Urban Forests: The Value of Trees for Cities and People

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Guest lecture FOR200 – Conservation of Canada's Forests
www.jananisivarajah.com

Menti: What tree is on the Canadian flag?

Why are urban forests important?

- Humans are increasingly becoming isolated from experiences of natural forest

Why are urban forests important?

- Primary interface between humans and forests is in the urban or peri-urban forests

Key Terminology

- **Urban Forest**: “A dense, widespread growth of trees and other plants covering an area of a city.”
- **Urban Forestry**: “...planning, design and management of trees and forest stands with amenity values, situated in or near urban areas.”

Key terminology

Peri-Urban Forest: "…forest on the fringe of urban settlements."

Potential regions for urban sprawl

Menti: Which of these images are part of Toronto’s urban forest?

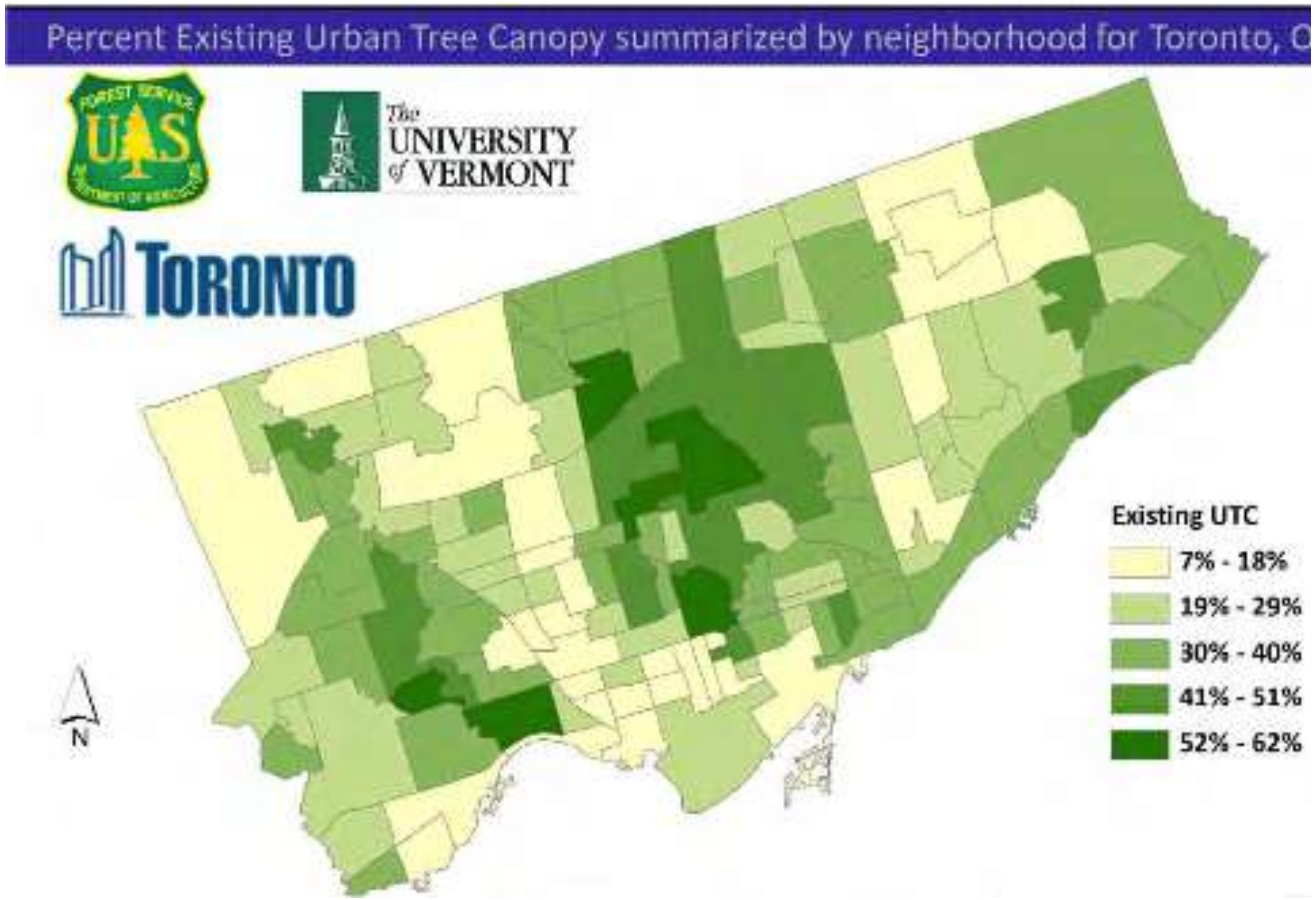
Background

- 1960: Erik Jorgensen, the first Urban Forester in Canada, became involved with organizing Dutch elm disease research and control at UofT
- Brigadier General J.F. Westhead: Head of the Superintendent Office, UofT
- Wanted to save their impressive tree cover of elms
- Needed the co-operation of its neighbours (e.g., Ontario Department of Public Works, Metropolitan Toronto Roads Department, City of Toronto Parks Department)

Creation of the Ontario Urban Forest Council (OUFC)

- A Dutch elm disease symposium and Borden laboratory in 1963
- Led to the creation of the Ontario Shade Tree Council
- Cofounders: Erik Jorgensen and Brigadier General J.F. Westhead
- Purpose: to preserve all shade trees in Ontario
- In 2000 : Ontario Urban Forest Council (OUFC) www.oufc.org

Toronto's Forest Cover



- Toronto has roughly 10.2 million trees (6 million on private land)
- Toronto's Canopy Cover 26.6-28% (Source: Every Tree Counts: A Portrait of Toronto's Urban Forest, 2013)
- Goal: 40% (2050)

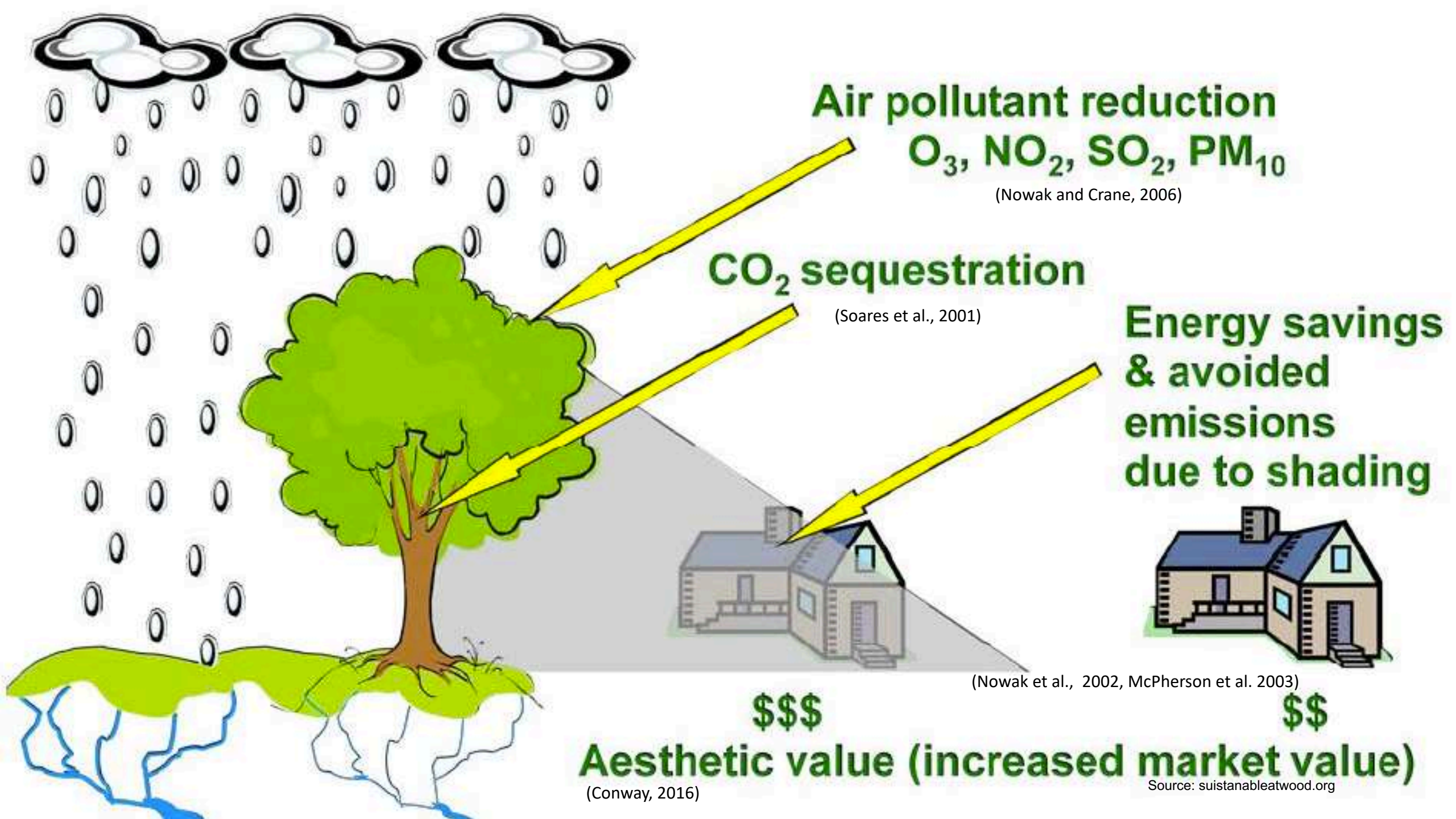
Canada’s Urban Forest Cover

- Montréal: Current 20% (2012), Target 25% (2025)
- Vancouver: Current 18% (2013), Target 22% (2025)
- Halifax: Current 43% (2013), Target n/a %
- Oakville: Current 27.8% (2016), Target 40% (2057)
- Winnipeg: Current 20% (est.), Target 25%(est.)
- Fort McMurray: Current 25%, 41% (pre-fire), Target 25% (2025)

