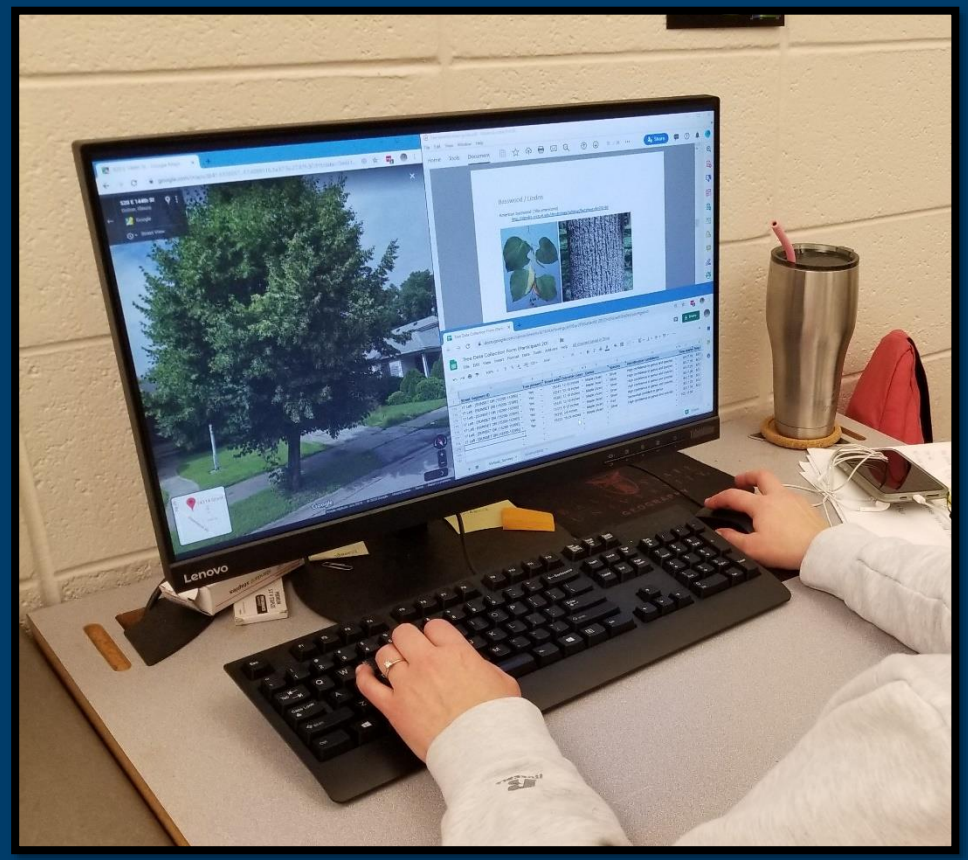
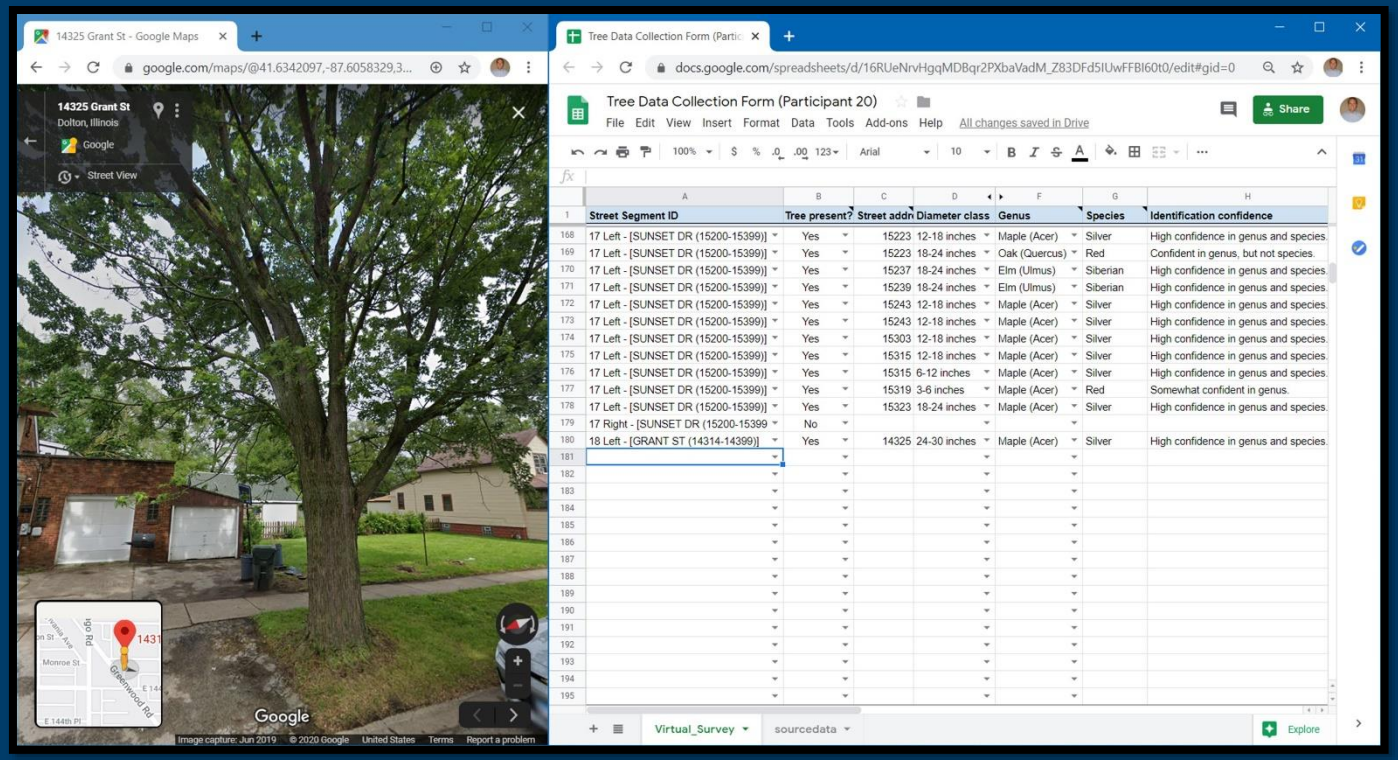
A simple technique for online street tree inventories

Is it right for my community?





Adam Berland Ball State University 21 April 2020

Collaborators

Lara Roman – USDA Forest Service
Jess Vogt – DePaul University
Lydia Scott – The Morton Arboretum

Students

Ball State University
Garrett Fuelling
Jackie Kerbler
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DePaul University
Kaitlyn Pike
Alli Preble

