NEBIE Project: Assessing different levels of silvicultural intensity in boreal forests


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Outline

• Background information

• NEBIE Plot Network
  – Experimental, treatment and plot design
  – Longer-term studies

• Application of Results
Background: Human Population

http://one-simple-idea.com/
WorldPopulation.jpg accessed 2008 01 18
Climate change

http://www.ghgonline.org/predictions.htm
Change in Forest Succession

Stand Dynamics theory
Many Factors
The single large or several small (SLOSS) hypothesis posits that a single large refuge will maintain more species than two or more small ones with total area equal to that of the single large one (Diamond 1975, Wilson and Willis 1975, Diamond and May 1976).
Northern Boreal Forest

Planning Area

... and enhance forest productivity

Kilometers: 0, 150, 300

- Natural (FIDS)
- Extensive
- Basic
- Intensive
- Elite

Southern Ontario
Lands for Life Process and 1999 Forest Accord
Enabled Implementation of Intensive Forestry Zones
<table>
<thead>
<tr>
<th>Natural disturbances</th>
<th>Extensive silviculture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic silviculture</td>
<td>Intensive silviculture</td>
</tr>
<tr>
<td>Elite silviculture</td>
<td></td>
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</tbody>
</table>
Why did we need a stand-level partnership to Study effects of silviculture intensities?

The majority of studies to date were designed to compare:

- natural origin forests with managed plantations of native tree species,
- silvicultural systems,
- harvest retention schemes,
- individual silvicultural treatments (e.g., mechanical site preparation, herbicide spraying and thinning).
Definitions

Natural disturbances

Extensive

Basic

Intensive

Elite

Originally 8 study sites covering the major commercial forest types were selected for study.
NEBIE Plot Network
Experimental design

Randomized complete block design with 3 to 4 blocks of each of the 5 treatments

- Natural
- Extensive
- Basic
- Intensive
- Elite
NEBIE Plot Network
Six sites were fully implemented
Consultation with Operational Foresters
Site specific silviculture prescriptions
Dryden (Boreal mixedwood)

**Natural disturbances**

**Extensive** – winter cut and let to regenerate to fir and aspen

**Basic** - cut, MSIP, plant 1200 SPH of black spruce and release

**Intensive** - cut, MSIP, plant 2500 SPH of improved stock white and black spruce, release, and commercial thin

**Elite** - cut, MSIP, plant 2500 SPH of improved spruce and white pine stock with pre-planned orientation, release, and commercial thin
Plot Design and Data collections

200 m x 100 m semi-operational sized plots
20 m x 20 m cells for data collection
Hypothetical Responses

Montreal Process C&I

- Conservation of Biological Diversity
- Maintenance of Productive Capacity of Forest Ecosystems
- Maintenance of Forest Ecosystem Health and Vitality
- Conservation and Maintenance of Soil and Water Resources
- Maintenance of Forest Contribution to Global Carbon Cycles
- Maintenance and Enhancement of Long-term Multiple Socio-economic Benefits

- Fibre quality
- Carbon sequestration
- Soil nutrients
- Exotic species
- Forest health losses
- Fibre quantity
- Compositional diversity
- Functional diversity
- Structural diversity
- Genetic diversity
- Benefit:cost

Related terms:
- Plant species
- Genes
- Compositional diversity
- Functional diversity
- Structural diversity
- Fibre quantity
- Forest health losses
- Carbon sequestration
- Soil nutrients
- Exotic species
- Benefit:cost
Compositional Diversity

Data Collections

Canopy layers:

L1 = Tree in canopy position
L2 = Tree in sub-canopy position
L3 = Shrub or tree 2.01 - 10.00 m
L4 = Shrub or tree 0.5 - 2.00 m
L5 = Shrub or tree < 0.50 m
L6 = Forbs/grasses/sedges/ferns
L7 = Mosses, lichens, liverworts

Nomenclature:

Flora Ontario Integrated Botanical Information System (FOIBIS)

Pre-harvest, 2nd, 5th and 10th year assessment of plant biodiversity completed in 2015.
Tested richness ($S$), abundance, evenness ($E_{\text{Heip}}$), Shannon entropy ($H'$), dominance ($D$), functional dispersion ($FDis$), and functional entropy ($FD_Q$).
Hierarchical structure is very strong among climate, soils, and disturbance and plant species richness.

