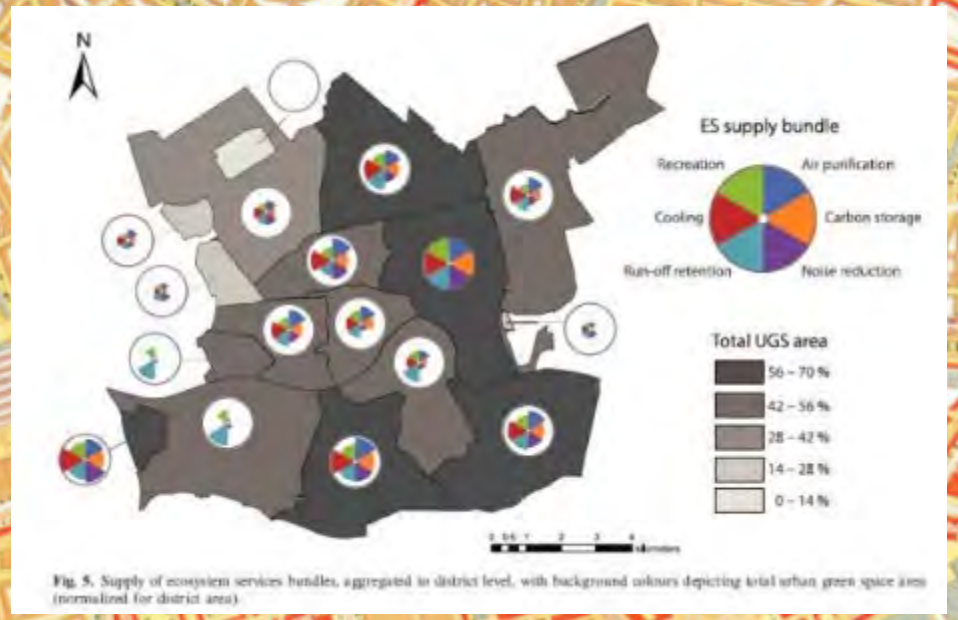

Fig. 5. Supply of ecosystem services bundles, aggregated to district level, with background colours depicting total urban green space area (normalized for district area).

Available online at www.sciencedirect.com
ScienceDirect
Current Opinion in Environmental Sustainability

Benefits of restoring ecosystem services in urban areas

T Elmqvist[1], H Setälä[2], SN Handel[3], S van der Ploeg[4], J Aronson[5,6], JN Blignaut[7], E Gómez-Baggethun[8,9], DJ Nowak[10], J Kronenberg[11] and R de Groot[4]

Table 2

Average value in US$/ha/y (2013) of selected services provided by green spaces in urban areas

Service	Average value (US$/ha/y*)	Range
1. Pollution and air quality regulation	647 (*n* = 9)	*60–2106*
2. Carbon sequestration (annual flow)	395 (*n* = 5)	*58–702*
Carbon storage (stock value)	3125 (*n* = 3)	*1917–5178*
3. Storm water reduction	922 (*n* = 6)	*615–2540*
4. Energy savings/ temperature regulation	1412 (*n* = 4)	*34–1908*
5. Recreation and other amenity services	6325 (*n* = 2)	*2133–10 517*
6. Positive health effects	18 870 (*n* = 1)	*N/A*
Total (excl. health effects and carbon storage)	9701 US$/ha/year	3212–17 772

* See ESM for details.

www.sciencedirect.com

$1,340 to $7,405 per acre

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#PlantsDoThat (nich.org)

Making the green work for you

THE RIGHT PLANTS FOR YOUR PROJECT

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What do you look for?

- Low input
- Resilience
- High ecological value
- Commercially available
- Ornamentally appealing

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Grasses & Sedges: Resilient, Low-input Plants

- Tolerant of low fertility
- Adaptable to wide pH range
- Relatively pest- and disease-free
- Rarely need supplemental fertilizer or irrigation
- Selections that tolerate pollutants and high salinity/salts

Add Ecological Value

- Slow runoff and increase infiltration
- Reduce erosion
- Improve soil and store carbon
- Help suppress weeds
- Support wildlife

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Interaction with Water

- Grasses tend to use water very efficiently
- Readily take up water when present
- Many tolerate extended dry conditions
- Sedges have a wide range
- Check wetland indicator status

