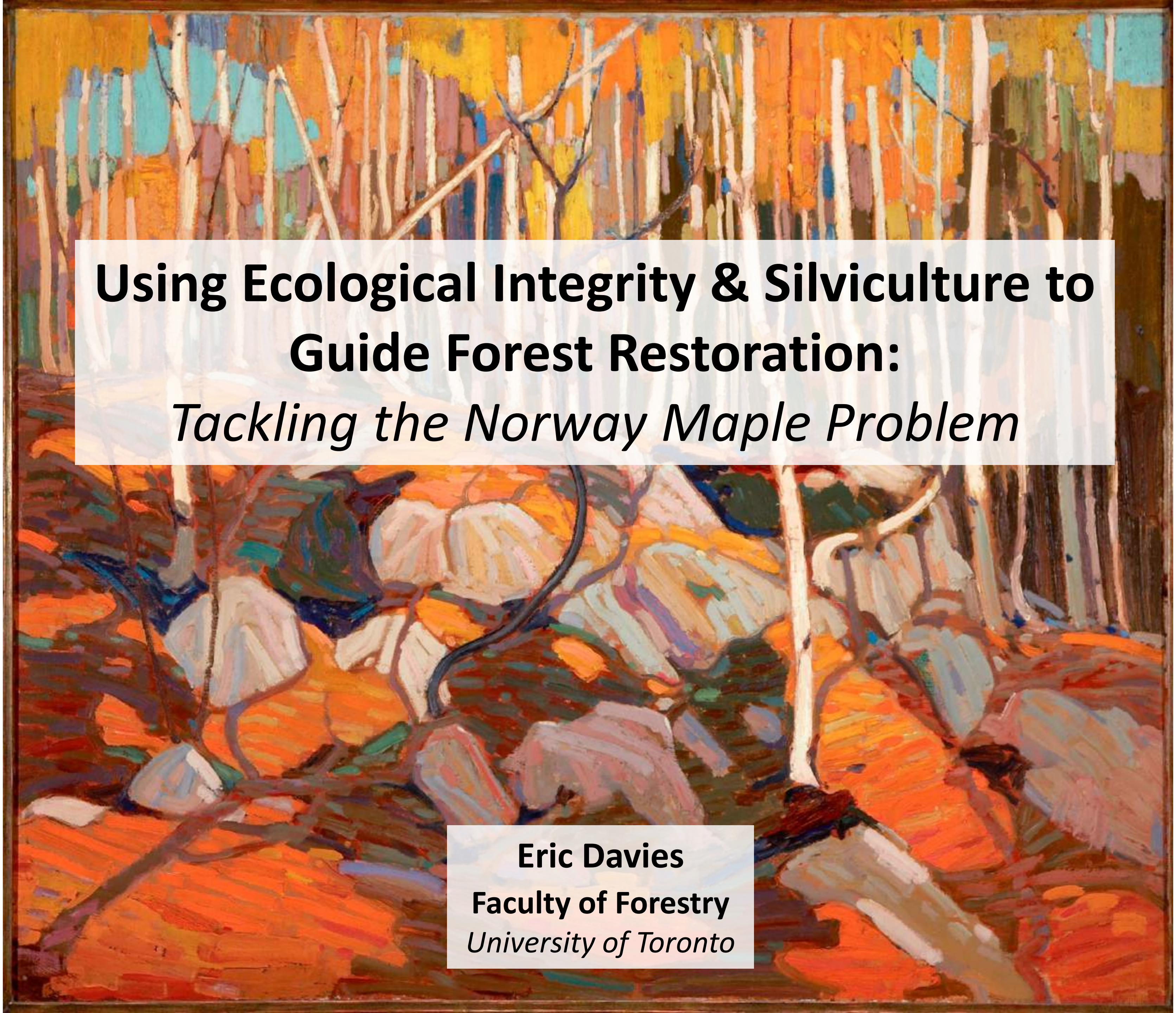


Using Ecological Integrity & Silviculture to Guide Forest Restoration:

Tackling the Norway Maple Problem

Eric Davies

Faculty of Forestry

University of Toronto

Outline:

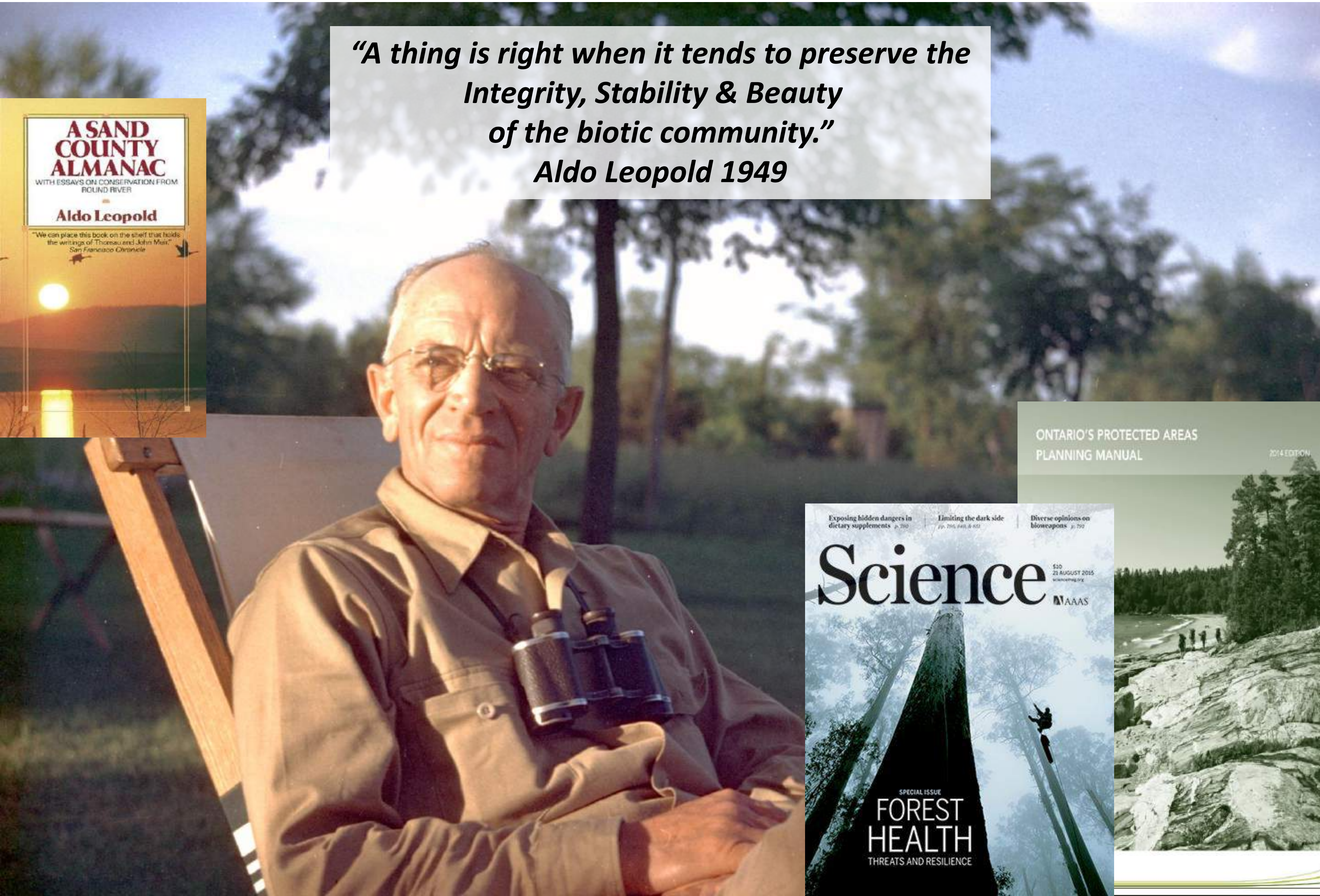
Using Ecological Integrity as a Guideline

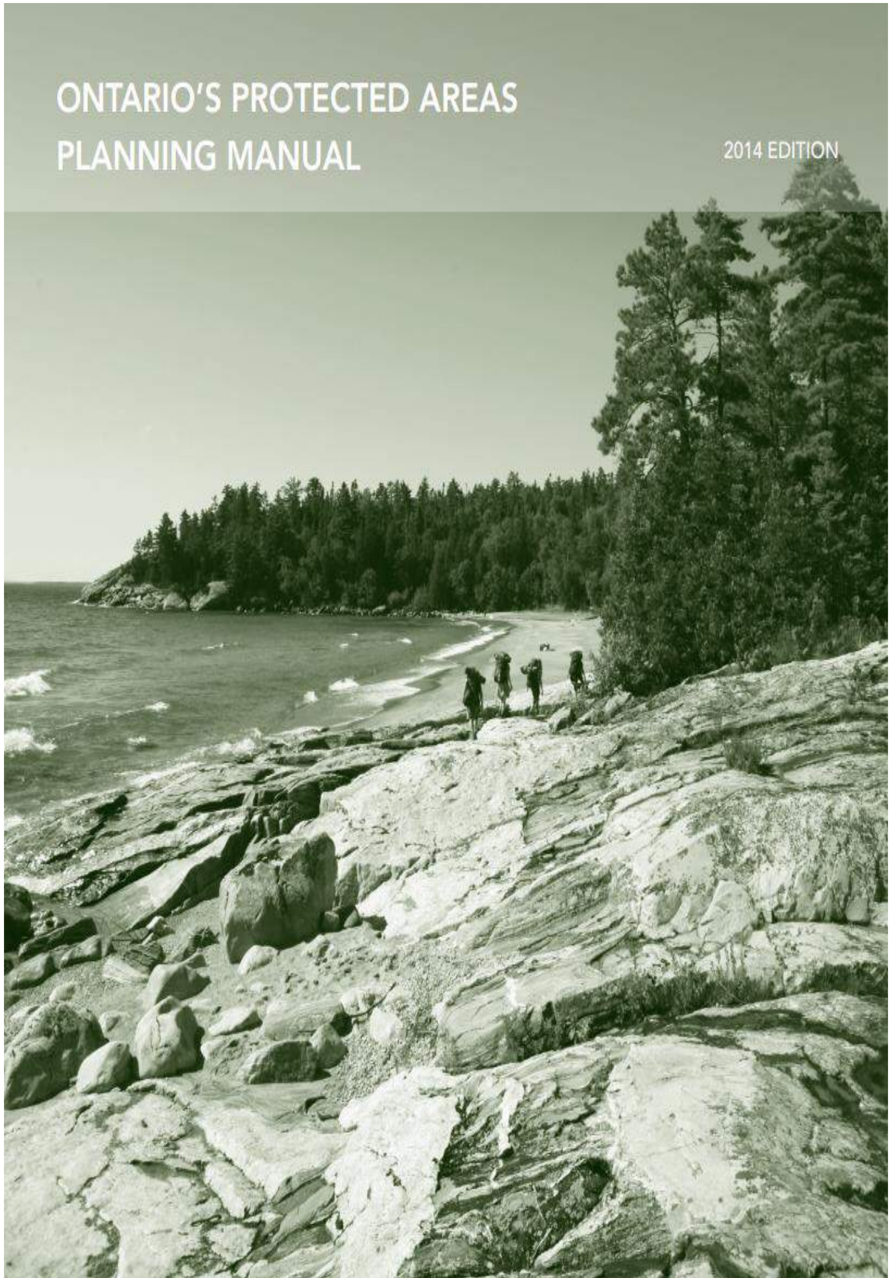
Using Silviculture as a Guideline

Tackling the Norway Maple Problem

Ecological Integrity

"A thing is right when it tends to preserve the
Integrity, Stability & Beauty
of the biotic community."
Aldo Leopold 1949





The new PPCRA (Provincial Parks and Conservation Reserves Act, 2006) states: *"maintenance of ecological integrity shall be the first priority and the restoration of ecological integrity shall be considered" for all provincial parks and conservation reserves.*

The new Act defines ecological integrity as: *"a condition in which biotic and abiotic components of ecosystems and the composition and abundance of native species and biological communities are characteristic of their natural regions and rates of change and ecosystem processes are unimpeded."*

Ecological **Integrity**
= 100% of native species
= each within natural abundance
= all functioning together

Parks Canada

Canada

Canada National Parks Act

(Passed: November 20th 2000)

"The definitions in this subsection apply in this Act.
Ecological integrity means, with respect to a park, a condition that is determined to be characteristic of its natural region and likely to persist, including abiotic components and the composition and abundance of native species and biological communities, rates of change and supporting processes."

"Maintenance or restoration of ecological integrity, through the protection of natural resources and natural processes, shall be the first priority of the Minister when considering all aspects of the management of parks."

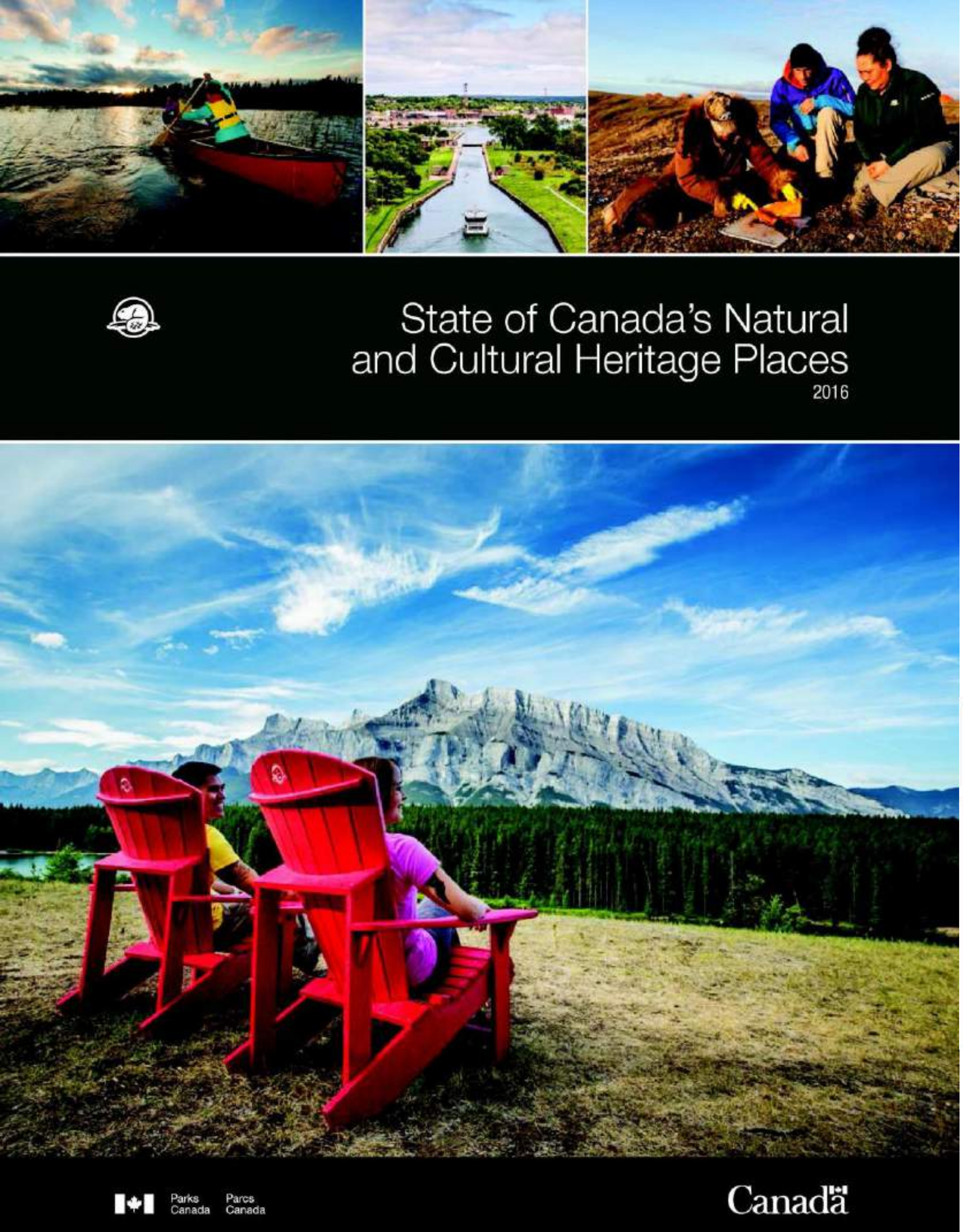
"The Minister shall, within five years after a park is established, prepare a management plan for the park containing a long-term ecological vision for the park, a set of ecological integrity objectives and indicators and provisions for resource protection and restoration, zoning, visitor use, public awareness and performance evaluation, which shall be tabled in each House of Parliament."

