Urban Site Index as a tool for site assessment and tree species selection

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Toronto Planting Protocol

Site Selection

- Streets with construction memorandum
- Capital work
- Streets with limited tree cover
- Areas hit with EAB and ALB

Site Assessment

- Climate and microclimate
- Soil Factors (pH, compaction, drainage, salt)
- Above-&Below-ground limitations

Species Selection

- Species restrictions related to EAB&ALB
- Overhead wires
- Soil compaction
- Salt spray
- Underground utilities
- Proximity to schools
- Access to water
- Community stewardship opportunities

Is it effective in achieving diverse and healthy street tree population?

Rationale for Urban Site Index Research

- During 2010 took Urban Forestry Field Course and observed a high-degree of monocultures in communities of Richmond Hill, Toronto, and Ottawa.
- Strategy of 5-10-20
- Not the case for Toronto (Norway Maple and Honeylocust dominating)

Current Status of Street Trees in Toronto

- Strategy to expand tree canopy to between 30 and 40 percent
  - Planting new trees
  - Implementing maintenance and protection programs
- Recent outbreaks
- Relatively in poor health
- Inadequate percentage of trees in large size (25% compared to 48% target)
- Trees planted increased from 4000 to over 9000 in 6 years

Urban Site Index

- A rapid site assessment process to quantify severity/quality of street planting sites
- Assigns the least hardy tree that will survive and thrive at a site
- Developed by Ohio Division of Forestry
- Takes into account soil factors, and street limitations
- Is currently a focus of urban forestry research at Indiana University (Dr. Fischer)


Urban Site Index Score
Soil factors
• Vegetation (0-3)
• Compaction(0-3)
• Probe Penetration(0-3)
• Soil Development(0-3)
Street Factors
• Speed Limit(0-2)
• Number of lanes(0-2)
• Availability of Parking(1-2)
• Length Between Stop Signs (0-2)

URBAN SITE INDEX (USI) INVENTORY

Collectors (s): _____ Page ____ Comments on back

Date _____ City/Rural _____

			Block Start	Block End													
No.	Street	Dir	Block Address Landmark	Block Address Landmark	Sign											Size	Fit
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	

Key

Benefits:

- ✓ Simple
- ✓ Cheap
- ✓ Time-efficient
- ✓ Easy to understand and use
- ✓ Systematic
- ✓ Requires few tools

Use USI for Diverse Planting Designs

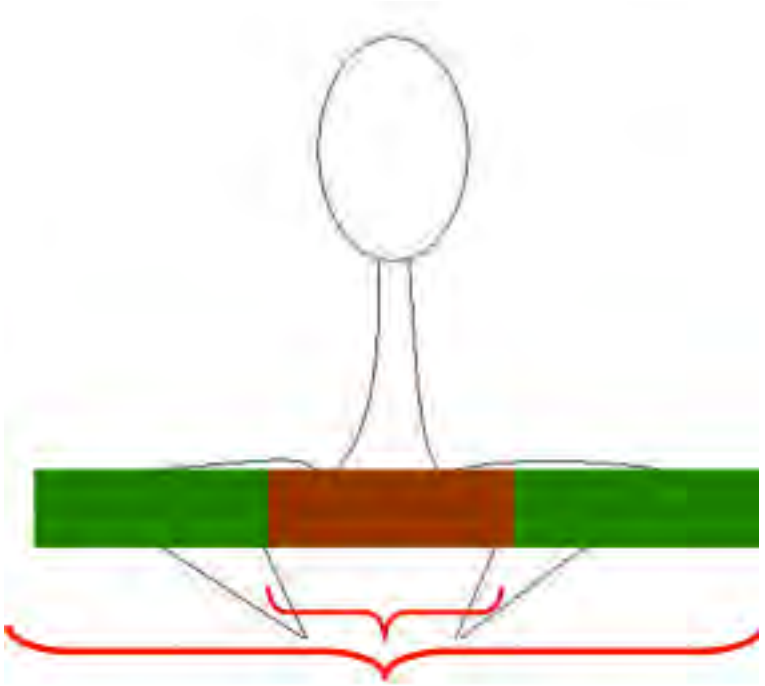
- Good
  - Large
- Good
  - Small
- Intermediate
  - Large
- Intermediate
  - Medium
- Intermediate
  - Small
- Poor
  - Large

