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
“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)
State of Canada’s Natural and Cultural Heritage Places

2016

Reporting Ecological Integrity: “Stoplight System”

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Good</td>
</tr>
<tr>
<td></td>
<td>Fair</td>
</tr>
<tr>
<td></td>
<td>Poor</td>
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<tr>
<td>N/R</td>
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Prov. | National Park | Forest |
--- | -------------- | ------ |
Ont. | Bruce Peninsula |        |
      | Georgian Bay Islands |     |
      | Point Pelee |        |
      | Pukaskwa |        |
      | Thousand Islands |    |
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)
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.

<table>
<thead>
<tr>
<th>Metric</th>
<th>Acadia NP</th>
<th>Marsh-Billings-Rockefeller NHP</th>
<th>Morristown NHP</th>
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<tr>
<td>Composition: Indicator Invasive Species</td>
<td><img src="chart" alt="" /></td>
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<td>Composition: Tree Condition</td>
<td><img src="chart" alt="" /></td>
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<td>Composition: Tree Regeneration</td>
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<td><img src="chart" alt="" /></td>
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<tr>
<td>Structure: Stand Structure</td>
<td><img src="chart" alt="" /></td>
<td><img src="chart" alt="" /></td>
<td><img src="chart" alt="" /></td>
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<tr>
<td>Structure: Snag Abundance</td>
<td><img src="chart" alt="" /></td>
<td><img src="chart" alt="" /></td>
<td><img src="chart" alt="" /></td>
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<tr>
<td>Structure: Coarse Woody Debris Volume</td>
<td><img src="chart" alt="" /></td>
<td><img src="chart" alt="" /></td>
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<tr>
<td>Function: Tree Mortality</td>
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<td><img src="chart" alt="" /></td>
<td>TBD</td>
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<tr>
<td>Function: Soil Acid Stress</td>
<td><img src="chart" alt="" /></td>
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<td><img src="chart" alt="" /></td>
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<tr>
<td>Function: Herbivory &amp; Food Webs</td>
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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.

<table>
<thead>
<tr>
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<th>Acadia NP</th>
<th>Marsh-Billings-</th>
<th>Morristown NHP</th>
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</thead>
<tbody>
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<td><strong>Composition:</strong> Indicator Invasive Species</td>
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<td>= Norway Maple</td>
<td>= Norway Maple</td>
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<tr>
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<td>= Norway Maple</td>
</tr>
<tr>
<td>Structure: Stand Structure</td>
<td>= Native Trees</td>
<td>= Native Trees</td>
<td>= Native Trees</td>
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<tr>
<td>Structure: Snag Abundance</td>
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<tr>
<td>Structure: Coarse Woody Debris Volume</td>
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<td>Function: Tree Mortality</td>
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<tr>
<td>Function: Herbivory &amp; Food Webs</td>
<td>= Norway Maple</td>
<td>= Norway Maple</td>
<td>= Norway Maple</td>
</tr>
</tbody>
</table>

See Mitchell et al. 2014.

**Big Question:**
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
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

“What escapes the eye however, is a much more insidious type of extinction: the extinction of ecological interactions”
Loss of foundation species: consequences for the structure and dynamics of forested ecosystems

Aaron M Ellison, Michael S Bank, Barton D Clinton, Elizabeth A Culberson, Katherine Ellison, Cheeky R Ford, David R Foster, Brian D Kloepfer, Jennifer D Knoepf, Gary M Lovett, Jacqueline Michan, David A Orwig, Nicholas L Rodenhouse, William V Soberak, Kristina A Stinson, Jeffrey K Stone, Christopher M Swan, Jill Thompson, Betsy Von Holle, and Jackson R Webster

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 flows; 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.
Douglas Tallamy

Bringing Nature Home

How You Can Sustain Wildlife with Native Plants

Douglas W. Tallamy

“If you have a backyard, this book is for you.”
—Richard Louv, author of Last Child in the Woods
Mean herbivory of trees in the various nativeness categories (Data: 2012 and 2016). Error bars represent 95% confidence intervals.