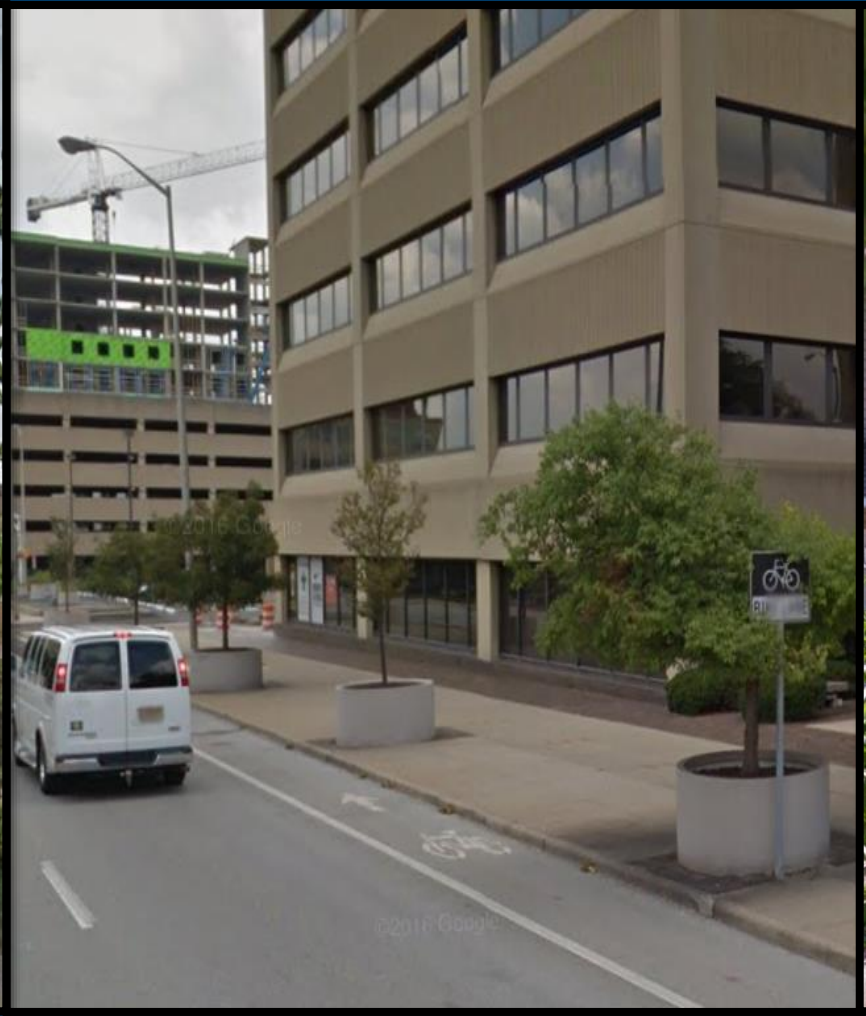
16 volunteer analysts

Funding

Street Trees

trees growing in the public right-of-way along streets


Photos: Google



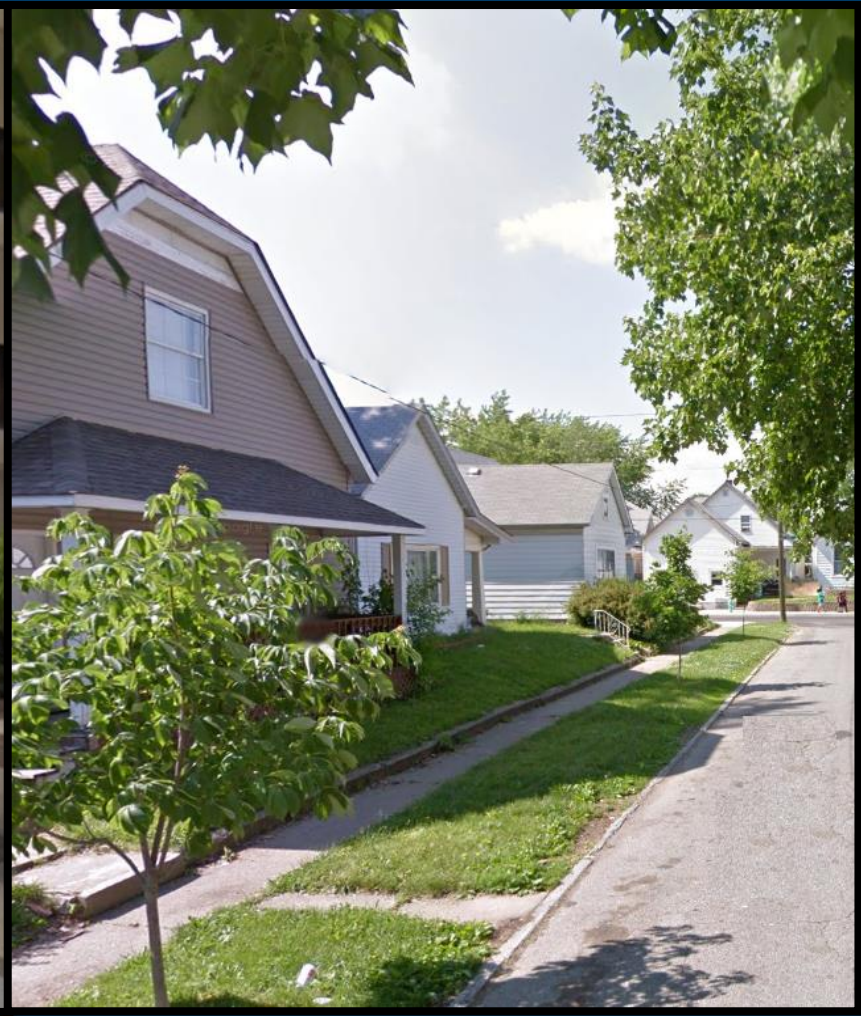


Photo: Google

In the cities surveyed:

0.27 street trees per capita
0.11 park trees per capita

Hauer & Peterson (2016). *Municipal Tree Care and Management in the United States*.

Whose responsibility?