- Site Evaluation
- Identify streets with the same constraints
- Assign species by site type
- Break sites into planting segments
- Assign species spacing

Ohio Division of Forestry, 2011

Other considerations

- Using USI method does not exclude from preparing the site for planting or regular tree maintenance
- Quantifies the environment the tree will grow into



Ohio Division of Forestry, 2011

Science behind USI

- Site Vegetation (Ryuichi et al 2004)
- Surface Compaction (Fonseca et al 2004, Steber 2007)
- Soil Development (Alzetta et al 2012, Bradley et al 2009, Marshall 2000, Schaberg et al 2006, Norra et al 2008, Scharenbroch et al 2005)

Science behind USI (cntd)

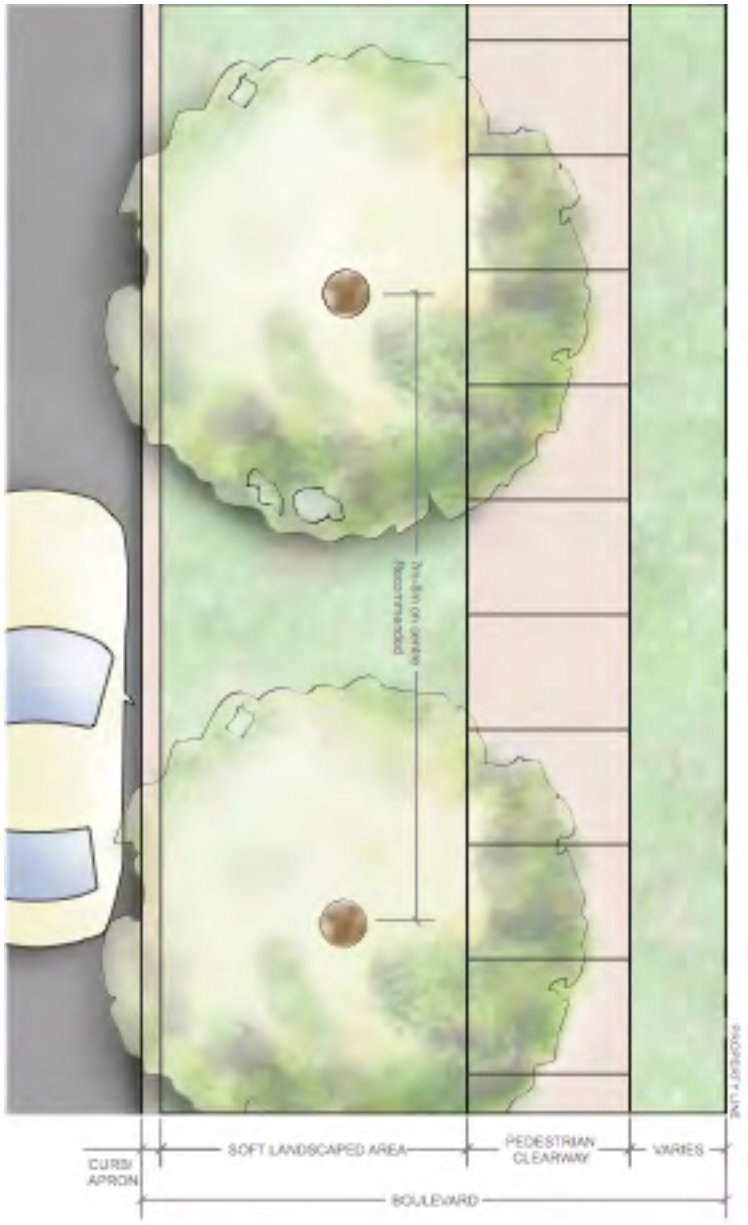
- USI Assumptions:
  - Greater speed, distance between traffic signs, and number of lanes – the more salt throw and vehicular pollutants end up in the soil
  - Presence of parking acts as a buffer
- Pollution leads to soil contamination with copper, zinc and lead (Norra et al 2008)
- Salt adversely affects trees closest to the road margin (Hautala et al 1992)

