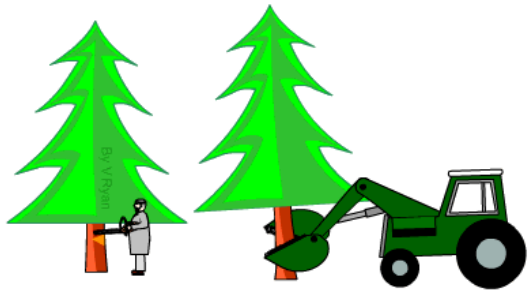
Fourteen-year impacts of partial and total forest harvest on epixylic bryophyte species in the boreal black spruce –feathermoss forests

By Jeffrey Opoku-Nyame,
Alain Leduc (UQAM) and Nicole Fenton (UQAT)

2nd May 2019, 13th Annual Conference of the Center for Forest Research(CFR), Chicoutimi

Partial cut



Lessons learned from 12 years of ecological research on partial cuts in black spruce forests of northwestern Québec

by Nicole J. Fenton[1,2,*], Louis Imbeau[1,2], Timothy Work[1,2], Jenna Jacobs[1,2], Hervé Bescond[1,2], Pierre Drapeau[1,3] and Yves Bergeron[1,2,3]

ABSTRACT

Multi-cohort management that creates or maintains an uneven structure within forest stands has been widely advocated as a means to attenuate the impact of forest harvesting. An experimental network was put in place in black spruce forests of northwestern Québec to test this assertion. Here we synthesize the biodiversity results in two main lessons: (1) at least 40% to 60% retention of pre-harvest basal area was required to maintain pre-harvest conditions for most species groups; (2) partial harvests showed the potential to be efficient deadwood delivery systems. In addition to these two main general conclusions, we emphasise that future research should examine whether partial harvest may be able to advance forest succession.

Partial harvesting in the Canadian boreal: Success will depend on stand dynamic responses

by H.C. Thorpe[1,2] and S.C. Thomas[1]

ABSTRACT

In the past 10 to 15 years, alternative silvicultural treatments involving partial harvesting have been developed for boreal

Partial cutting in old-growth boreal stands: An integrated experiment

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Does partial harvesting promote old-growth attributes of boreal mixedwood trembling aspen (*Populus tremuloides* Michx.) stands?

Arun K. Bose *, Brian D. Harvey, Suzanne Brais

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Forest Ecology and Management
Volume 256, Issue 4, 10 August 2008, Pages 536-547

Partial cutting as a conservation alternative for oak (*Quercus* spp.) forest—Response of bryophytes and lichens on dead wood

Heidi Paltto [a], Björn Nordén [a], Frank Götmark [b]

Journal of Applied Ecology 2001
38, 1234–1252

Influence of variable retention harvests on forest ecosystems. II. Diversity and population dynamics of small mammals

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Summary

1. Variable retention harvests in temperate coniferous forests provide various intens-

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Linking the biological traits of boreal bryophytes to forest habitat change after partial harvesting

Richard T. Caners [a,*], S. Ellen Macdonald [b], René J. Belland [c]

Forestry *An International Journal of Forest Research*
Institute of Chartered Foresters

Forestry 2015; **88**, 471–483, doi:10.1093/forestry/cpv017
Advance Access publication 8 June 2015

Effect of three partial cutting practices on stand structure and growth of residual black spruce trees in north-eastern Quebec

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Journal of Applied Ecology
Journal of Applied Ecology 2012, **49**, 145–154 doi: 10.1111/j.1365-2664.2011.02089.x

Factors affecting white spruce and aspen survival after partial harvest

Kevin A. Solarik[1]*, W. Jan A. Volney[2], Victor J. Lieffers[1], John R. Spence[1] and Andreas Hamann[1]

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Effects of partial cutting on the ectomycorrhizae of *Picea glauca* forests in northwestern Alberta

Lance W. Lazaruk, Gavin Kernaghan, S. Ellen Macdonald, and Damase Khasa

Partial harvesting in the Canadian boreal: Success will depend on stand dynamic responses

by H.C. Thorpe[1,2] and S.C. Thomas[1]

ABSTRACT

In the past 10 to 15 years, alternative silvicultural treatments involving partial harvesting have been developed for boreal forests, with the goal of achieving a balance between biodiversity maintenance and continued timber production. Most prior research has focussed on the impacts of partial harvesting on biological diversity, while stand dynamic responses remain little studied. In this paper we explore partial stand harvesting in the Canadian boreal—its rationale, current

Forest Ecology and Management

Partial cutting does not maintain spider assemblages within the observed range of natural variability in Eastern Canadian black spruce forests

Conservation Biology

Experimental Test of Postfire Management in Pine Forests: Impact of Salvage Logging versus Partial Cutting and Nonintervention on Bird–Species Assemblages

Prueba Experimental del Manejo Post-Fuego en Bosques de Pino: Impacto de la Tala de Salvamento Versus el Corte Parcial y la No Intervención sobre Ensambles de Especies de Aves

JORGE CASTRO, GREGORIO MORENO-RUEDA, JOSÉ A. HÓDAR

ıe impact of various harvesting practices (including those designed to emulate natural
e (ECM) associated with white spruce (*Picea glauca* (Moench) Voss) in northwestern
luded clearcuts, partial cuts (dispersed green-tree retention with 20%, 50%, and 75%
d green-tree retention), unharvested control sites, and a burned stand. The percentage
and ECM richness and diversity, as observed in soil cores collected throughout the
reasing disturbance intensity. Effects were particularly pronounced in clearcuts, ma-
y harvesting equipment in the dispersed green-tree retention stands, and in burned ar-
rsity could be attributed to the sensitivity of late-stage ectomycorrhizae (e.g.,

Réseau d'expérimentation des coupes partielles en Abitibi (RECPA)

- Network of experimental sites (Est. 2003)
- Permanent plots
- Evaluate partial cut impacts on biodiversity, forest productivity, etc.
- Comparison with unharvested control and CPRS

- **This study forms part of the RECPA project**
  - **Partial cut impacts on bryophytes**

Bryophytes in the boreal forest

❖ Importance

- ❖ Species diversity
- ❖ Biomass
- ❖ Nutrient cycle
- ❖ Soil moisture
- ❖ Habitat for invertebrates
- ❖ Seed bed for tree regeneration