Brookside Gardens
Wheaton, MD

Graphic and photos courtesy of Ching-Feng Chen, PLA, LEED-AP

Brookside Gardens
Wheaton, MD

Photo courtesy of Ching-Feng Chen, PLA, LEED-AP

Bioswale at Brookside Gardens, Wheaton, MD

Photo courtesy of Ann English, RLA, ASLA, LEED AP BD+C

Bushy Bluestem
Andropogon glomeratus (FACW)


Soft Rush
Juncus effusus (FACW, OBL)


Wool Grass
Scirpus cyperinus (FACW, OBL)


Tussock Sedge
Carex stricta (OBL)

Larger, Wetland Sedges

Includes *Carex comosa* (OBL)
C. crinita (FACW, OBL)
C. frankii (OBL)
C. lurida (OBL)
C. squarrosa (FACW)
C. vulpinoidea (FACW, OBL)
and others…

Switchgrass: *Panicum virgatum* selections

- Heat and drought tolerant
- Adapt to a wide variety of conditions
- Provide nesting, cover, and food for birds and small mammals
- FAC: stormwater projects, erosion control, meadow/prairie plantings, phytoremediation

Switchgrass
Panicum virgatum

Plants as Living Mulch

- Reduce weed competition
- Slow and treat runoff
- Increase infiltration
- Retain soil and reduce erosion
- Provide wildlife habitat


Indianapolis, IN

Cherokee Sedge
Carex cherokeensis (FACW)

White-topped Star Sedge
Rhynchospora colorata (FACW)

Creek Sedge
Carex amphibola (FAC, FACW)

Photo courtesy of Ann English and Darlene Robbins

Silver Spring, MD
February 2019

On the Edges. Grasses for Tough Spots

- Urban settings
- Difficult soils; rocky or sandy soils
- Xeriscaping
- Low-resource use

Little Bluestem:
Schizachyrium scoparium cvs.

- Adaptable to a range of soil conditions
- Sun-loving and drought tolerant
- Supports birds, small mammals, and pollinators
- FACU: erosion control, green roofs, meadow and prairie plantings

Little Bluestem
Schizachyrium scoparium cvs.


Brookside Gardens, Wheaton, MD
Photo courtesy of Brookside Gardens
Black Mountain Bluestem
Andropogon ternarius 'Black Mountain'
(FACU)
Rose Muhly
Muhlenbergia reverchonii (FAC)

We Are Learning:
Working Trees at the Morton Arboretum

The list of trees ranked by transpiration performance

- *Quercus macrocarpa*
- *Syringa pekinensis* 'Morton'
- *Acer campestre*
- *Acer miyabei* 'Morton'
- *Acer* x *freemanii* 'Jeffersred'
- *Carpinus caroliniana*
- *Cercis canadensis*

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Tree Species Suitability to Bioswales and Impact on the Urban Water Budget, Scharenbroch, Bryant C.; Morgenroth, Justin; Maule, Brian, Journal of Environmental Quality; https://acsess.onlinelibrary.wiley.com/doi/abs/10.2134/jeq2015.01.0060

We Are Learning:
Plant Effectiveness at Pollution Sequestration

- Vegetation significantly impacts the levels of remediation in a rain garden
- Species and cultivar selection matters and can affect the level of sequestration
- A diversity of plants equals the best removal over a wid range of nutrients and conditions

- ***Panicum virgatum*** *vs.* 'Shenandoah'
- *Eupatorium purpureum* ssp. *maculatum* *vs.* **'Gateway'**
- *Magnolia virginiana* vs. ***'Sweet Thing'***
- ***Helianthus angustifolius*** vs. 'First Light'
- ***Itea virginica*** vs.'Henry's Garnet'

Rebecca Pledger (Turk)

Remediation of Urban Stormwater Pollution:
Plant Effectiveness in Pollution Sequestration