Nearly half of national park ecosystems rate as 'fair' or 'poor' in Parks Canada report

Rating an improvement from 2011, but impact of more visitors on parks a concern

By Susan Lunn, CBC News Posted: Jan 26, 2017 5:00 AM ET | Last Updated: Jan 26, 2017 11:32 PM ET

Canada's national parks are known for wild, open spaces, like Healy Pass in Banff National Park. But nearly half of national parks have areas and waterways or lakes rated by Parks Canada as 'fair' or 'poor' in terms of their ecological integrity. (Robson Fletcher/CBC)

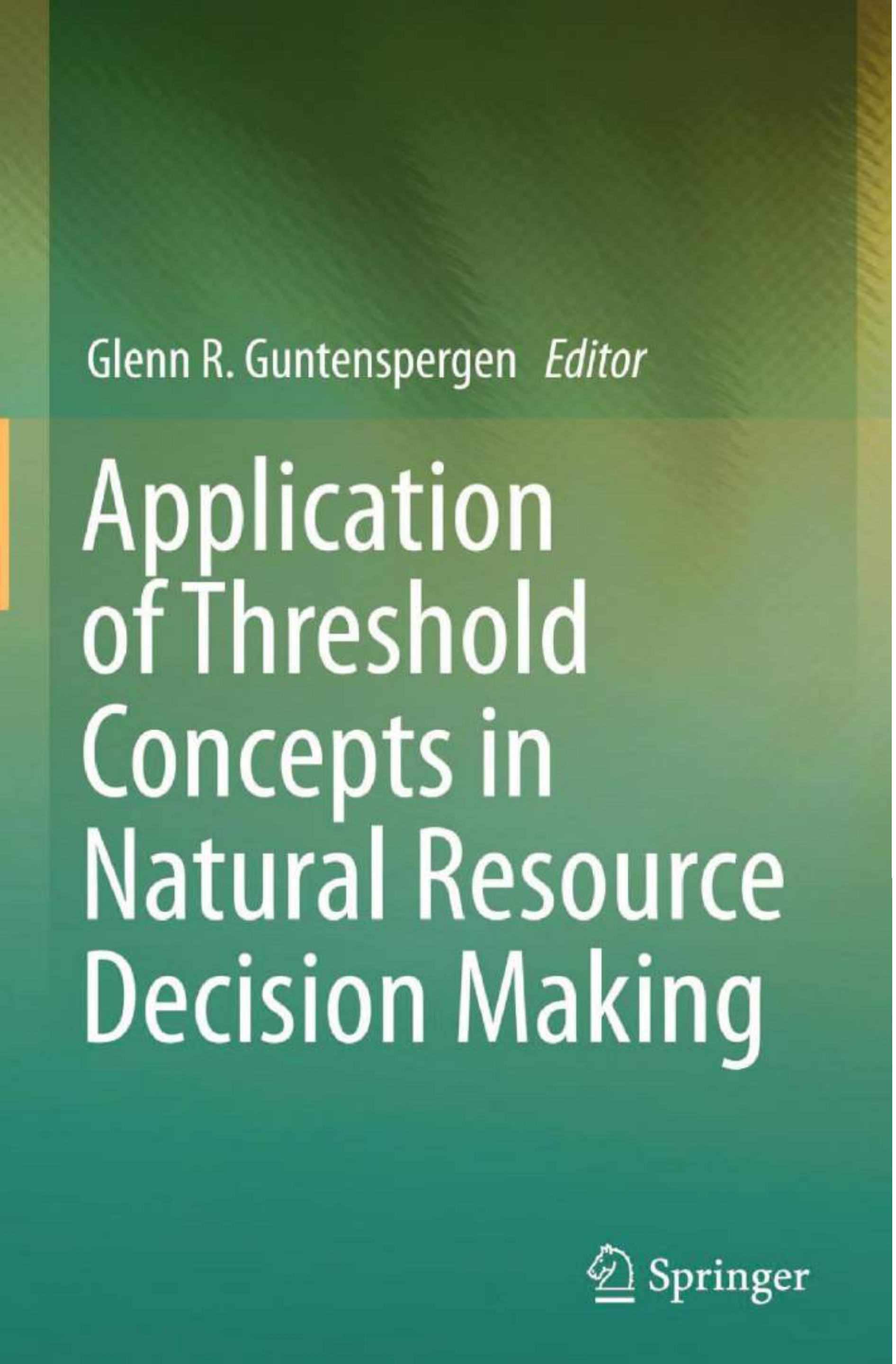


✓

Reporting Ecological Integrity: "Stoplight System"

●	Good
▼	Fair
■	Poor
N/R	Not Rated

Prov.	National Park	Forest
Ont.	Bruce Peninsula	●
	Georgian Bay Islands	●
	Point Pelee	▼
	Pukaskwa	●
	Thousand Islands	●



2014

Chapter 10
Getting the Message Across: Using Ecological Integrity to Communicate with Resource Managers

Brian R. Mitchell, Geraldine L. Tierney, E. William Schweiger, Kathryn M. Miller, Don Faber-Langendoen and James B. Grace

Abstract This chapter describes and illustrates how concepts of ecological integrity, thresholds, and reference conditions can be integrated into a research and monitoring framework for natural resource management. Ecological integrity has been defined as a measure of the composition, structure, and function of an ecosystem in relation to the system's natural or historical range of variation, as well as perturbations caused by natural or anthropogenic agents of change. Using ecological integrity to communicate with managers requires five steps, often implemented iteratively: (1) document the scale of the project and the current conceptual understanding and reference conditions of the ecosystem, (2) select appropriate metrics representing integrity, (3) define externally verified assessment points (metric values that signify an ecological change or need for management action) for the metrics, (4) collect data and calculate metric scores, and (5) summarize the status of the ecosystem using a variety of reporting methods. While we present the steps linearly for conceptual clarity, actual implementation of this approach may require addressing the steps in a

---

1) Define Scale & Conceptual Framework
2) Select Metrics
3) Determine Assessment Points
4) (Design a Monitoring System)
5) Collect Data and Calculate Metrics
6) Report Results
7) (Conduct Adaptive Management)

See Mitchell et al. 2014.

Table 10.1 Forest ecological integrity at three Northeast Temperate Network parks, based on a subset of ecological integrity metrics and data collected in 2007–2010. *Green* indicates that the park (or a percentage of the park for multicolored pie charts) is within the range of natural variation; *yellow* indicates that the surveillance (and first ecological) assessment point has been passed; *red* indicates that the action (and second ecological) assessment point has been exceeded

Metric	Acadia NP	Marsh-Billings-Rockefeller NHP	Morristown NHP
Composition: Indicator Invasive Species			
Composition: Tree Condition			
Composition: Tree Regeneration			
Structure: Stand Structure			
Structure: Snag Abundance			
Structure: Coarse Woody Debris Volume			
Function: Tree Mortality			TBD
Function: Soil Acid Stress			
Function: Herbivory & Food Webs			

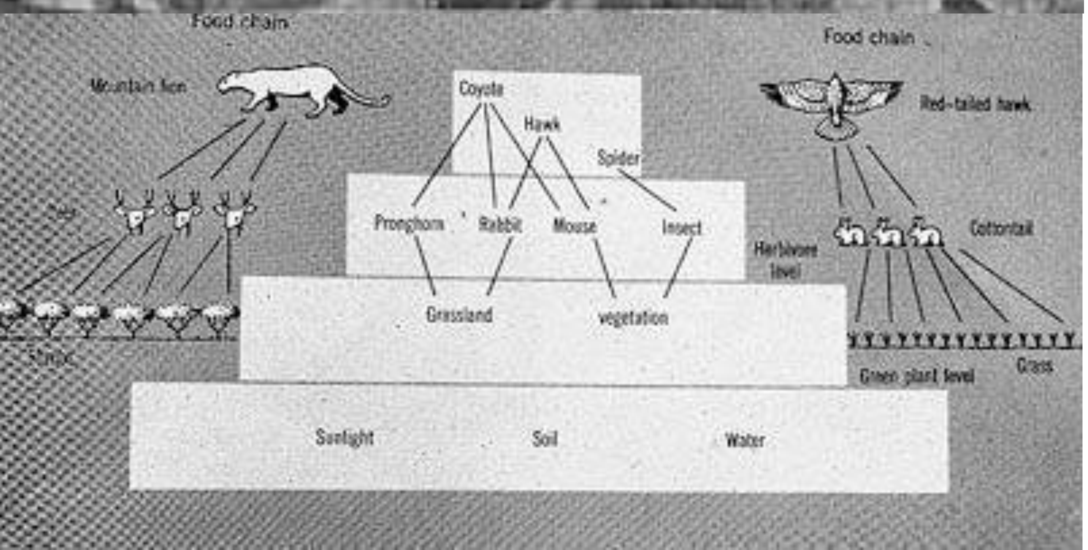
See Mitchell et al. 2014.

Table 10.1 Forest ecological integrity at three Northeast Temperate Network parks, based on a subset of ecological integrity metrics and data collected in 2007–2010. *Green* indicates that the park (or a percentage of the park for multicolored pie charts) is within the range of natural variation; *yellow* indicates that the surveillance (and first ecological) assessment point has been passed; *red* indicates that the action (and second ecological) assessment point has been exceeded

Metric	Acadia NP	Marsh-Billings-Rockefeller NHP	Morristown NHP
Composition: Indicator Invasive Species	= Norway Maple		
Composition: Tree Condition			
Composition: Tree Regeneration	= Norway Maple = Native Trees		
Structure: Stand Structure			
Structure: Snag Abundance			
Structure: Coarse Woody Debris Volume			
Function: Tree Mortality			TBD
Function: Soil Acid Stress			
Function: Herbivory & Food Webs	= Norway Maple = Native Trees		

<u>Big Question:</u>
The link between 'structure' 'composition' & 'function'

e.g. *Does 'nativeness' affect 'ecological function'?*



Does 'nativeness' affect 'ecological function'?

Charles Elton & Aldo Leopold

1931 Matamek Conference on Biological Cycles
Copley Amory's Fishing Camp
Labrador, Canada

"Forestry should always prescribe a mixed stand – that is, the perpetuation of every indigenous species. Variety is as valuable as quantity".

Leopold. 1918. Journal of Forestry
Elton. 1927. Animal Ecology

"Elton was laying the foundations of ecology; and Leopold was attempting to apply the science even before the principals were set"
(Meine. 1988)

Leopold. 1949. A Sand County Almanac
Elton. 1958. Ecology of Invasions

Leopold. 1939. The Biotic Pyramid

Land Health = Energy Flow

Non-Native Plants = Reduce Flow

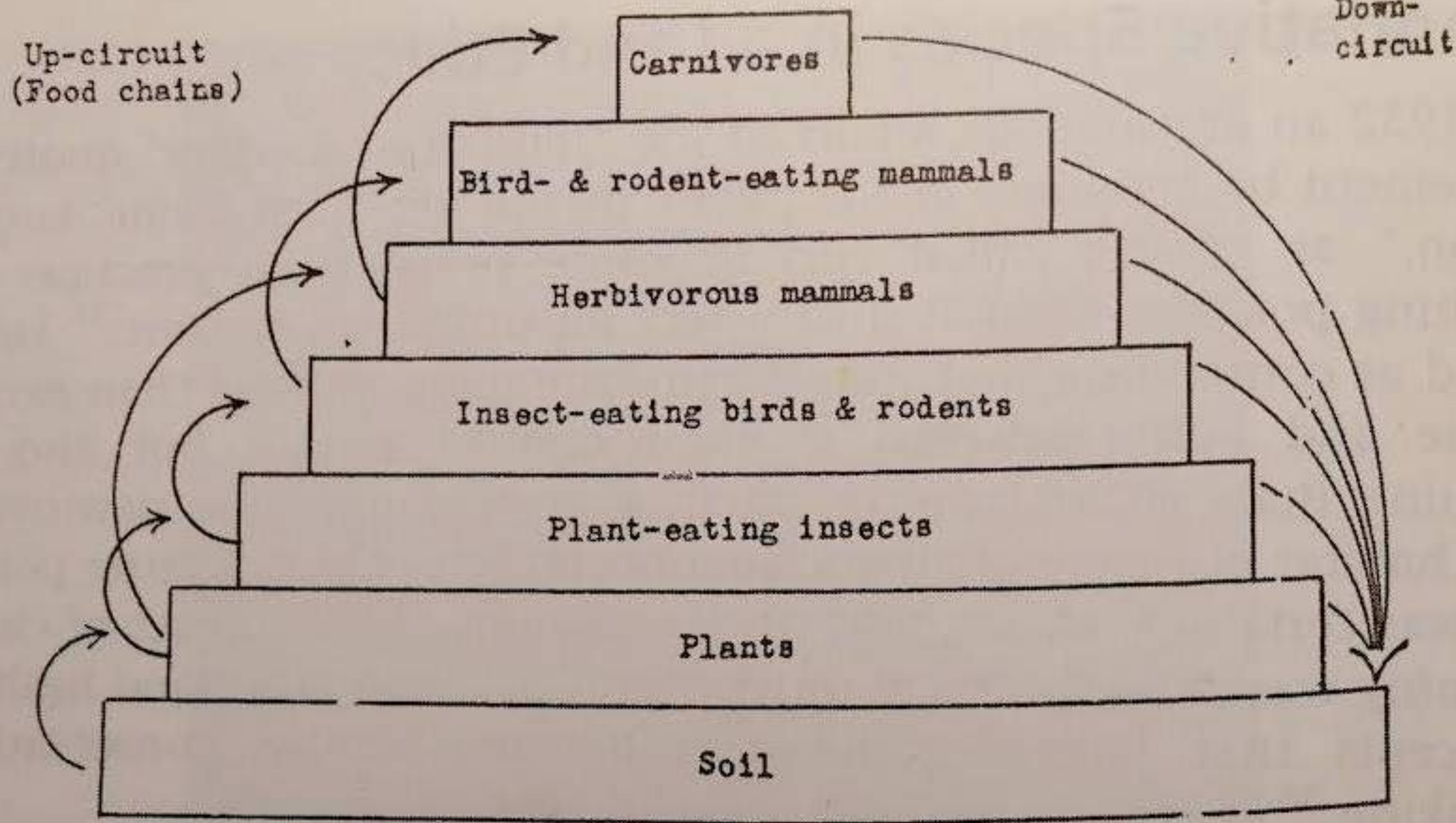
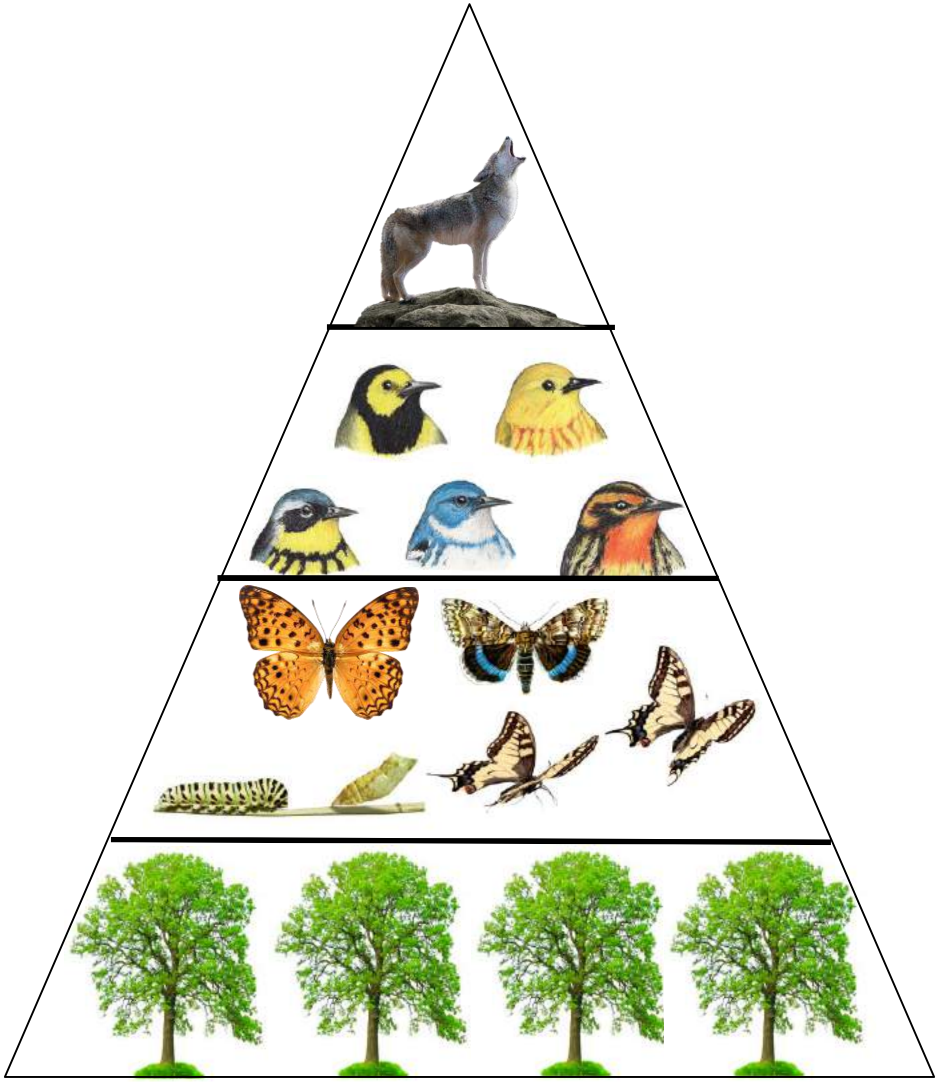
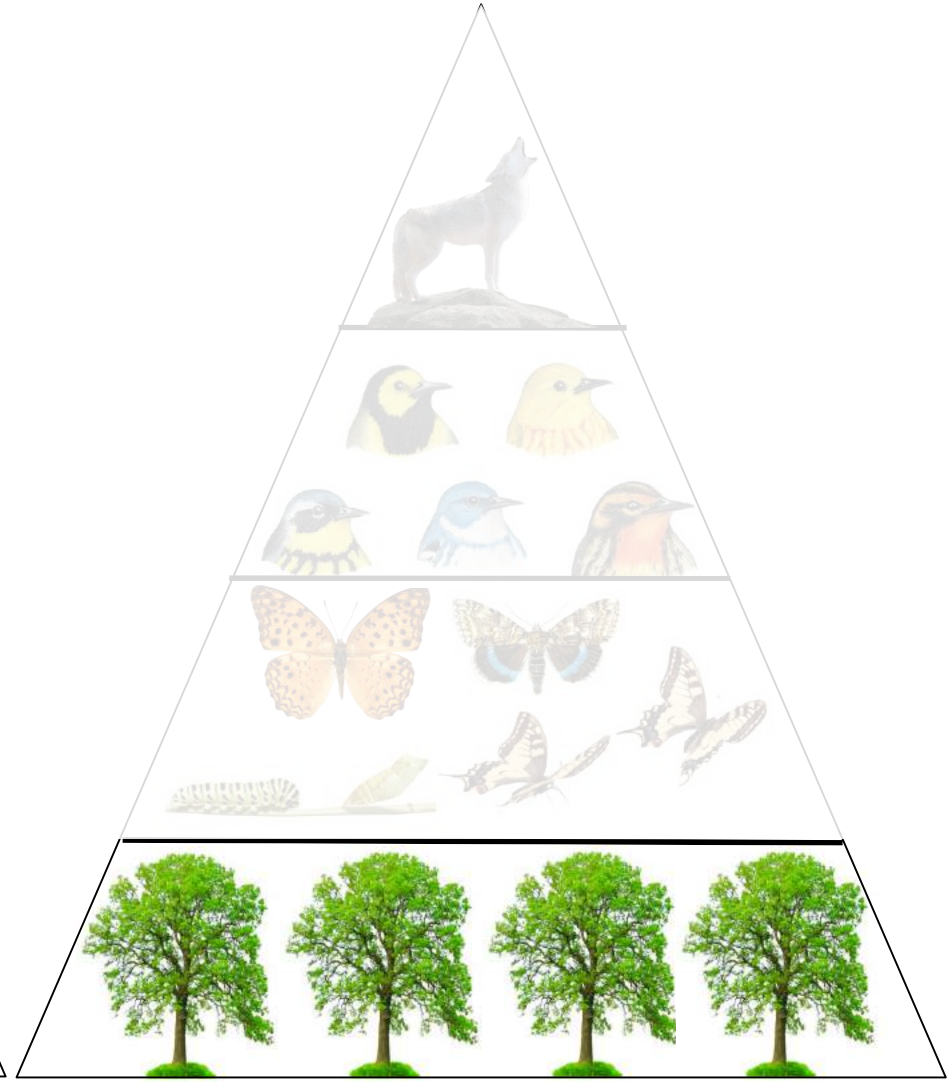


Figure 2: Aldo Leopold published this "biotic pyramid," which uses arrows to depict energy transfers in the environment, in the essay "A Biotic View of the Land" for the Journal of Forestry in 1939. Leopold modeled it on Charles Elton's pyramid of numbers. Leopold saw maintenance of this energy transfer as crucial to "land health" and believed that non-native species were likely to disrupt it. Credit: Journal of Forestry 37, 9: 728.