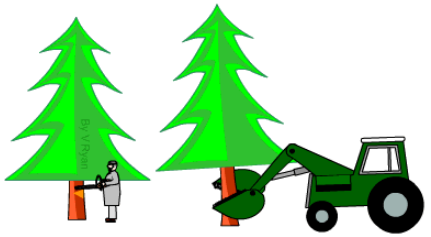
❖ Life habit

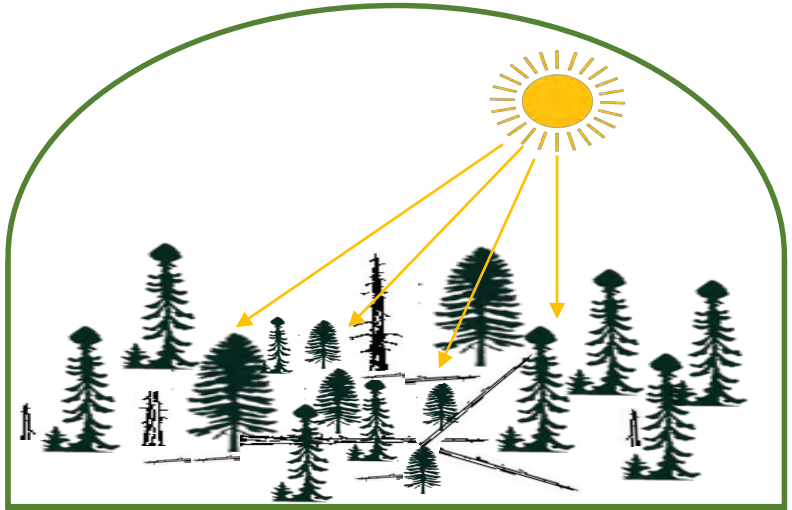
- ❖ Sensitive to habitat change
  - ❖ Microclimate change (Poikilohydric nature)
  - ❖ Good indicators for changes in forest microhabitat

❖ Deadwood living bryophytes (epixylic)

- ❖ Vulnerable to forest harvest
  - ❖ Microclimate change
  - ❖ Substrate change

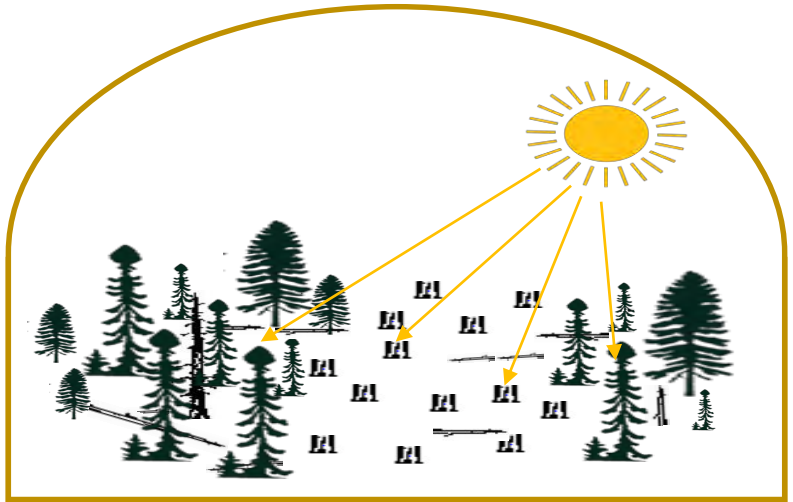
Effects of forest harvest on epixylic bryophytes





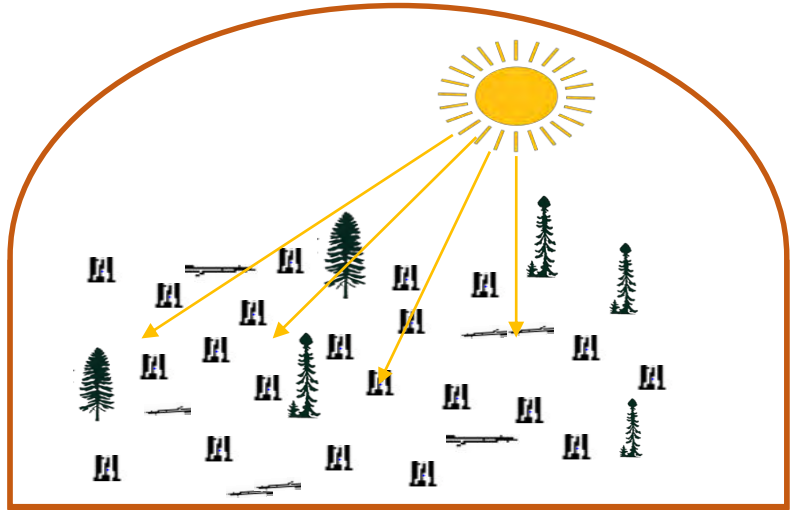
Natural forest

- Coarse woody debris(CWD) of different decay class
- Continual input of CWD
- Favourable microclimate
- High species diversity



Partial cut

- Residual stand
  - Refuge for bryophytes
  - Regulate moisture conditions
  - Continual input of CWD



Clear cut (CPRS)

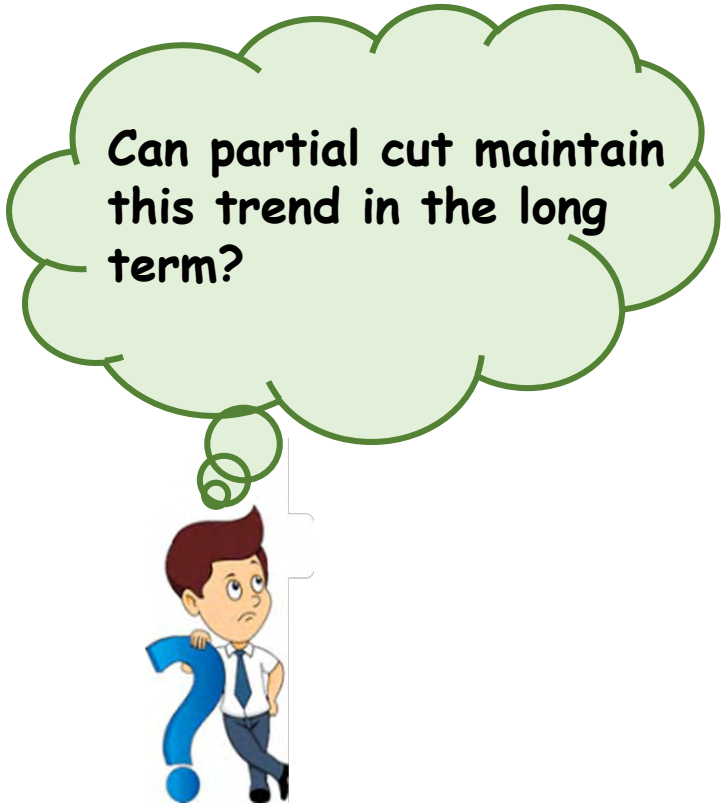
- **Direct**
  - Slash deposition
  - Machine damage to established bryophytes
- **Indirect**
  - Reduction of moisture conditions
  - Substrate availability and quality

Initial post-harvest study (5 years after harvest)

Partial cut ;

- Reduced the impacts associated with forest harvest on epixylic habitat conditions.
- Supported richer epixylic community compared to clear cut (CPRS).