*a posteriori* model
Species diversity
Relative influence of Silviculture

<table>
<thead>
<tr>
<th>Explanatory variables†</th>
<th>Woody (R² = 0.868, P = &lt;0.001)</th>
<th>Herbaceous (R² = 0.937, P = &lt;0.001)</th>
<th>Bryophytes &amp; lichens (R² = 0.944, P = &lt;0.001)</th>
<th>Total richness (R² = 0.933, P = &lt;0.001)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Partial R²</td>
<td>Partial R²</td>
<td>Partial R²</td>
<td>Partial R²</td>
</tr>
<tr>
<td>climate (%)</td>
<td>59.7</td>
<td>73.3</td>
<td>70.5</td>
<td>86.4</td>
</tr>
<tr>
<td>soils (%)</td>
<td>4.2</td>
<td>3.1</td>
<td>3.9</td>
<td>1.9</td>
</tr>
<tr>
<td>forest canopy (%)</td>
<td>11.4</td>
<td>3.9</td>
<td>9.4</td>
<td>0.4</td>
</tr>
<tr>
<td>forest floor (%)</td>
<td>10.2</td>
<td>10.3</td>
<td>10.1</td>
<td>3.9</td>
</tr>
<tr>
<td>Relative herbicide</td>
<td>0.019</td>
<td>0.007</td>
<td>0.005</td>
<td>0.007</td>
</tr>
<tr>
<td>Silvicultural intensity</td>
<td></td>
<td>0.023</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub-total other (%)</td>
<td>1.9</td>
<td>3.0</td>
<td>0.5</td>
<td>0.7</td>
</tr>
<tr>
<td>Total</td>
<td>87.4</td>
<td>93.6</td>
<td>94.4</td>
<td>93.3</td>
</tr>
</tbody>
</table>
Exotic Plant Species

Year 10

Kapuskasing

Exotic

Native

Natural  Extensive  Basic  Intensive  Elite
Genetic Diversity

Soil seedbank

DNA of Flora of the NEBIE plot network
- 60 families, 163 genera, 306 species

Maloles, J.R. 2015. The effects of the intensification of silvicultural practices on seed bank diversity in the boreal and northern temperate forests. University of Guelph, Guelph, ON., Master of Science thesis
Functional diversity

- Effect on ecosystem properties
  - leaf N content (nutrient cycling)
  - root depth (soil stabilization)
  - water retention (ecosystem hydrology)

- Response to environment
  - Individual persistence
  - Population persistence
  - Competitive ability
  - Landscape dispersal

- Effect traits
  - Individual persistence
  - Population persistence
  - Competitive ability
  - Landscape dispersal

- Response traits

Functional Diversity

When functional traits are linked to a phylogenic classification it may improve our ability to predict many things about species including:

- resistance to disturbance, invasive species, climate change and/or nitrogen pollution
- ability to sequester carbon, produce food or medicinal, or provide other goods and services.
Species diversity may be associated with the presence, abundance, and variability of structural features.

Structural features studied in the NEBIE plot network include:

- live and dead tree diversity
- woody material, including standing dead stems and downed wood
- spatial variability in micro-topography and forest floor characteristics

These figures show the locations for live (green) and dead (brown) trees in an example 400 m² plot at the Petawawa NEBIE site 10 years post harvest. The circles are scaled to tree diameter.
Structural Diversity
Heterogeneity of the Forest Floor

Post-harvest forest floor structure surveys were conducted within two to three years post-harvest using transects to quantify site characteristics such as bare ground, rock, wet holes, unharvested areas, berms (soil and organic material mixed and piled from road building, site preparation, or other skidding), and coarse woody material (CWM).

As silviculture intensified, the amount of undisturbed area decreased and the area in berms and exposed soil increased.
Carbon Sequestration and Nutrient Cycling

Pre-harvesting and 2nd and 5th year post-harvesting carbon and total nitrogen information by depth class (cm) for the intensive treatment at three NEBIE sites.
There are many uncertainties related to growing trees over long periods of time. Some of these uncertainties can be addressed by using a range of silvicultural intensities.
Acknowledgements

Data collection partners

Operations partners

Funding Agencies