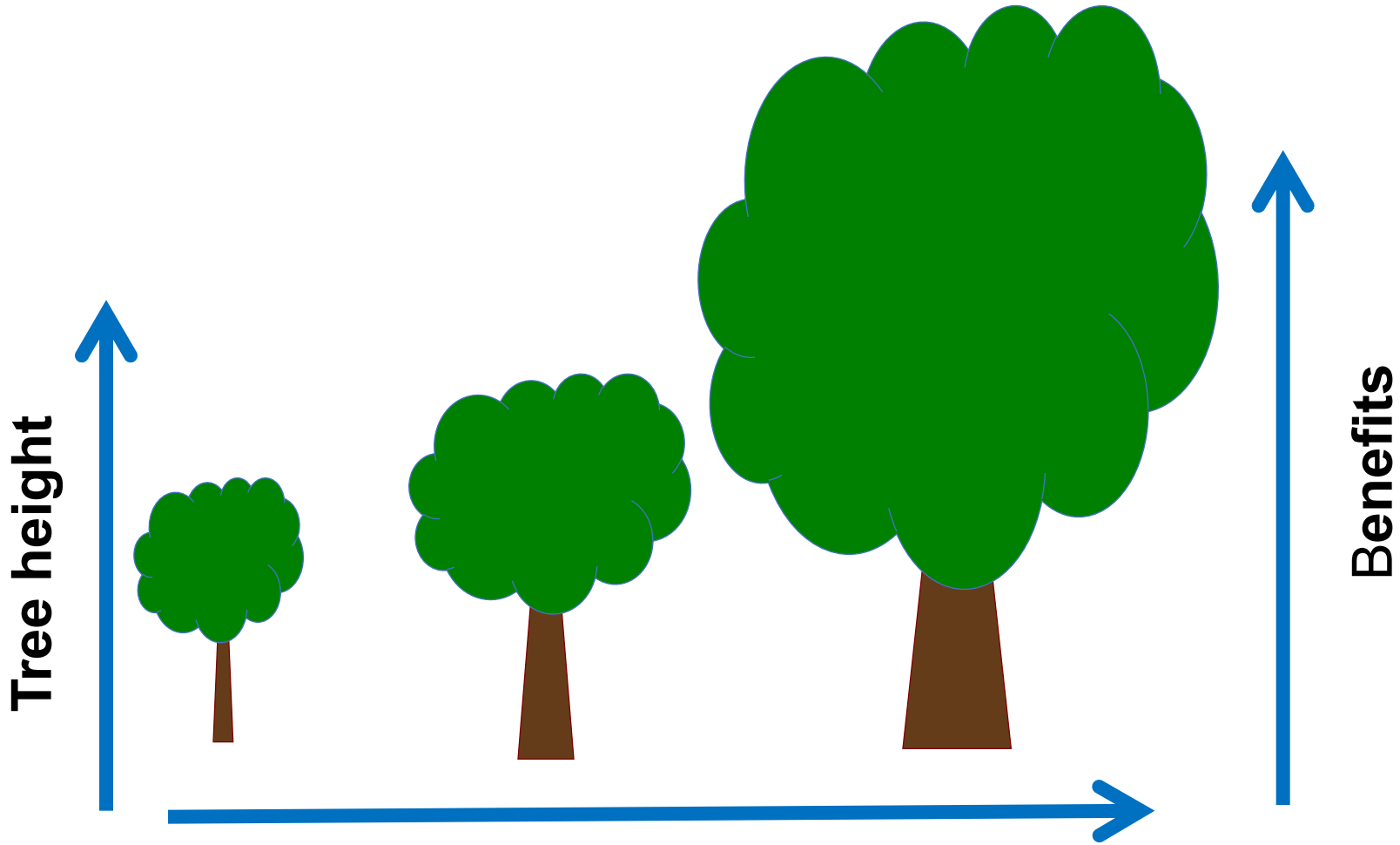
(source: Tree Canada, 2019)

Menti: What roles do trees play cities?

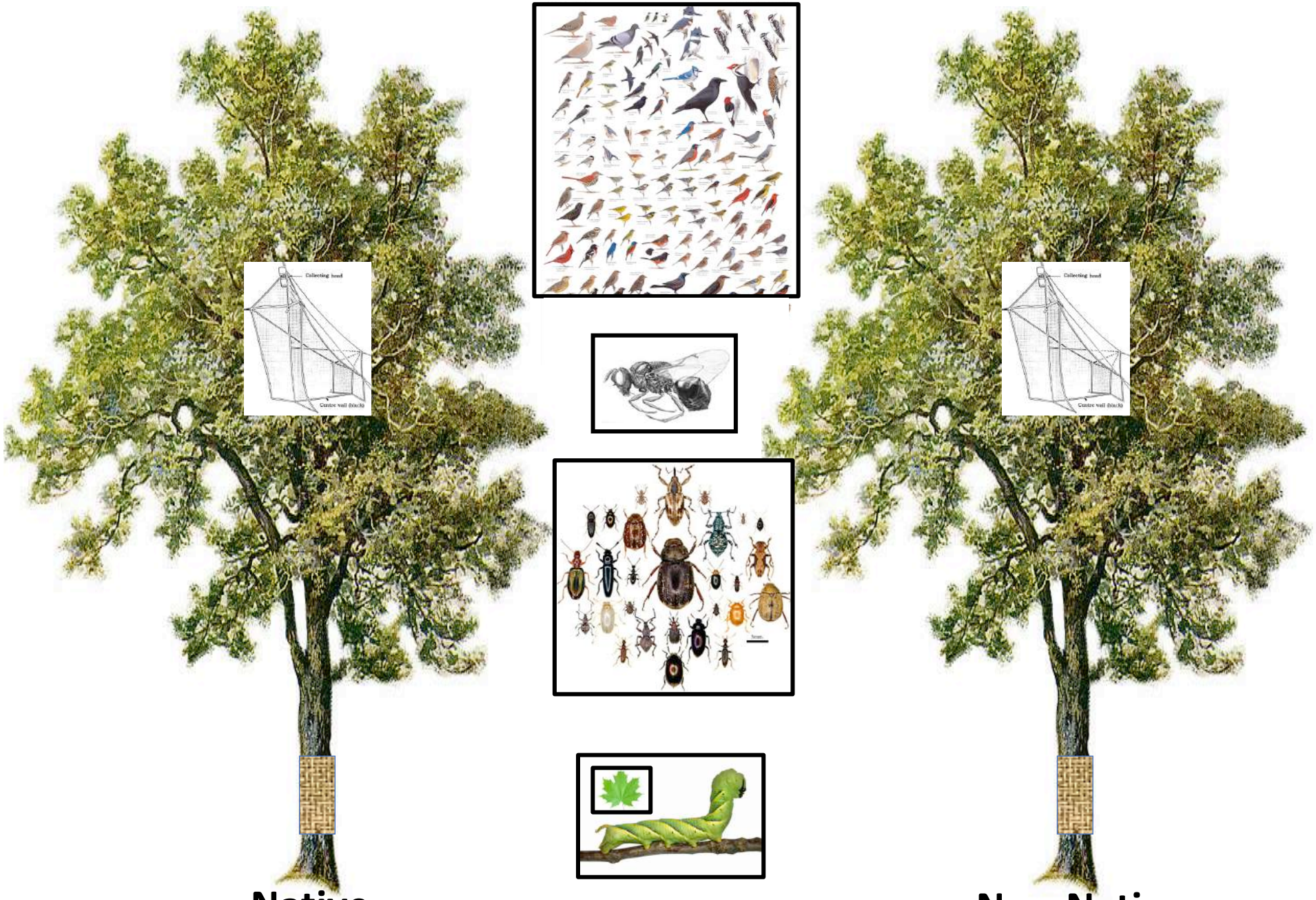
Urban trees are public health and environmental infrastructure


