The Sustainability of Forest Residue for Bioenergy in Canada: What can biodiversity tell us?
Forest Residue

Tree-length Harvest

Residue Roadside Piles
Interest in using forest biomass is high

- Reduction in greenhouse gas emissions
- New jobs in energy and forestry sector
- Diversification of Canadian energy portfolio
Context


- Fuelling a BioMess: Why burning trees for energy will harm people, the climate and forests. 2011. Greenpeace.
It is the opinion of many organizations that forest residue is not an acceptable biomass resource. This material is essential for biodiversity, wildlife habitat, soil fertility and forest productivity

Dagg et al. 2011
# Estimates of CWD volume

<table>
<thead>
<tr>
<th>Stand</th>
<th>Managed (m³/ha)</th>
<th>Unmanaged (m³/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ontario (upland conifer) (Parton 2013)</td>
<td>15.21 (21-50%)</td>
<td>30.3, 34.1, 73.4</td>
</tr>
<tr>
<td>Ontario (Pj) (Parton 2013)</td>
<td>9.81 (47%)</td>
<td>20.8</td>
</tr>
<tr>
<td>BC (Densmore 2011)</td>
<td>78.8-167% of unmanaged</td>
<td></td>
</tr>
<tr>
<td>BC (Densmore 2011)</td>
<td>4.4-80 % of CWD large pieces of unmanaged</td>
<td></td>
</tr>
<tr>
<td>Sweden (Fridman and Walheim 2000)</td>
<td>0.5-11 (2-15%)</td>
<td>11-91</td>
</tr>
<tr>
<td>Fennoscandia(1-140 yrs) (Siitonen 2001)</td>
<td>2-10 (2-17%)</td>
<td>60-90</td>
</tr>
<tr>
<td>Fennoscadina &gt;140 yrs (Siitonen 2001)</td>
<td>15.9 (18-27%)</td>
<td>60-90</td>
</tr>
</tbody>
</table>
Biodiversity and deadwood

- Northern Europe has hundreds of red listed species associated with deadwood while Canada does not
- Quantity and quality is important
- Examples
  - High bryophyte and rove beetle diversity in late decay logs (Cole et al. 2008, Buddle et al. 2006)
  - Insect species composition changes with decay class (Vanderwel et al. 2006)
  - Decay class and log diameter are important predictors of suitable foraging substrate for Black-backed Woodpeckers (Tremblay et al. 2009)
Mammals

If we build habitat, will they come? Woody debris structures and conservation of forest mammals

Thomas P. Sullivan,* Drucilla S. Sullivan, Pontus M. F. Lindgren, and Douglas B. Ransome

- Red-backed voles and weasels were more abundant in piles.
- Removal of deadwood limits management options for mammals.
Birds

Research Papers
Habitat Requirements of Breeding Black-Backed Woodpeckers (*Picoides arcticus*) in Managed, Unburned Boreal Forest

Besoins en termes d’habitat chez le Pic à dos noir (*Picoides arcticus*) nichant en forêt boréale non brûlée et sous aménagement

*Junior A. Tremblay*, *Jacques Ibarzabal*, *Christian Dussault*, and *Jean-Pierre L. Savard*


- Threshold of 35m³/ha of deadwood
- 15m³/ha early decay class
- Majority of foraging on recently dead snags
Macro-arthropods

Stand composition and structure of the boreal mixedwood and epigaeic arthropods of the Ecosystem Management Emulating Natural Disturbance (EMEND) landbase in northwestern Alberta

Timothy T. Work, David P. Shorthouse, John R. Spence, W. Jan A. Volney, and David Langor


Reductions in downed deadwood from biomass harvesting alter composition of spiders and ground beetle assemblages in jack-pine forests of Western Quebec

Timothy T. Work a,c,* , Suzanne Brais b,c , Brian D. Harvey b,c
Initial responses of rove and ground beetles (Coleoptera, Staphylinidae, Carabidae) to removal of logging residues following clearcut harvesting in the boreal forest of Quebec, Canada