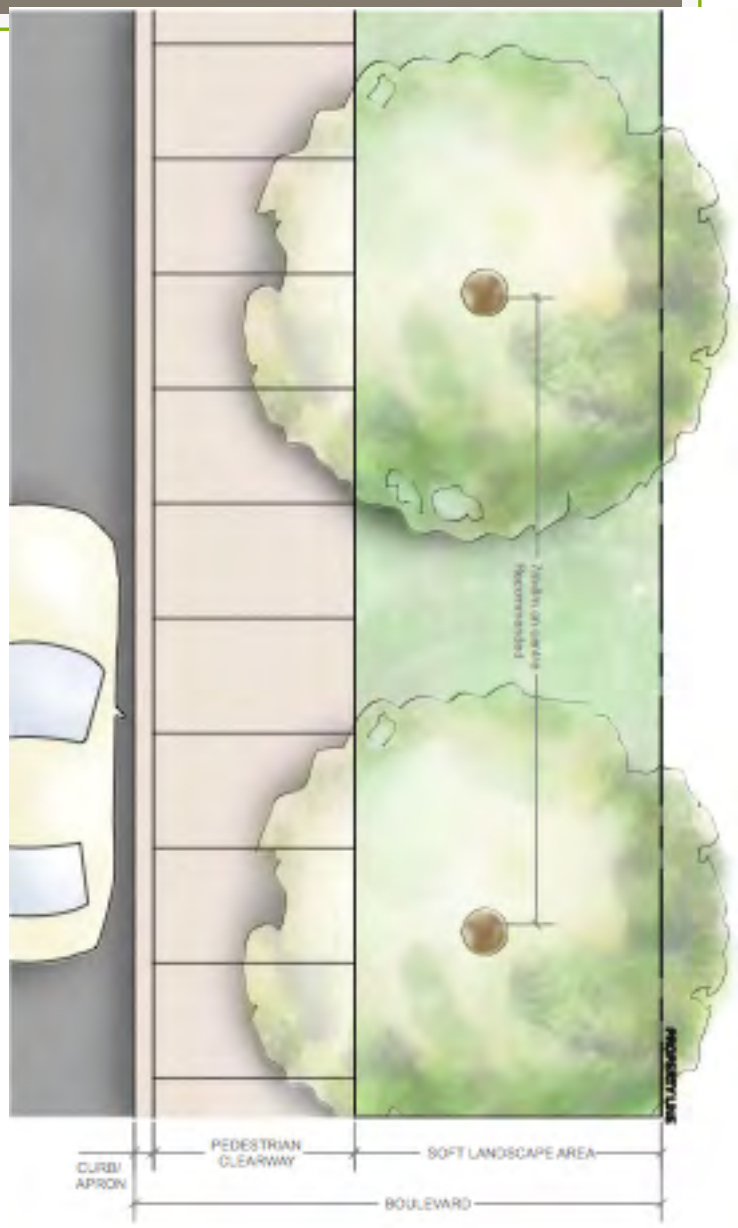
Research Questions and Objectives

- Assuming that soil and street characteristics stay consistent over time, how does site quality affect the condition of the tree growing on it?
  - Are trees growing on high-quality sites generally in better condition than trees growing on poor sites?
  - Are there differences in response to the site quality variations between common street tree species?
- Are the minimum USI scores provided by Ohio Division of Forestry consistent with minimum scores observed in Toronto?
- Could Urban Site Index be applied to City of Toronto Street Tree Planting Protocol to help improve species diversity and size class distribution?

Materials and Methods

- Used NeighbourWoods inventory data from 2009 to select sample
- Species with at least five in poor and five in good condition trees
- Random selection
- Ash and Elm species combined by Genus





