Urban Tree Crown Evaluation Efforts

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Computerized Crown Analysis from Digital Images

LCrown variables are collected for direct analysis and as model parameters to predict tree vigor, light / rainfall interception, and air pollution removal.

LWith the proper procedures digital images can be used to provide inexpensive, consistent foliage change estimates over time.

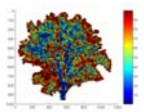
LIn addition to mitigating observer variability, digital images can be used for more detailed analysis

Analyses

Area Ratio

The ratio of the area of sky to area of crown structure, within the defined boundary closely relates to **transparency**, the representation of the amount of skylight visible through the live, normally foliated portion of the crown (USDA Forest Service. 2004).

The area of crown structures can also be used as **Silhouette Area** represented on the 2-D visual plane has been successfully used to model leaf area (Lindsey & Bassuk 1992, Peper & McPherson 2003) and crown density (Wagar & Heisler 1986).



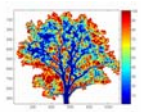
Transparency Distribution Maps

Point-wise

Generated from the mean transparency within smaller, square areas (windows). This gives a representation of the crown structural concentrations within the crown-space. Use of mulitple window-sizes can be used to estimate lacunarity.

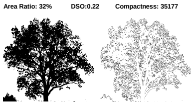
Region-wise

Generated by creating variable-sized, triangular tessellations. The vertices of these triangles are determined using the center points of areas defined using a watershed transformation. This can be used to represent the crown area more efficiently.



Area Ratio: 32% DSO:0.22 Compactness: 35177

Morphologic approaches evaluate the crown complexity using shape-analysis techniques. Morphologic approaches eliminate the previously mentioned problems of defining boundary conformity and gap size parameters.



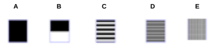
Area Ratio: 28% DSO:0.30 Compactness: 20505

DSO, the difference between the fractal dimension of a crown silhouette to the fractal dimension of the **crown outline** (Mizoue 2001). DSO decreases curvilinearly as transparency increases and is more sensitive at lower levels of transparency.

Compactness, defined as, **perimeter2 / area** is another shape descriptor that correlates with transparency. This measure increases in sensitivity at higher transparencies.

This example demonstrates the characteristics of area and morphological methods. Blue line represents outline for area methods.

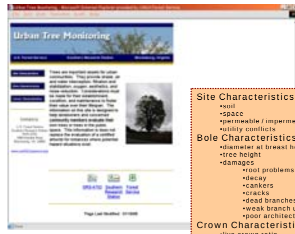
- Due to boundary conformity, area-based methods will report some amount of sky visible, even if entire silhouette is filled.
- Area estimates are consistent within the defined space (which is good for repeated measures), however lacks descriptiveness as there is no information of how the crown structures are clumped.
- DSO is better for dense crowns, compactness for sparse crowns.



	A	B	C	D	E
Area Ratio:	95%	48%	48%	48%	48%
DSO:	1.00	1.00	0.65	0.47	0.00
Compactness:	16	13	85	221	11250

Crown Training Website

Much of the information about urban tree data collection is very case-specific and collection and analysis methods are only reported in scientific literature. As citizens become more involved with urban forestry or their individual trees they will desire information on how to assess and evaluate urban trees. The internet is an effective way to distribute information and interactive training.



Site Characteristics
- soil
- space
- permeable / impermeable surfaces
- utility conflicts

Bole Characteristics
- diameter at breast height
- tree height
- damages
  - root problems
  - decay
  - cankers
  - cracks
  - dead branches
  - weak branch unions
  - poor architecture

Crown Characteristics
- live crown ratio
- diameter
- density
- transparency
- leaf blights, spots, necrosis, etc.

LProvide easily accessible information on urban tree monitoring

LUseful resource for training community volunteers

LWill provide comprehensive treatment of methods used by many national and local urban forest health monitoring groups

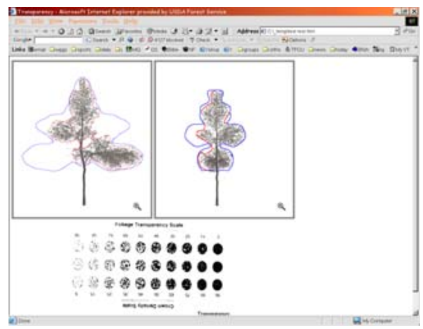
Skill Testing Component

LAllow users to take timed, online test for transparency and density analysis

L3D graphic tree models created to provide ability to generate defined crown attributes

LTwo perpendicular angles will be defined, reducing variability caused by uncontrolled vantage points

LThis component will also be used with specific datasets to examine perspective effects on density measurement

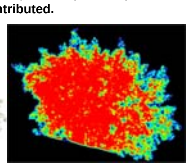


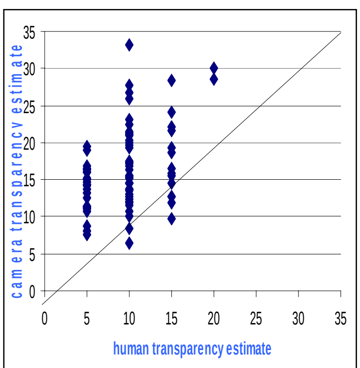
Street Tree Results

LObservations made in conjunction with urban monitoring studies in Maryland and Tennessee. Data shown here from 53 trees in Maryland in 2004.
(- 19 Maple *Acer spp.*, 18 Callery Pear *Pyrus calleryana*, 8 Sycamore *Platanus occidentalis*, 5 Oak *Quercus palustris*, 3 other)

LCamera methods (using area ratio with moderately tight boundary for all species) overestimated human estimates.

LOutline factors as well as age- and species-specific differences may have contributed.





Comparison of human vs. camera-derived (area ratio) transparency estimates

LThe largest overestimates occurred on vigorously growing young trees where spiky, rapid growth exacerbated outline area effects.

LWhile there is correlation between methods there is a large amount of variation within each observer class. This has been borne out in many studies of observer variation (Mizoue and Dobbertin 2003, Solberg and Strand 1999).

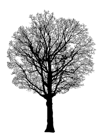
LImproved methods are being developed to correct for morphological effects of age and outline.

LThere were no camera estimates in the 5% class among a large number of *Pyrus calleryana* and *Acer spp.* which exhibit a very dense, uniform crown. Thus, boundaries must be adjusted based on species or crown continuity

Simple scaling devices can be created to calculate distance from observer to the central tree axis

- **distances and tree heights to 100'**
- **± 1 feet up to about 50 ft / ± 3 feet at 100 ft**

Custom Crown Analysis Via Web Interface



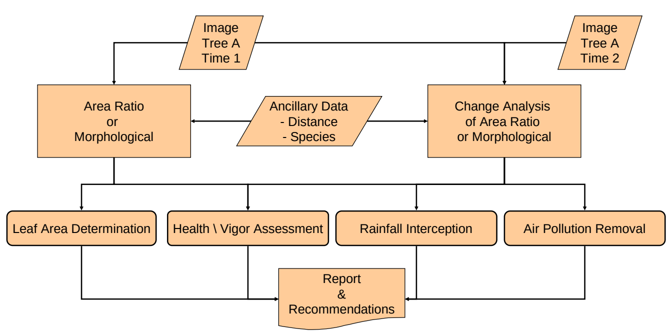
LAllow individuals to upload images of their own trees for customized analysis

LPerforms transparency and density estimates

LGiven sufficient input data (species, distance, etc.) can produce leaf surface area estimate which can be used to calculate rainfall interception, air pollution removal, etc.

LMulti-date health evaluation

LAlso, provide links to information for diagnosis of health problems



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