Air pollutant reduction
O_3, NO_2, SO_2, PM_{10}
(Nowak and Crane, 2006)
CO_2 sequestration
(Soares et al., 2001)
Energy savings & avoided emissions due to shading
(Nowak et al., 2002, McPherson et al. 2003)
$$$
$$
Aesthetic value (increased market value)
(Conway, 2016)
Source: suistanableatwood.org

Bigger is better



(Kenney, 2000)



Davies et al. 2014

Science News

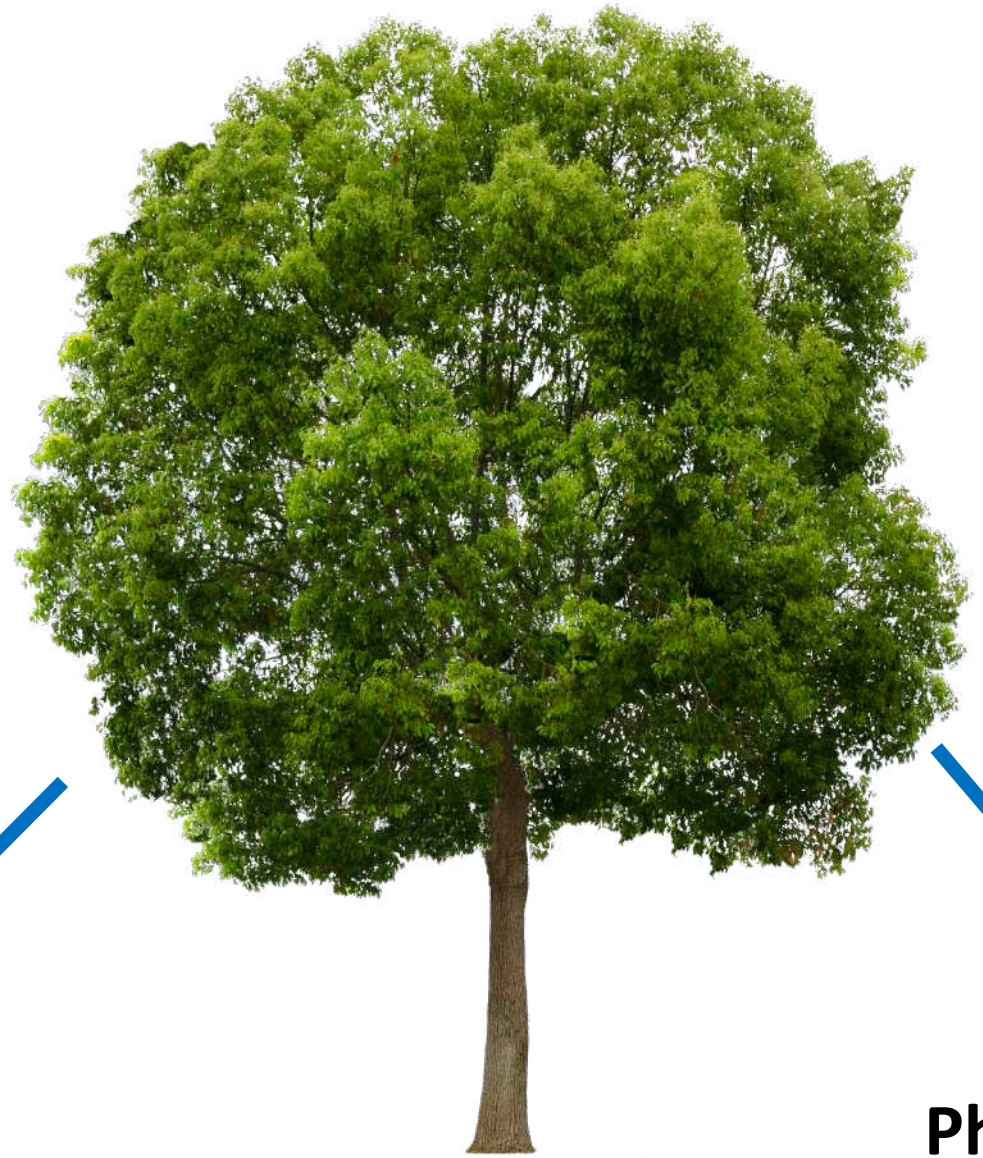
Some City Trees May Discourage 'Shady' Behavior; Study Explores Relationship Between Urban Trees and Crime

ScienceDaily (Nov. 2, 2010) — Along with energy conservation and storm-water reduction, scientists may soon be adding crime-fighting to the list of benefits that urban trees provide. Researchers with the U.S. Forest Service's Pacific Northwest (PNW) and Southern Research Stations have published a new study that suggests that certain types of city trees may help lower property and violent crime rates.

Their study -- which is posted online in advance of its appearance in a forthcoming printed issue of the journal *Environment and Behavior* -- is the first to examine the effects of trees and other factors on crime

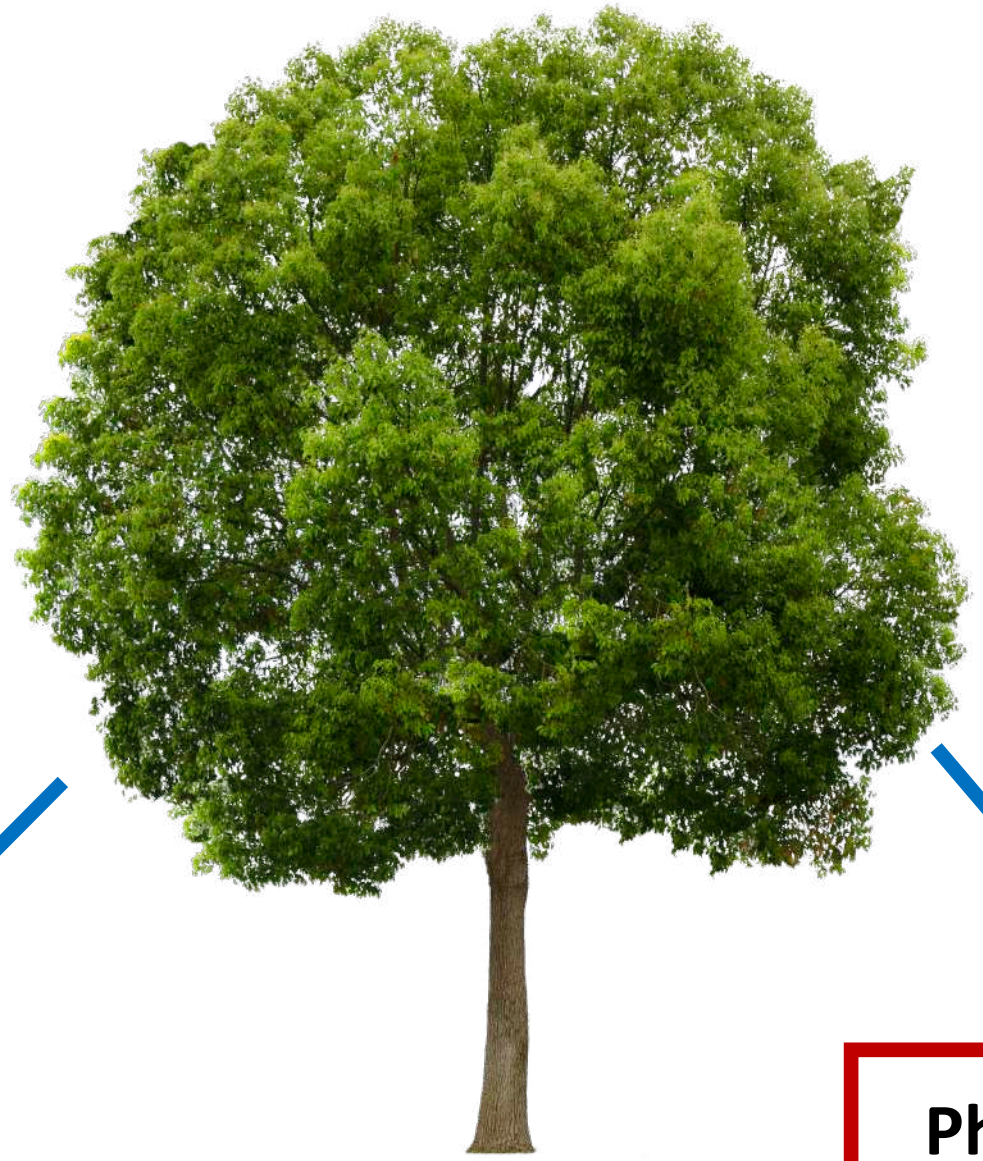
See Also:

Plants & Animals
- Trees
- Botany



Mental Health

Physical Health



Mental Health

Physical Health

The Relationship Between Trees and Human Health

Evidence from the Spread of the Emerald Ash Borer

Geoffrey H. Donovan, PhD, David T. Butry, PhD, Yvonne L. Michael, ScD, Jeffrey P. Prestemon, PhD, Andrew M. Liebhold, PhD, Demetrios Gatziolis, PhD, Megan Y. Mao

Background: Several recent studies have identified a relationship between the natural environment and improved health outcomes. However, for practical reasons, most have been observational, cross-sectional studies.