(Arseneault et al., 2012)

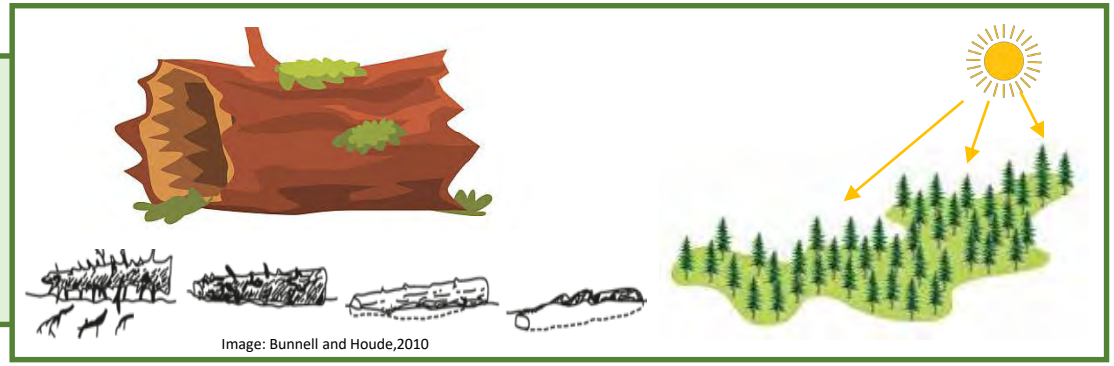


14 years after harvest, this study investigated the impacts of **partial cut** on **epixylic bryophytes** and their **microhabitat**.

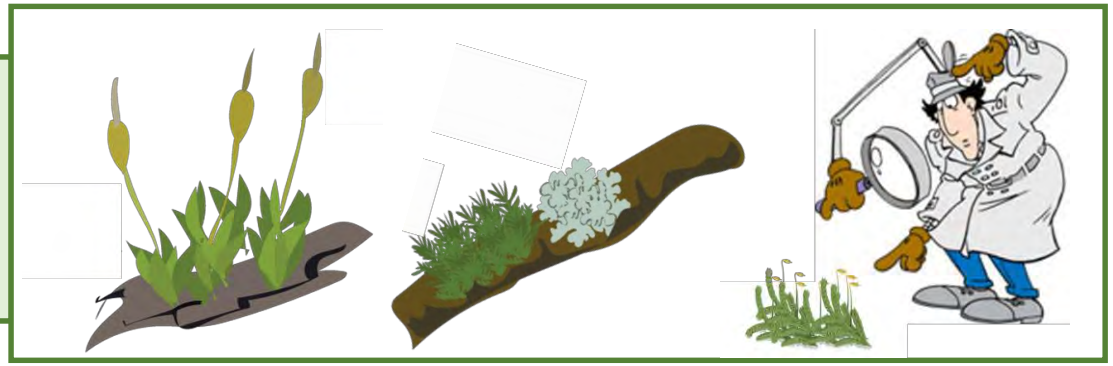
Image: Northern forest Atlas

Specific objectives

1 Examine microhabitat condition changes **(CWD characteristic and microclimate)** along **unharvested, partial cut and clear cut** harvest gradient.



2 Examine the changes in **epixylic bryophyte** species **composition** and **richness** along the harvest gradient.

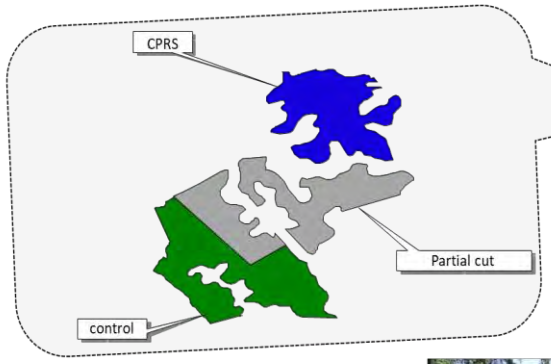


3 Compare results with; **Initial post harvest study** (changes over time)

Study Area

Clay Belt region of northwestern Quebec

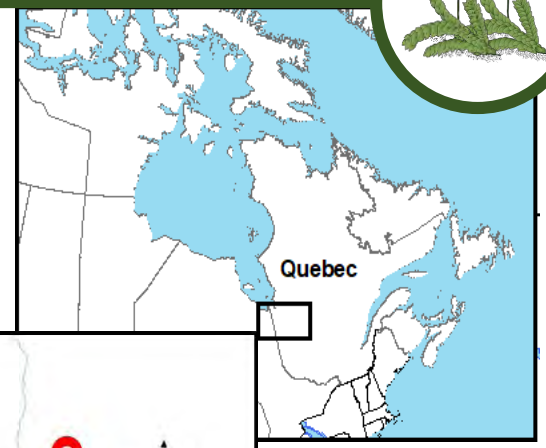
- Dominated by black spruce forest
- Average stand age over 100 years
- Réseau d'expérimentation des coupes partielles en Abitibi (RECPA)
- Three harvest treatment types:
  - Unharvested Control
  - Partial cut
  - Clear cut (CPRS)