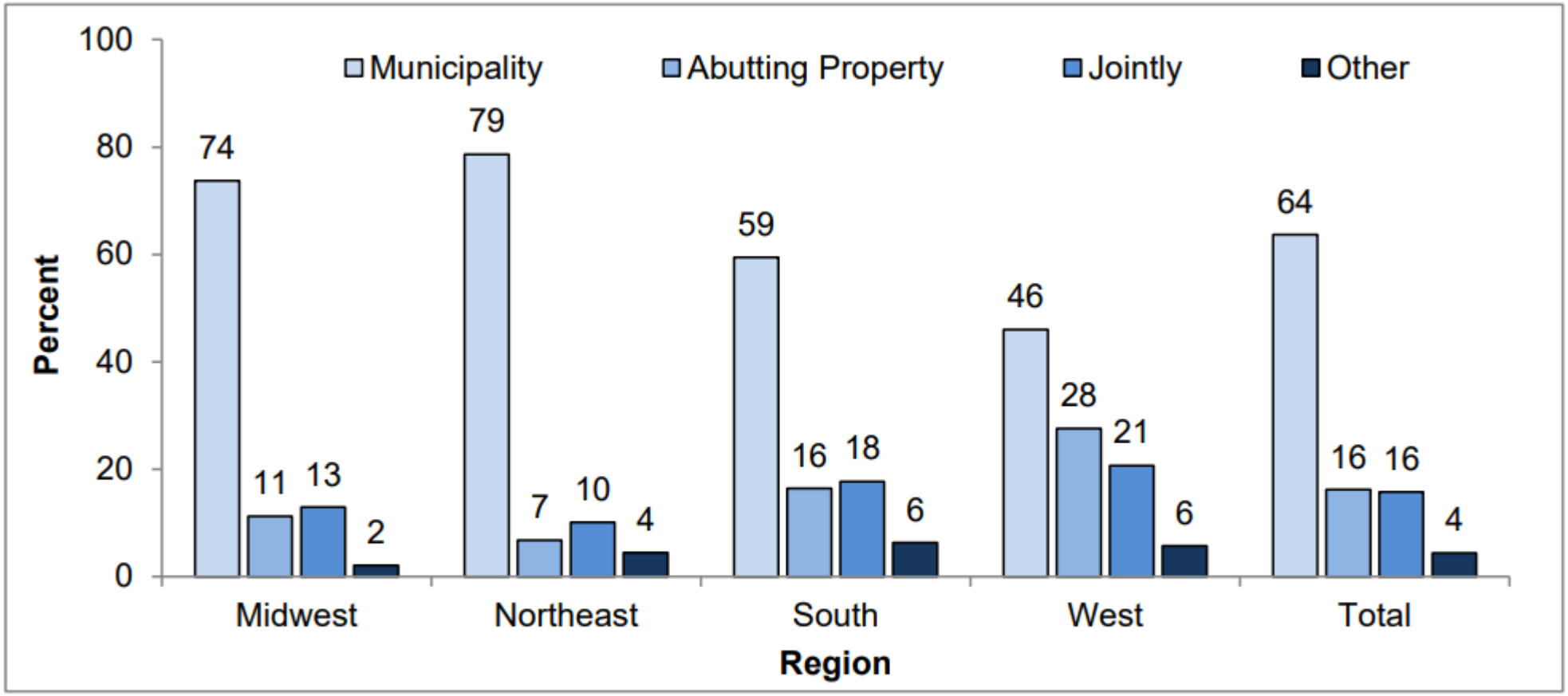
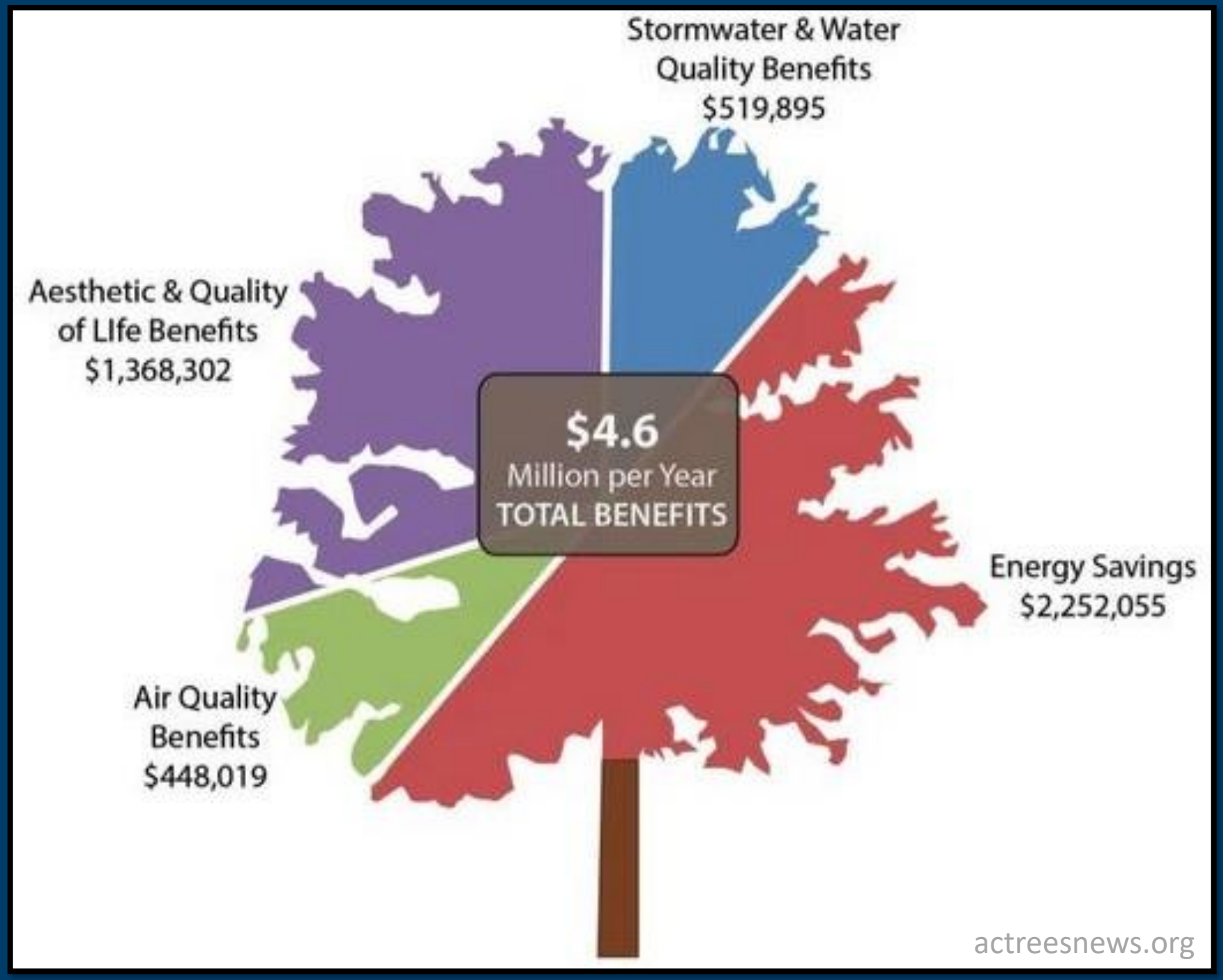


Figure 1-1. Who in your community is primarily (legally) responsible for maintaining trees in municipal rights-of-way, for example street trees between sidewalk and curb or alley trees? (n=661)

Hauer & Peterson (2016). *Municipal Tree Care and Management in the United States*. Special Publication 16-1, College of Natural Resources, University of Wisconsin – Stevens Point.



Ann Arbor, MI

41,000 street trees
7,000 park trees

$96 / tree / year

Why do we inventory?