Native Trees



Non-Native Trees

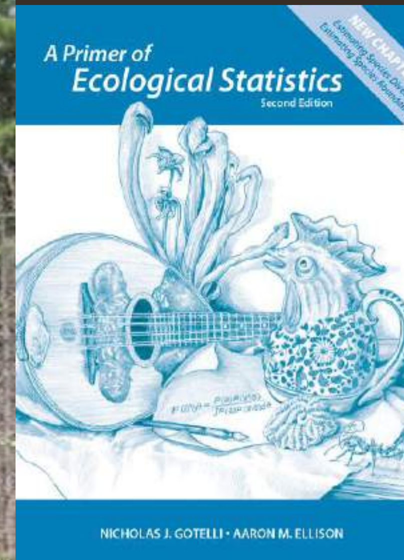
Dan Janzen. 1974. The Deflowering of Central America. Nat. Hist.

"What escapes the eye however, is a much more insidious type of extinction: the extinction of ecological interactions"

Aaron Ellison

HARVARD FOREST

Established 1907
Harvard University's 3500 acre laboratory & classroom
Long Term Ecological Research Site since 1988



REVIEWS REVIEWS REVIEWS

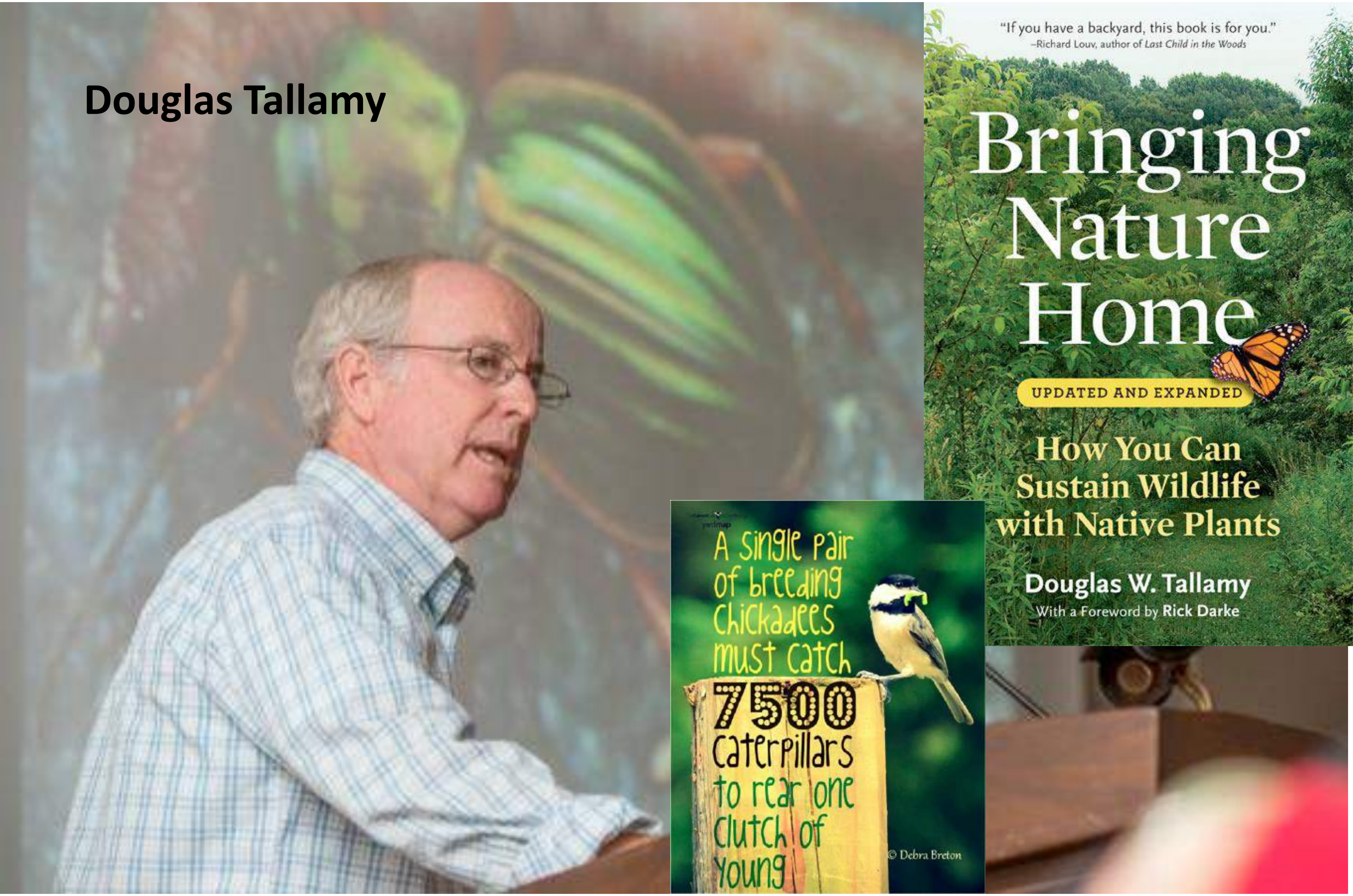
Loss of foundation species: consequences for the structure and dynamics of forested ecosystems

Aaron M Ellison[1*], Michael S Bank[1], Barton D Clinton[2], Elizabeth A Colburn[1], Katherine Elliott[2], Chelcy R Ford[2], David R Foster[1], Brian D Kloeppel[3], Jennifer D Knoepp[2], Gary M Lovett[4], Jacqueline Mohan[1], David A Orwig[1], Nicholas L Rodenhouse[5], William V Sobczak[6], Kristina A Stinson[1], Jeffrey K Stone[7], Christopher M Swan[8], Jill Thompson[9], Betsy Von Holle[1], and Jackson R Webster[10]

In many forested ecosystems, the architecture and functional ecology of certain tree species define forest structure and their species-specific traits control ecosystem dynamics. Such foundation tree species are declining throughout the world due to introductions and outbreaks of pests and pathogens, selective removal of individual taxa, and over-harvesting. Through a series of case studies, we show that the loss of foundation tree species changes the local environment on which a variety of other species depend; how this disrupts fundamental ecosystem processes, including rates of decomposition, nutrient fluxes, carbon sequestration, and energy flow; and dramatically alters the dynamics of associated aquatic ecosystems. Forests in which dynamics are controlled by one or a few foundation species appear to be dominated by a small number of strong interactions and may be highly susceptible to alternating between stable states following even small perturbations. The ongoing decline of many foundation species provides a set of important, albeit unfortunate, opportunities to develop the research tools, models, and metrics needed to identify foundation species, anticipate the cascade of immediate, short- and long-term changes in ecosystem structure and function that will follow from their loss, and provide options for remedial conservation and management.

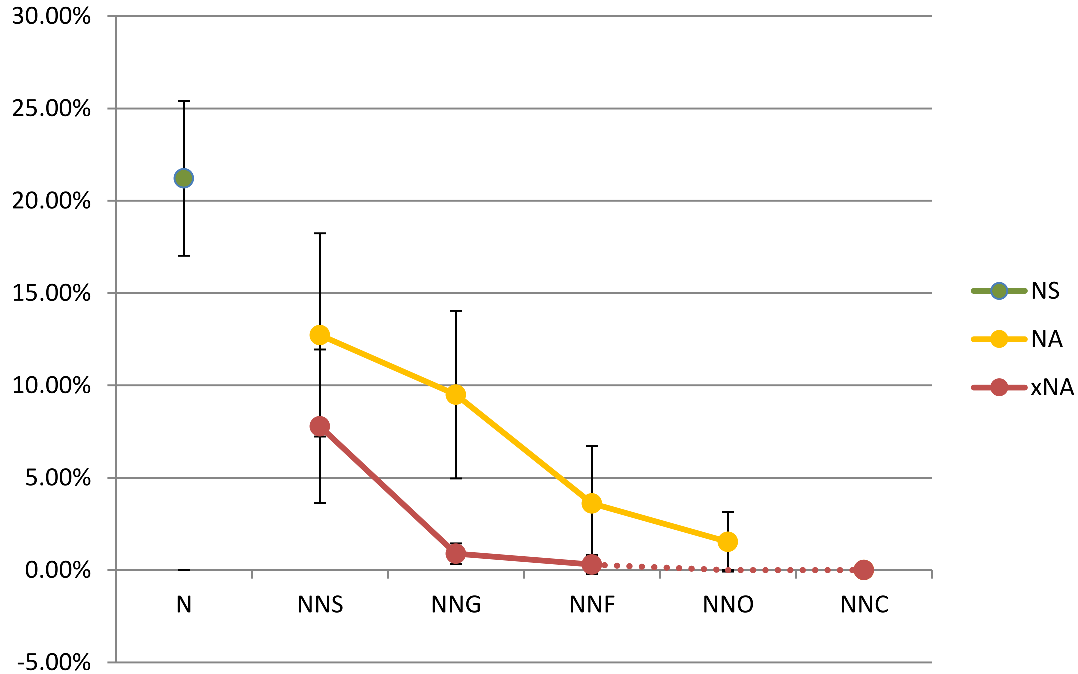
Front Ecol Environ 2005; 3(9): 479–486

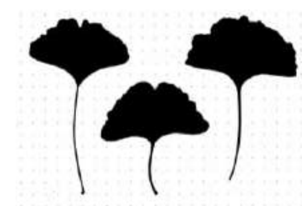
Douglas Tallamy



UNIVERSITY · OF · TORONTO ·
FORESTRY

Mean herbivory of trees in the various nativeness categories (Data: 2012 and 2016). Error bars represent 95% confidence intervals.





		Within NA				*Outside NA*		
TD	*n*	*Cat. Mean (%)*	*Cat. 95%CI (%)*	*Rel. ES (times)*	*n*	*Cat. Mean (%)*	*Cat. 95%CI (%)*	*Rel. ES (times)*
NS	9	21.21	4.18	1.00	N/A	N/A	N/A	N/A
NNS	4	12.73	5.50	1.67	8	7.79	4.16	2.72
NNG	4	9.50	4.54	2.23	6	0.89	0.55	23.83
NNF	6	3.60	3.12	5.89	3	0.29	0.52	73.14
NNO	3	1.53	1.61	13.86	N/A	N/A	N/A	N/A
NNC	N/A	N/A	N/A	N/A	1	0.00	0.00	~2121

