PLANT SELECTION, SUSTAINABILITY, AND SITE SAFETY/DESIGN

THE STRATEGIC IMPORTANCE OF PLANT SELECTION

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“Nature in the Balance”
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TOPICS

• Ecological Restoration remarks

• Plant Selection = fundamental process underlying planting outcomes and achievement of goals—whether restoring native ecosystems or designing aesthetic / ornamental, or functional landscapes

• Plant Selection Model

• ‘Limiting Factors’ for Plant Growth and Design Success

• Examples: Maintenance, Climate Change

• Observations
What About the Last 40 Years?

- diversification, specialization, and consolidation
- technological innovation (GIS, barcoding, radio frequency ID; automated data collection, remote sensing, telemetry…)
- workforce changes
- native plants; ecological restoration
- wildlife habitat; beneficial insect support
- water and soil conservation
- urban forests, green infrastructure, stormwater management
- pesticide and fertilizer use (education; reduction of use)
- edible landscaping
- greater diversity of plant materials; landscape plant selection
- weed and pest management (diagnosis; integrated management)
- management of invasive species
- more and diverse training/education opps for public and professionals
- recycling of green wastes and biomass
- organic, climate-appropriate gardening (enviro. issues; sustainability….)
CROSS-DISCIPLINE INTEGRATION AND USE OF SCIENCE

• Deeper understandings in biology, ecology, AND increasing integration among horticulture, landscape design and maintenance, ecology (ecological restoration; ecological landscape design)

• Stronger appreciation of the science underlying the natural world allows us to do our jobs more successfully: soilfoodwebs, soil health, OM, invasive species, biofilms, endophytic diazotrophs….

• Integration and appreciation produce more multi-dimensional and multi-functional landscapes beneficial to humans and many other species

Chastain Soil Series, NC (hydric)
RESTORATION ECOLOGY IS UNIQUELY POSITIONED

• Has a unique heritage and breadth of practice

• Builds on agriculture, engineering, design, and construction practices

• Bridges theory and practice—applying theory, scientific knowledge, research…

• Experiencing diversification and elaboration of roles (social, economic, environmental)

• Coordinates among city infrastructure, impaired environmental conditions, and maintenance challenges

• Provides some of the best solutions within complex and often poorly understood ecological and urban systems
HOW DO RESTORATION ECOLOGISTS GROW EXPERTISE AND IMPACT??

• Take risks and greater challenges at multiple levels (project siting and scoping, stakeholder negotiations, project design and aesthetic, understanding where to compromise…)

• Collaborate on interdisciplinary teams

• Rethink reference ecosystems and historic landscapes to guide strategies; consider novel ecosystems

• Target multi-functional landscapes with restoration as a component

• Integrate restoration into multiple areas: architecture and building systems; green infrastructure; urban ag; energy landscapes…

• Target public health; industrial / infrastructural replacement; parkland and open space

Alexander J. Felson, Yale
SOPHISTICATION: KNOWLEDGE AND USE OF PLANT MATERIALS

• More species and cultivar diversity than ever before!

• Creatively solve design challenges, particularly plant combinations designed for maintenance, extended seasonal interest, resistance to invasive species, drought tolerance...

• Species diversity can be at odds with uniformity, which is often a key element in landscape design; but urban sites are custom-made for plant diversity...

• “Landscape as Infrastructure” (green infrastructure; ecological urbanism)

• Restoring the urban forest
• Beware rapid evolution of new, showy introductions demanding high levels of resources / maintenance (hydrangeas that bloom all summer; > 65 cultivars of coneflower?)

• While diversity is good, it demands greater sophistication in plant materials, design use, cultivation, maintenance…

• Nursery industry continues to introduce countless plants, some of which are becoming, or will prove to be, future invasive species causing significant ecological / economic damage.
Certain useful species or selections still not available in the commercial trade:

Western Washington Forms:  
*Pinus ponderosa*  
*Populus tremuloides*

Inter-specific Hybrids:  
*Spiraea x pyramidata*  
*Arctostaphylos x media*

Disease-resistant Forms:  
*Castanea dentata*  
*Pinus monticola*  
*Pinus albicaulis*
PLANT MATERIALS SPECIALTY

“...INTELLIGENT, CONSIDERED PLANT SELECTION CAN SOLVE ANY LANDSCAPE OR RESTORATION DESIGN CHALLENGE”

• Resist invasive species?
• Anticipate effects of climate change?
• Conserve water; reduce irrigation?
• Deter human trespass?
• Live under bridges???
THE DESIGN PROCESS

Goals, Objectives, and Constraints

Limiting Factors on the Outplanting Site

Stock Type

Source of Plant Material:

- Appropriate ‘source of origin’ for the plants to be used
- Maintaining adequate genetic diversity in the plant materials introduced

Outplanting, Follow-up, Maintenance
THE DESIGN PROCESS

Objectives and Constraints

Limiting Factors on the Outplanting Site

Stock Type

Source of Plant Material:

• Appropriate ‘source of origin’ for the plants to be used

• Maintaining adequate genetic diversity in the plant materials introduce

Outplanting, Follow-up, Maintenance
WHAT DESIGN CRITERIA DO WE USE??