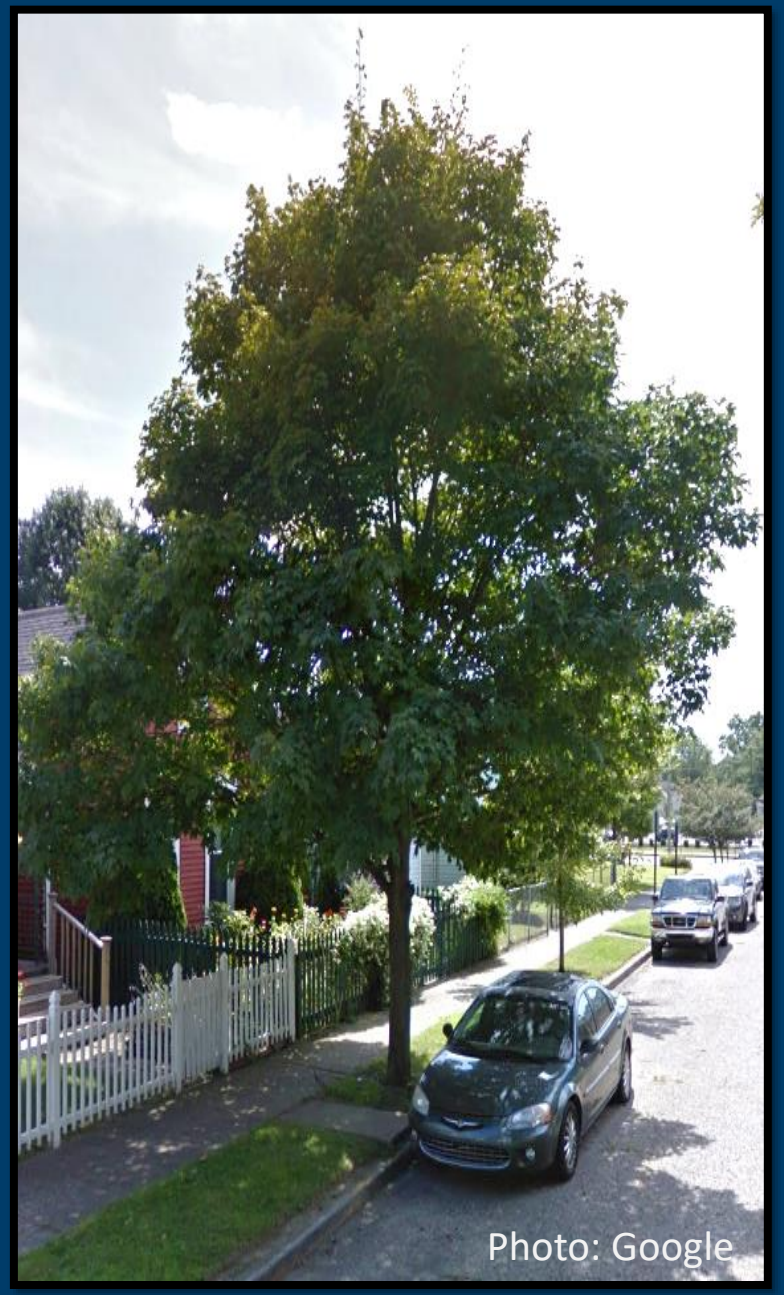
Street trees are widespread

Effective management requires tree data

Inventory data open the door for next steps

But…

inventories are expensive & labor intensive



Consider your community's needs

If you currently have an inventory, what pieces of info does it contain for each tree?

Do you actually use all of that information for management?

What info are you missing that would be nice to have?

What is the list of tree attributes you absolutely must have to manage public trees effectively?

Muncie, IN public tree inventory shortcomings

What we have	**Shortcomings**
Inventory date:	2008-2009
13,500 trees:	Probably about 10,000 now
Location:	No info for available planting spaces
Genus / Species:	Some errors; don't really need every species
Diameter	
Condition rating:	Specific issues should be noted + timestamped photos

Options for data collection

- Field data collected by experts
- Field data collected by citizen scientists
- Virtual survey data collected using Google Street View

Field data collected by experts

Detailed & reliable

But not perfectly accurate

Qualified assessment of condition, hazards, pest/pathogens

Expensive and/or time-consuming

Photo: USDA Forest Service

Citizen science data collection

Crowdsourced data from non-professionals

Facilitated by mobile technology

Public engagement and buy-in

Volunteers in Portland, OR
225,000+ trees inventoried

Can volunteers generate usable data?

Citizen science data quality

Compared volunteer data to expert data

Volunteer agreement with experts:

- Good: tree presence, mortality status, DBH within 1”
- OK: DBH within 0.1”, dieback rating
- Poor: crown transparency, wood condition

Genus & species ID varied by species

Volunteers do best with simple tasks

Roman et al. (2017). *Urban Forestry & Urban Greening 22: 124*

Bancks et al. (2018). *Arboriculture & Urban Forestry* 44: 73-86


W Charles St
Google
Photo: Google

Computer vision – the next big thing?

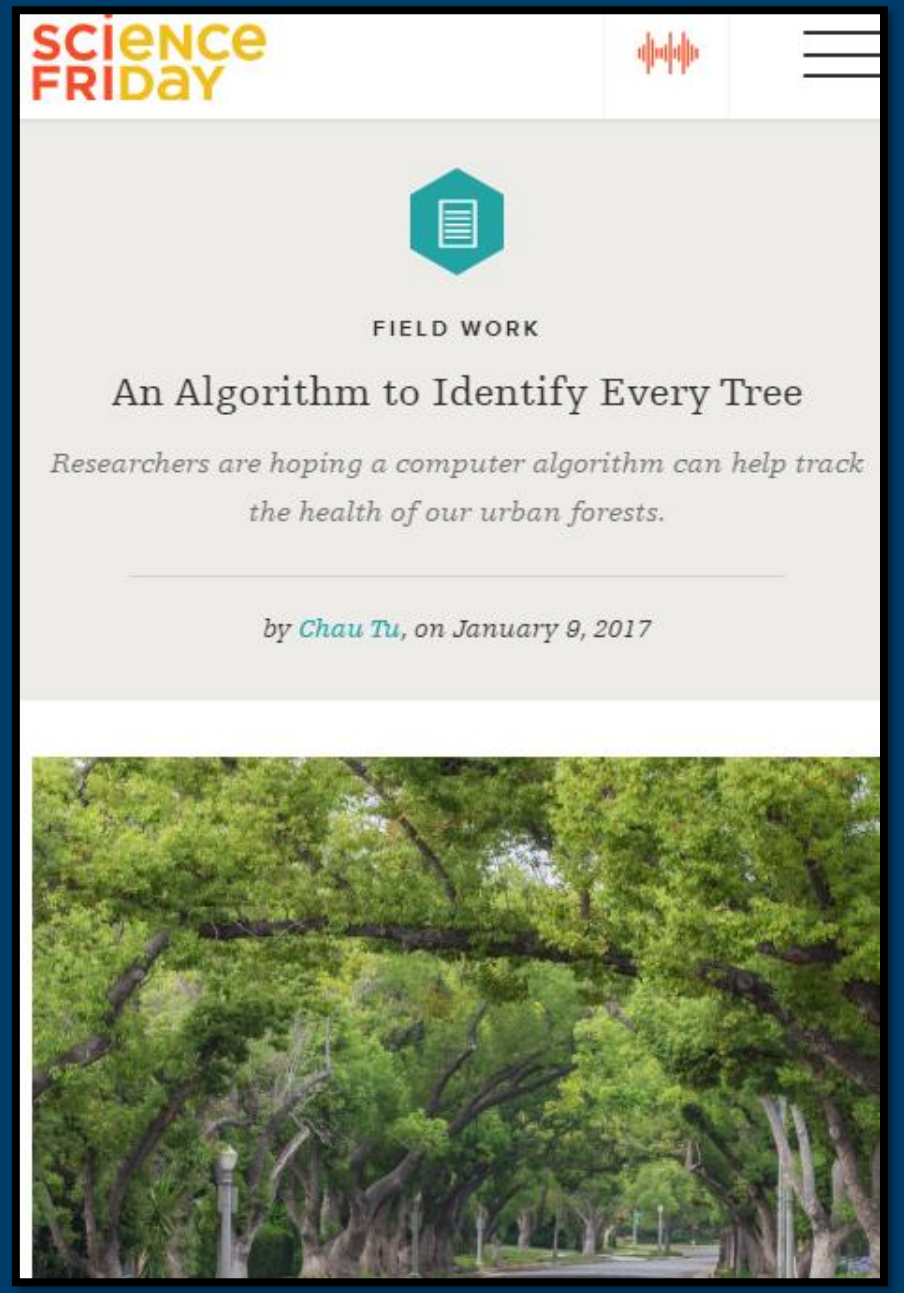
Trains a computer to find trees in GSV images

Colors, textures, shapes

Successfully mapped about 70% of street trees
Species ID >80% accurate for common species
Could measure diameter in the future