CPRS

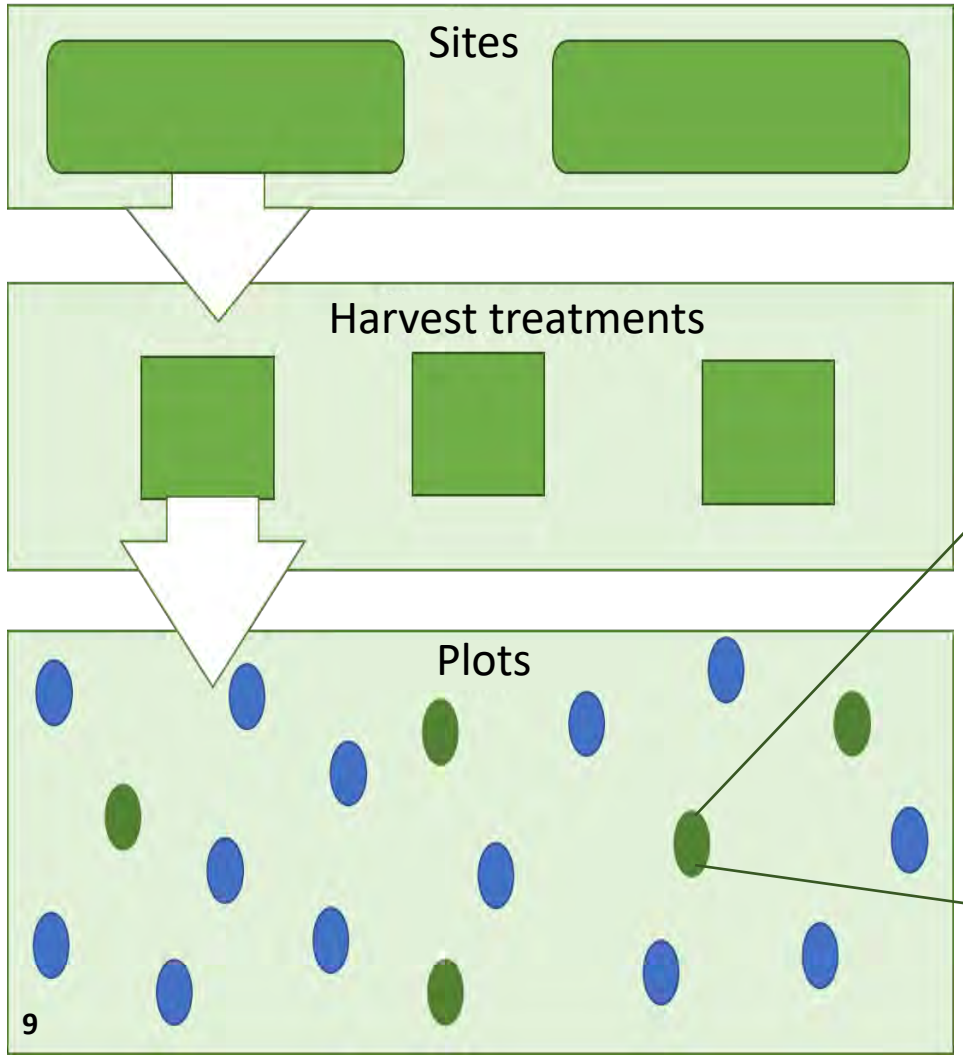

Partial cut


Control

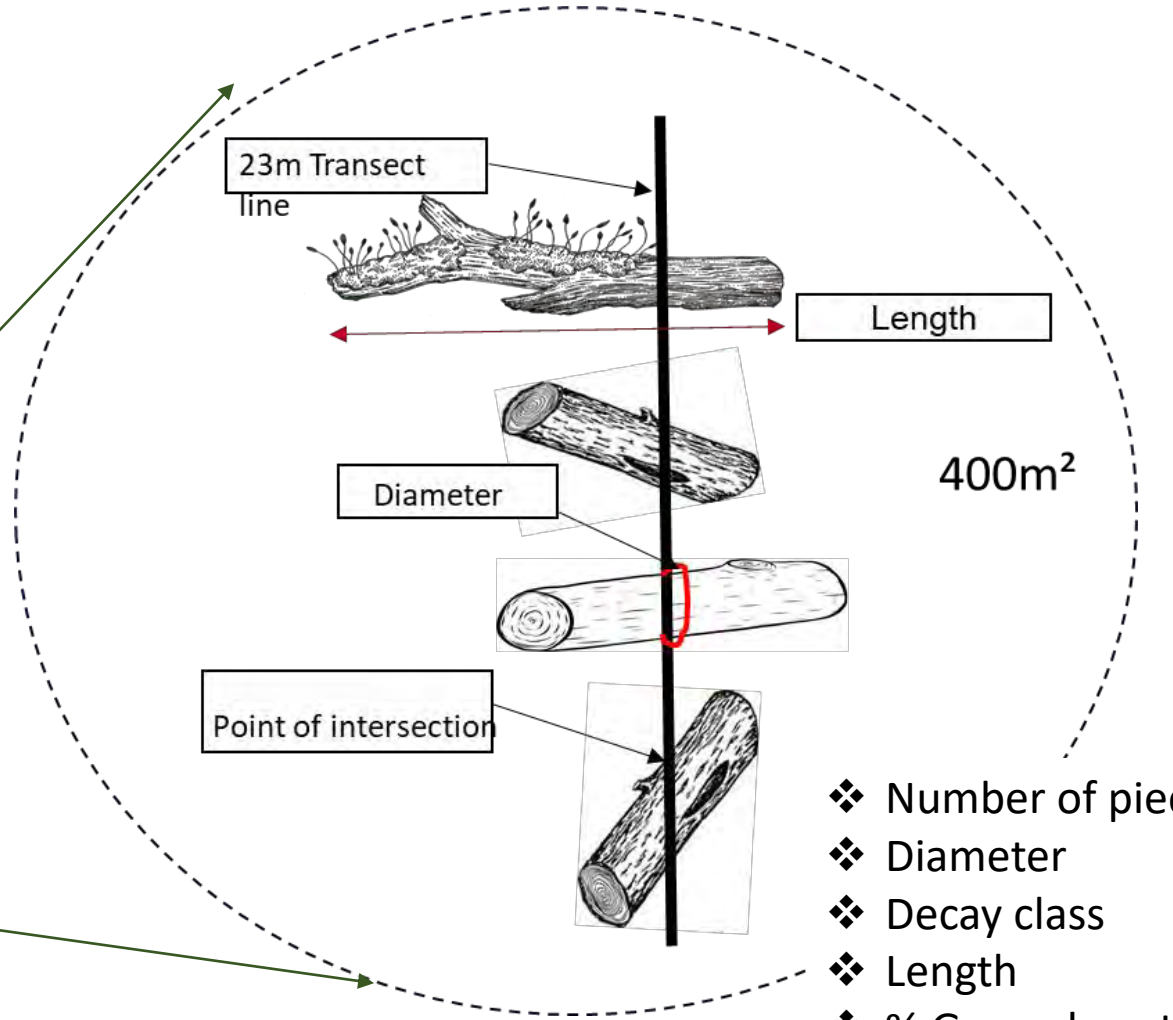


Approach

Experimental design



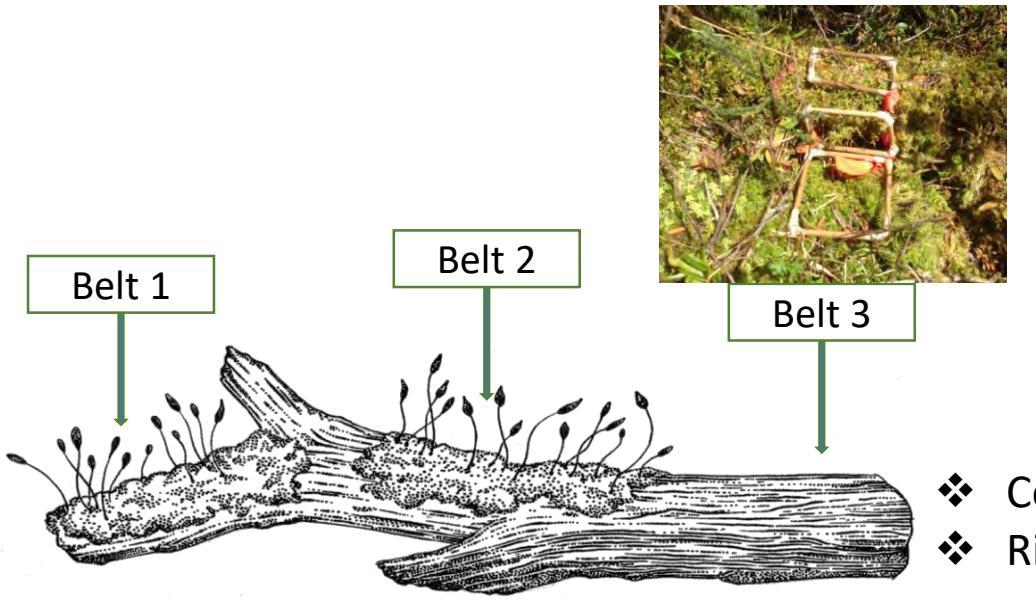
Coarse Woody Debris (CWD) Survey



- Number of pieces
- Diameter
- Decay class
- Length
- % Ground contact

Approach

Bryophytes sampling



- Composition
- Richness

Bryophytes identification

Changes over time

Data from initial study (5years after harvest) by Arseneault et al., 2012.

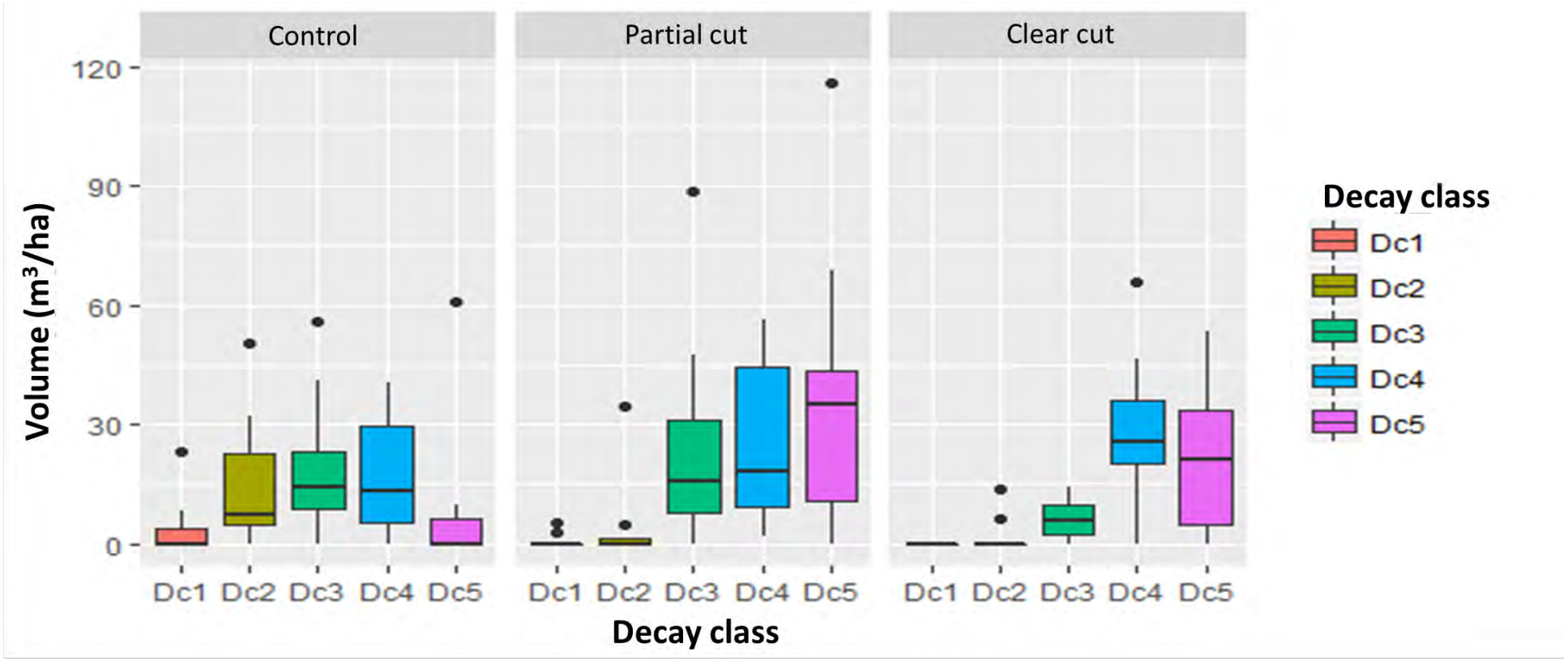
Results: Coarse woody debris characteristics