### Table: Mean Herbivory of Trees in Various Nativeness Categories

<table>
<thead>
<tr>
<th>Nativeness</th>
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<tbody>
<tr>
<td>NS</td>
</tr>
<tr>
<td>NNS</td>
</tr>
<tr>
<td>NNG</td>
</tr>
<tr>
<td>NNF</td>
</tr>
<tr>
<td>NNO</td>
</tr>
<tr>
<td>NNC</td>
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### Within NA

<table>
<thead>
<tr>
<th>TD</th>
<th>n</th>
<th>Cat. Mean (%)</th>
<th>Cat. 95%CI (%)</th>
<th>Rel. ES (times)</th>
</tr>
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<tbody>
<tr>
<td>NS</td>
<td>9</td>
<td>21.21</td>
<td>4.18</td>
<td>1.00</td>
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<tr>
<td>NNS</td>
<td>4</td>
<td>12.73</td>
<td>5.50</td>
<td>1.67</td>
</tr>
<tr>
<td>NNG</td>
<td>4</td>
<td>9.50</td>
<td>4.54</td>
<td>2.23</td>
</tr>
<tr>
<td>NNF</td>
<td>6</td>
<td>3.60</td>
<td>3.12</td>
<td>5.89</td>
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<tr>
<td>NNO</td>
<td>3</td>
<td>1.53</td>
<td>1.61</td>
<td>13.86</td>
</tr>
<tr>
<td>NNC</td>
<td>N/A</td>
<td>N/A</td>
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### Outside NA

<table>
<thead>
<tr>
<th>TD</th>
<th>n</th>
<th>Cat. Mean (%)</th>
<th>Cat. 95%CI (%)</th>
<th>Rel. ES (times)</th>
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<tbody>
<tr>
<td>NS</td>
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<tr>
<td>NNC</td>
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<td>0.00</td>
<td>0.00</td>
<td>~2121</td>
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</tbody>
</table>
City of Toronto
Recommended planting list - mostly Non-Native Trees
Percent of Toronto street trees that are native species (including varieties)

- Native: 30%
- Non-native: 60%
- Unknown: 10%
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

30 North American cities

Every Tree Counts
A Portrait of Toronto’s Urban Forest

NATIVE
NON-NATIVE
Toronto, ON

Extant Native vs. Dark Diversity

56% 44%
Toronto, ON

Native vs. Non-Native

36% 64%
"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

Native to Southern Ontario
1. Sugar Maple (SO) Acer saccharum
2. Black Maple (SO) Acer negundo
3. Silver Maple (SO) Acer saccharinum
4. Red Maple (SO) Acer rubrum
5. Red Oak (SO) Quercus rubra
6. Bur Oak (SO) Quercus macrocarpa
7. White Oak (SO) Quercus alba
8. Chinquapin Oak (SO) Quercus muehlenbergii
9. Swamp White Oak (SO) Quercus bicolor
10. Hackberry (SO) Celtis occidentalis
11. Ironwood (SO) Carya virginiana
12. Black Gum (NA) Nyssa sylvatica
13. Cucumbertree (NA) Magnolia acuminata
14. Northern Catalpa (NA) Catalpa speciosa
15. Black-locust (NA) Robinia pseudoacacia “Purple Robe”
16. Tuliptree (NA) Liriodendron tulipifera
17. Sweet Gum (NA) Liquidambar styraciflua
18. Yellow-wood (NA) Cladrastis kentukea
19. Kentucky Coffee Tree (NA) Gymnocladus dioicus
20. Honey-locust (NA) Gleditsia triacanthos insinis “Skyline”
21. Ohio Buckeye (NA) Aesculus glabra

Native to North America
22. English Oak (EA) Quercus robur
23. Ginkgo (EA) Ginkgo biloba
24. Horse-chestnut (EA) Aesculus hippocastanum
25. Japanese Katsura (EA) Cercidiphyllum japonicum
26. Turkish Hazel (EA) Corylus colurna
27. Amur Cork (EA) Phellodendron amurense
28. Little Leaf Linden (EA) Tilia cordata
29. European Beech (EA) Fagus sylvatica
30. London Plane (H) Platanus x acerifolia
31. Ruby Red Horse-chestnut (H) Aesculus carnea bireli
32. Accolade Elm (H) Ulmus japonica x wilsoniana
33. Freeman Maple (H) Acer x freemanii
34. Redmond Linden (H) Tilia americana “Redmond”

Source:
- Trees in Canada
- Manual of Woody Landscape Plants
- Noble Trees of Canada

July 2012
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)
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.)