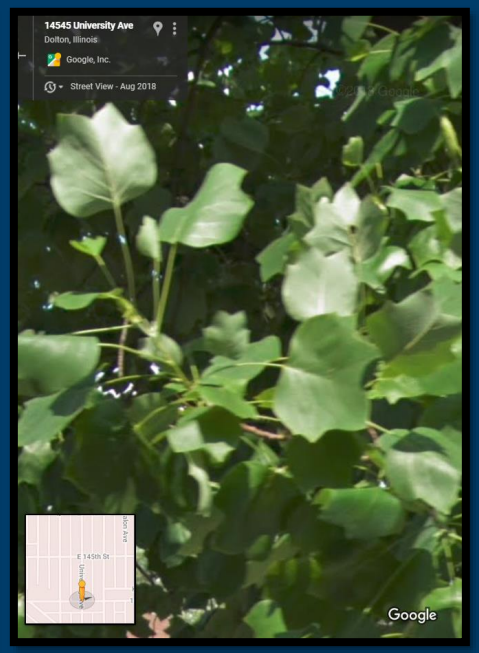
Branson et al. (2018). *ISPRS Journal of Photogrammetry and Remote Sensing 135: 13*

Requires serious computing expertise (at least for now)
Let's consider something far simpler



Virtual surveys in Google Street View

Photos: Google



Virtual survey data collection

Compare Google Street View data to field data from the same locations

16 analysts across 3 expertise groups

Address Diameter class (DBH)
Genus Species

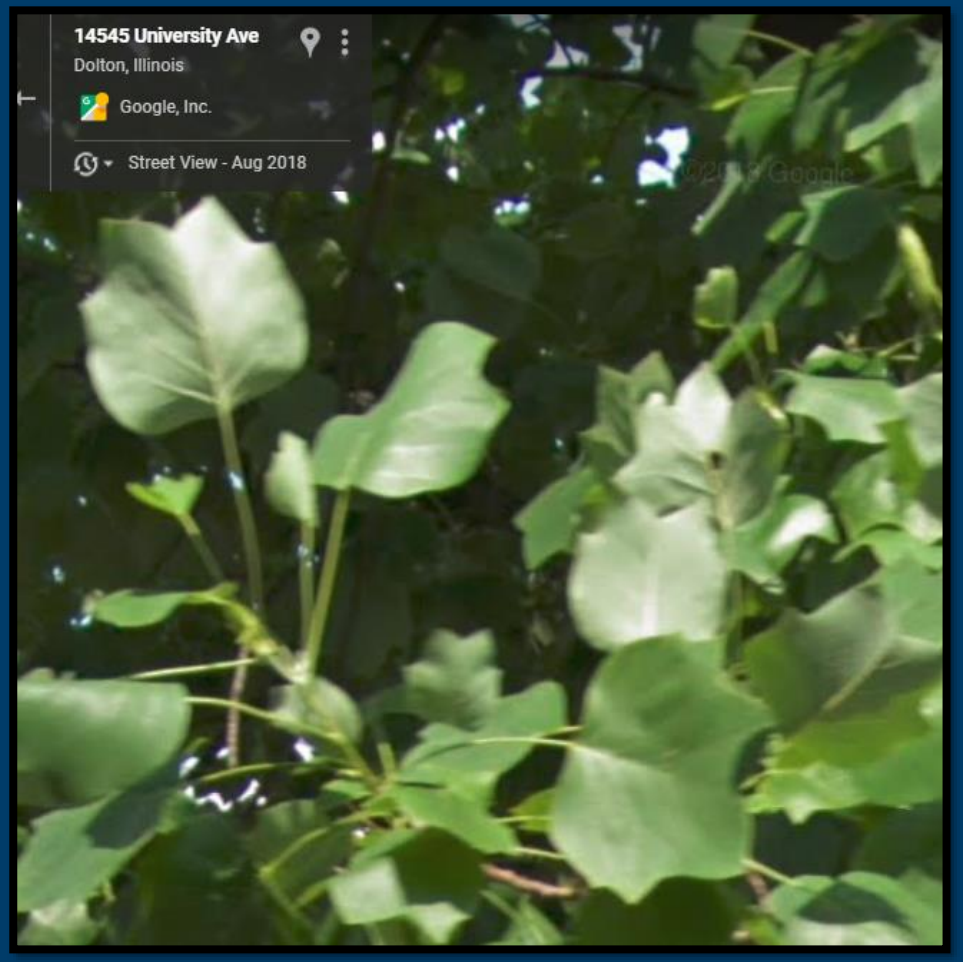
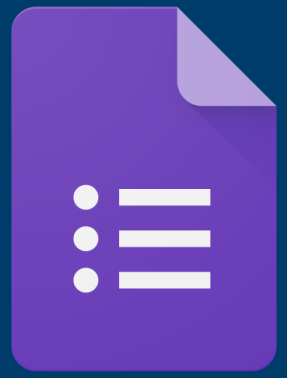


Photo: Google

Virtual survey recruitment



Google Forms

Survey to gauge self-rated expertise

experience with urban forestry, tree ID, field techniques, Google Street view, occupation, etc.

We recommend some familiarity with the citizen scientists (you know something about their expertise)

Self-rated expertise is a decent indicator of data quality

Analyst training

Documents available at **https://bit.ly/2V9LhVG**

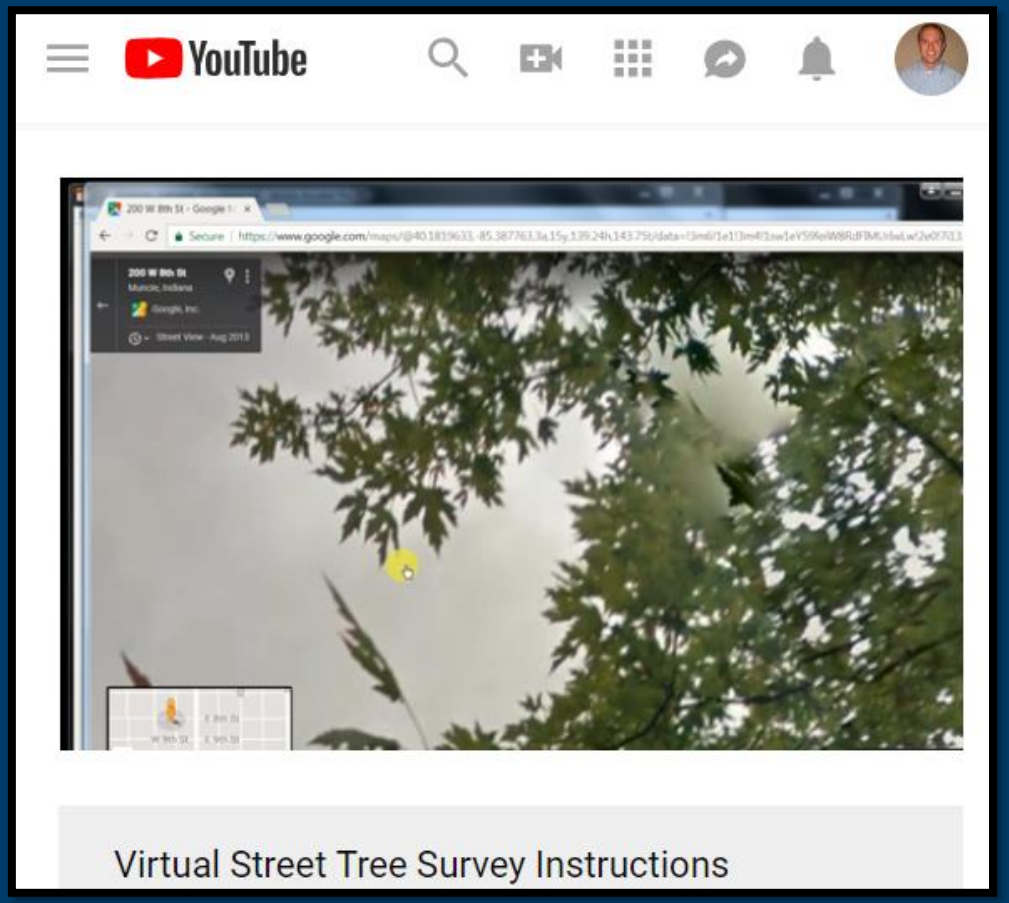
User guide

Overview of terms
(What is a street tree?
How to estimate DBH?)