Timothy T. Work, Jan Klimaszewski, Evelyne Thiffault, Caroline Bourdon, David Paré, Yves Bousquet, Lisa Venier, Brian Titus

Insect community composition and trophic guild structure in decaying logs from eastern Canadian pine-dominated forests

Mark C. Vanderwel, Jay R. Malcolm, Sandy M. Smith, Nurul Islam
Estimating species loss of saproxylic insects under scenarios of reduced coarse woody material in eastern boreal forests

Timothy T. Work1,2† and Annie Hibbert1

Volume 2(4) Article 41
More than a decade after harvesting, diversity and structure of soil fungal communities remained significantly altered by different levels of organic material removal but differences were small.
LTSP design and intensive forest biomass removals

- Conceptual model - organic matter a major variable regulating soil processes affecting productivity
- Modification of site organic matter is a main effect treatment
- Long-term forest growth measurements
- Pre- and post-harvest measurements of site C and nutrient pools that enable accurate determination of site removals and retention

Powers 2006. Long-term soil productivity: genesis of the concept and principles behind the program. CJFR
LTSP treatments

- Targeted infertile coarse textured and shallow soils
- 14 sites, mature 60-125 year-old boreal stands – Pj and Sb
- Harvest treatments tree-length (TL), full-tree harvest (FT), full-tree harvest and forest floor removal (FFR) – 30m X 30m plots X 3 replicates/site
- Sites replanted – NE Pj, NW Sb
LTSP Biodiversity work

- Mohn et al. Soil microbial communities; University of British Columbia
- Berch et al. Soil fauna (collembola and mites) BC Ministry of Forests
- Venier, Rousseau et al. Soil fauna (collembola and mites) Canadian Forest Service and University of Quebec at Montreal
Dead wood as a surrogate for biodiversity

- British Columbia Forest and Range Evaluation Program
- Data collected from 2006-2009
- Comparison of dead wood in uncut retention patches and harvested areas in 3 forest regions (18 biogeoclimatic subzones)
- Volume of CWD left on harvested sites was similar or higher than within retention patches
- Density of large pieces of CWD (>=20 cm diameter and >=10 m long) is significantly lower
- No direct measures of biodiversity
Ecosystem

Living Trees

CWD

Snags

Logs

Fine Woody Debris

Leaf Litter Humus Soil

CO₂

photosynthesis

mortality

breakage

Internal Transformation

Fragmentation

Fragmentation

burial

respiration

Harmon et al 1986
Collaborative science: multi partnership; Island Lake and Forêt Montmorency

Forest communities & First Nations

Industries

Government agencies

Universities
Island Lake post-harvest coarse wood
(all aboveground > 5 cm diameter)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Volume (m³ ha⁻¹)</th>
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<tbody>
<tr>
<td>Tree-length</td>
<td></td>
</tr>
<tr>
<td>Full-tree</td>
<td></td>
</tr>
<tr>
<td>Stumped</td>
<td></td>
</tr>
<tr>
<td>Bladed</td>
<td></td>
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</tbody>
</table>
Image sources for this figure: bumblebee.org; plants.usda.gov; Borror and White (1970) Peterson Field Guide to the Insects of America North of Mexico
Multi-trophic scale project

- Response traits
- Overlap
- Effect traits

Trophic level 1

Ecosystem process and function

Trophic level 2

Response traits

Overlap

Effect traits


Moretti et al. submitted
Conclusions

- Work on sustainability of biomass removal based on biodiversity is in early stages in Canada especially relative to work on soil and tree productivity.
- There is much interest in thresholds of biomass removal or the corollary of how much biomass needs to be left on site to be sustainable. Studies to address this question are preliminary to date but ongoing.
Conclusions

- Most work to date has looked at short-term impacts. There are some opportunities with the LTSP network to examine longer-term impacts but only for species that operate at very small scales.

- Biomass inventories are being suggested and used as surrogates for biodiversity because of the difficulty of monitoring biodiversity. A related idea is the modelling of deadwood to provide long-term predictions of biomass availability relative to forest type and disturbance or harvesting approaches.
  - Direct links between biodiversity and deadwood quantity and quality will still need to be made using experimental approaches.