Urban streetscape manual, 2010

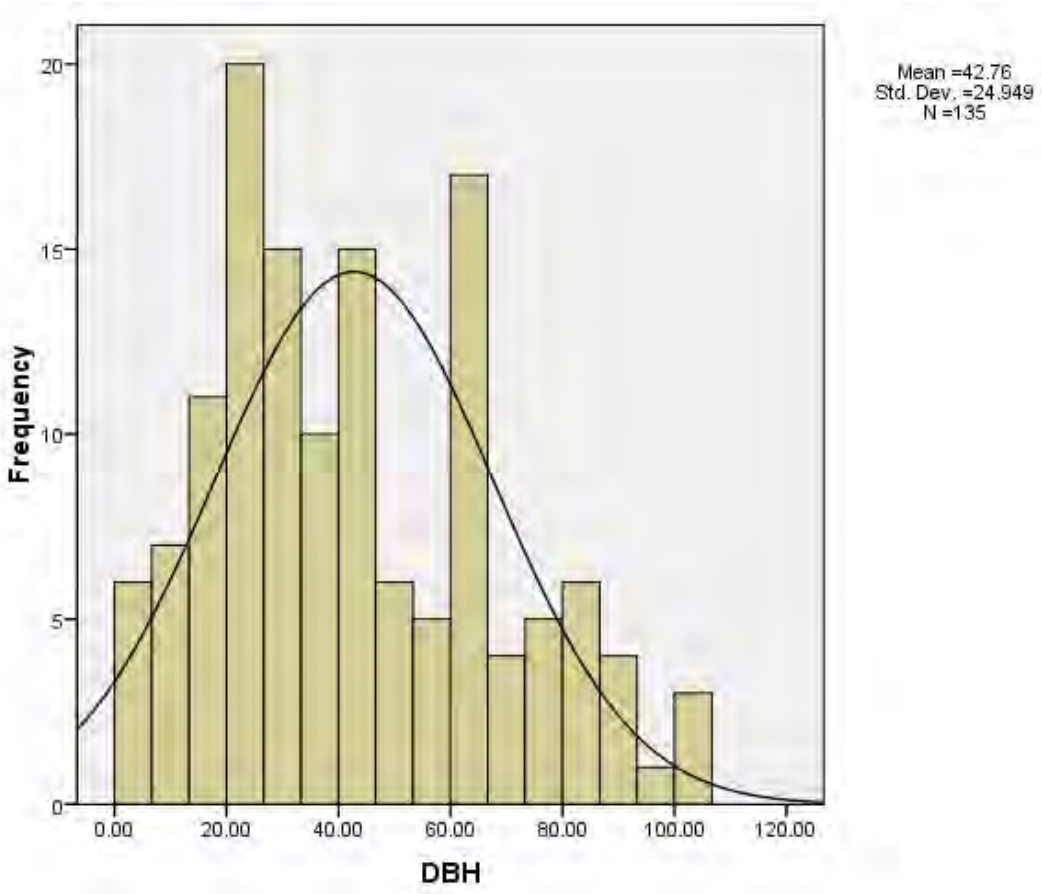
Methods cntd.

- Scoring the sites
- Good vs. Poor condition
- Establishing minimum USI scores
  - Trees must be established in environment
  - Must be in good condition
  - Tree should not have been on site prior to site development
  - Ohio Division of Forestry provided minimum scores for sugar maple, littleleaf linden, honeylocust and red maple
- Data management and Analysis
  - Used Excel and SPSS Statistical Software
    - Independent t-test
    - ANOVA
    - Ordinal Regression
    - Model Estimation analysis