Reference guides
(DBH, species ID)

Instructions for data collection

Instructional videos



Tree Identification Guide

This guide is designed to assist people conducting virtual street tree surveys using Google Street View. The list below contains most of the tree species we expect to encounter among street trees in the Chicago region, but it is not a complete list. For each type of tree, you will see a picture of the leaves, the bark, and a link to more detailed information on the internet.

Ginkgo (Ginkgo biloba)

http://dendro.cnre.vt.edu/dendrology/syllabus/factsheet.cfm?ID=122

Hackberry

Common hackberry (*Celtis occidentalis*)

http://dendro.cnre.vt.edu/dendrology/syllabus/factsheet.cfm?ID=26

DBH estimation reference sheet (all measurements in inches)

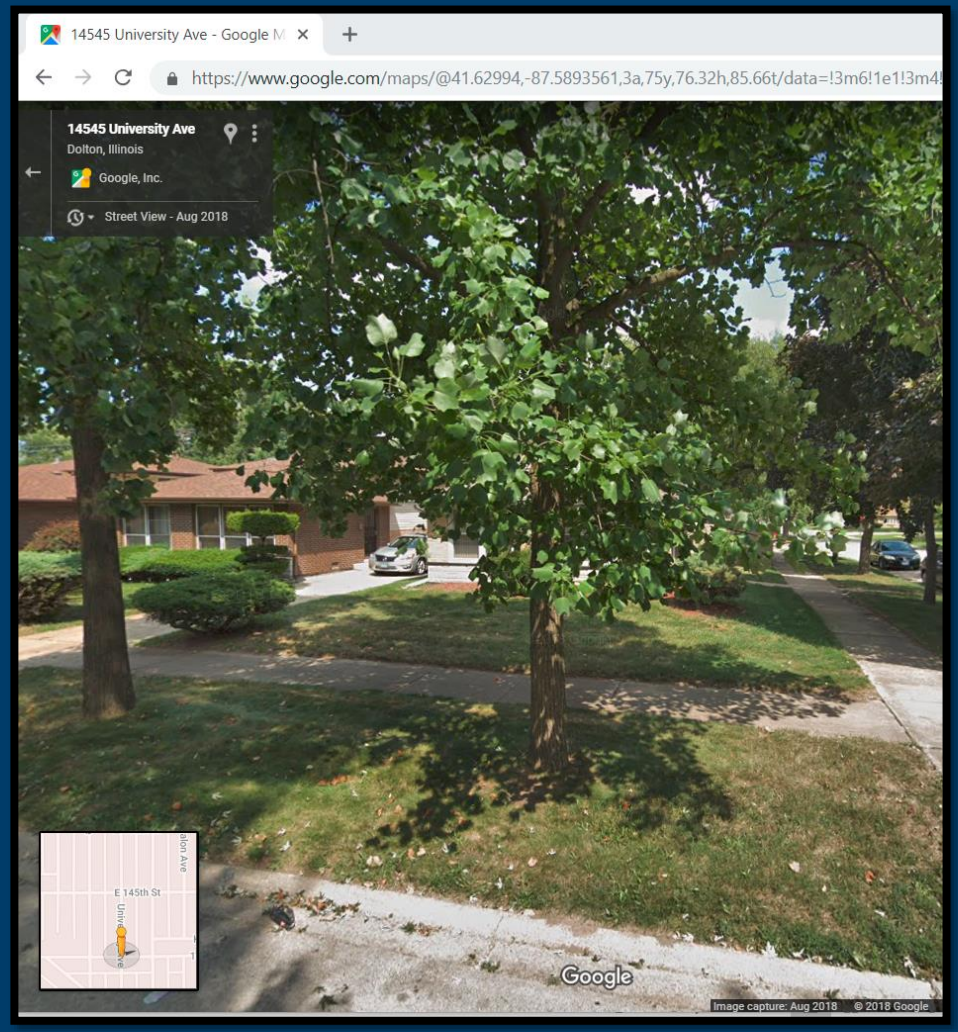
0-3	3-6	6-12	12-18	18-24	24-30	Over 30
						
Red maple 2.2″ Link	Eastern redbud 5.1″ Link	Green ash 8.1″ Link	Swamp white oak 15.2″ Link	Silver maple 21.5″ Link	Sugar maple 24.4″ Link	Northern hackberry 30.1″ Link
						
Callery pear 2.6″ Link	River birch 3.1″ Link	London planetree 11.3″ Link	Sweetgum 14.6″ Link	Callery pear 19.2″ Link	American elm 26.1″ Link	Northern red oak 39.1″ Link