WHAT PLANTS ARE APPROPRIATE??

Midvale Stormwater Det. Facility, Seattle
Capehart Restoration, Discovery Park

Katsura (Cercidiphyllum)

500 Area, Discovery Park, Seattle

Capehart Restoration, Discovery Park
PLANT SELECTION MODEL

AESTHETICS
- Seasonal Interest
- Presentation

ADAPTABILITY
- Climate and Climate Change
- Soils
- Maintenance Regimes
- Hydroperiod

FUNCTION
- Screening
- Groundcover
- Ornament
- Bioretention
- Native…

MAINTENANCE
- Pruning
- Pest Management
- Irrigation
- Aggressiveness

COST:
Direct (capital and O&M) and Opportunity

PLANT SELECTION MODEL
PRINCIPLE OF LIMITING FACTORS

Justus von Liebig’s ‘Law of the Minimum’

Growth is controlled not by total available resources, but by the **scarcest** resource or **most intense** stressor (= **Limiting Factor**).

REGIONAL CLIMATE CONDITIONS
(including extremes)

Climate Diagram for Bellingham, WA (1949-1996)
CLIMATE AS A LIMITING FACTOR: Summer Drought

Climate Diagram for Bellingham, WA (1949-1996)
PRINCIPLE OF LIMITING FACTORS

What are potential limiting factors for plant growth and design success in bioretention / biofiltration contexts?

- Pollutant loadings: salt, zinc, lead, copper, PAH’s, etc.?
- Sediment loadings?
- Soil pH?
- Soil texture?
- Hydroperiod (depth, timing, frequency, duration of flooding and/or soil saturation)?
  - dramatically fluctuating (flashy) water levels?
  - alteration between soil saturation and drought?
  - potential soil hypoxia and anoxia?
MAINTENANCE AS A LIMITING FACTOR

1. Routine inspection/maintenance required for continued correct functioning.

2. Maintenance personnel need high skill levels in plant identification (desirables vs. adventives vs. invasives).

3. If properly designed for maintenance, expect maintenance levels to be high initially, but to decline with time once facility is established and functioning.

4. Proper maintenance increases lifespan and enhances aesthetics of the facility.

5. Maintenance plans for project owner present clear guidelines, objectives, tasks, and timelines/schedules.
Seattle Municipal Code
Chapter 10.52
Piper Village, Greenwood Town Center, Seattle
slough sedge
(Carex obnupta)
slough sedge
(Carex obnupta)

Ballard Raingardens, Seattle
“PRAIRIE” PALETTE FOR SHADE

**Description:** Mostly evergreen species are low-growing, non-spreading, and low- or no-maintenance; emphasizes grasses and grass-like species; other species add seasonal color, pollinator function, etc. along the lines of forbs in a prairie plant community. When planted densely and in small groupings each species is expected to co-habitat peacefully with the other species to form a perpetual quilt of color, texture….

**Maintenance:** Once per year (March), everything gets string-trimmed, or clipped, or otherwise trimmed back to 3 inches above the ground surface. All removed vegetation is raked out and hauled off-site to be composted. Remove any weeds, mulch as possible.

<table>
<thead>
<tr>
<th>BOTANICAL NAME</th>
<th>COMMON NAME</th>
<th>NATIVE TO KING COUNTY?</th>
<th>ON SEATTLE GREEN FACTOR LIST?</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Geranium x cantabrigiense</strong> and related (e.g. ‘Biokovo’)/<strong>G. macrorrhizum</strong></td>
<td>Perennial Geranium</td>
<td>No</td>
<td>Yes</td>
<td>Emphasize at edges—along curbs and sidewalks.</td>
</tr>
<tr>
<td><strong>Melica nutans</strong></td>
<td>European Oniongrass</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td><strong>Festuca californica</strong></td>
<td>California Fescue</td>
<td>No</td>
<td>No</td>
<td>Blue forms available.</td>
</tr>
<tr>
<td><strong>Phlomis russelliana</strong></td>
<td>Russell Jerusalem-sage</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td><strong>Danthonia californica</strong></td>
<td>California Oatgrass</td>
<td>Yes</td>
<td>No</td>
<td>Semi-evergreen.</td>
</tr>
<tr>
<td><strong>Luzula sylvatica</strong></td>
<td>European Woodrush</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td><strong>Sesleria autumnalis</strong></td>
<td>Autumn Moor Grass</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td><strong>Aster divaricatus</strong></td>
<td>White Wood Aster</td>
<td>No</td>
<td>No</td>
<td>Only deciduous species in the palette.</td>
</tr>
</tbody>
</table>
## “WELL-BEHAVED SHRUB” PALETTE FOR SUN

**Description:** Mostly evergreen species are low-growing, slowly or non-spreading, and low- or no-maintenance. When planted densely and in small groupings each species is expected to co-habitate peacefully with the other species to form a perpetual quilt of color and texture.