Results

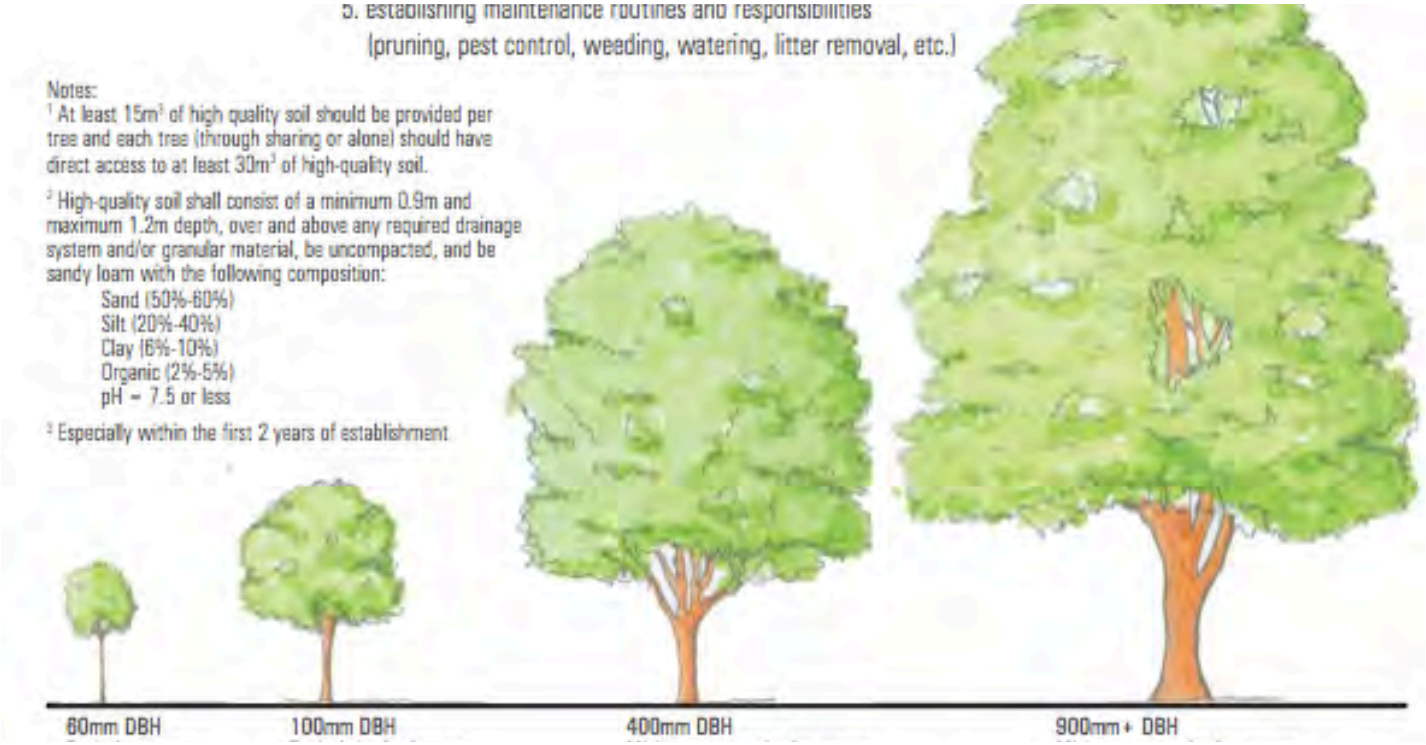
- 53.3% of trees were in good and 46.7% were in poor condition
- Norway maple represents the largest percent of all trees sampled (21.2%), followed by silver maple, common horsechestnut, elm and honeylocust, sugar maple and ash