NATIVE

NON-NATIVE

RESILIENCY

ECOSYSTEM SERVICES

HUMAN HEALTH

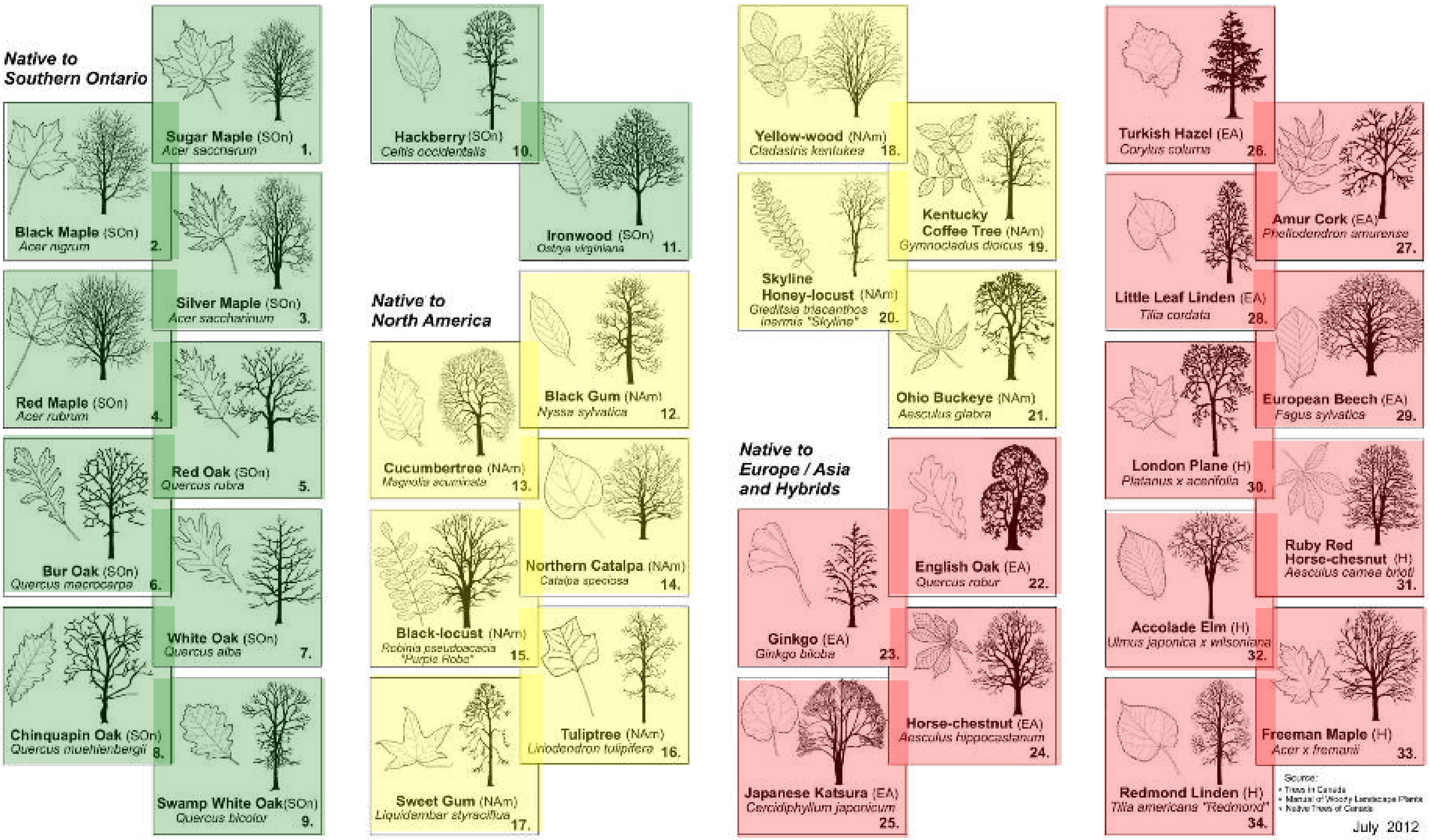
MATERIALS

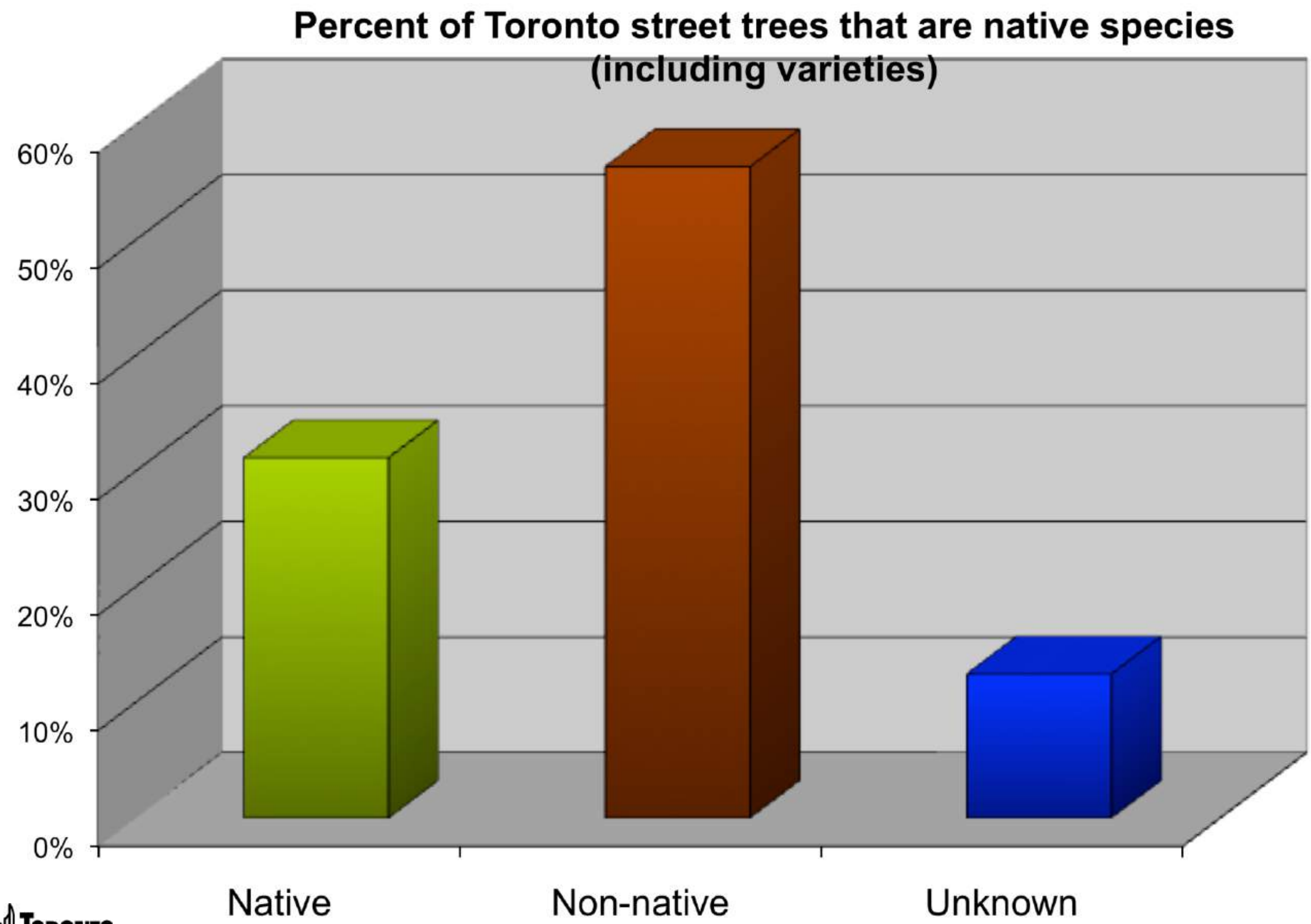
SOIL + VEGETATION

WATER

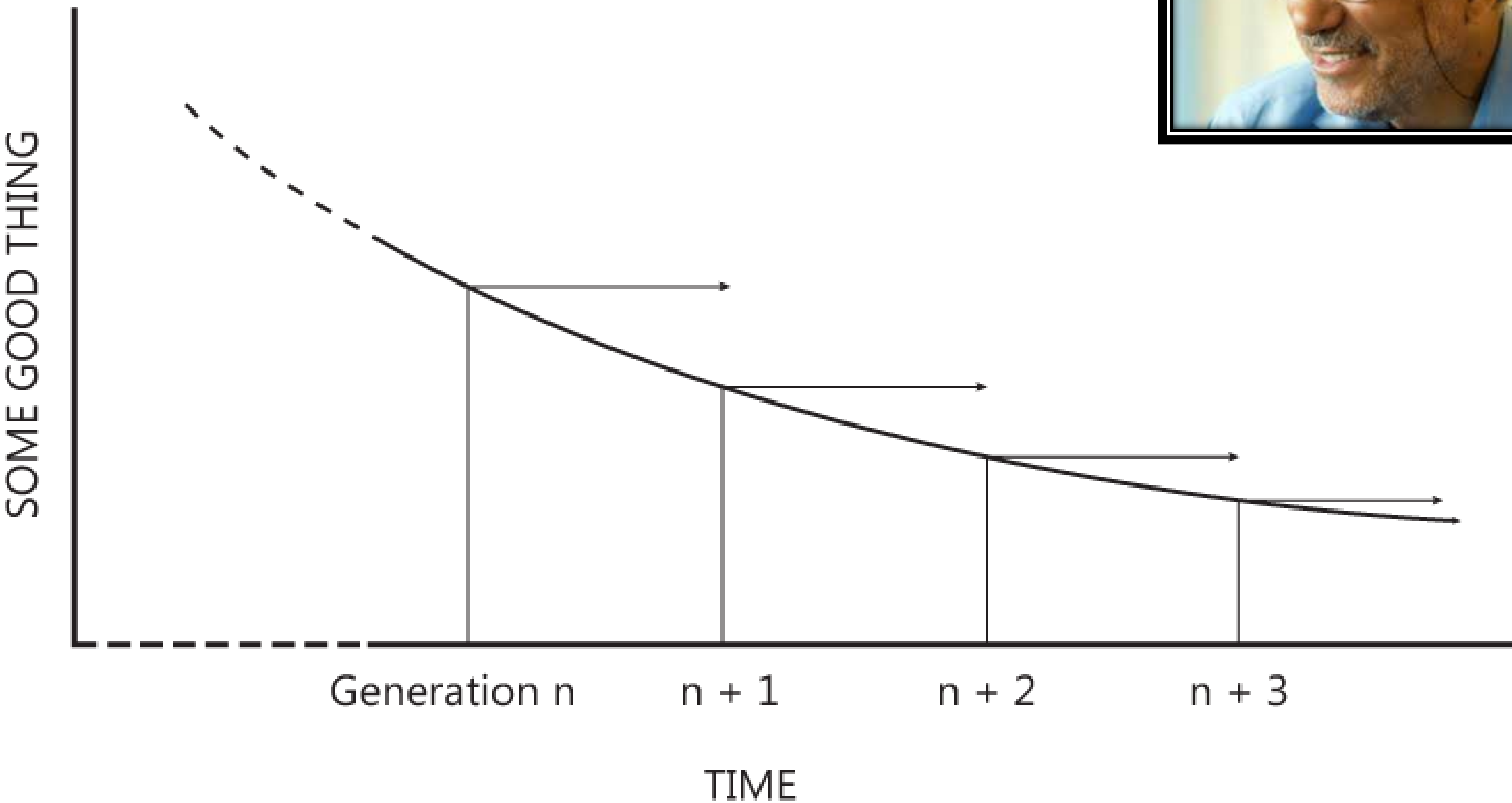
City of Toronto

Recommended planting list - mostly Non-Native Trees

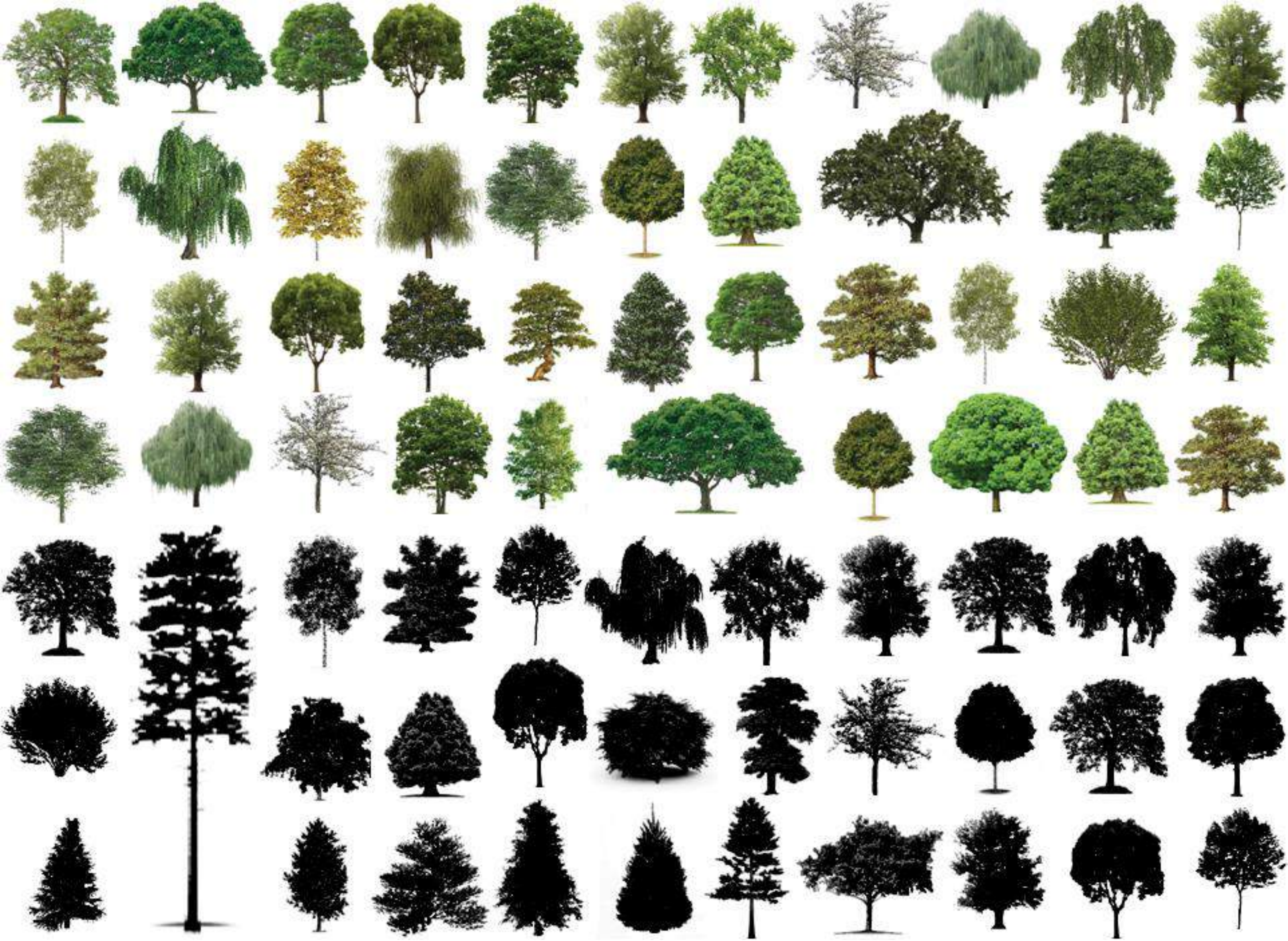



Percent of Toronto street trees that are native species (including varieties)
60%
50%
40%
30%
20%
10%
0%
Native
Non-native
Unknown

Anecdotes and the shifting baseline syndrome of fisheries
Daniel Pauly, 1995, Trends in Ecology & Evolution