Mean (±SE) values of coarse woody debris (CWD) characteristics per harvest treatment

	2017			2009		
	Control	Partial cut	Clear cut	Control	Partial cut	Clear cut
CWD length (cm)	858.13 ±47.52a	547.76 ±39.79b	543.84 ±37.78b	872.47 ±44.72a	695.77 ±45.3b	669.7 ±43.25b
CWD decay class	3.06 ± 0.15b	3.77 ± 0.14a	3.98 ± 0.10a	2.77 ± 0.14a	2.93 ± 0.12a	2.83 ± 0.13a
Number of CWD per plot	8.2± 1.58a	8.9 ± 1.1a	8.6 ± 1.54a	9.2 ± 0.38a	10.34 ± 0.49a	9.6 ± 0.39a

Results: Coarse woody debris characteristics

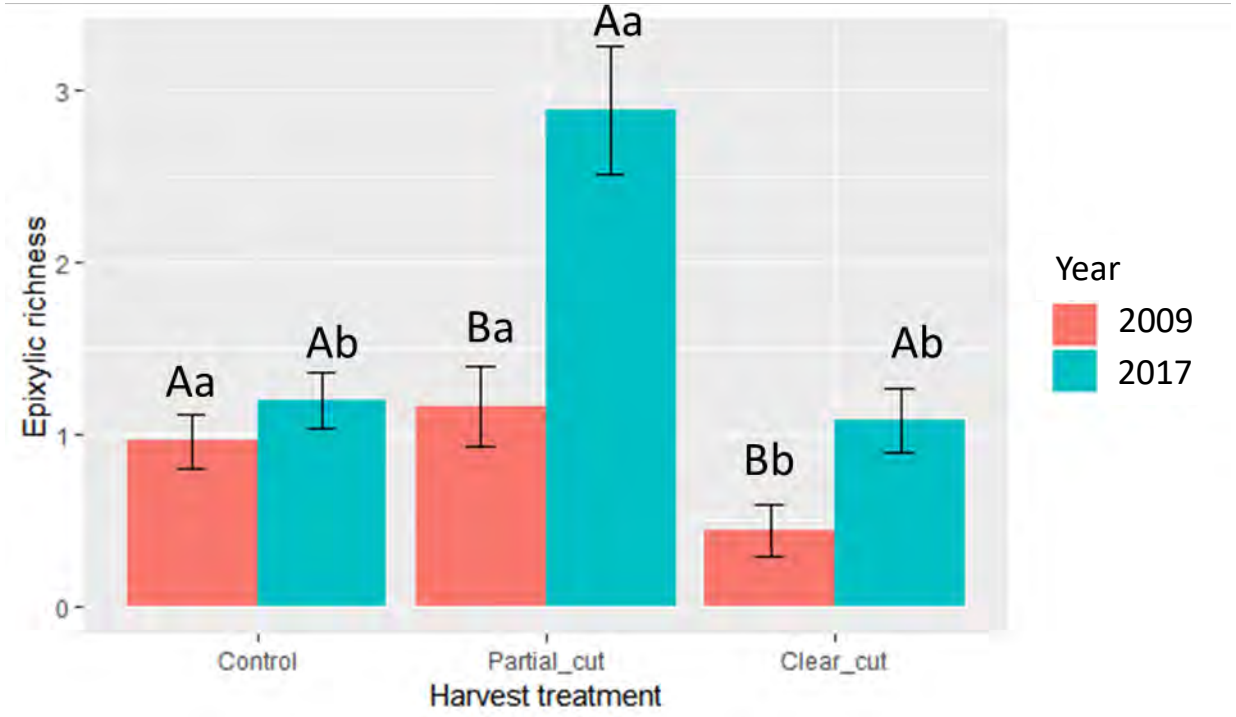
Coarse woody debris volume by decay class per harvest treatment (2017)