**Maintenance:** In December, hand-pick, vacuum, or otherwise remove deciduous leaves fallen onto the shrubs; limited pruning around the edges to maintain sidewalk and curb clearances; lightly shear Germander patches; remove weeds, mulch it up as possible.

<table>
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<tr>
<th>BOTANICAL NAME</th>
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<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mahonia repens</td>
<td>Creeping Oregon-grape</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Potentilla tridentata</td>
<td>Three-tooth Cinquefoil</td>
<td>No</td>
<td>No</td>
<td>Emphasize at edges—along curbs, sidewalks.</td>
</tr>
<tr>
<td>Iberis sempervirens</td>
<td>Evergreen Candytuft</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Thymus (shrubby species and cultivars)</td>
<td>Thyme</td>
<td>No</td>
<td>Yes</td>
<td>Emphasize at edges—along curbs, sidewalks.</td>
</tr>
<tr>
<td>Potentilla fruticosa</td>
<td>Shrubby Cinquefoil</td>
<td>Yes/No</td>
<td>Yes</td>
<td>Numerous forms available for habit, height, and flower color. The only deciduous species in this palette.</td>
</tr>
<tr>
<td>Daboecia cantabrica</td>
<td>Irish Heath</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Teucrium chamaedrys</td>
<td>Germander</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Escallonia (dwarf forms)</td>
<td>Escallonia</td>
<td>No</td>
<td>Yes</td>
<td>Numerous dwarf and compact forms available.</td>
</tr>
</tbody>
</table>
“WELL-BEHAVED SHRUB”
PALETTE FOR SHADE

Description: Species are low-growing, slowly or non-spreading, and low- or no-maintenance. When planted relatively densely and in small groupings each of these species is expected to co-habitate peacefully with the other species to form a perpetual quilt of color and texture.

Maintenance: In December, hand-pick, vacuum, or otherwise remove deciduous leaves fallen onto the shrubs; limited pruning around the edges to maintain sidewalk and curb clearances; remove weeds, lightly mulch as possible.

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<tr>
<th>BOTANICAL NAME</th>
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<tbody>
<tr>
<td>Mahonia nervosa</td>
<td>Low Oregon-grape</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Paxistima myrsinites</td>
<td>Oregon-box</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Hydrangea quercifolia ‘Pee-wee’</td>
<td>Dwarf Oak-leaf Hydrangea</td>
<td>No</td>
<td>Yes</td>
<td>Only deciduous species in this palette.</td>
</tr>
<tr>
<td>Nandina domestica ‘Compacta,’ ‘Harbor Dwarf,’ ‘Moon Bay,’ ‘Gulf Stream,’ etc.</td>
<td>Dwarf Heavenly-Bamboo</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Ruscus aculeatus and/or R. hypoglossum</td>
<td>Ruscus</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Osmanthus heterophyllus ‘Goshiki’</td>
<td>Fragrant Osmanthus</td>
<td>No</td>
<td>No</td>
<td>Variegated; leaves with prickly margins; slow growing to 6 feet.</td>
</tr>
<tr>
<td>Ilex crenata ‘Green Island’</td>
<td>Japanese Holly</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Liriope</td>
<td>Lilyturf</td>
<td>No</td>
<td>Yes</td>
<td>Not a shrub, obviously, but does not need to be cut back annually.</td>
</tr>
</tbody>
</table>
CPTED: BARRIERS AND MAINTENANCE

• Fences, walls, hedges, and other obstacles referred to as Boundary (Territorial) Markers (NCPI)
• Identify property / project lines
• Limited protection from trespass; first line of defense
• Enhance access control
  • Prevent casual trespass
  • confine small children and pets
• Add aesthetic appeal, BUT
CPTED: BARRIERS AND MAINTENANCE

• Prevent surveillance (looking in)
• Limit ability to identify potential threats (looking out)
• Increase potential for graffiti, vandalism, stealth encampment…SO,