DBH distribution

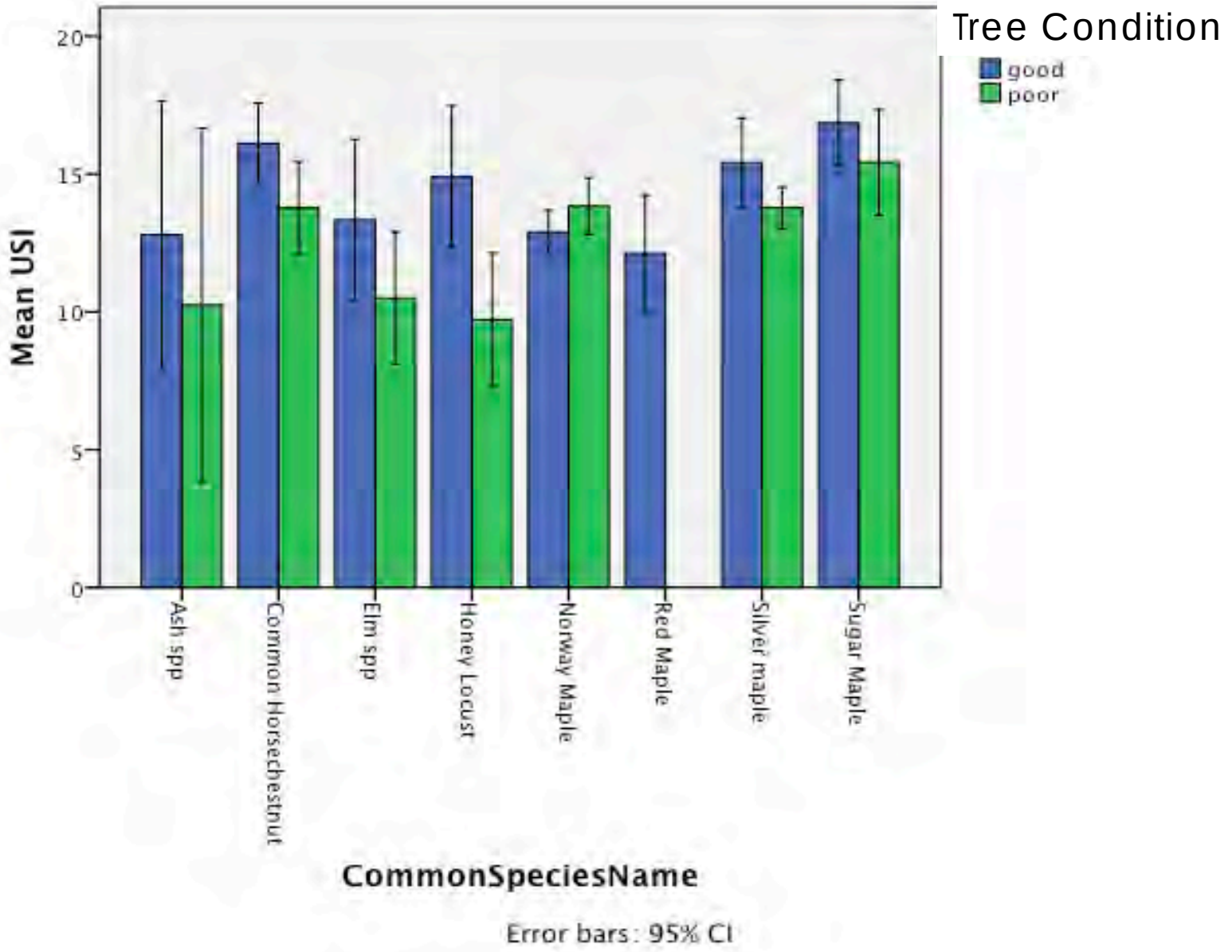


Skewed normal distribution

Target Diameter at Breast Height for trees planted in various street environments.



(Urban Streetscape Manual 2010).


Tree Condition
good
poor
Mean USI
20
15
10
5
0
Ash spp
Common Horsechestnut
Elm spp
Honey Locust
Norway Maple
Red Maple
Silver maple
Sugar Maple
CommonSpeciesName
Error bars: 95% CI