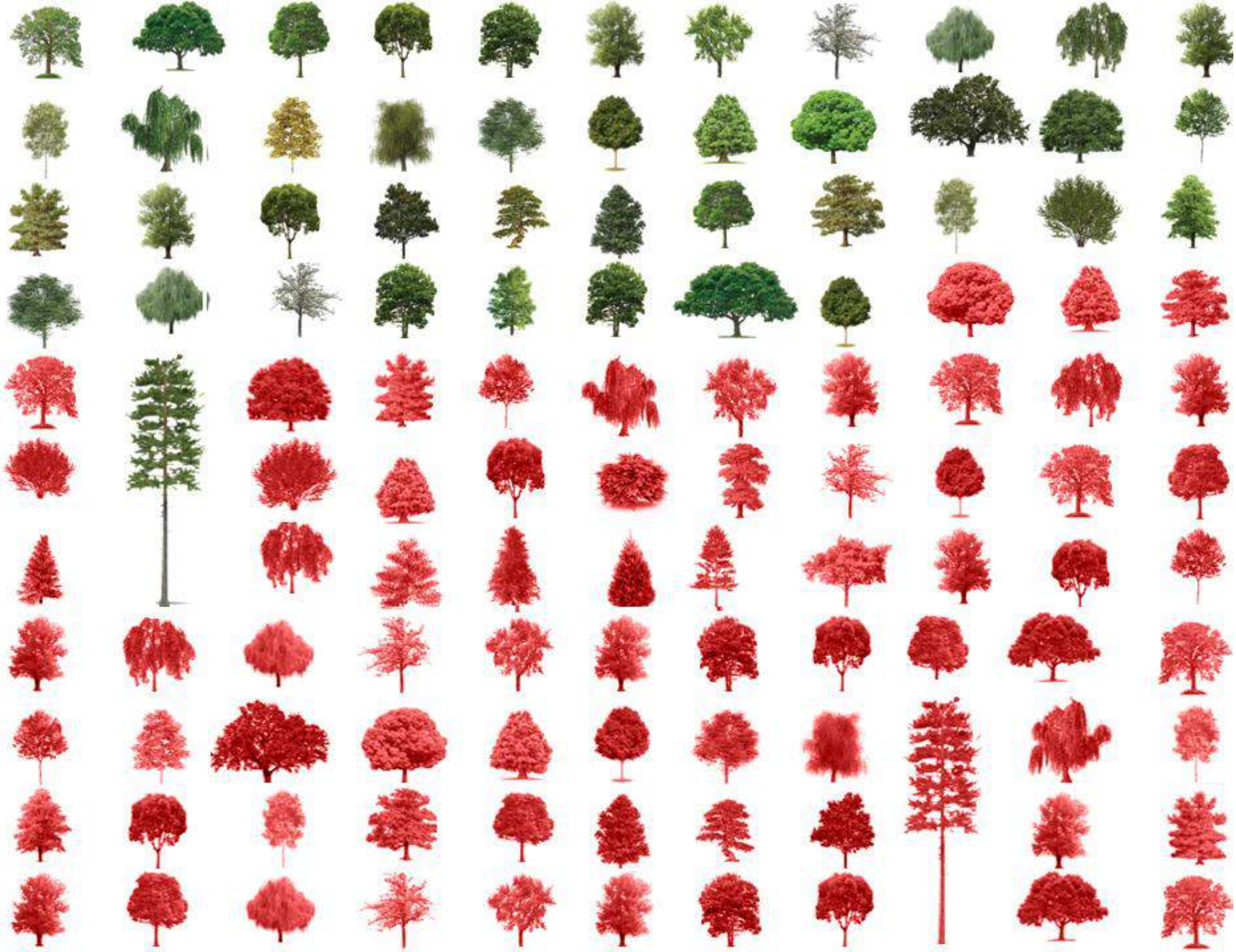


The State of North America's Urban Forests: A Call for Rewilding



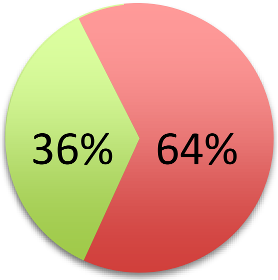
Toronto, ON

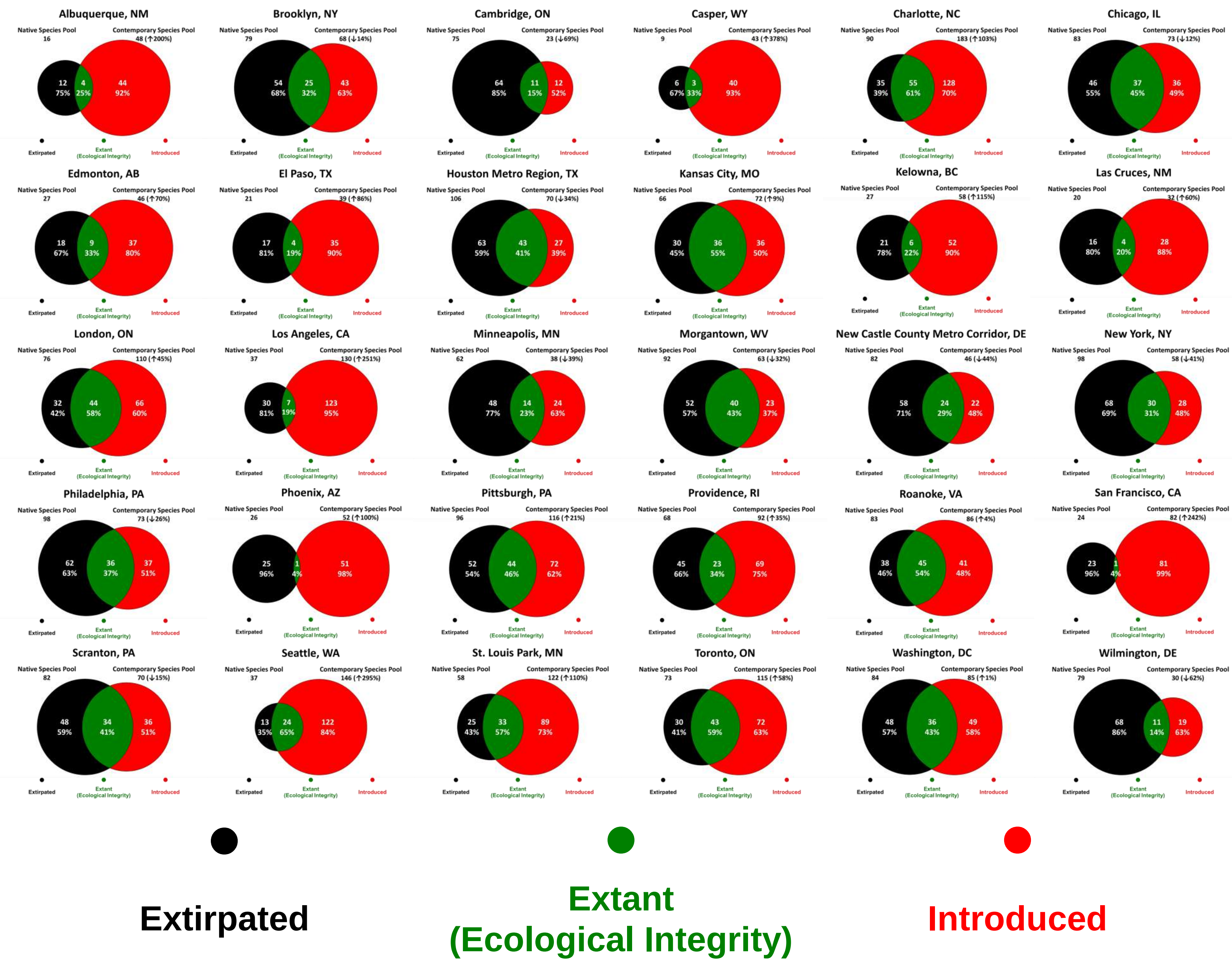
Extant Native vs. Dark Diversity



Toronto, ON

Native vs. Non-Native




Albuquerque, NM
Native Species Pool 16
Contemporary Species Pool 48 (↑200%)
12 75%
4 25%
44 92%
Extirpated
Extant (Ecological Integrity)
Introduced
Brooklyn, NY
Native Species Pool 79
Contemporary Species Pool 68 (↓14%)
54 68%
25 32%
43 63%
Extirpated
Extant (Ecological Integrity)
Introduced
Cambridge, ON
Native Species Pool 75
Contemporary Species Pool 23 (↓69%)
64 85%
11 15%
12 52%
Extirpated
Extant (Ecological Integrity)
Introduced
Casper, WY
Native Species Pool 9
Contemporary Species Pool 43 (↑378%)
6 67%
3 33%
40 93%
Extirpated
Extant (Ecological Integrity)
Introduced
Charlotte, NC
Native Species Pool 90
Contemporary Species Pool 183 (↑103%)
35 39%
55 61%
128 70%
Extirpated
Extant (Ecological Integrity)
Introduced
Chicago, IL
Native Species Pool 83
Contemporary Species Pool 73 (↓12%)
46 55%
37 45%
36 49%
Extirpated
Extant (Ecological Integrity)
Introduced
Edmonton, AB
Native Species Pool 27
Contemporary Species Pool 46 (↑70%)
18 67%
9 33%
37 80%
Extirpated
Extant (Ecological Integrity)
Introduced
El Paso, TX
Native Species Pool 21
Contemporary Species Pool 39 (↑86%)
17 81%
4 19%
35 90%
Extirpated
Extant (Ecological Integrity)
Introduced
Houston Metro Region, TX
Native Species Pool 106
Contemporary Species Pool 70 (↓34%)
63 59%
43 41%
27 39%
Extirpated
Extant (Ecological Integrity)
Introduced
Kansas City, MO
Native Species Pool 66
Contemporary Species Pool 72 (↑9%)
30 45%
36 55%
36 50%
Extirpated
Extant (Ecological Integrity)
Introduced
Kelowna, BC
Native Species Pool 27
Contemporary Species Pool 58 (↑115%)
21 78%
6 22%
52 90%
Extirpated
Extant (Ecological Integrity)
Introduced
Las Cruces, NM
Native Species Pool 20
Contemporary Species Pool 32 (↑60%)
16 80%
4 20%
28 88%
Extirpated
Extant (Ecological Integrity)
Introduced
London, ON
Native Species Pool 76
Contemporary Species Pool 110 (↑45%)
32 42%
44 58%
66 60%
Extirpated
Extant (Ecological Integrity)
Introduced
Los Angeles, CA
Native Species Pool 37
Contemporary Species Pool 130 (↑251%)
30 81%
7 19%
123 95%
Extirpated
Extant (Ecological Integrity)
Introduced
Minneapolis, MN
Native Species Pool 62
Contemporary Species Pool 38 (↓39%)
48 77%
14 23%
24 63%
Extirpated
Extant (Ecological Integrity)
Introduced
Morgantown, WV
Native Species Pool 92
Contemporary Species Pool 63 (↓32%)
52 57%
40 43%
23 37%
Extirpated
Extant (Ecological Integrity)
Introduced
New Castle County Metro Corridor, DE
Native Species Pool 82
Contemporary Species Pool 46 (↓44%)
58 71%
24 29%
22 48%
Extirpated
Extant (Ecological Integrity)
Introduced
New York, NY
Native Species Pool 98
Contemporary Species Pool 58 (↓41%)
68 69%
30 31%
28 48%
Extirpated
Extant (Ecological Integrity)
Introduced
Philadelphia, PA
Native Species Pool 98
Contemporary Species Pool 73 (↓26%)
62 63%
36 37%
37 51%
Extirpated
Extant (Ecological Integrity)
Introduced
Phoenix, AZ
Native Species Pool 26
Contemporary Species Pool 52 (↑100%)
25 96%
1 4%
51 98%
Extirpated
Extant (Ecological Integrity)
Introduced
Pittsburgh, PA
Native Species Pool 96
Contemporary Species Pool 116 (↑21%)
52 54%
44 46%
72 62%
Extirpated
Extant (Ecological Integrity)
Introduced
Providence, RI
Native Species Pool 68
Contemporary Species Pool 92 (↑35%)
45 66%
23 34%
69 75%
Extirpated
Extant (Ecological Integrity)
Introduced
Roanoke, VA
Native Species Pool 83
Contemporary Species Pool 86 (↑4%)
38 46%
45 54%
41 48%
Extirpated
Extant (Ecological Integrity)
Introduced
San Francisco, CA
Native Species Pool 24
Contemporary Species Pool 82 (↑242%)
23 96%
1 4%
81 99%
Extirpated
Extant (Ecological Integrity)
Introduced
Scranton, PA
Native Species Pool 82
Contemporary Species Pool 70 (↓15%)
48 59%
34 41%
36 51%
Extirpated
Extant (Ecological Integrity)
Introduced
Seattle, WA
Native Species Pool 37
Contemporary Species Pool 146 (↑295%)
13 35%
24 65%
122 84%
Extirpated
Extant (Ecological Integrity)
Introduced
St. Louis Park, MN
Native Species Pool 58
Contemporary Species Pool 122 (↑110%)
25 43%
33 57%
89 73%
Extirpated
Extant (Ecological Integrity)
Introduced
Toronto, ON
Native Species Pool 73
Contemporary Species Pool 115 (↑58%)
30 41%
43 59%
72 63%
Extirpated
Extant (Ecological Integrity)
Introduced
Washington, DC
Native Species Pool 84
Contemporary Species Pool 85 (↑1%)
48 57%
36 43%
49 58%
Extirpated
Extant (Ecological Integrity)
Introduced
Wilmington, DE
Native Species Pool 79
Contemporary Species Pool 30 (↓62%)
68 86%
11 14%
19 63%
Extirpated
Extant (Ecological Integrity)
Introduced
Extirpated
Extant (Ecological Integrity)
Introduced

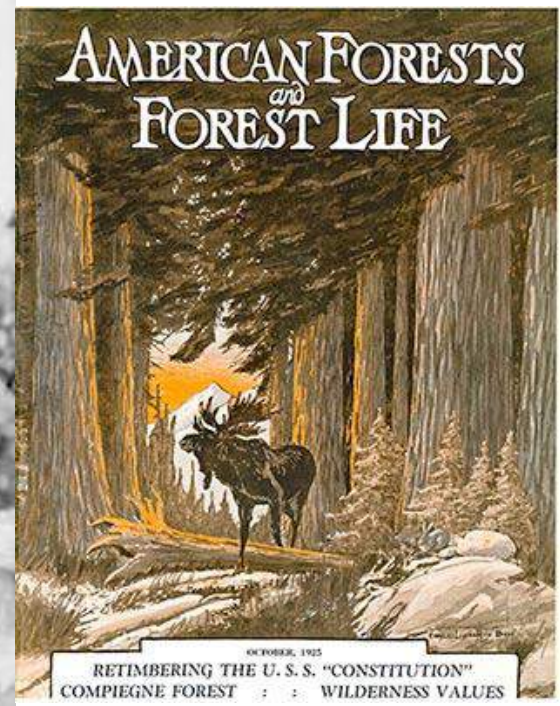
"The **Sugar Maple** is as American as the rail fence or the Kentucky rifle.
Generations have been rocked in maple cradles, clothed from maple spinning wheels,
and fed with maple-sweetened cakes served on maple tables before maple fires.

Yet the demise of the maple forest brings us less regret than the demise of an old tire.
Like the shrew who burrows in maple woods, we take our environment for granted while it lasts.

Unlike the shrew, we make shift with substitutes. The poorest is the European **"Norway Maple"**,
a colourless fast-growing tree persistently used by misguided suburbanites to kill lawns."*

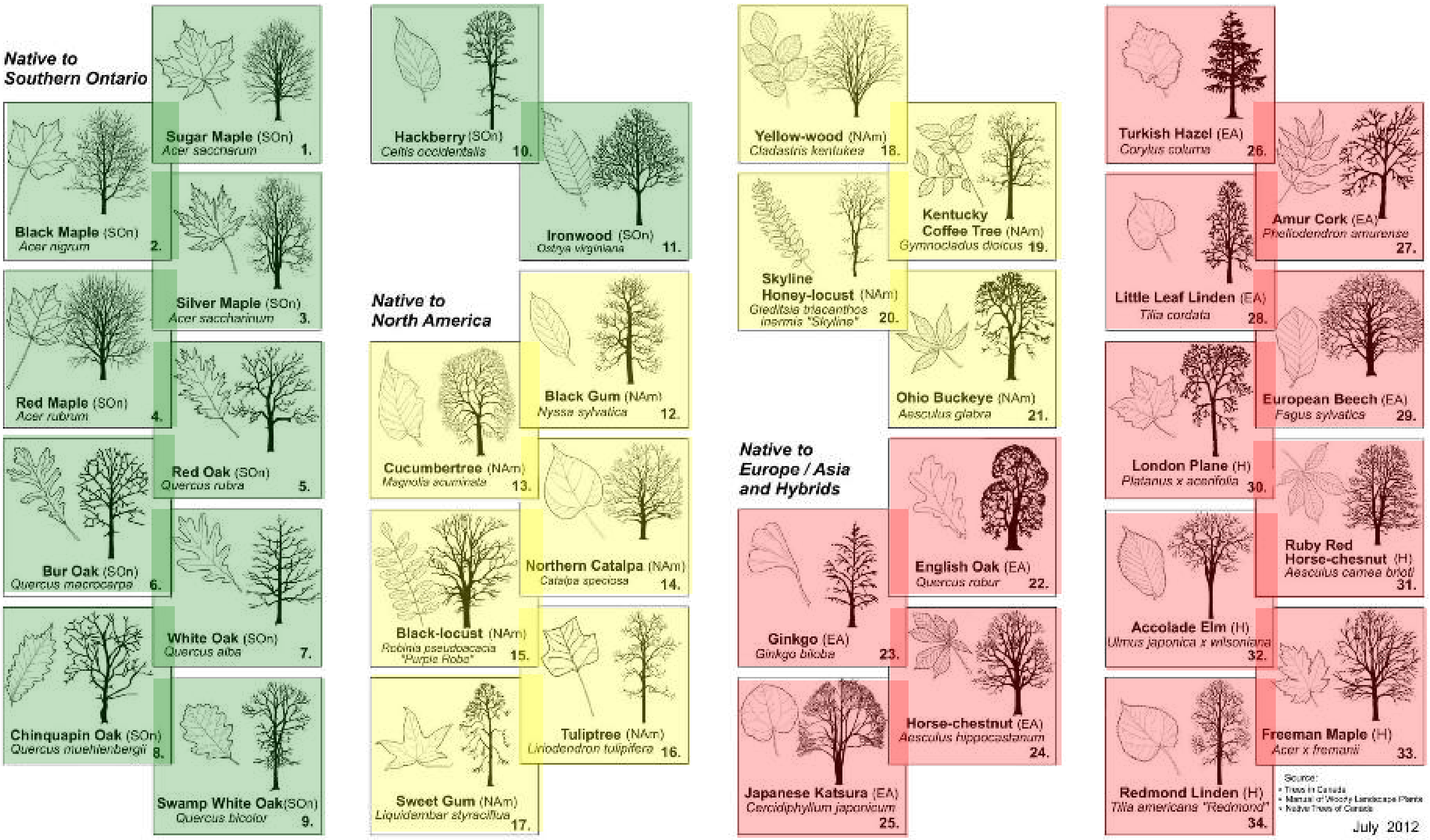
Aldo Leopold. 1942.
The Last Stand. Outdoor America.

Aldo Leopold. 1925
The Last Stand of the Wilderness

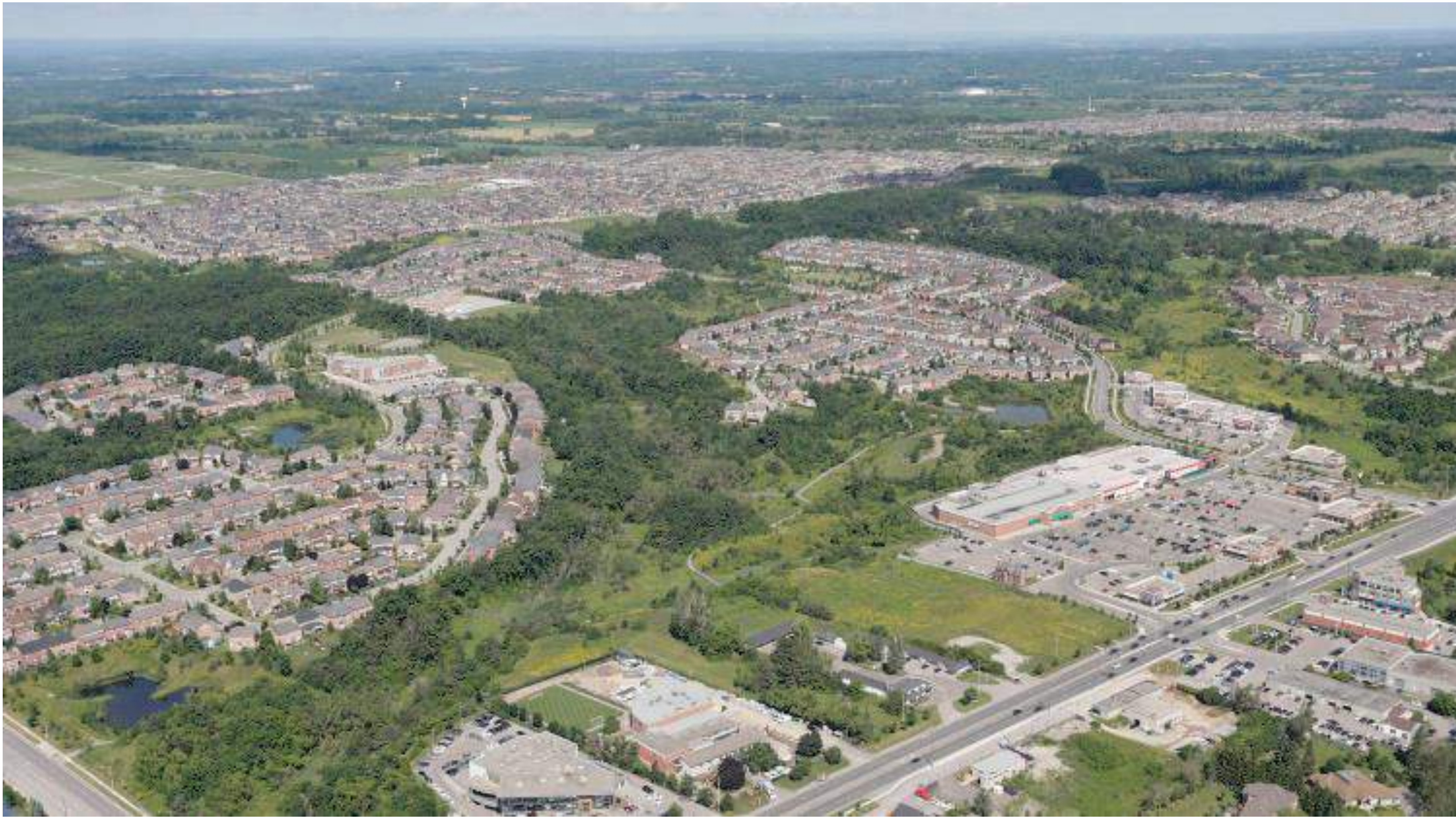


City of Toronto

Recommended planting list - mostly Non-Native Trees



Toronto's Urban Forests…surround the Ravines



Non-native plants = biotic pollution

City of Toronto: No Plan for Ecological Integrity

- *2 years thinking about it*
- *No Report yet, Taking to Council in 1 month*
- *Hired consultant to invent an alternate framework*

The University of Toronto, Faculty of Forestry

Toronto Ravine Study

www.TorontoRavines.org

Developing (Silvicultural) Guidelines for Monitoring & Restoring the Ecological Integrity of the Toronto Ravine Forests

Linking with City of Toronto's:

Toronto Ravine Strategy

(UofT Forestry is on Advisory Group)