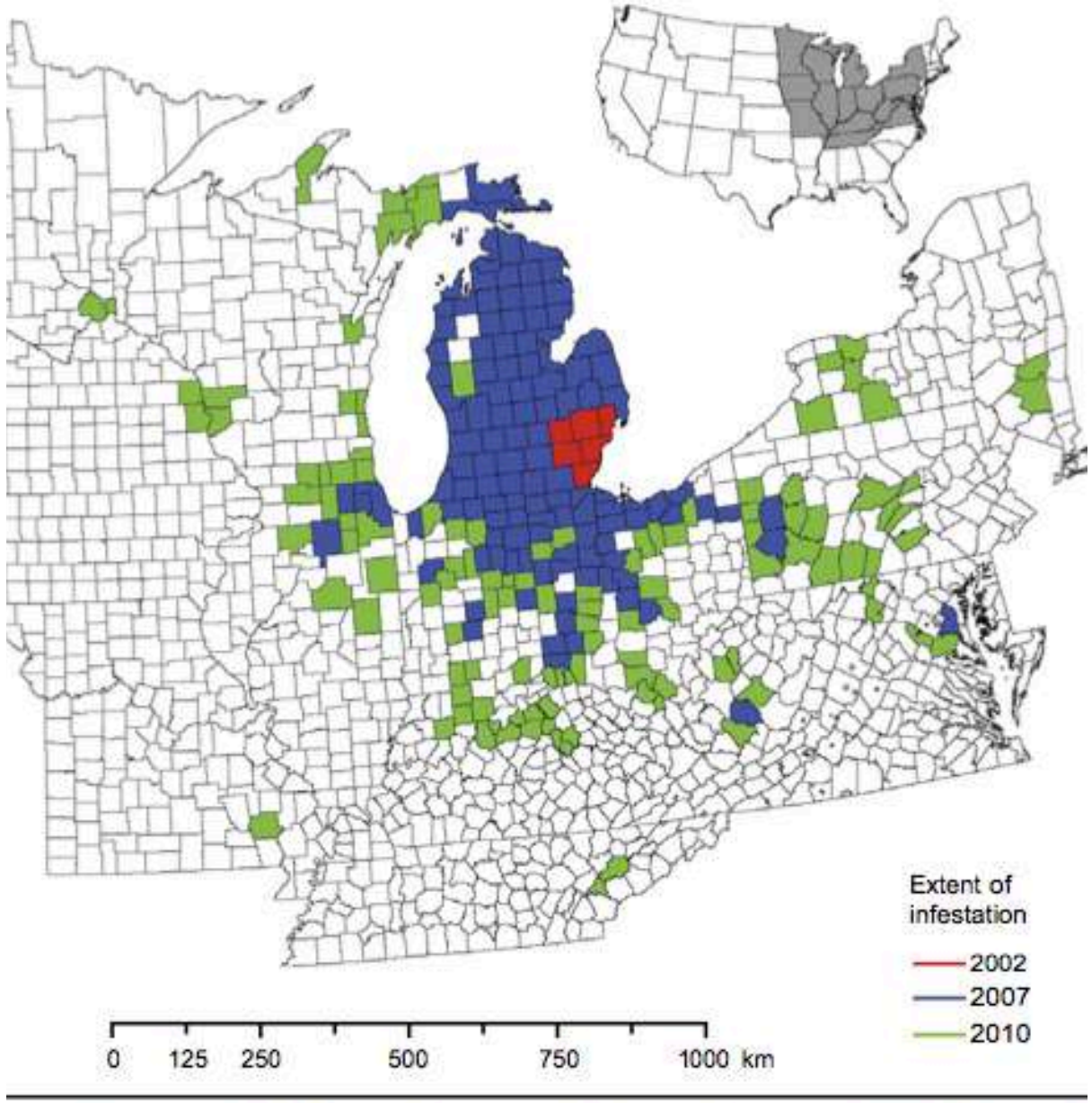
Purpose: A natural experiment, which provides stronger evidence of causality, was used to test whether a major change to the natural environment—the loss of 100 million trees to the emerald ash borer, an invasive forest pest—has influenced mortality related to cardiovascular and lower-respiratory diseases.

Methods: Two fixed-effects regression models were used to estimate the relationship between emerald ash borer presence and county-level mortality from 1990 to 2007 in 15 U.S. states, while controlling for a wide range of demographic covariates. Data were collected from 1990 to 2007, and the analyses were conducted in 2011 and 2012.

Results: There was an increase in mortality related to cardiovascular and lower-respiratory-tract illness in counties infested with the emerald ash borer. The magnitude of this effect was greater as infestation progressed and in counties with above-average median household income. Across the 15 states in the study area, the borer was associated with an additional 6113 deaths related to illness of the lower respiratory system, and 15,080 cardiovascular-related deaths.

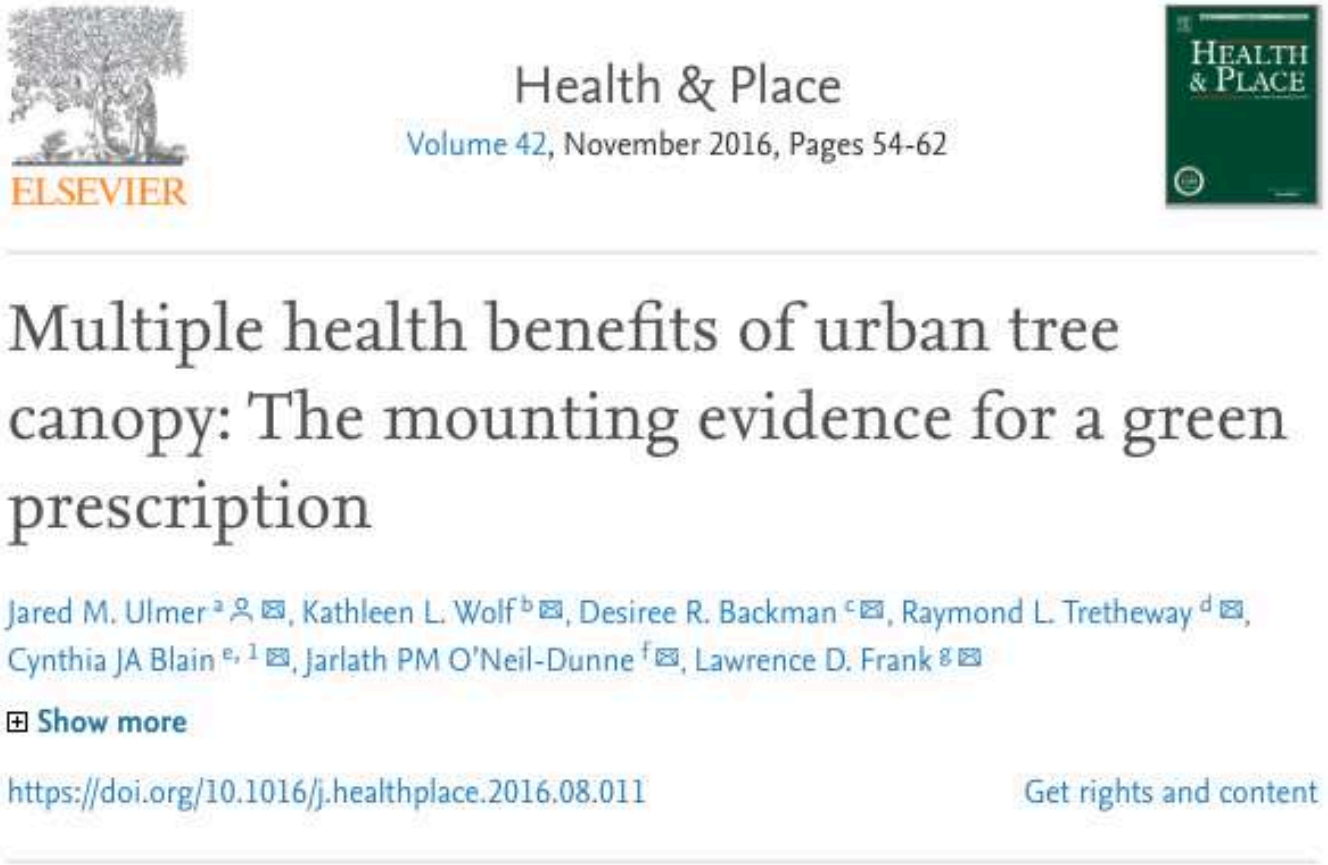
Conclusions: Results suggest that loss of trees to the emerald ash borer increased mortality related to cardiovascular and lower-respiratory-tract illness. This finding adds to the growing evidence that the natural environment provides major public health benefits.