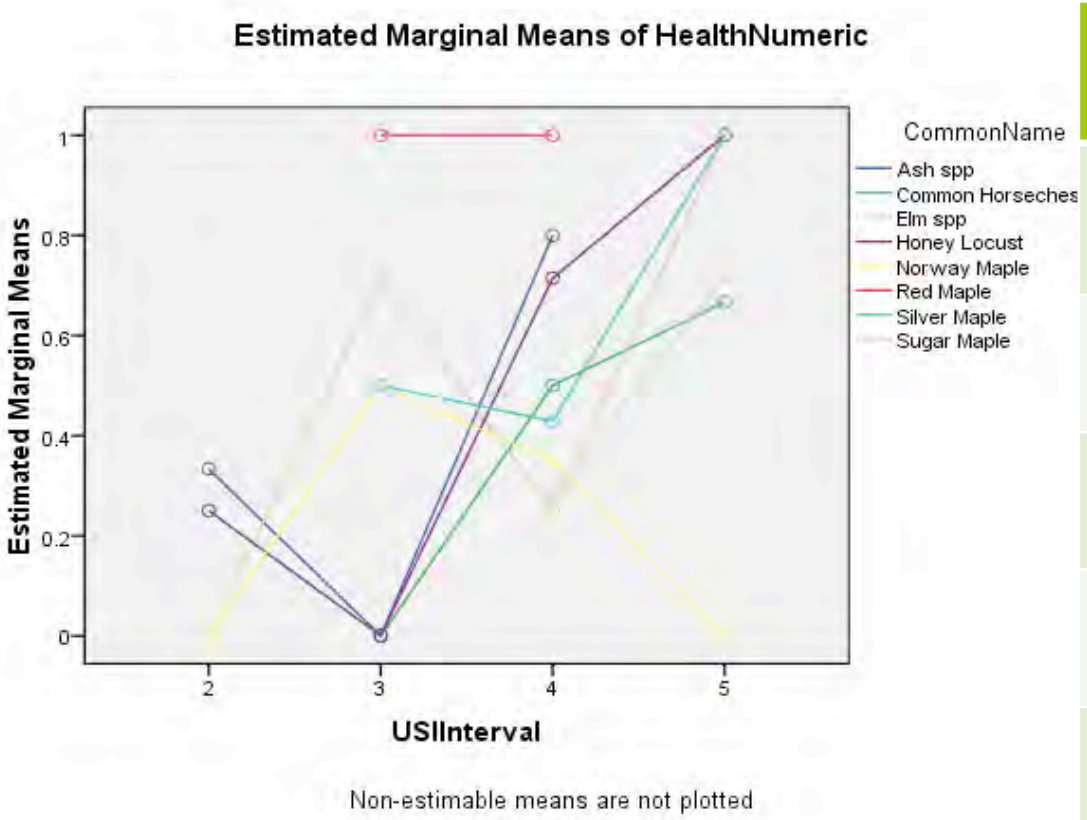
Differences within species

Species	Levene's test for equality of variances (>0.10)	T-test for equality of means		
	Significant Value	**Degrees of Freedom**	**Significant value (2-tailed)**	**Mean Difference**
Ash spp.	0.925	7	0.369	2.550
Common horsechestnut	0.730	16	**0.027**	2.333
Elm spp.	**0.066** (Equal variance not assumed)	14.665	0.103	**2.833**
Honey locust	0.633	15	**0.006**	**5.185**
Norway maple	**0.095**(Equal variance not assumed)	25.993	0.131	-0.933
Silver maple	**0.002**(Equal variances not assumed)	14.933	**0.059**	1.639
Sugar maple	0.373	12	0.181	1.429

Tree Rankings

Species	Minimum USI Score Needed	
	State of Ohio	Harbord Village, Toronto
Sugar Maple	16	15
Little Leaf Linden	11	13
Honeylocust	9	8-9
Red Maple	12	9
Common Horsechestnut	Not available	13
Ash spp.	Not available	6-7
Elm spp.	Not available	9
Norway Maple	Not available	11
Silver Maple	Not available	11

Estimated Tree Condition



Interval	Score	Site Quality
1	0-4	Very Poor – no tree
2	5-8	Poor
3	9-12	Intermediate
4	13-16	Good
5	17-20	Very Good

How strong is the relationship?

- Determine whether there is enough relationship between USI scores and it's constituents to construct a model that could predict what tree condition based on the USI score.
- Logistic regression had the best fit (sig=0.001)
- There is significant relationship between USI scores and the condition of the tree

Benefits

- Time efficient
- Inexpensive
- Easy to learn and use
- Systematic
- USI considers street features such as number of lanes, speed limit, presence of parking, and distance between stop signs
- Lets urban forest managers quantify site characteristics
- Fits tree into environment it can thrive in

Limitations

- Present and Future USI- we don't know how much the soil and environment will change
- We still do not have enough evidence that it is accurate in predicting future tree condition
- Minimum USI scores are missing for many tree species
- Does not account for poor planting practices
- Regional differences in soils and microclimates
- Could not be applied to tree boxes and parks

Conclusions

- Significant differences in tree condition based on the quality of planting site
- Significant differences in response to site quality between and within some species
- Minimum site quality USI scores established in Ohio are showing to be similar for Toronto
- Due to easy of use, low cost and strong relationship between site quality and tree condition it could be adapted into Toronto's planting protocol

Suggested USI Enhancements

- Incorporate other factors that influence urban tree growth and condition
  - Soil pH
  - Site drainage
- Include tree spread and growth rate in addition to stress tolerance during species selection phase of planting design planning to increase proximity of trees with similar growth rate and minimize future maintenance fees
- Look into research on urban soil dynamics to see if there are significant improvements in soil quality over time that could be accounted for when using the USI method

Further Recommendations

- Test inter-rater reliability to see variation in USI scores
- This was a small-scale preliminary study and more research is needed to prove USI reliability
- Trees that are showing to be more vulnerable to decreased environmental conditions do not necessarily have to be planted less but planted in a more controlled environment