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Tips for securing plants

WORKING WITH INDUSTRY

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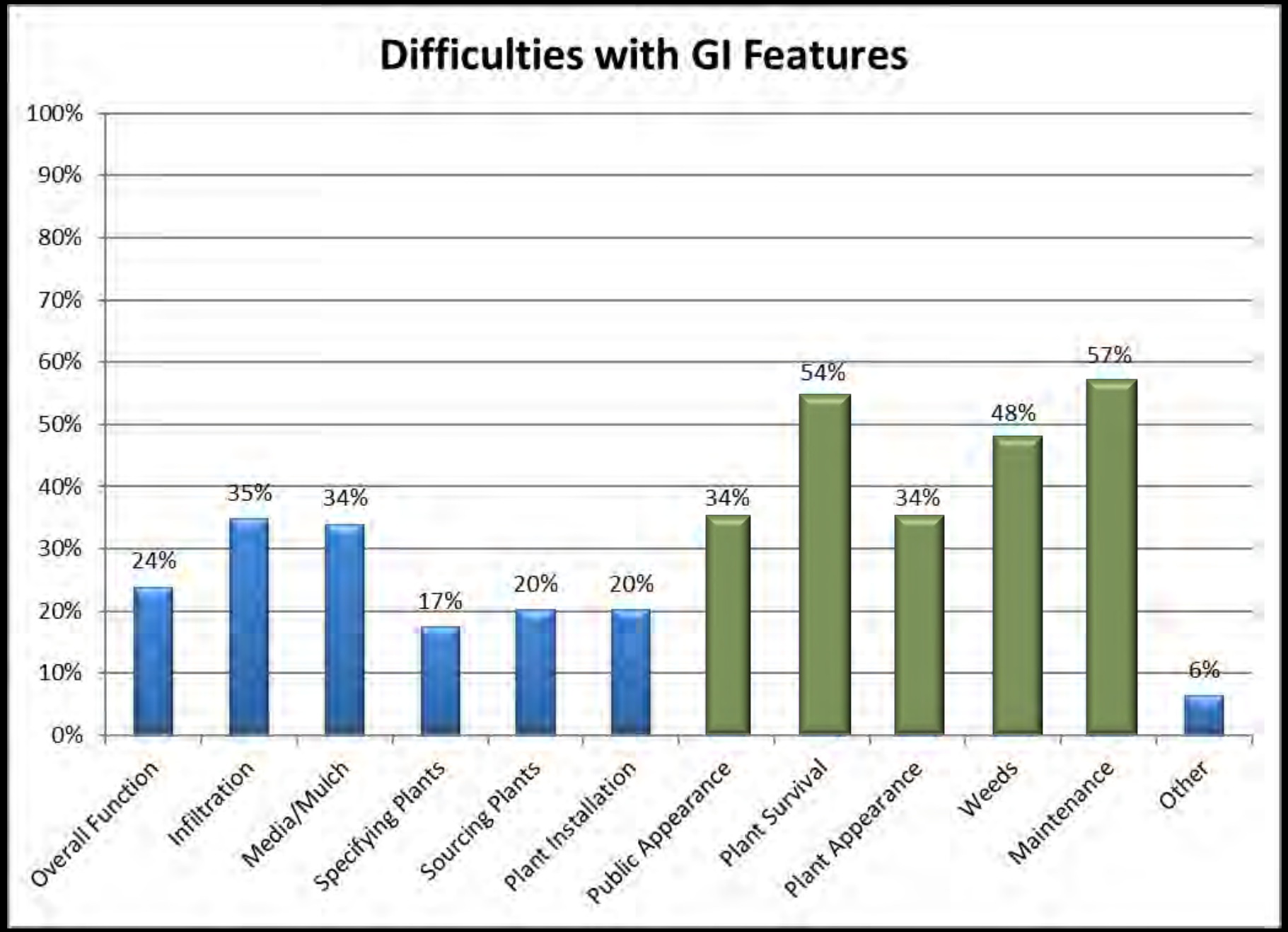
Civil engineers have had many more centuries of experience in developing gray infrastructure than ecologists have had with their new concept of green infrastructure.

-(Kaushal and Belt, 2012) **National Academy of Sciences Urban Forest Services, tools, and management**



Percent of Respondents Who Reported Each Difficulty with GI Features

"Growing the Urban Landscape Market," *American Nurseryman*, Nov. 2014

“We’re talking about thousands of rain gardens and green roofs, and pavement installations and street trees and that’s a different sort of public works project to manage, administer and maintain. That brings all sorts of challenges along with it that cities are really rapidly having to adapt to and learn the best ways to deal with.”