(Am J Prev Med 2013;44(2):139–145) Published by Elsevier Inc. on behalf of American Journal of Preventive Medicine



1. Counties where the emerald ash borer had been detected in 2002, 2007, a

More tree cover = better overall health



ELSEVIER

Health & Place
Volume 42, November 2016, Pages 54-62

Multiple health benefits of urban tree canopy: The mounting evidence for a green prescription

Jared M. Ulmer [a], Kathleen L. Wolf [b], Desiree R. Backman [c], Raymond L. Tretheway [d], Cynthia JA Blain [e, 1], Jarlath PM O'Neil-Dunne [f], Lawrence D. Frank [g]

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https://doi.org/10.1016/j.healthplace.2016.08.011

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- Tree cover = lower obesity, better social cohesion, less type 2 diabetes, high blood pressure, and asthma

Country mouse versus City mouse

Normal Diet

High Fat Diet

Sun et al. 2005

Trees provide shade and UV protection (Sivarajah et al., unpublished)

Tree species with high UV protection (PF: 3-3.5)

Norway maple
Acer platanoides "Crimson King'

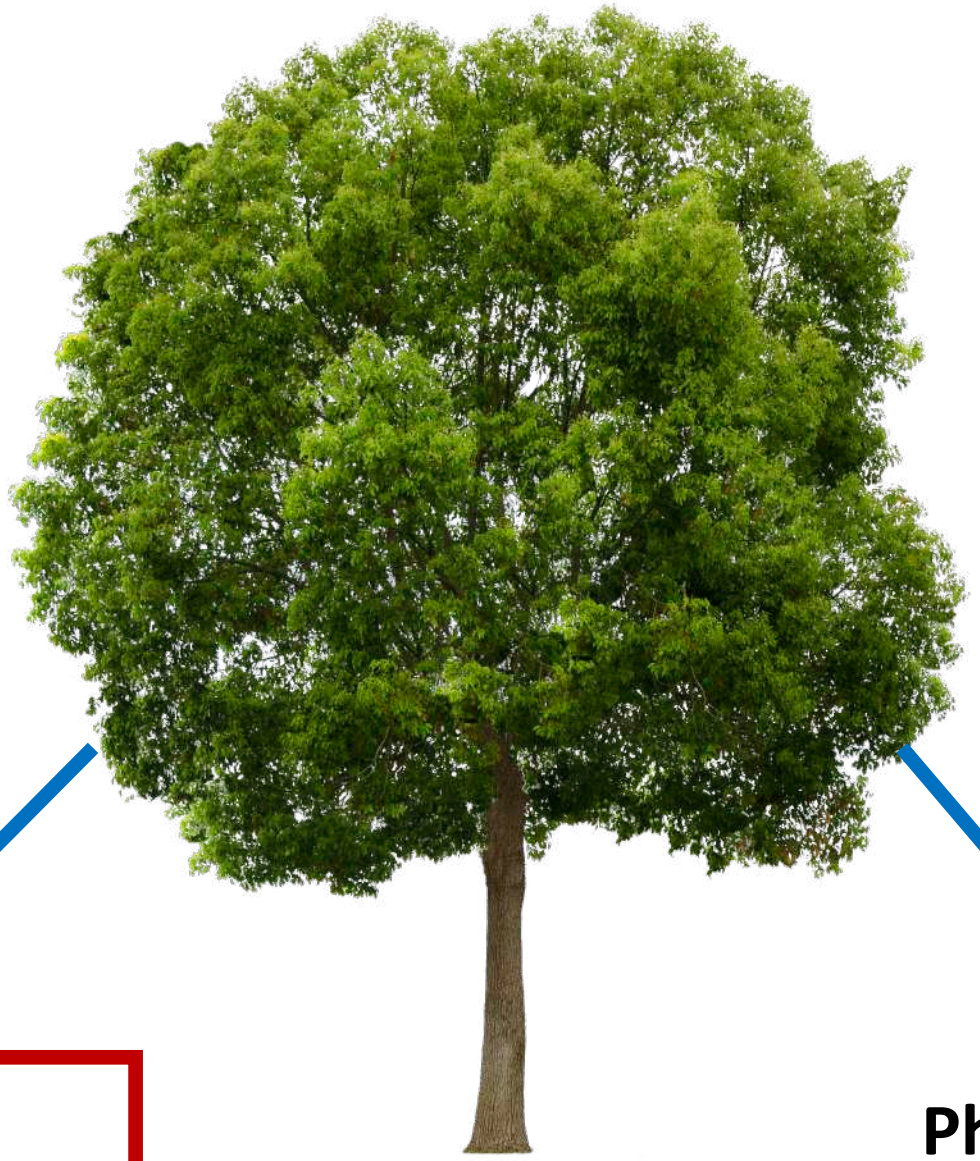
Common horsechesnut
Aesculus hippocastinum

Copper beech
Fagus sylvatica 'purpurea'

Swamp white oak
Quercus bicolor

Little-leaf linden
Tilia cordata

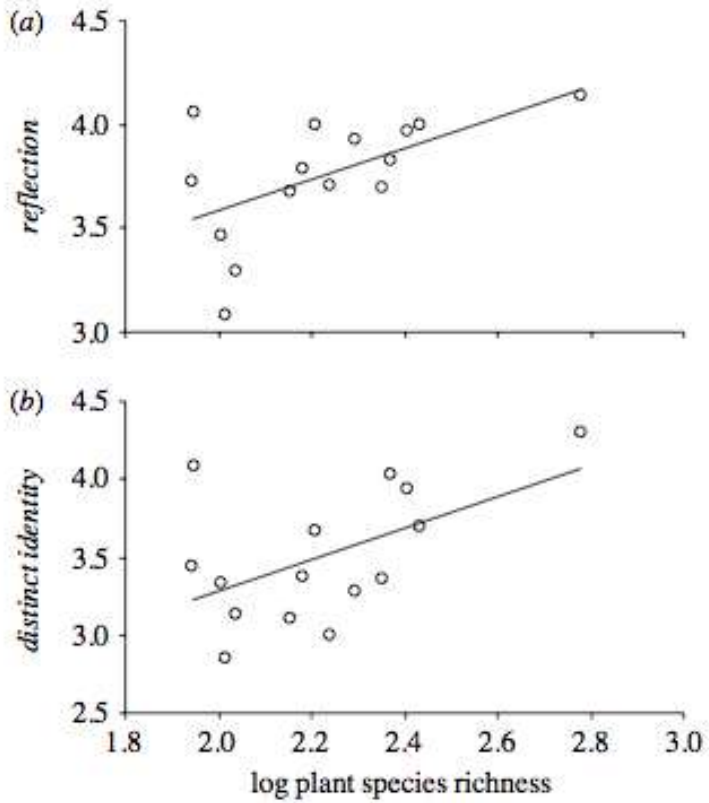
Sivarajah et al., unpublished



Mental Health

Physical Health

Psychological well-being



biology letters
Community ecology

Biol. Lett. (2007) **3**, 390–394
doi:10.1098/rsbl.2007.0149
Published online 15 May 2007

Psychological benefits of greenspace increase with biodiversity

Richard A. Fuller[1,*], Katherine N. Irvine[2], Patrick Devine-Wright[2,†], Philip H. Warren[1] and Kevin J. Gaston[1]

[1]*Department of Animal and Plant Sciences, University of Sheffield, Sheffield S10 2TN, UK*
[2]*Institute of Energy and Sustainable Development, De Montfort University, Leicester LE1 9BH, UK*
**Author for correspondence (r.a.fuller@dunelm.org.uk).*
[†]*Present address: School of Environment and Development, University of Manchester, Manchester M13 9PL, UK.*

PLOS ONE

RESEARCH ARTICLE

Tree cover and species composition effects on academic performance of primary school students

Sivajanani Sivarajah*, Sandy M. Smith, Sean C. Thomas

Faculty of Forestry, University of Toronto, Toronto, Ontario, Canada

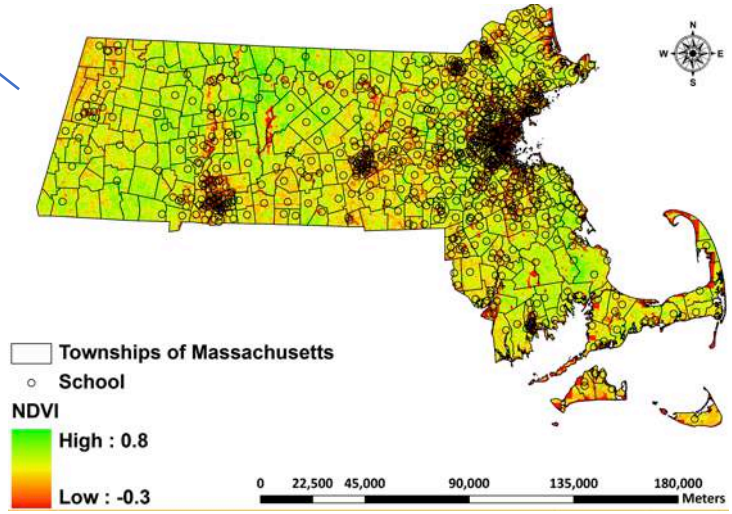
Retrieved image www.timeout.com/chicago

Prior research on “green space” and standardized test performance

Matsuoka et al. 2010: Evaluation of “greenness” of images taken from school cafeteria windows (101 high schools, Michigan, USA)

Fig. 2. Examples of the level of naturalness in the view from each school's primary cafeteria window.