1977 Rosedale Ravine Study

(Dale Taylor & Paul Scrivener)

Legend

Study Ravines
1. Burke Brook
2. Moore Park
3. Park Drive
4. Rosedale Valley

Toronto Ravine Revitalization Study

Evergreen Brickworks

St. Clair Ave. E.
Mt. Pleasant Rd.
Bloor St.
Ecological Integrity in the Park Drive Ravine: 1977 & 2015

Anqi Dong
11 December 2015
- Ash species (Fraxinus spp.)
- American beech (Fagus grandifolia)
- Norway maple (Acer platanoides)
Historical
Observed 1977
Observed 2015
"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

- Observed Red Oak
- Recommended Stems
- Observed Norway Maple

Trees/ha:
- Acorn >100,000
- Seedling >38,588
- Sapling 5,000-10,000
- Polewood 400-700
- Small Sawlog 220-350
- Medium Sawlog 120-200
- Large Sawlog 100-120
- X-Large Sawlog 100
- Supercanopy 0.75

0
Sources:


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

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


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.

<table>
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<tr>
<th>Plant Type</th>
<th>DBH(cm)</th>
<th>Quercus rubra</th>
<th>Northern Hardwood</th>
<th>Other Sources</th>
<th>Q. rubra (trees/ha)</th>
<th>% Recommended</th>
<th>A. platanoides (trees/ha)</th>
<th>Volume (board ft/ha)</th>
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<td>120-200</td>
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<td>180</td>
<td>100-120</td>
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<td>NA</td>
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<td>6.0</td>
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<td>0.75</td>
<td>0</td>
<td>0</td>
<td>0</td>
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Total: 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!
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

Native to Southern Ontario
- Sugar Maple (SON) - Acer saccharum
- Black Maple (SON) - Acer negundo
- Silver Maple (SON) - Acer saccharinum
- Red Maple (SON) - Acer rubrum
- Bur Oak (SON) - Quercus macrocarpa
- White Oak (SON) - Quercus alba
- Chinquapin Oak (SON) - Quercus muehlbergii
- Swamp White Oak (SON) - Quercus bicolor

Native to North America
- Hackberry (SON) - Celtis occidentalis
- Ironwood (SON) - Garrya virginiana
- Black Gum (NA) - Nyssa sylvatica
- Cucumber (NA) - Magnolia acuminata
- Northern Catalpa (NA) - Catalpa speciosa
- Black-locust (NA) - Robinia pseudoacacia "Purple Robe"
- Sweet Gum (NA) - Liquidambar styraciflua

Native to Europe/Asia and Hybrids
- Yellow-wood (NA) - Gleditsia triacanthos
- Honey-locust (NA) - Gleditsia triacanthos
- Kentucky Coffee Tree (NA) - Gleditsia triacanthos
- Skyline Honey-locust (NA) - Gleditsia triacanthos
- Ohio Buckeye (NA) - Aesculus glabra
- English Oak (EA) - Quercus robur
- Ginkgo (EA) - Ginkgo biloba
- Horse-chestnut (EA) - Aesculus hippocastanum
- Japanese Katsura (EA) - Cercidiphyllum japonicum

Native to North America and Hybrids
- Turkish Hazel (EA) - Corylus colurna
- Amur Cork (EA) - Phellodendron amurense
- Little Leaf Linden (EA) - Tilia cordata
- European Beech (EA) - Fagus sylvatica
- London Plane (H) - Platanus x acerifolia
- Ruby Red Horse-chestnut (H) - Aesculus carnea "Glandulosa"
- Accolade Elm (H) - Ulmus japonica x wilsoniana
- Freeman Maple (H) - Acer x framptonii

Source:
- Trees in Canada
- Manual of Woody Landscape Plants
- North Trees of Canada
July 2012
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

Eric Davies
Faculty of Forestry
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