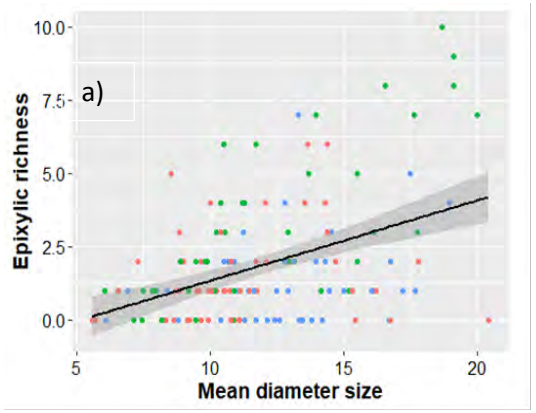
Decay 1 (fresh material) to Decay 5 (well decomposed)
Hunter Jr, (1990)

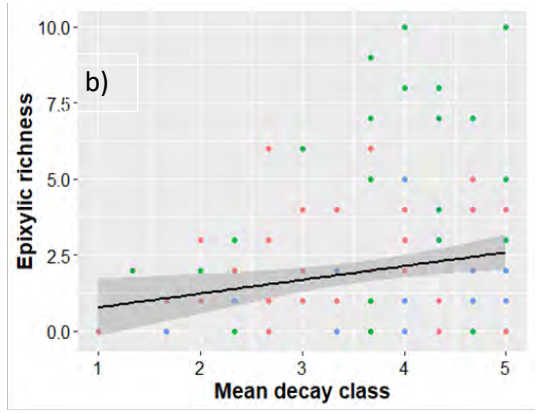
Results: Epixylic species richness

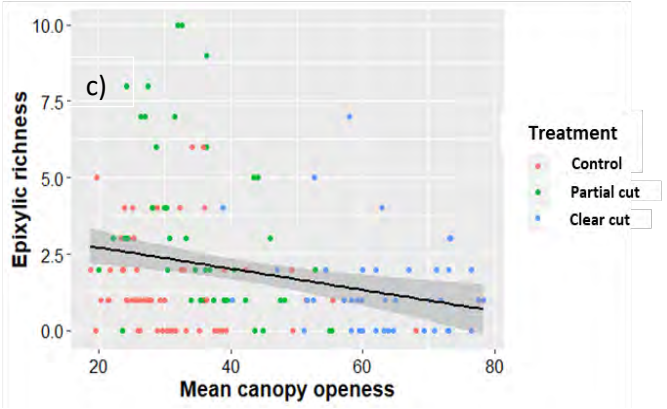
Mean epixylic species richness per harvest treatment between 2009 and 2017



Epixylic richness relationship with a) CWD diameter size, b) CWD decay class and c) canopy openness