Wu et al. 2014: Remote-sensing-based evaluation of “greenness” near 905 grade schools in Massachusetts, USA



Both studies find positive effects of greenness indices on test performance, statistically correcting for (larger) effects of socioeconomic factors

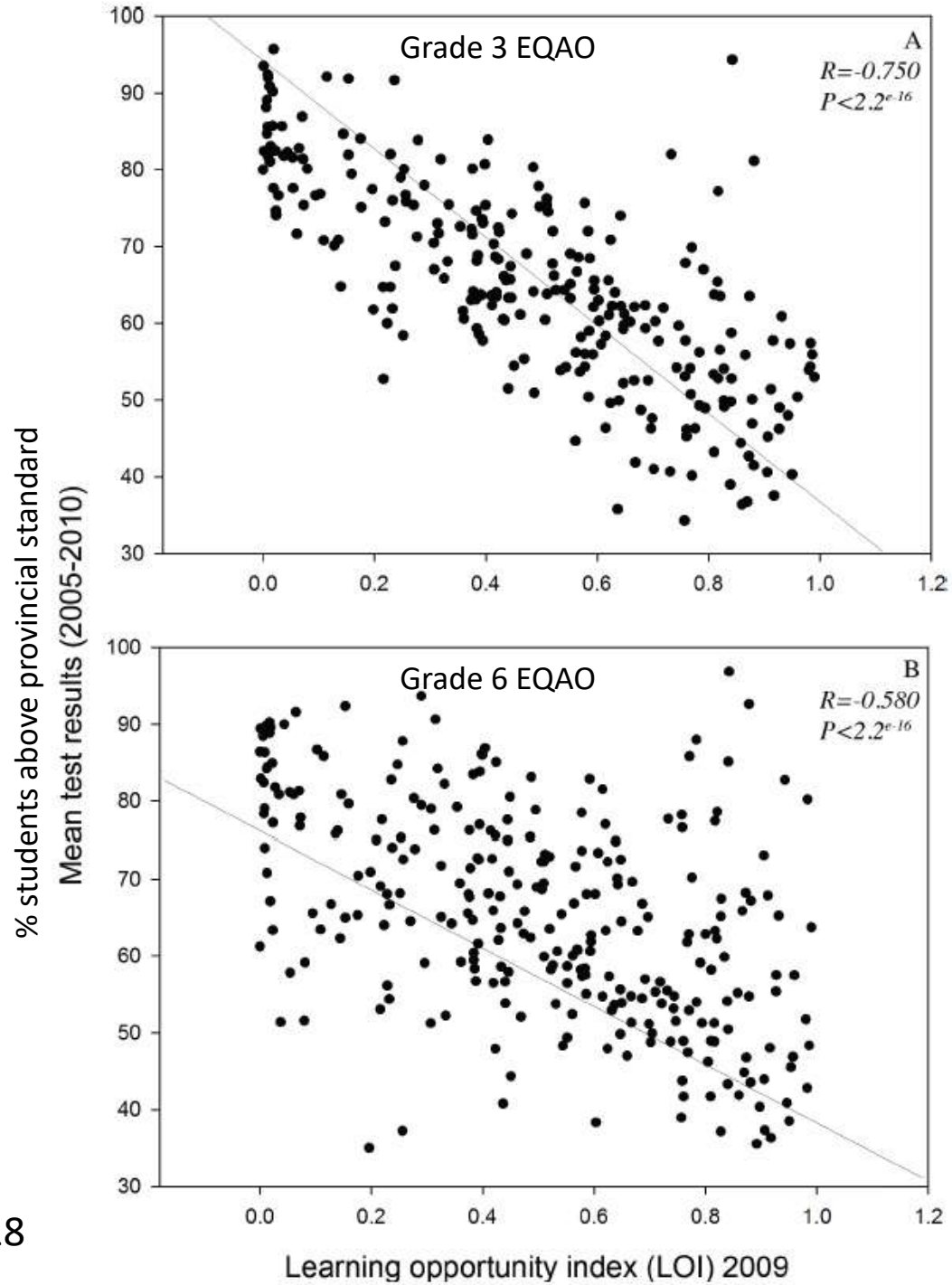
<u>Variables:</u>
-Median income
-% of families below the low-income measure
-% of families receiving social assistance
-Adults with low education
-Adults with univesity degrees
-Lone-parent families

High LOI

Highest level of external challenge

Lowest level of external challenge

Low LOI



Sivarajah et al. 2018

Tree cover positively effects all test scores

Category n=281	**Model 1** LOI	**Model 2** LOI+ Tree Cover	**Model 3** LOI + Tree Cover + (LOI x Tree Cover)
Reading	2221.3	2220.4	**2216.8**
Writing	2175.2	2172.8	**2170.2**
Math	2301.0	2300.0	**2298.5**
Mean of all test results	2195.8	2194.0	**2191.1**

- **Tree cover effects account for 10.7-17.6% (13.0% for mean test scores) of the variance explained by the minimum AICc models ($P < 0.05$; $\Delta AICc = 1.5\text{-}3.9$)**

- **LOI X Tree cover interaction corresponds to higher effects on high LOI schools**

Sivarajah et al. 2018

Tree composition effects is significant for *Math*

(P<0.05; ΔAICc = 2.7)

Category n=144	Model 1 LOI + Tree Cover + (LOI x Tree Cover)	Model 2 LOI + Tree Cover + (LOI x Tree Cover) + Axis 1	Model 3 LOI + Tree Cover + (LOI x Tree Cover)+ Axis 1 + Axis 2
Reading	**1128.5**	1129.7	1131.4
Writing	**1105.7**	1106.2	1106.7
Math	1187.1	1186.4	**1183.7**
Mean of all test results	**1126.7**	**1126.7**	**1126.7**