✓ Keep shrubs trimmed to 3 feet
✓ Prune lower branches of trees up to 7 feet
✓ Design landscape plantings to allow open lines-of-sight between area frequented by users and potential locations of undesirable activity
<table>
<thead>
<tr>
<th>NATIVE PLANTS WITH AGGRESSIVE (UNDERGROUND) STEM SYSTEMS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SHRUBS: DRY / MOIST</strong></td>
</tr>
<tr>
<td>Salal (<em>Gaultheria shallon</em>)</td>
</tr>
<tr>
<td>Naked-hip rose (<em>Rosa gymnocarpa</em>)</td>
</tr>
<tr>
<td>Pea-fruited rose (<em>Rosa pisocarpa</em>)</td>
</tr>
<tr>
<td>Thimbleberry (<em>Rubus parviflorus</em>)</td>
</tr>
<tr>
<td>Salmonberry (<em>Rubus spectabilis</em>)</td>
</tr>
<tr>
<td>Dewberry (<em>Rubus ursinus</em>)</td>
</tr>
<tr>
<td>Birch-leaf spirea (<em>Spiraea lucida</em>)</td>
</tr>
<tr>
<td>Hardhack (<em>Spiraea douglasii</em>)</td>
</tr>
<tr>
<td>Snowberry (<em>Symphoricarpos alba</em>)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Sweet gale (<em>Myrica gale</em>)</td>
</tr>
<tr>
<td>Nootka rose (<em>Rosa nutkana</em>)</td>
</tr>
<tr>
<td>Salmonberry (<em>Rubus spectabilis</em>)</td>
</tr>
<tr>
<td>Hardhack (<em>Spiraea douglasii</em>)</td>
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PREDICTED CLIMATE CHANGE IN THE PACIFIC NORTHWEST
PREDICTED CLIMATE CHANGE IN THE PACIFIC NORTHWEST

- Increased summer temperature
- Increased winter temperature
- Drier summers
- Wetter winters
- More precipitation as rain rather than snow
- More intense storms

Average Annual Precipitation
Washington
Period: 1961-1990  Units: inches

Legend (inches per year):
- Less than 10
- 10 to 15
- 15 to 20
- 20 to 25
- 25 to 30
- 30 to 40
- 40 to 60
- 60 to 80
- 80 to 100
- 100 to 140
- 140 to 180
- More than 180
BRANCH SHEDDING
(Summer Limb Drop; not cladoptosis)

oak
maple (big-leaf maple)
‘Raywood,’ ‘Modesto’ ash
Bradford pear
Chinese pistache
sycamore
eucalyptus
cottonwood, poplar
tree-of-heaven
giant sequoia
Japanese pagoda tree
sweetgum….

• lack of rays?
• defect?
• disease?
• “water weight gain” after rain event during hot dry weather….?
• ??
TREES

• Using trees in bioretention and other urban applications is challenging

• Resistance to using trees

• Trees can impact pipes, utility lines, sight-lines, maintenance, renovation...

• Avoid species with invasive roots; coarse abundant leaves

• Shading can reduce understory plant cover

• For bioretention, plant trees in mesic zones (slopes); not hydric zones (wet)

Oregon ash (*Fraxinus latifolia*)  Western redcedar (*Thuja plicata*)
Red alder (*Alnus rubra*)  Shore pine (*Pinus contorta*)
Willow oak (*Quercus phellos*)  Bald-cypress (*Taxodium distichum/T. ascendens*)
1. Intelligent, considered plant selection can solve any landscape or restoration design challenge

2. Designers and restoration practitioners must have a sophisticated knowledge of plant materials and their cultivation, maintenance

3. Anticipate trends to simplification either at front-end or back-end or both, but diversity is good! Weeds invade; succession happens; conditions change…

4. Be prepared to re-select and re-plant based on post-construction plant losses or actual limiting factors

5. Maintenance personnel need high skill levels in plant identification (desirable plants versus adventives / invasives)

6. Plant selection is integrative, functioning optimally when applied with understandings and appreciations of the underlying science (e.g. evergreen tree cover, bioretention, healthy soils and soil food webs, innovations such as mycotechnology….)
THE STRATEGIC IMPORTANCE OF PLANT SELECTION

“...INTELLIGENT, CONSIDERED PLANT SELECTION CAN SOLVE ANY LANDSCAPE OR RESTORATION DESIGN CHALLENGE”

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WASHINGTON FLORA

• Native vascular plants: ??
• Non-native vascular plants: ??
• Mosses, liverworts: ??
• Lichens: more than ??

• Washington is ranked ?? in vascular plant diversity (NatureServe 2002)
WASHINGTON FLORA

- Native vascular plants: 2,748
- Non-native vascular plants: 995
- Mosses, liverworts: ??
- Lichens: more than 1,000??

- Washington is ranked 15th in vascular plant diversity (NatureServe 2002)