1977 Rosedale Ravine Study

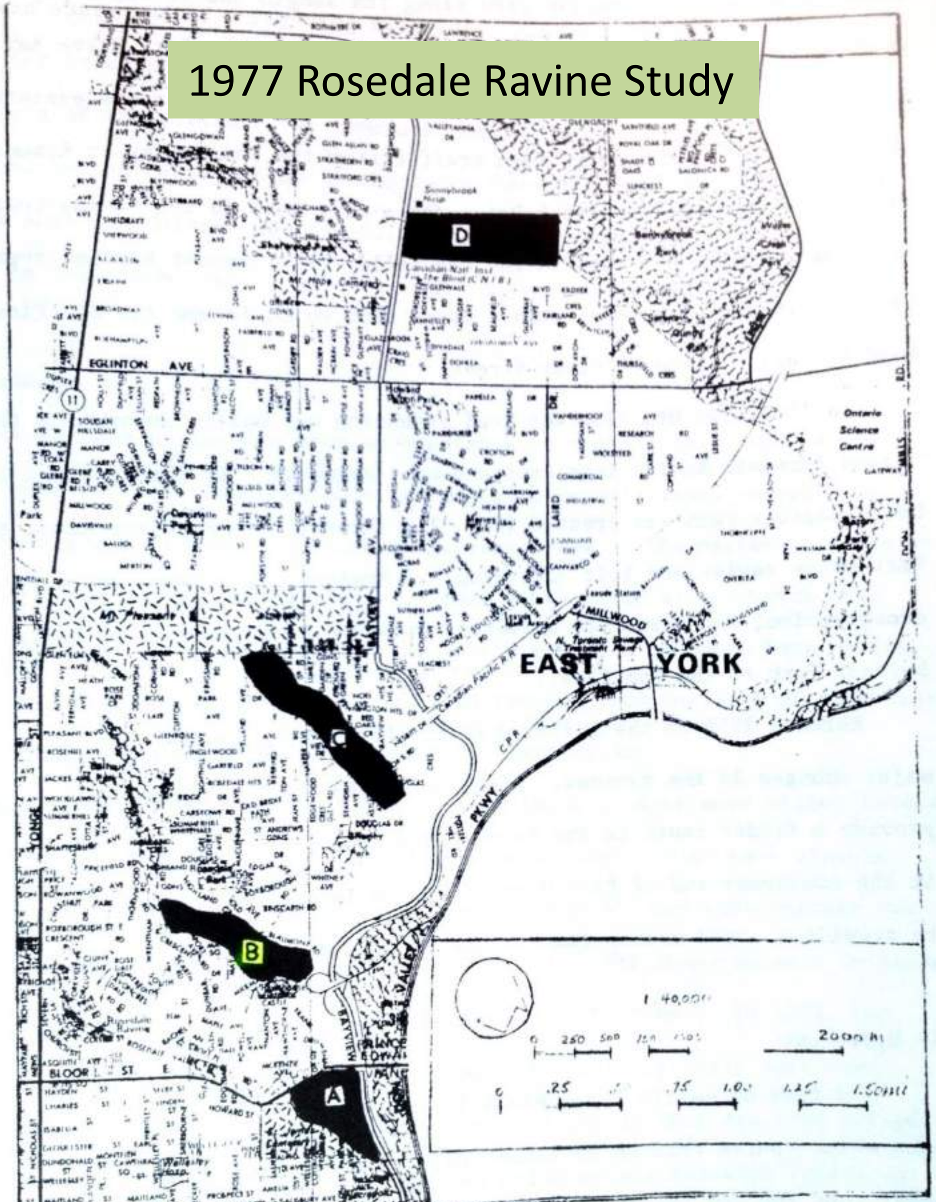
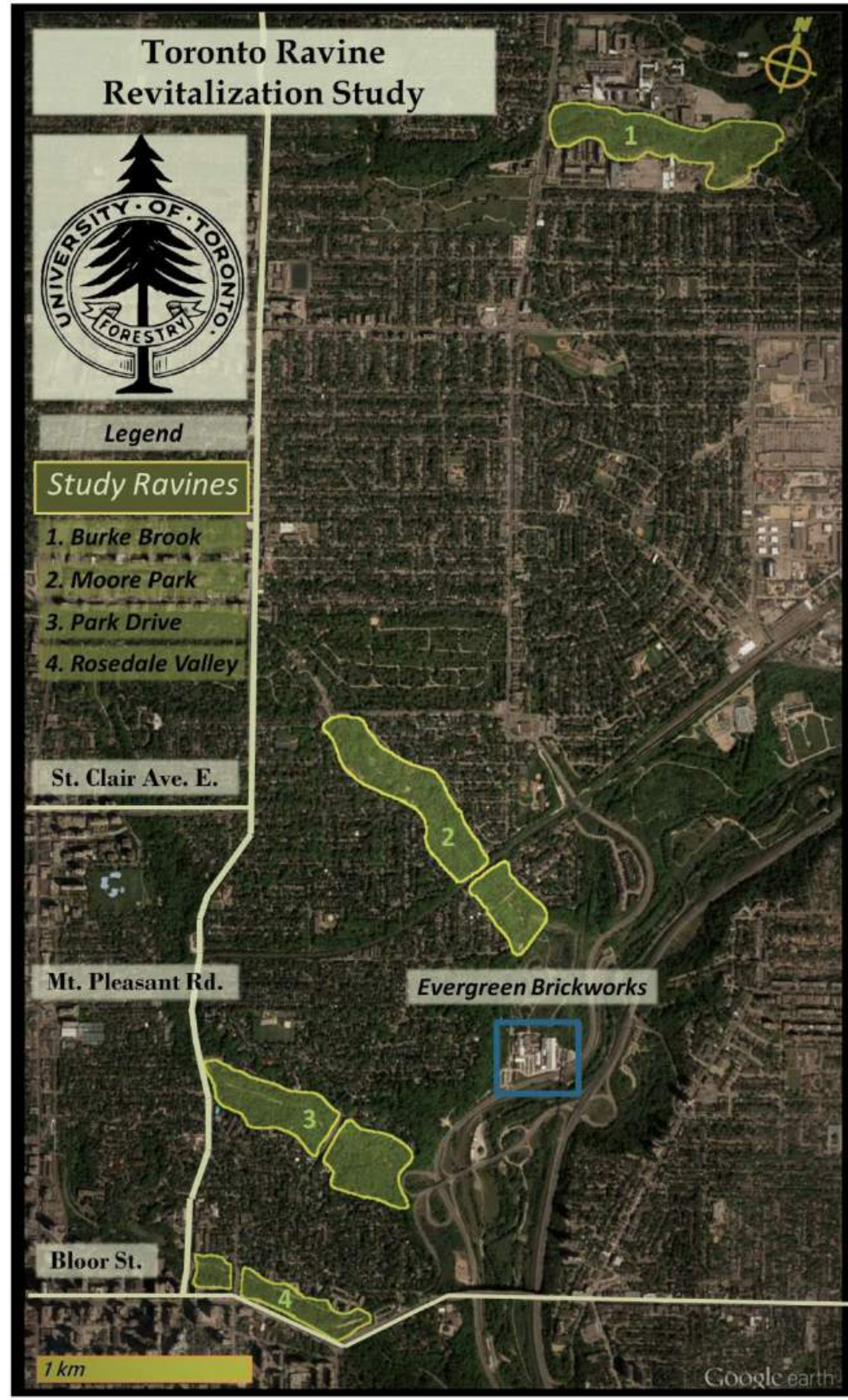


Figure 1. East-central Metropolitan Toronto. A = Rosedale Valley; B = Park Drive ravine; C = Moore Park ravine; D = Burke Brook ravine. (Creative Sales, 1976. Scale, ca. 1:40,000.)

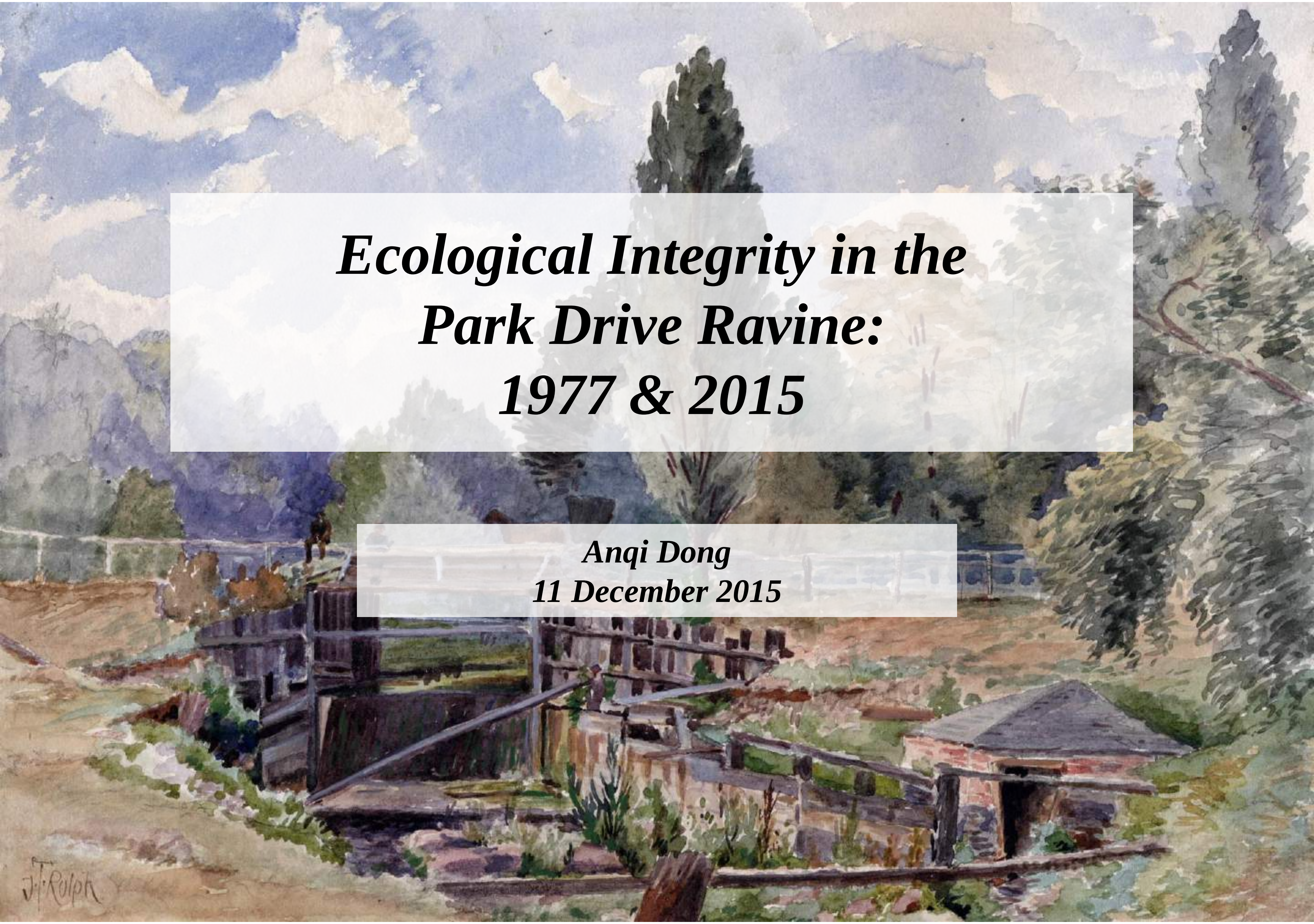
(Dale Taylor & Paul Scrivener)



Ecological Integrity in the Park Drive Ravine: 1977 & 2015

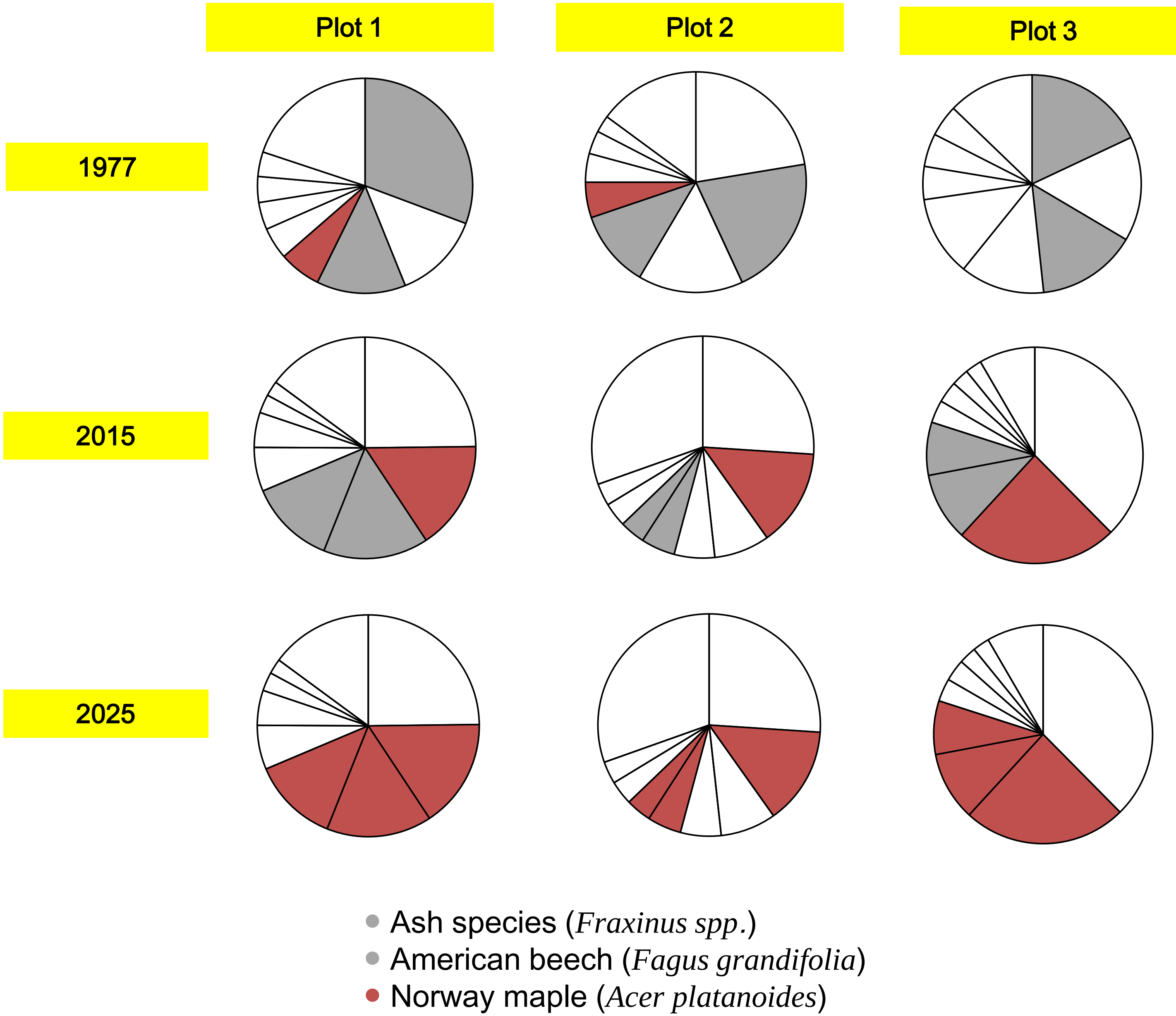
Anqi Dong

11 December 2015



Rosedale
Evergreen Brick Works
Google earth
© 2016 Google
404 m
2002
Imagery Date: 5/22/2015 43°40'48.97" N 79°22'06.04" W elev 91 m eye alt 1.87 km


Evergreen Brick Works
Rosedale
404 m
© 2016 Google
Google earth
Imagery Date: 5/22/2015

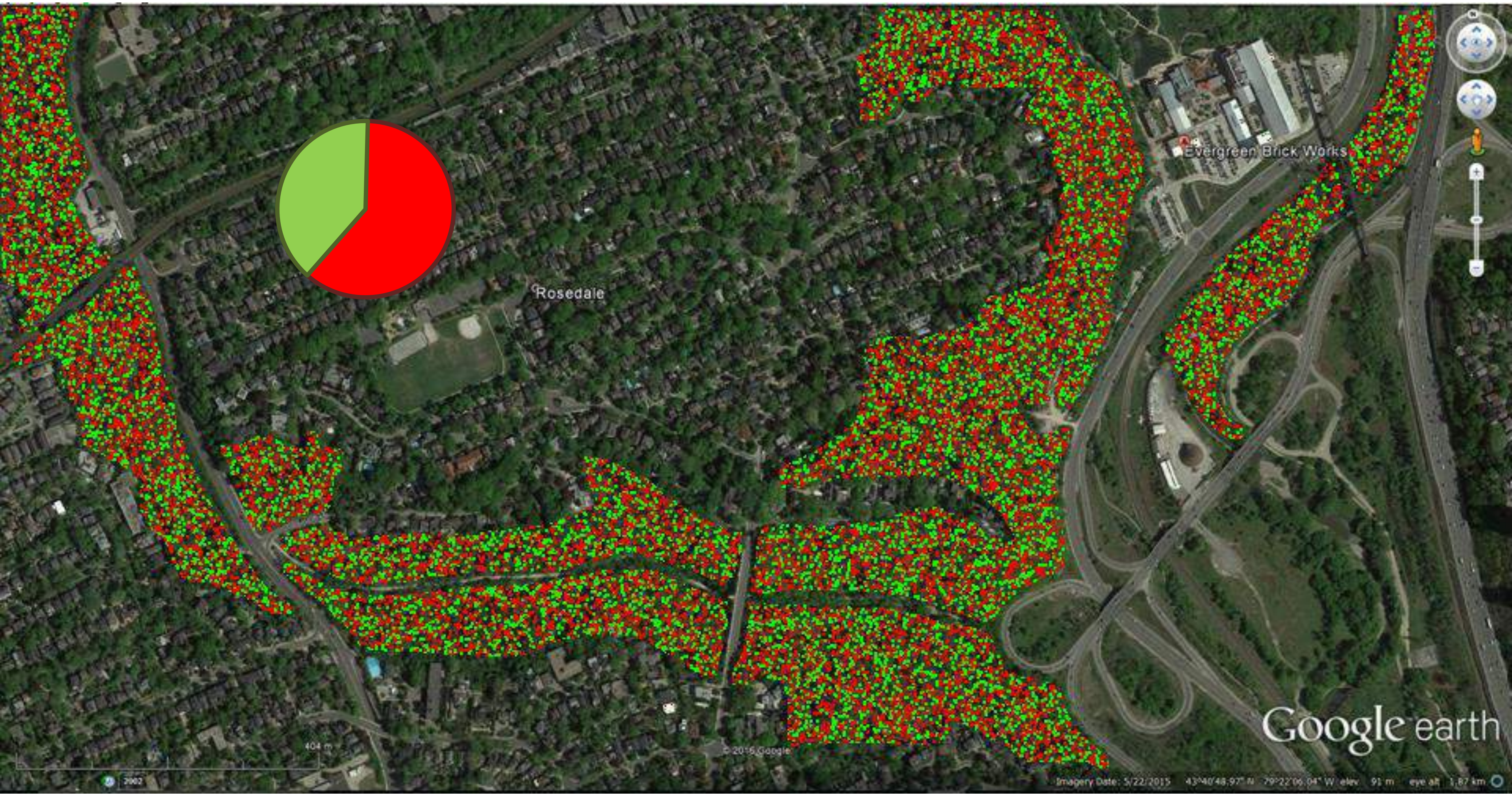

Plot 1
Plot 2
Plot 3
1977
2015
2025
Ash species (*Fraxinus spp.*)
American beech (*Fagus grandifolia*)
Norway maple (*Acer platanoides*)