Sivarajah et al. 2018

Combination of species with positive effect (on EQAO math scores only

Austrian pine

Colorado spruce

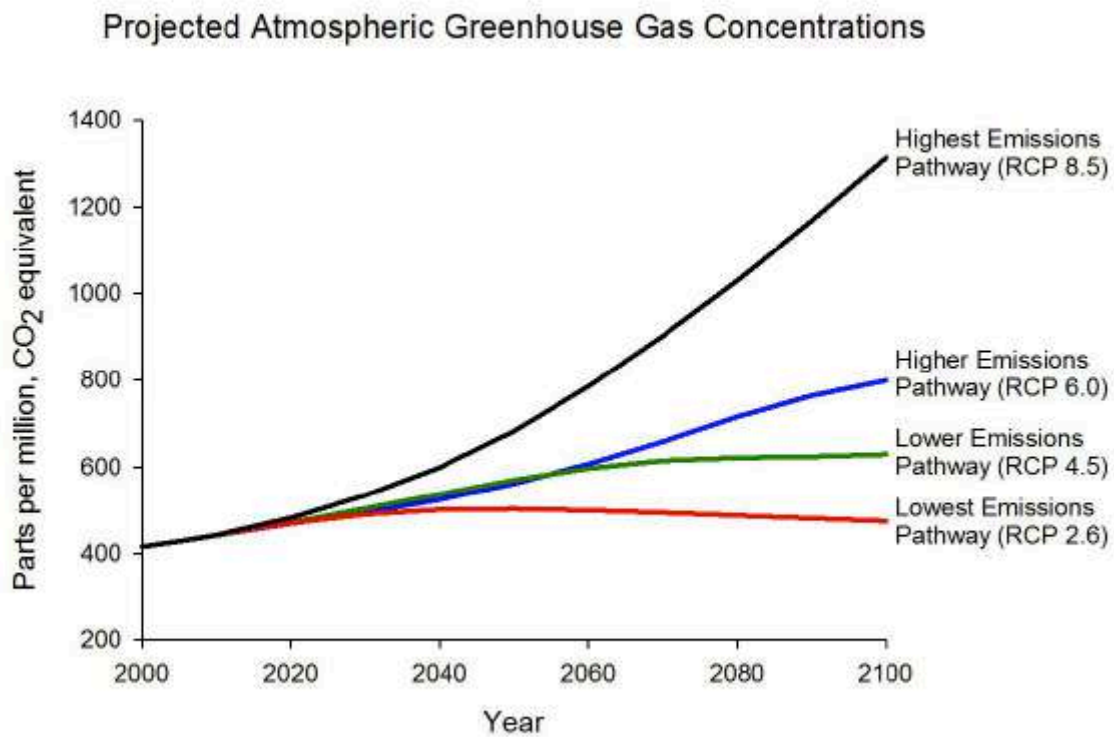
Sugar maple

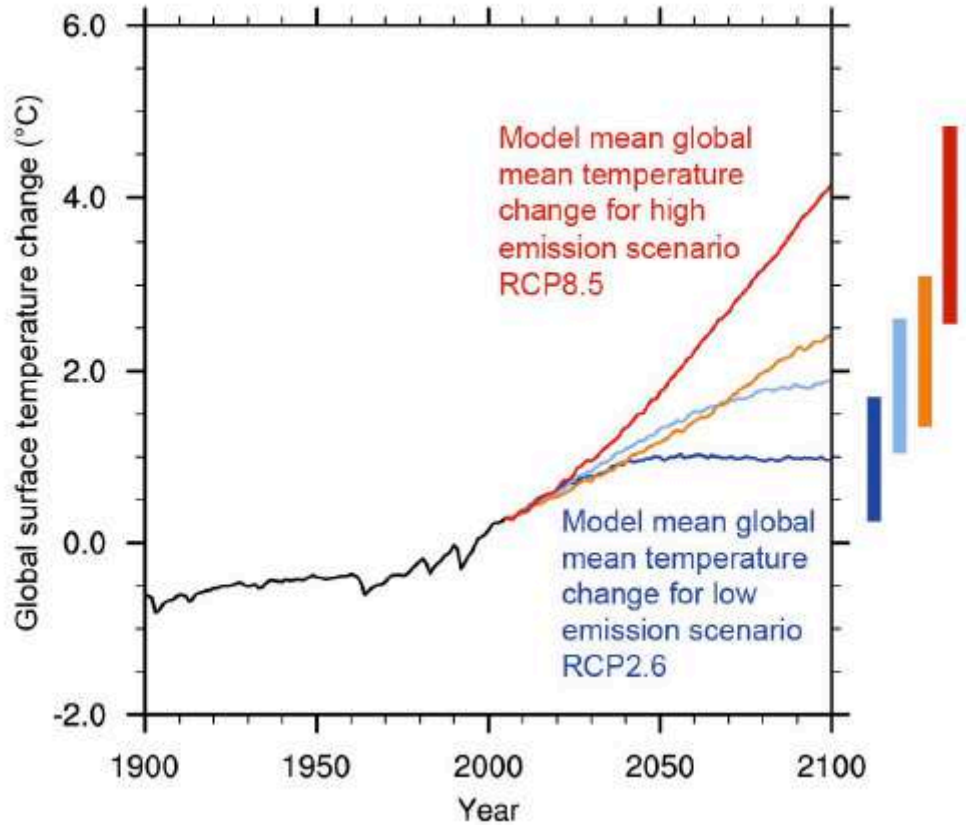
Green ash

Weak community composition effect detected (on math score results only) – no detectable effect of conifer % or species diversity

Challenges faced by our urban forests and trees

Global climate change projections





Projected Climatic Changes in Ontario

Climatic Changes	Projections
	Increase in annual average temperature. More “hot days” above 30 degrees Celsius.
	Increase an average annual precipitation with a decrease in summer.
	Increase in extreme weather events including heavy rainfall, ice storms, and wind storms.

Bioclimatic data –Town of Ajax

- Study finds several common tree species outside their bioclimatic envelopes outside of the predicted mean ANNUAL temperature level:
  - Eastern White Cedar
  - Bebb's Willow
  - Freeman Maple
  - Green Alder
  - Yellow Birch
  - White Birch
  - European Larch
  - Norway Spruce
  - White Spruce

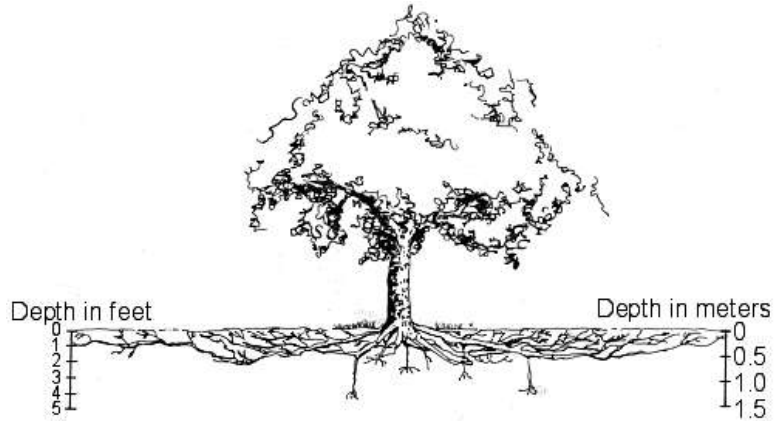
Possible solution: Assisted migrations (e.g., 50:25:25 rule, Lake Simcoe Conservation Authority)

(Source: Town of Ajax, 2018)

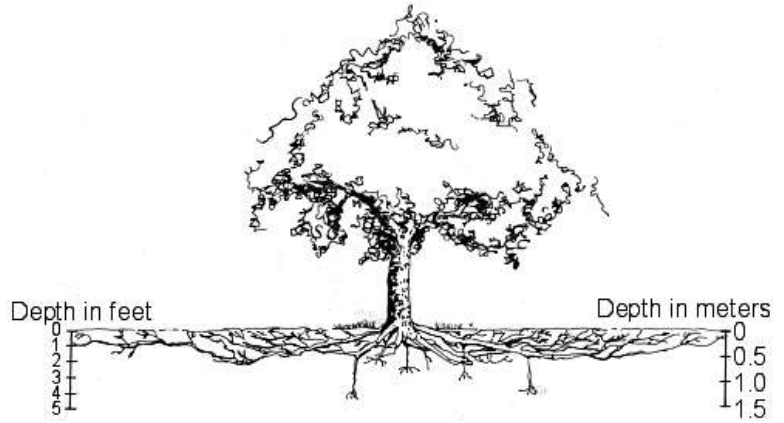
Conservation concerns

- Converting woodlots into non-treed environments or a single-tree environment
- Salt pollution

Restricted rooting zones and compacted soil



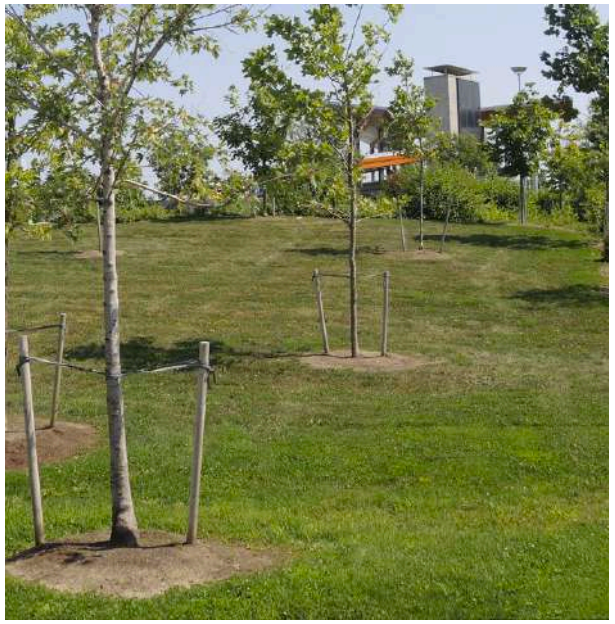
Restricted rooting zones and compacted soil



Solution

Continous soil trench construction to provide Toronto street trees with increased soil volume.
Photo by Urban Forestry, City of Toronto, used with permission.

Poor planting techniques



Poor planting techniques

Solution

Invasive pests

Emerald ash borer

Gypsy moth

Asian long-horned beetle

Conservation concerns

Weak strategic efforts (all levels of government)

Provincial Impacts, Primary Legislation

- **Municipal Act, under Ministry of Municipal Affairs and Housing introduction of Section;**
- "135. **(1) Subject to subsection (4) and without limiting sections 9, 10 and 11, a local municipality may prohibit or regulate the destruction or injuring of trees. 2006, c. 32, Sched. A, s. 71 (1).**
- Woodlands
- (2) Without limiting sections 9, 10 and 11, an upper-tier municipality may prohibit or regulate the destruction or injuring of trees in woodlands designated in the by-law. 2006, c. 32, Sched. A, s. 71 (1)."

- This results are each municipality decides how they want to protect public and private trees based on Council position and staff resources. Single tree, multiple tree, tree conservation bylaws, 3 trees per year, 20cm, 30cm DBH…..