Valessa Souter-Kline, Philadelphia Water Dept.
in *e360* by Yale Univ.

Make Green Your Partner

- Hire a landscape contractor partner, not a bid number
- Ask about certifications
- Has the landscape contractor attended NCSU stormwater training? How do they train their GI installation crews?
- Include the landscape contractor and the nursery in early project discussions: The right plants form the basis of the functional landscape
- Construction sequencing for plant performance is critical

CBLP CHESAPEAKE BAY Landscape Professional

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Cities Need the Right Plants

- Cities need billions of plants
- Municipal and non-profit nurseries are not able to meet the same demand as commercial production
- The existing nursery industry needs to see a viable, stable market that can be served at a profit
- It takes time: Months or even years to produce a plant

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Place, plants, and partners

WHEN IT ALL COMES TOGETHER

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Plant Experts needed

No mention of problems with the original installation. North Creek Nursery's Claudia West redesigned planting plans.

Photo below taken June 2015, the first season after replanting.

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GI "improved traffic and pedestrian safety" and "enhanced a local business…" Engineers at WEF TEC reported in Stormwater 12/2015

The Plum and Walnut intersection before (top) and after (bottom) the City of Lancaster, Pa., improved traffic and pedestrian safety, implemented significant green infrastructure, and enhanced a local business through this integrated, public-private partnership project. *Images by CH2M*

Bioretention Planter in Lancaster, PA
Design and photo by Claudia West,
photo courtesy of Thomas Rainer

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While the green industry may not be experts on green infrastructure yet, **we do know plants**

Updating the NC Stormwater Design Manual

We talked for hours about plants and water depth during establishment in constructed wetlands…

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Updating the NC Stormwater Design Manual

Bioretention Plant List

2018
8	22	26	2015

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SEVENTH AVENUE CONCEPTUAL STREETSCAPE PHASE 1

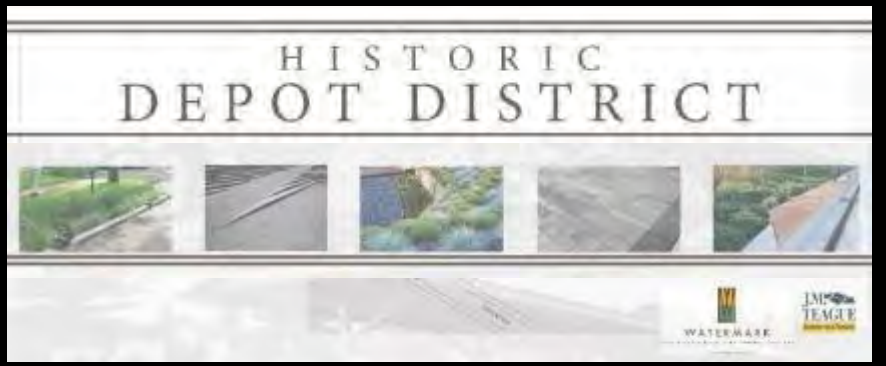
- SCHEDULE: BEGIN CONSTRUCTION FALL 2020
- GOALS: ECONOMIC VITALITY, SENSE OF PLACE, COMMUNITY CONNECTIONS, ENHANCED PEDESTRIAN EXPERIENCE/SAFETY, STORMWATER/ ENVIRONMENTAL IMPROVEMENTS, MULTI-FUNCTIONALITY, BEAUTIFICATION
- DESIGN CONSIDERATIONS: PARKING, CYCLISTS, TRAFFIC, PEDESTRIANS, BUSINESS OWNERS, COMMUNITY MEMBERS, CUSTOMERS

PERSPECTIVE

SECTION

SECTION

PERSPECTIVE



WATERMARK
LANDSCAPE ARCHITECTURE ■ LAND PLANNING ■ CONSULTING

Conceptual plan courtesy of Watermark Landscape Architecture
Used with permission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Buffalo Bayou Park, Houston, TX


Asheville, NC
Photo courtesy of Living Roofs
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Denver Botanic Gardens Chatfield Farms


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Thank you!

hoffmannursery.com
shannoncurrey@hoffmannursery.com
www.linkedin.com/in/shannoncurrey/

debbie.hamrick@ncfb.org
www.linkedin.com/in/debbiehamrick/