Historical

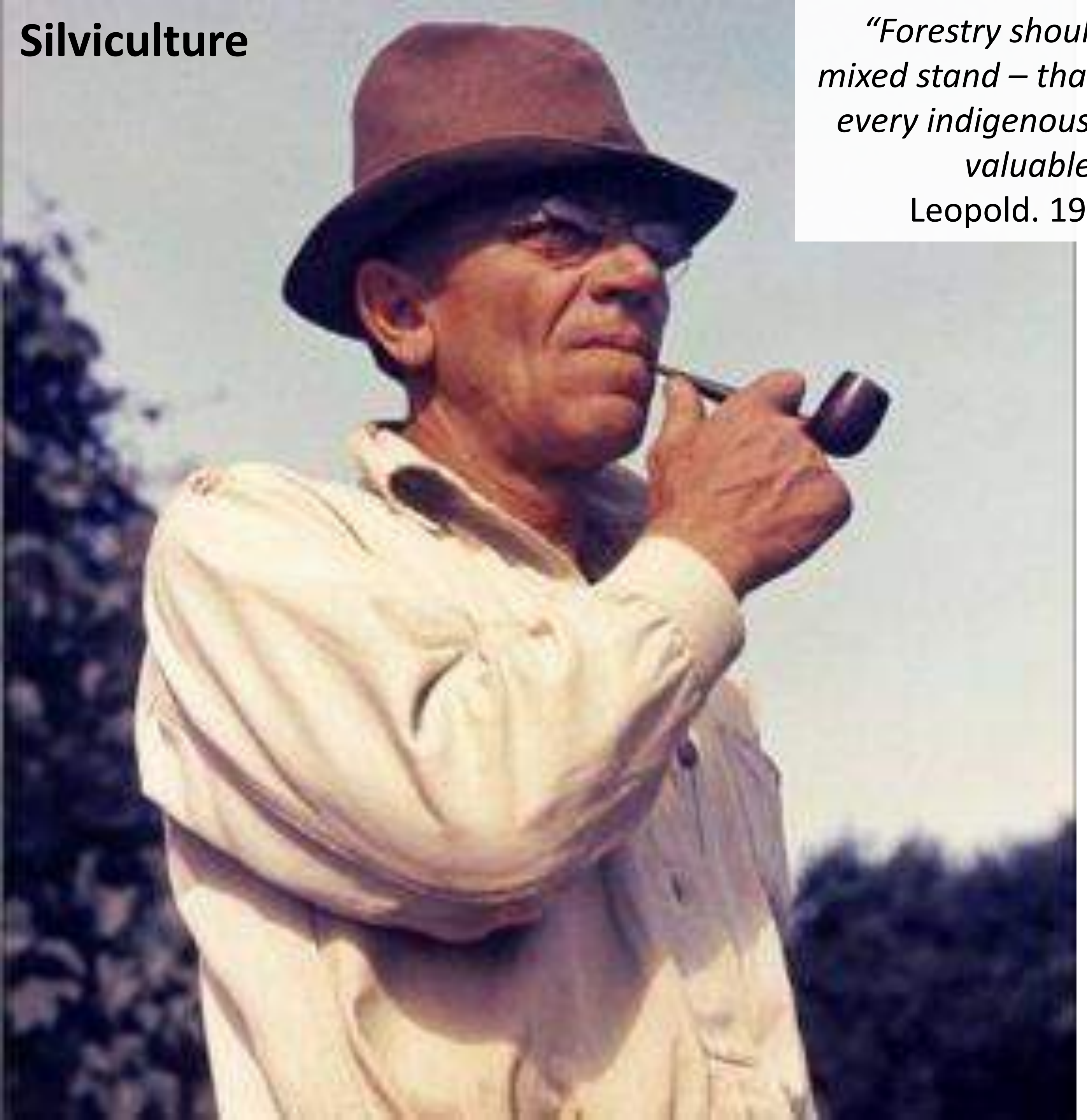
Observed 1977

Observed 2015

Predicted by 2050 (Business as usual)



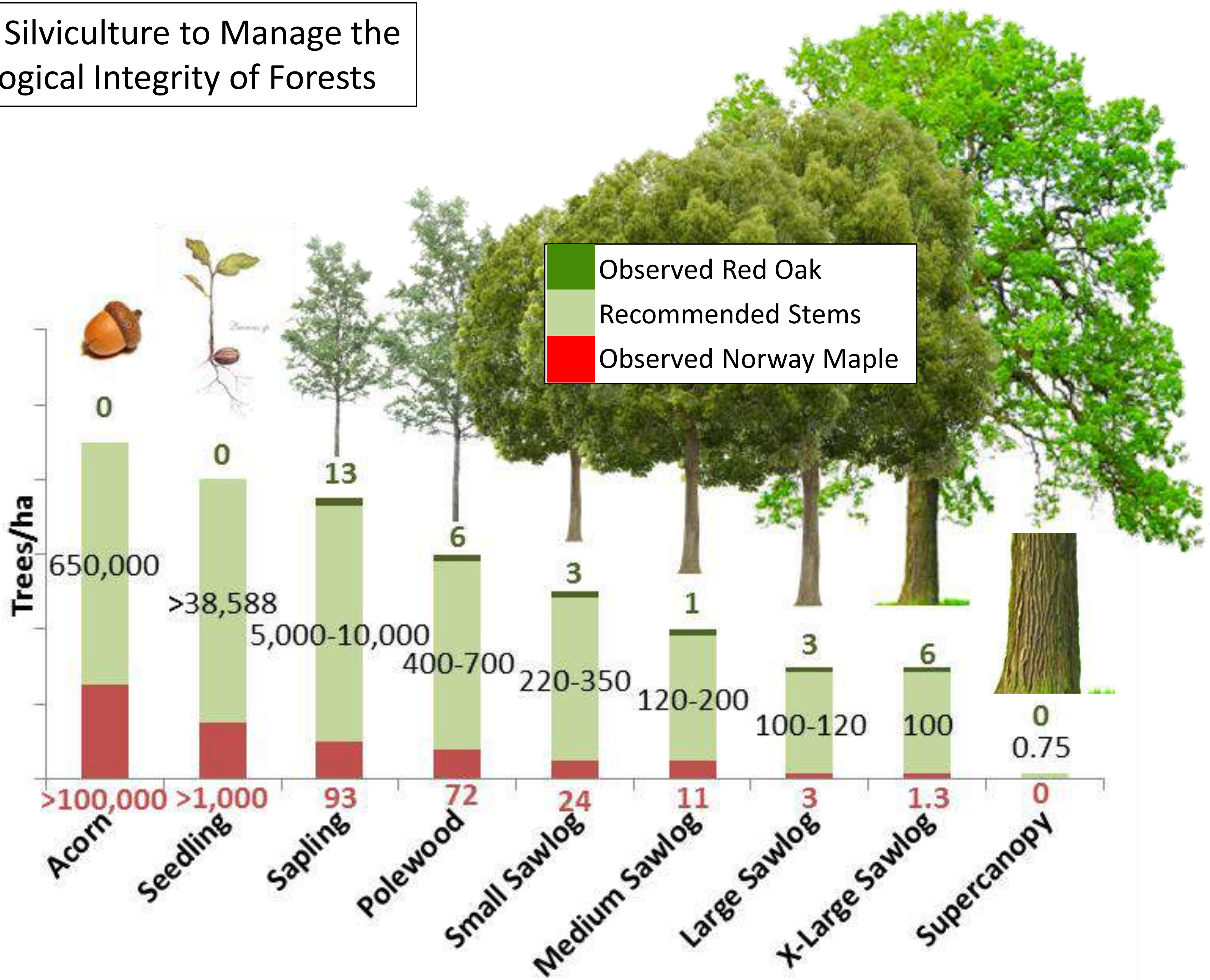
Silviculture



"Forestry should always prescribe a mixed stand – that is, the perpetuation of every indigenous species. Variety is as valuable as quantity".

Leopold. 1918. Journal of Forestry

Using Silviculture to Manage the Ecological Integrity of Forests



Sources:

[a] Batchelor et al. (2004). *Ontario Tree Marking Guide, Version 1.1.* MNRF.

[b] MNRF. (2000). *A silvicultural guide to managing southern Ontario forests.* MNRF

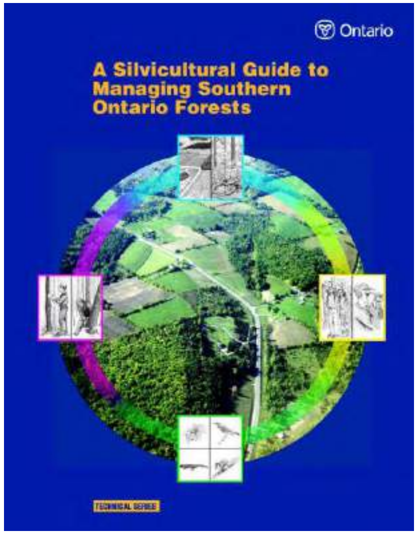
[c] Dey, D.C. 1995. *Acorn production in red oak.* MNRF

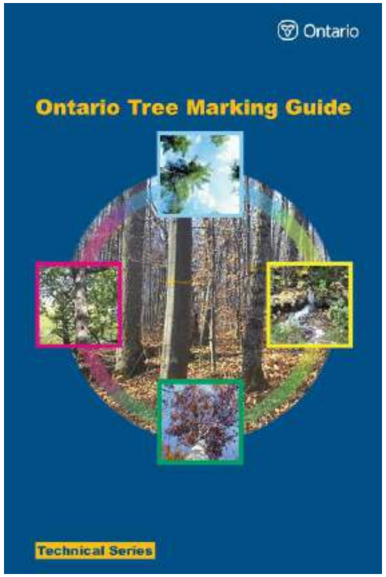
[d] Baughman, M.J., and Jacobs, R.D. (2013). *Woodland owners' guide to oak management.*

[f] MNRF. (1999). *Restoring old-growth features to managed forests in southern Ontario*.

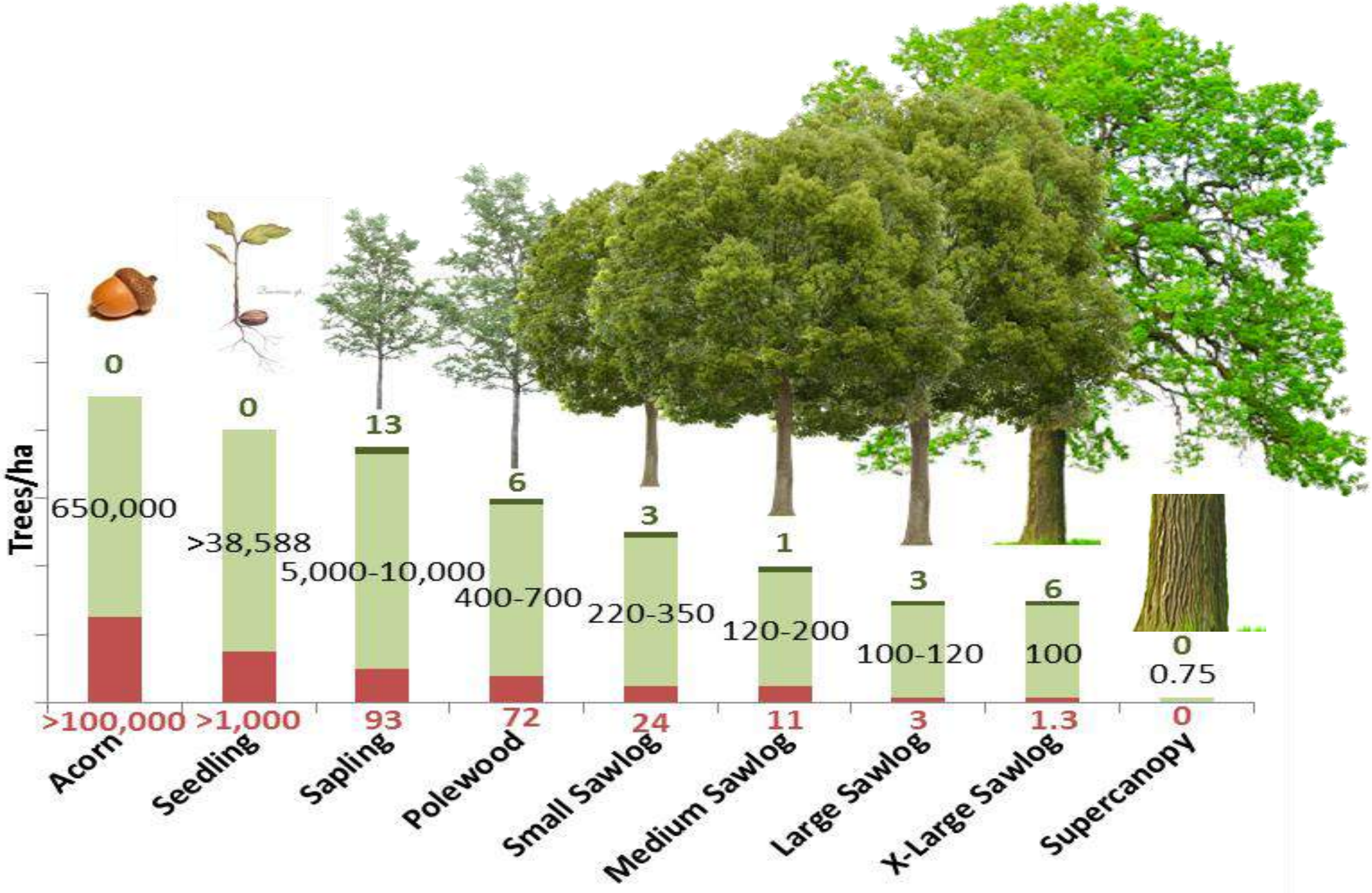
[g] Honer, T. G. 1983. *Metric timber tables for the commercial tree species of central and eastern Canada*.