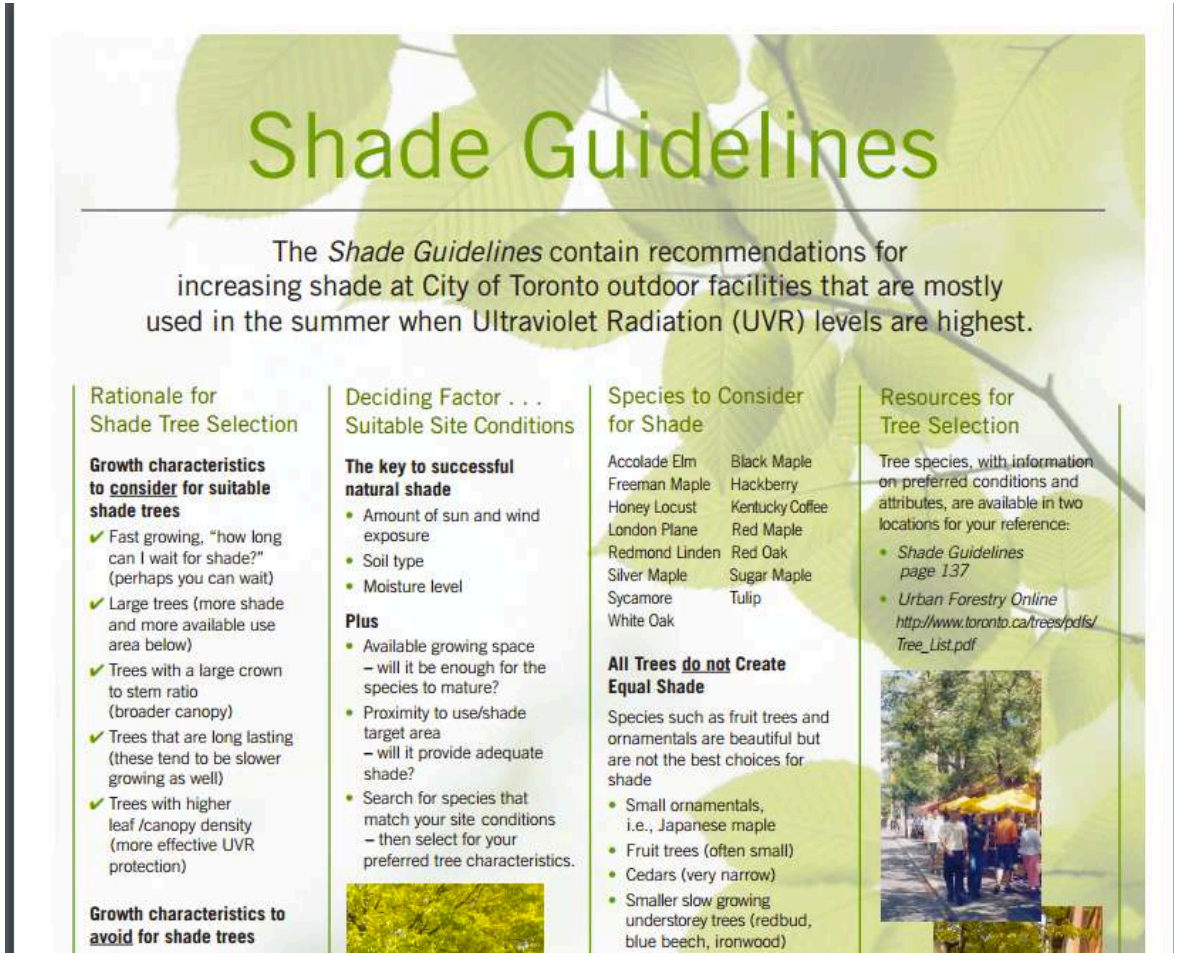
Provincial Impacts, Primary Legislation

- Planning Act RSO 1990 June 6 2019 under Ministry of Municipal Affairs and Housing
- **‘Conditions to approval of plans**
- **(17) As a condition to the approval of the plans and drawings referred to in subsection (4), a municipality may require the owner of the land to,**
- **(a) provide to the satisfaction of and at no expense to the municipality any or all of the following:**
- **6. <u>Walls, fences, hedges, trees, shrubs or other groundcover or facilities for the landscaping of the lands or the protection of adjoining lands’</u>**

- Planning applications are usually policy driven and can be backstopped by Bylaws

- The development of Planning policy generally meets the “Spirit of the Bylaw”

Some regulations…



Shade Guidelines

The *Shade Guidelines* contain recommendations for increasing shade at City of Toronto outdoor facilities that are mostly used in the summer when Ultraviolet Radiation (UVR) levels are highest.

Rationale for Shade Tree Selection

Growth characteristics to consider for suitable shade trees

- ✔ Fast growing, "how long can I wait for shade?" (perhaps you can wait)
- ✔ Large trees (more shade and more available use area below)
- ✔ Trees with a large crown to stem ratio (broader canopy)
- ✔ Trees that are long lasting (these tend to be slower growing as well)
- ✔ Trees with higher leaf /canopy density (more effective UVR protection)

Growth characteristics to avoid for shade trees

Deciding Factor . . . Suitable Site Conditions

The key to successful natural shade

- Amount of sun and wind exposure
- Soil type
- Moisture level

Plus

- Available growing space – will it be enough for the species to mature?
- Proximity to use/shade target area – will it provide adequate shade?
- Search for species that match your site conditions – then select for your preferred tree characteristics.

Species to Consider for Shade

Accolade Elm, Black Maple, Freeman Maple, Hackberry, Honey Locust, Kentucky Coffee, London Plane, Red Maple, Redmond Linden, Red Oak, Silver Maple, Sugar Maple, Sycamore, Tulip, White Oak

All Trees do not Create Equal Shade

Species such as fruit trees and ornamentals are beautiful but are not the best choices for shade

- Small ornamentals, i.e., Japanese maple
- Fruit trees (often small)
- Cedars (very narrow)
- Smaller slow growing understorey trees (redbud, blue beech, ironwood)

Resources for Tree Selection

Tree species, with information on preferred conditions and attributes, are available in two locations for your reference:

- *Shade Guidelines page 137*
- *Urban Forestry Online http://www.toronto.ca/trees/pdfs/Tree_List.pdf*

- The Shade Policy for the City of Toronto
- Toronto Green standard

Not all are bad!

Term “Urban forestry” is recognized

Urban Forestry in legislation

Expansion in Education : S.S. Fleming/ UNB (2013), UBC Urban Forestry Program (2015), and UofT?

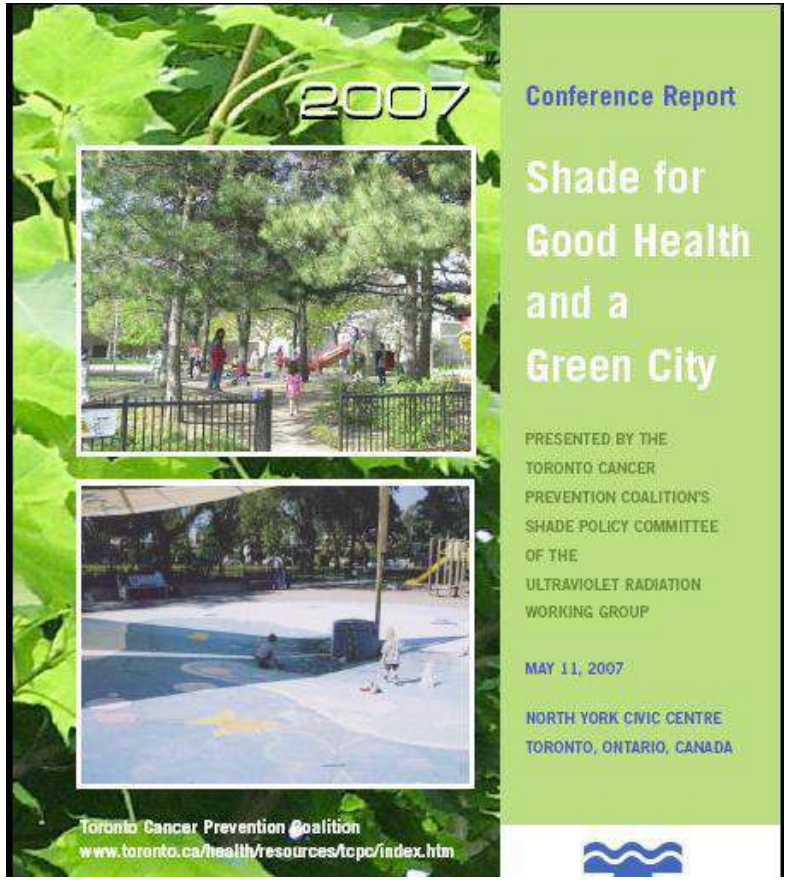
Municipalities and public are recognizing the value of trees

Expansion of Urban Forestry departments

Better technical info relating trees to people (e.g., i-Tree, tree inventory, ecosystem values)

Menti: In your opinion, how can we help build greener cities?

Community stewardship, enforcing stronger urban forest policies and by-laws, and research



Thank you/Questions?

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