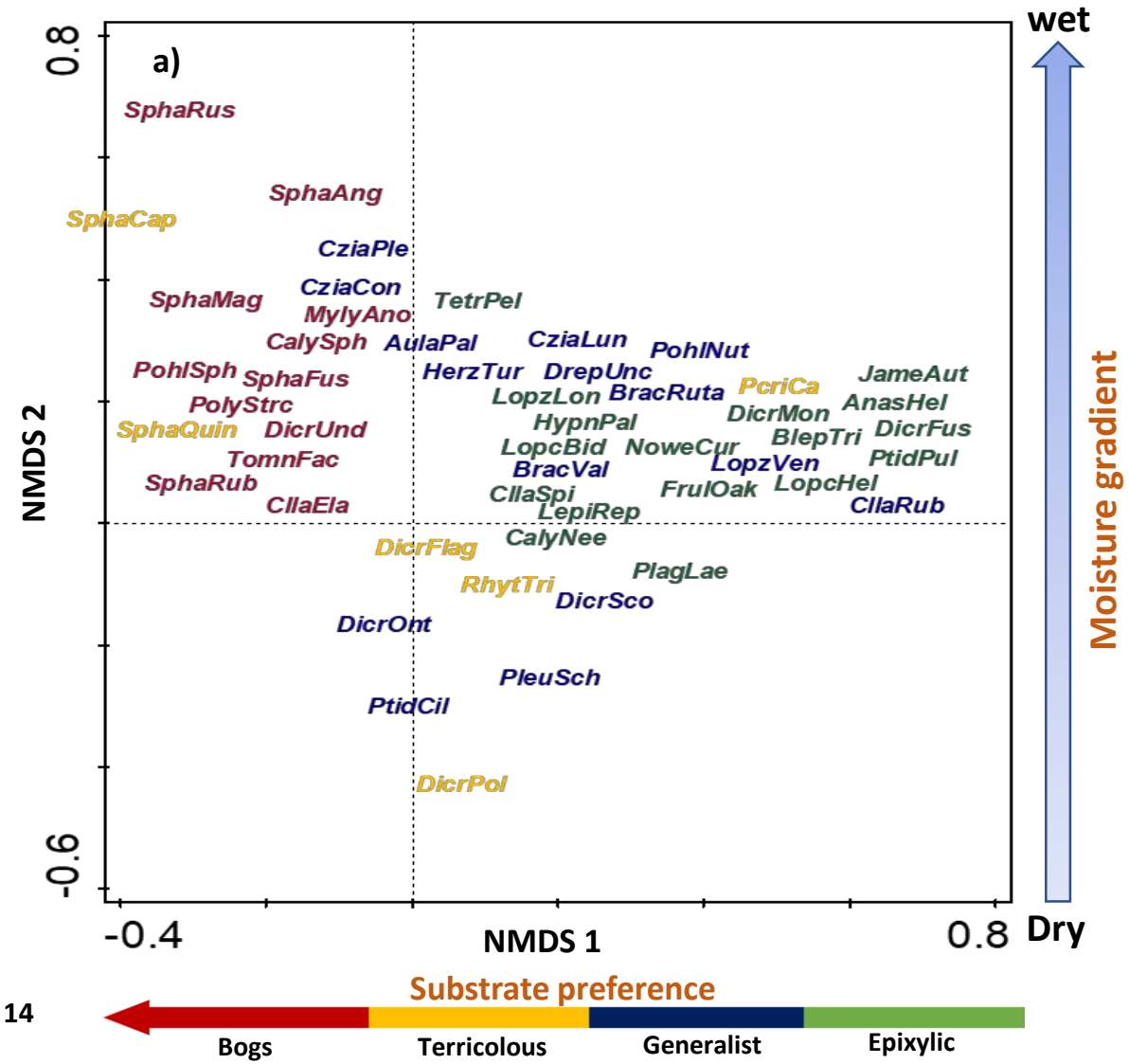


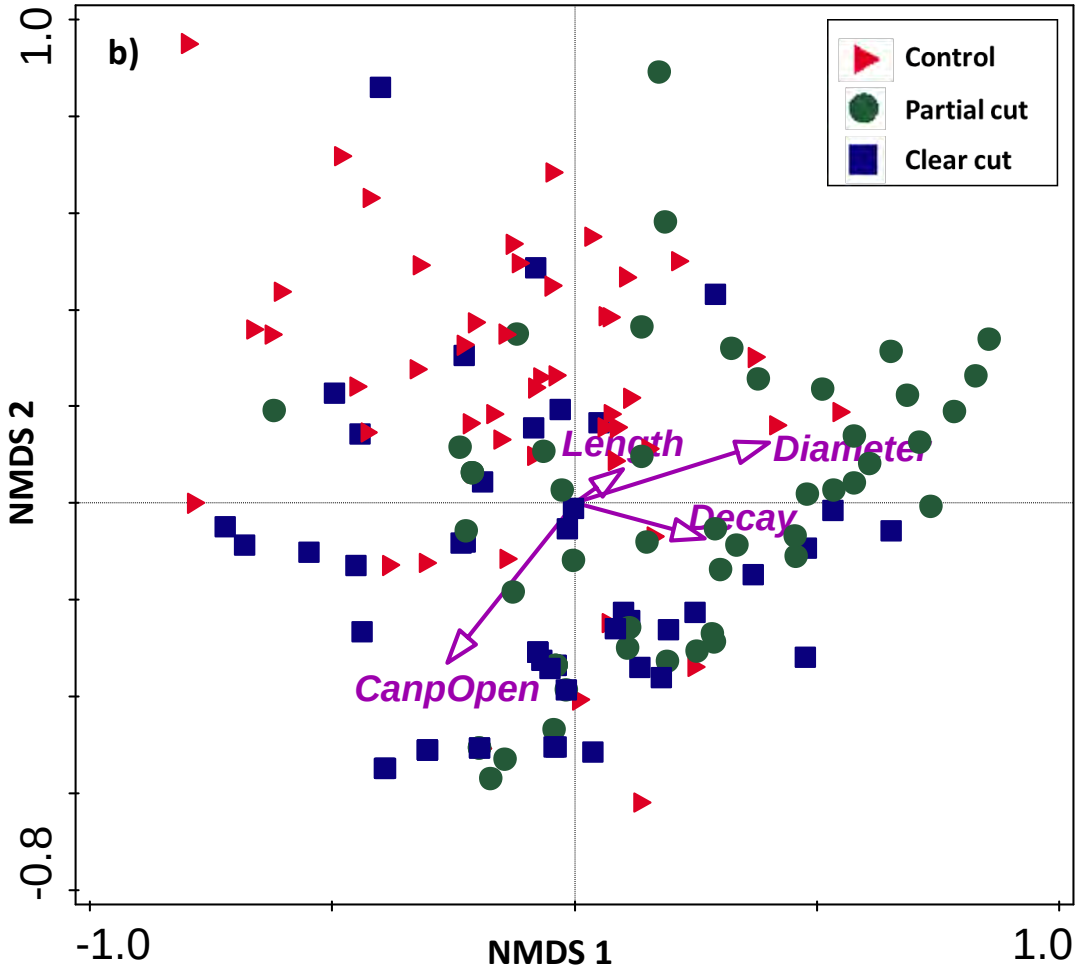




Results: Species composition

Species composition pattern along the harvest gradient



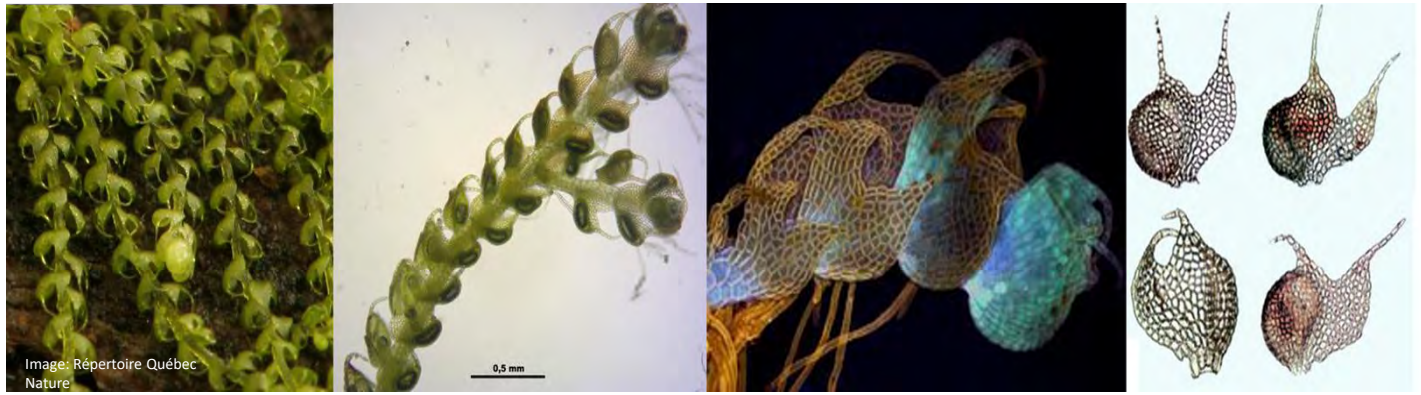


Discussion: Clear cut (CPRS)