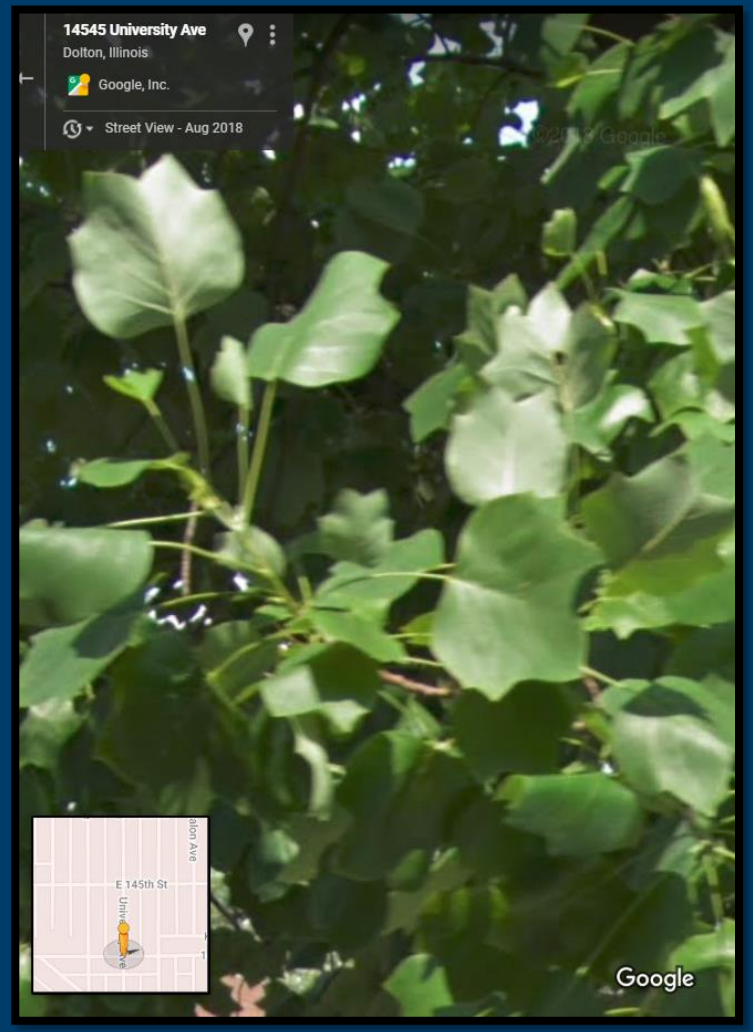
Data collection – Street segment list

Hyperlinks drop analyst at the correct intersection in Street View

Segment 1	**E 146TH ST**	1326 - 1399	[331 feet]
	From: KENWOOD AVE	To: DORCHESTER AVE	
Segment 2	**LANGLEY AVE**	14200 - 14229	[326 feet]
	From: E 142ND ST	To: MCARTHUR CT	
Segment 3	**LINCOLN AVE**	14551 - 14629	[449 feet]
	From: INGLESIDE AVE	To: ELLIS AVE	
Segment 4	**GRANT ST**	14900 - 14999	[660 feet]
	From: E 149TH ST	To: E SIBLEY BLVD	
Segment 5	**DEARBORN ST**	14700 - 14799	[661 feet]
	From: W 147TH ST	To: W 148TH ST	
Segment 6	**OAK ST**	14900 - 14999	[659 feet]
	From: E 149TH ST	To: E SIBLEY BLVD	

Data collection – Google Street View





Data collection – Google Sheets

1	Street Segment ID	Tree present?	Street address #	Diameter class	Mortality status	Genus	Species	I
350	38 Left - [COTTAGE GRO	Yes	15145	18-24 inches	Alive	Maple (Acer)	silver	H
351	38 Left - [COTTAGE GRO	Yes	15145	18-24 inches	Alive	Maple (Acer)	silver	H
352	38 Right - [COTTAGE GR	No						
353	39 Left - [LINCOLN AVE (	Yes	15223	18-24 inches	Alive	Ash (Fraxinus)	green	N
354	39 Left - [LINCOLN AVE (	Yes	15243	24-30 inches	Alive	Elm (Ulmus)	American	N
355	39 Right - [LINCOLN AVE	No						
356	40 Left - [E 149TH ST (10	Yes	1000	12-18 inches	Alive	Oak (Quercus)	red	C
357	40 Right - [E 149TH ST (1	No						
358	41							
359								
360								
361								

41 Left - [E 145TH ST (1000-1023)]

41 Right - [E 145TH ST (1000-1023)]

1	Genus	Species	Identification confidence	Other notes	Time started	Time finished
350	Maple (Acer)	silver	High confidence in genus and species.		5/9 12:20	5/9 12:20
351	Maple (Acer)	silver	High confidence in genus and species.		5/9 12:21	5/9 12:21
352					5/9 12:22	5/9 12:22
353	Ash (Fraxinus)	green	Not confident in genus (poor view of tre		5/9 12:22	5/9 12:23
354	Elm (Ulmus)	American	Not confident in genus (poor view of tre		5/9 12:23	5/9 12:24
355					5/9 12:24	5/9 12:25
356	Oak (Quercus)	red	Confident in genus, but not species.		5/9 12:26	5/9 12:27
357					5/9 12:27	5/9 12:27
358					10/5 13:35	