Recommendations to the City of Toronto

- Current species selection protocol is vague and needs modifications to make it more consistent and user-friendly
- Consider adopting the USI method in the site assessment and species selection phase of tree planting to improve diversity and size class distribution of street trees
- Focus on increasing public involvement in urban forestry issues through
  - Conducting workshops to interested residents on Neighbourwoods Inventories, Urban Site Index scoring, Tree Maintenance and Stewardship
  - Collaborating on construction of diverse planting designs

Acknowledgements

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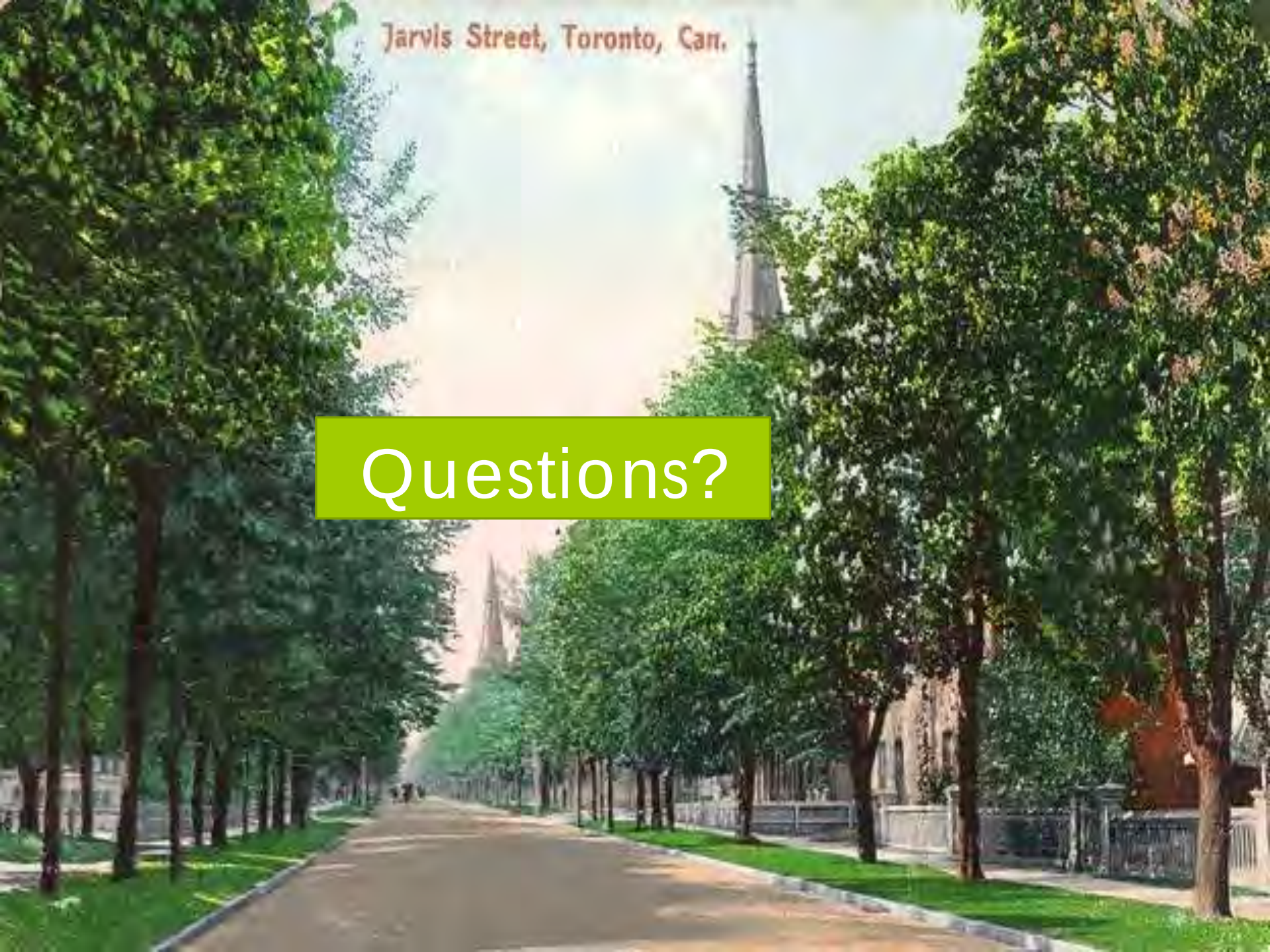
My family

Thank You!



Questions?