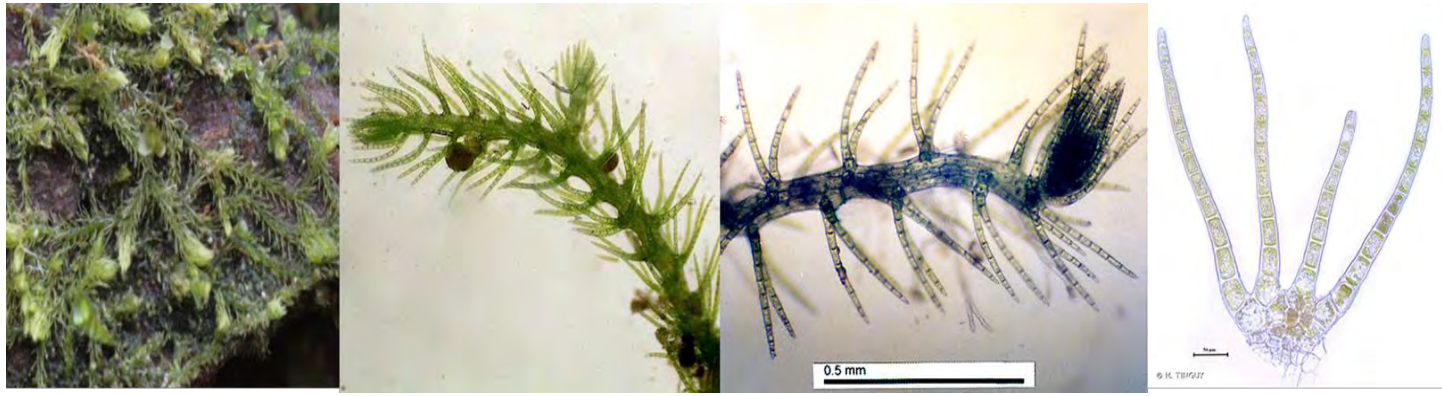
- Richer epixylic community in 2017 than in 2009
  - **Tree regeneration** enhanced moisture conditions
  - Improved **substrate quality (**Advanced decay and moisture)
- **Threatened species (Old growth indicator species)**
- **Future trend ?**
  - **Reduced** substrate availability
    - Lower volumes of early decay
    - Regenerating stand not a reliable source of bigger CWD.
- **Decline in epixylic community richness**

Drought sensitive and **old growth confined species**
(Söderström, 1988; Boudreault et al., 2018)

Nowellia curvifolia



Blepharostoma trichophyllum



Discussion:Partial cut

- **Substrate quality**
  - Advanced decay (Rambo, 2001)
- **Favourable microclimate**
  - Canopy and moisture conditions

- **Higher epixylic richness** compared to:
  - Control and clear cut (CPRS)
  - Initial post harvest study (2009)

- Presence of **drought sensitive** and **old growth confined species**

Discussion:Control

Overgrowing (Dynesius et al. 2010) affected epixylic community on CWD.

- ❖ Lower volumes of advance decay stage (**Buried**)
- ❖ Dominance of larger species (e.g. **sphagnum**).

Conclusion

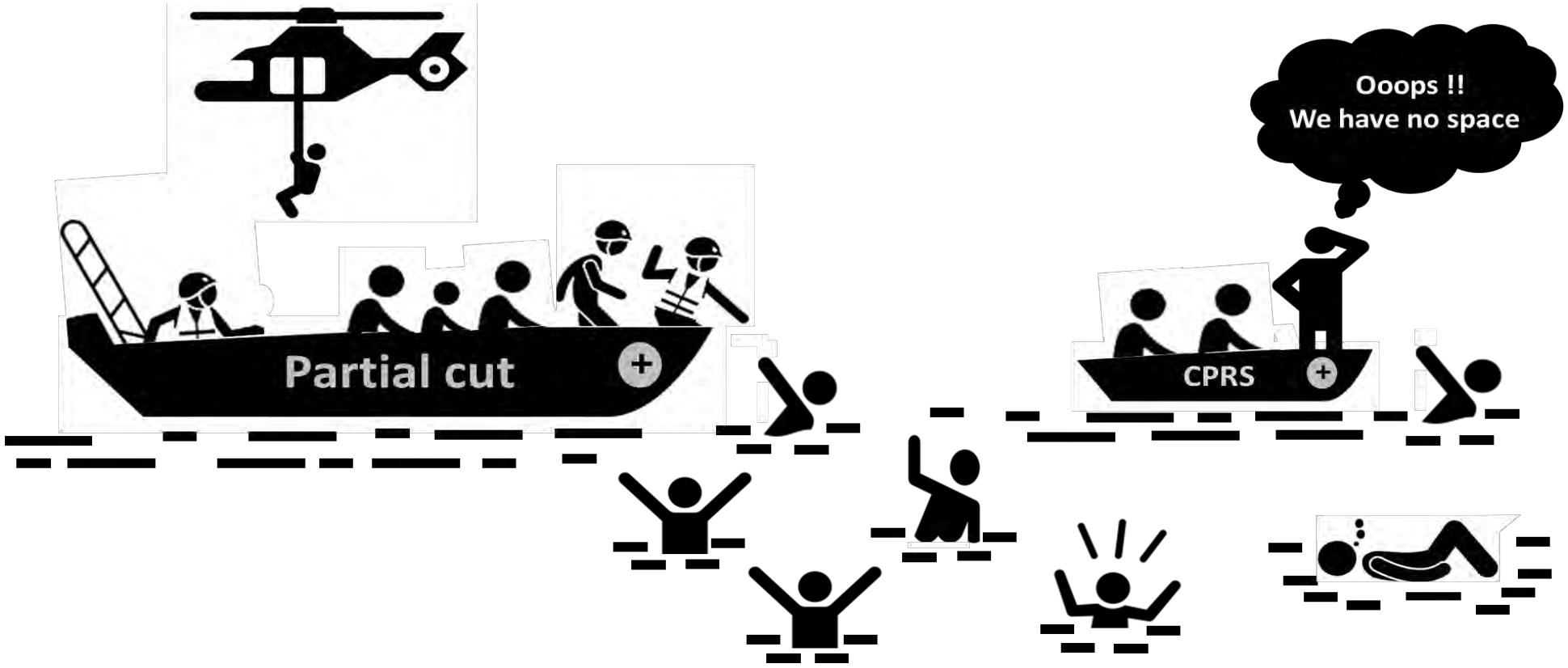
- **Partial cut offers an effective harvest strategy to attain epixylic species and habitat conservation goals than CPRS.**

Caution

- Lower volumes of early decay deadwood raises future substrate concerns
- **Residual stands** provides potential source of deadwood supply.
- Regular deadwood inventory
  - Remote sensing (LiDAR) approach can be explored.
- Deadwood should be created in stands with lower volumes

Image: Bio-forum

Epixylic rescue mission (season 2)



THANK YOU!

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