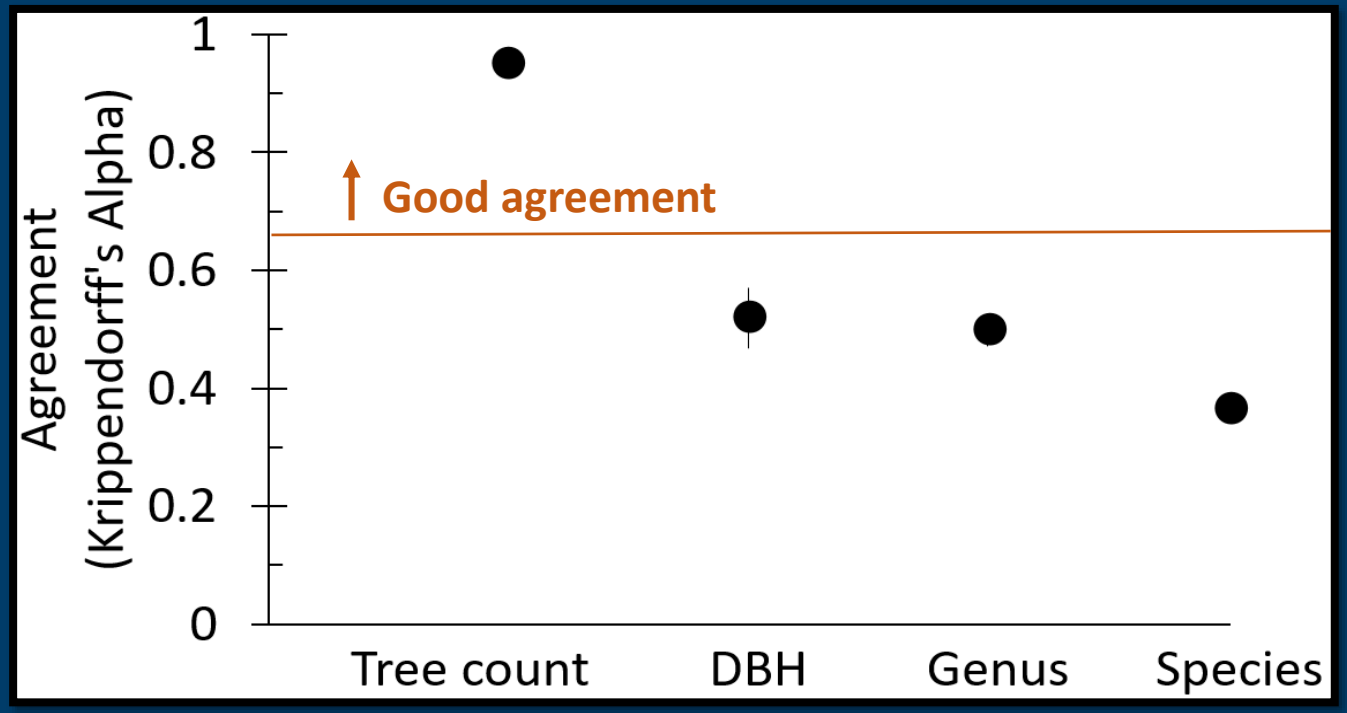
Virtual survey data quality

High agreement on number of trees on each street

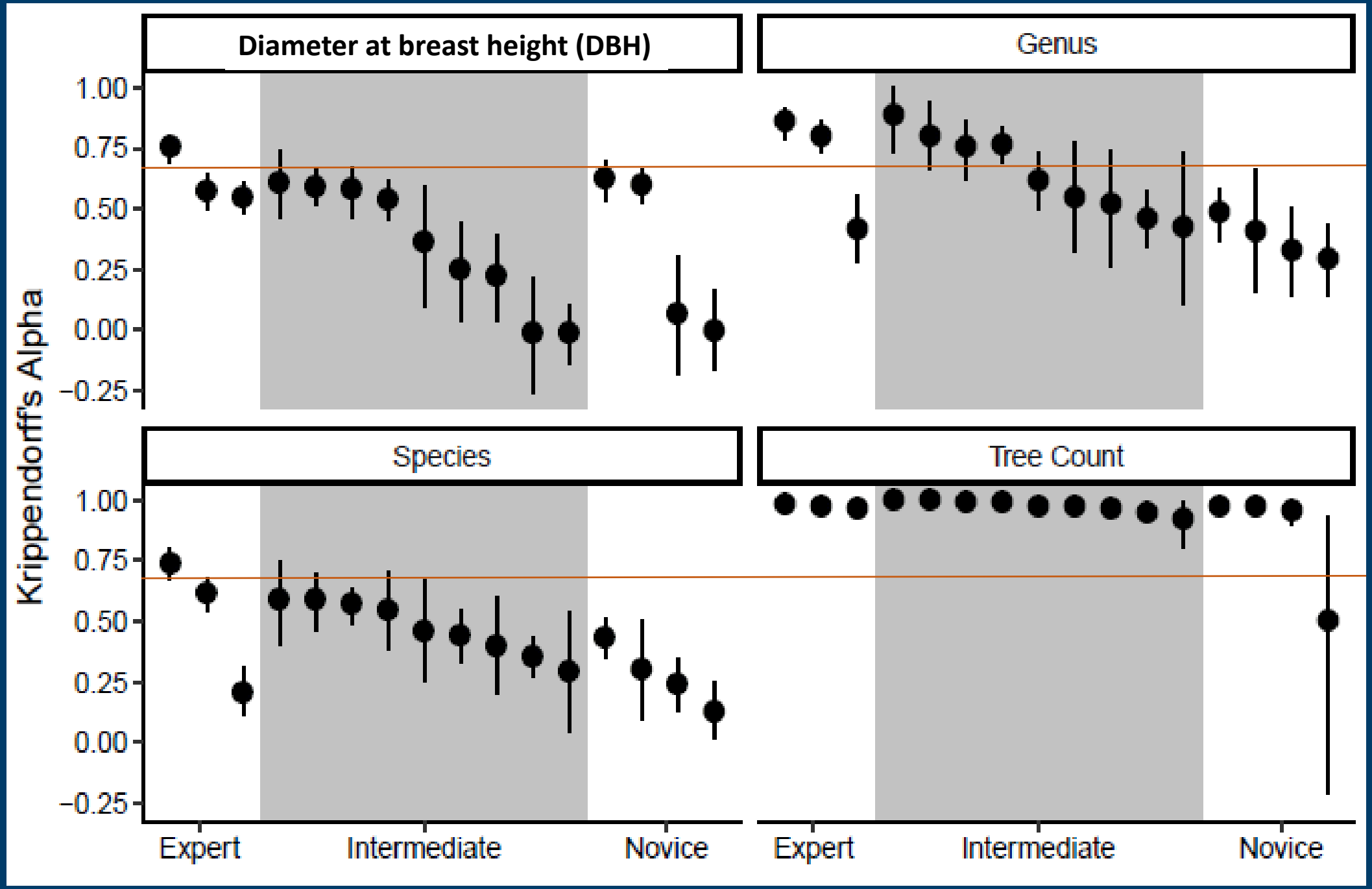
Poorer performance for DBH & genus/species ID

Experts performed best

Novices struggled with identification



Berland et al. (2019). *Forests 10: 349*



Berland et al. (2019). *Forests 10: 349*

Analyst group	Minutes per tree
Expert	1.45 (1.07-1.90)
Intermediate	3.41 (1.45-8.75)
Novice	4.23 (2.99-7.16)
All virtual survey analysts	3.01
Field crew (2 people)	3.14

Virtual survey recommendations

- Virtual surveys do not replace field inspections for tree condition, risk, or pests/pathogens
- Virtual surveys may not maximize public engagement
- Consider the importance of image date
- Tailor the task complexity to analyst expertise – skilled analysts can reliably complete more detailed work

Virtual survey recommendations

- Virtual surveys do not replace field inspections
- Virtual surveys may not maximize public engagement
- Consider the importance of image date
- Tailor task complexity to analyst expertise
- Ask analysts to rate their confidence level

Percent agreement with field data

	Confident	Somewhat confident	Not confident
Genus			
Expert	99	77	39
Intermediate	94	66	46
Novice	89	60	20
Species			
Expert	96	60	26
Intermediate	90	47	28
Novice	79	45	13

Virtual survey recommendations

- Virtual surveys do not replace field inspections
- Virtual surveys may not maximize public engagement
- Consider the importance of image date
- Tailor task complexity to analyst expertise
- Ask analysts to rate their confidence level
- Provide midstream feedback to analysts

Virtual survey recommendations

- Virtual surveys do not replace field inspections
- Virtual surveys may not maximize public engagement
- Consider the importance of image date
- Tailor task complexity to analyst expertise
- Ask analysts to rate their confidence level
- Provide midstream feedback to analysts
- Virtual surveys could be great for inventory updates

Questions to consider

Inventory data are key to strategic management

What information do we **want**?

What information do we **need**?

How can we generate that information?

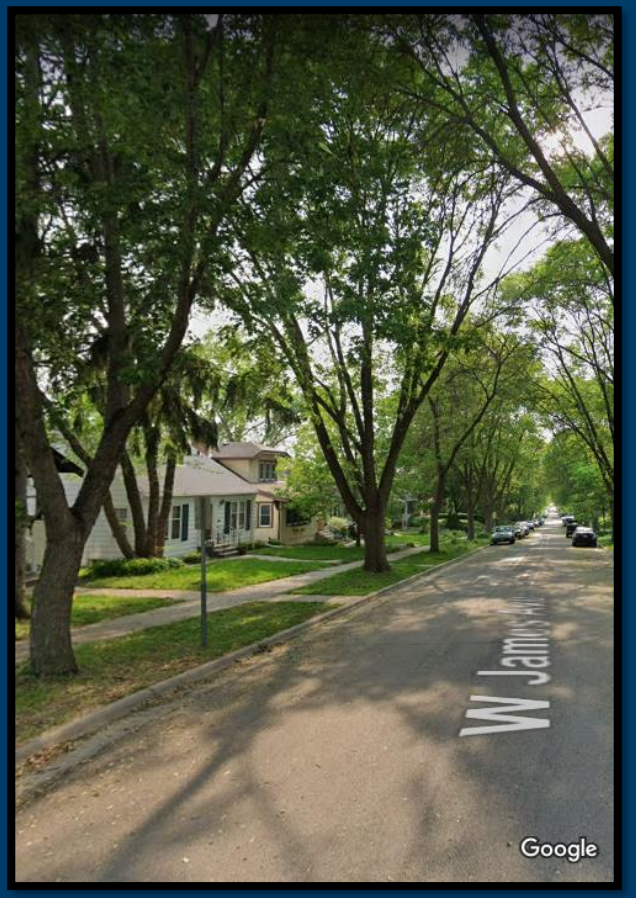
Additional Resources

Documents we used to facilitate data collection

https://bit.ly/2V9LhVG

Forests article "Can field crew telecommute?"

https://bit.ly/2xjLEFj



Arborist News article "New possibilities for virtual street tree inventories"

https://www.fs.usda.gov/treesearch/pubs/59661