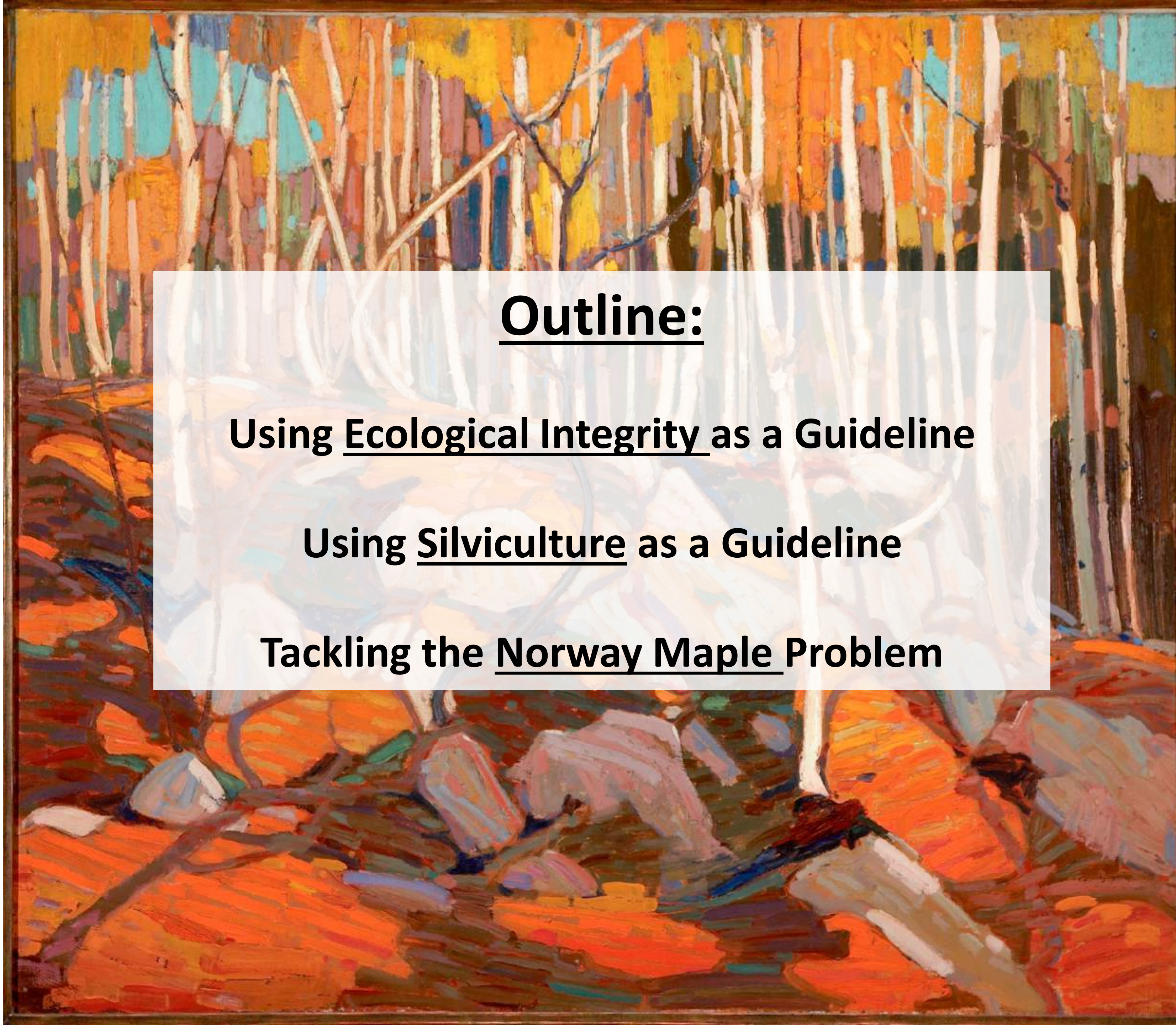
[h] Canadian Institute of Forestry. (2014). *Estimating Board Feet.*





	Recommended Density (Trees/ha)				Observed Density (Toronto Ravines)			
	DBH(cm)[a]	*Quercus rubra*[b]	Northern Hardwood[b]	Other sources	*Q. rubra* (trees/ha)	%Recommended (%)	*A. platanoides* (trees/ha)	Volume (board ft/ha)
Acorn	NA	NA	NA	650,000[c]	0	0	*>100,000*[e]	NA
Seedling	<3	NA	NA	>38,588[d]	0	0	*>1,000*[e]	NA
Sapling	3-9	NA	NA	*5,000-10,000*[e]	13	0.2[e]	101	NA
Polewood	10-24	500-2,500	400-700	206[a]	6	1.1[b]	72	4,168[g]
Small Sawlog	26-36	300-500	220-350	67[a]	3	1.1[b]	25	5,071[g]
Med. Sawlog	38-48	200-300	120-200	33[a]	2	1.2[b]	12	4,715[g]
Large Sawlog	50-60	180	100-120	15[a]	3	2.7[b]	3	1,933[g]
X-Large Sawlog	62+	NA	NA	7[a]	6	6.0[b]	1.3	1,024[h]
Supercanopy	NA	NA	NA	0.75[f]	0	0	0	0
								16,911





Outline:

Using Ecological Integrity as a Guideline

Using Silviculture as a Guideline

Tackling the Norway Maple Problem

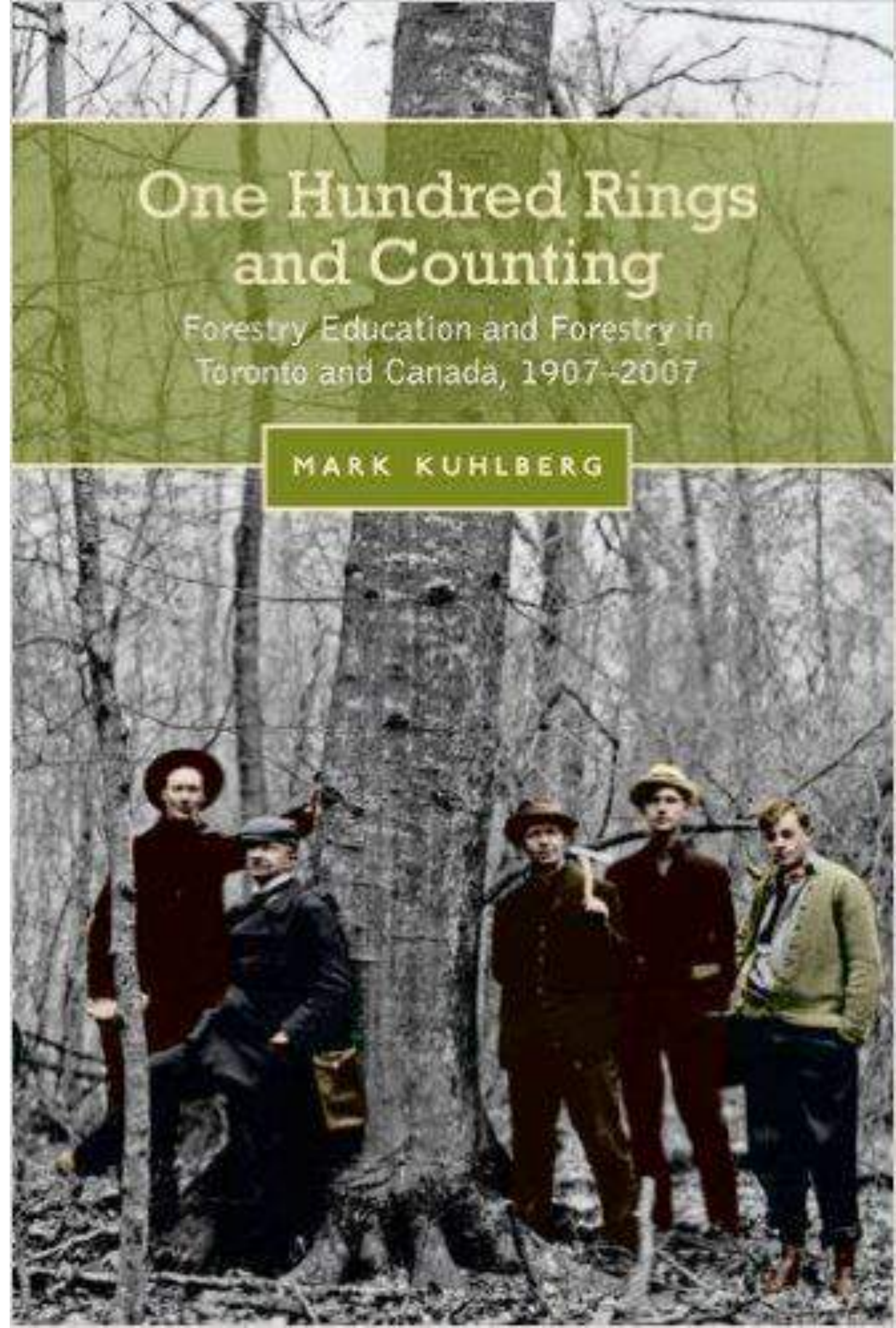
Beauty….the first or final tenet?

Do we have what it takes to restore our ecosystems?
Yes, we do!

1907 - 2017

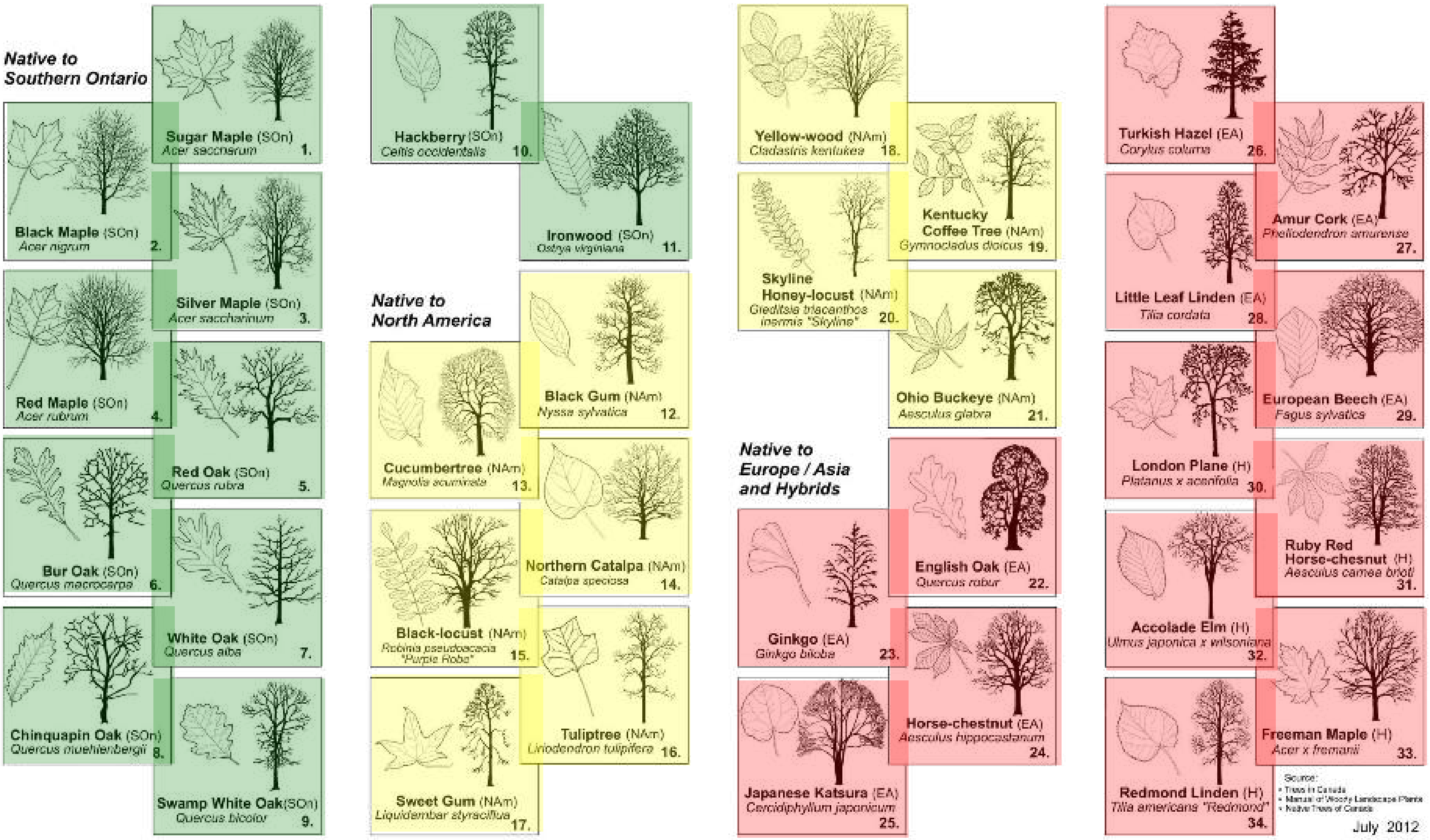
120 Years of Forestry Leadership
Canada's 1st Forestry School
Helped start MNR, CIF, etc etc etc

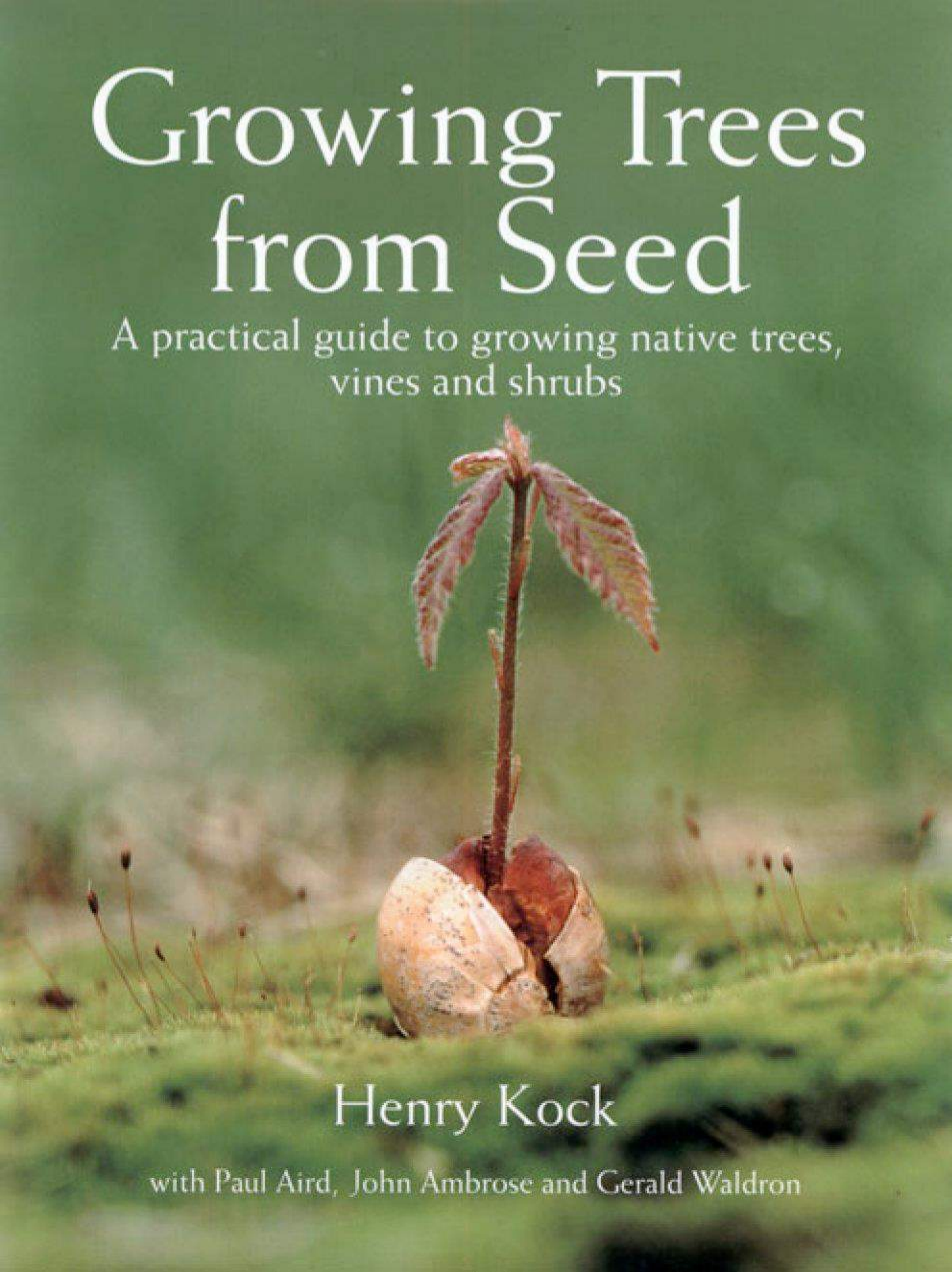
Specialists on:
Forest Inventory
Forest Harvesting
Forest Restoration
Forest Conservation



City of Toronto

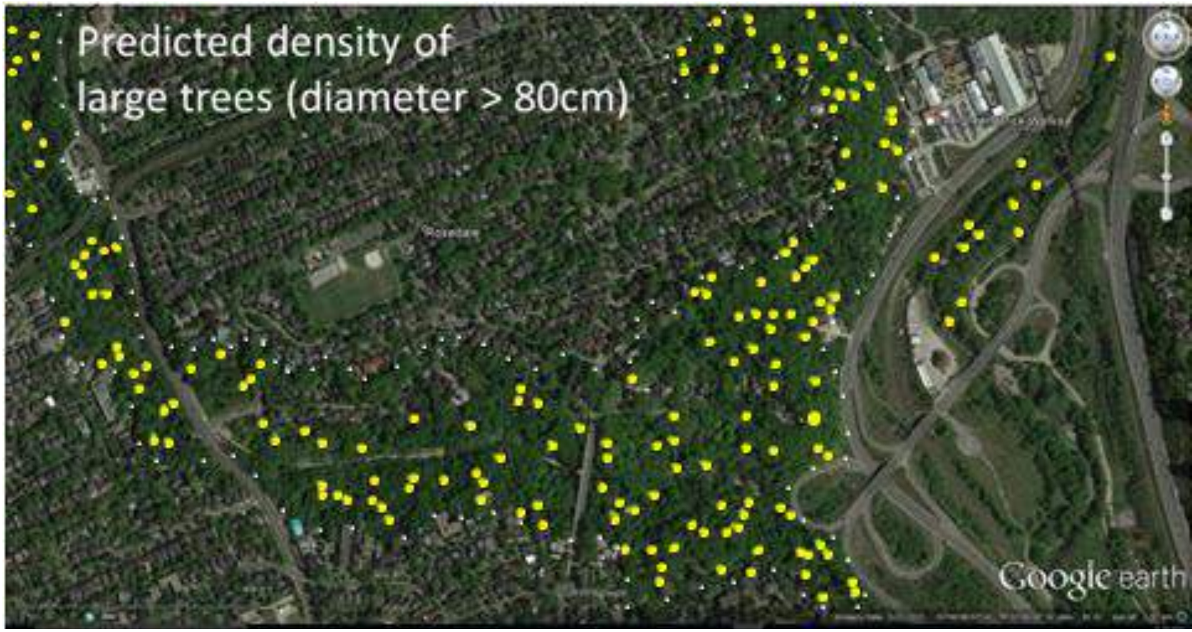
Recommended planting list - mostly Non-Native Trees




Growing Trees from Seed
A practical guide to growing native trees, vines and shrubs
Henry Kock
with Paul Aird, John Ambrose and Gerald Waldron

Citizen Science: Growing Native Trees

- Map heritage trees
- Forecast seeds
- Collect seeds
- Plant seeds
- Forest Stewardship



Thanks for your time,

For the invitation, thanks to:
Kellie Sherman, Coordinator
Ontario Invasive Plant Council

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