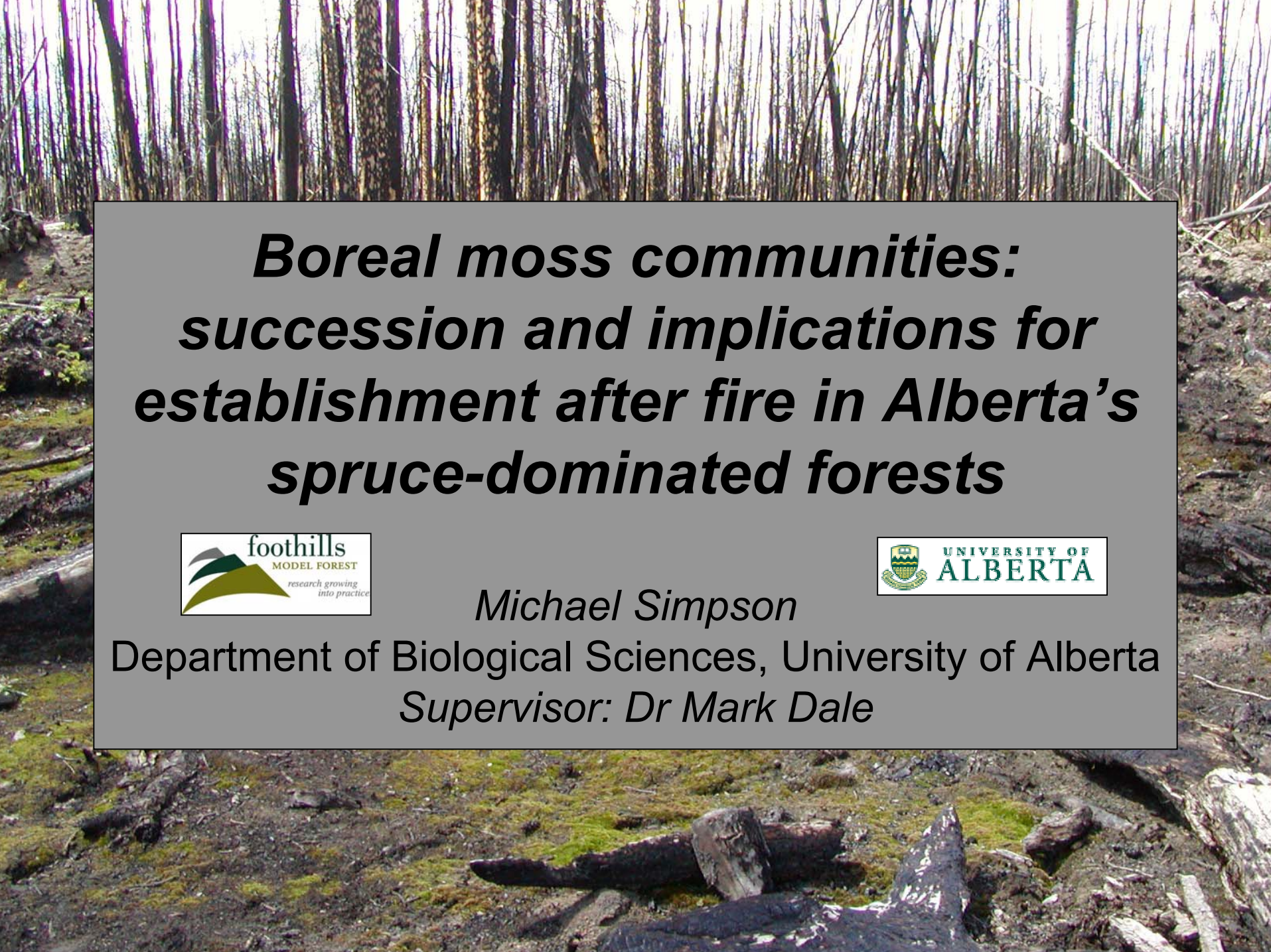


Boreal moss communities: succession and implications for establishment after fire in Alberta's spruce-dominated forests

Michael Simpson

Department of Biological Sciences, University of Alberta

Supervisor: Dr Mark Dale

Funaria hygrometrica

Ceratodon purpureus

Bryum argenteum

Polytrichum juniperinum

Hylocomium splendens

Ptilium crista-castrensis

Pleurozium schreberi

RESEARCH OBJECTIVES

1. Successional change in boreal moss communities – characteristics and controls
   A. Describe short-term variations in composition, diversity and species distribution in early-successional communities
   B. Test hypotheses about controls on timing of establishment of late-successional feather mosses
   C. Generate a model of species change over time

2. Implications for wider forest community
   - Effects of moss on post-fire recruitment of selected conifer species

HYPOTHESES

Establishment and growth of feather mosses is controlled by:

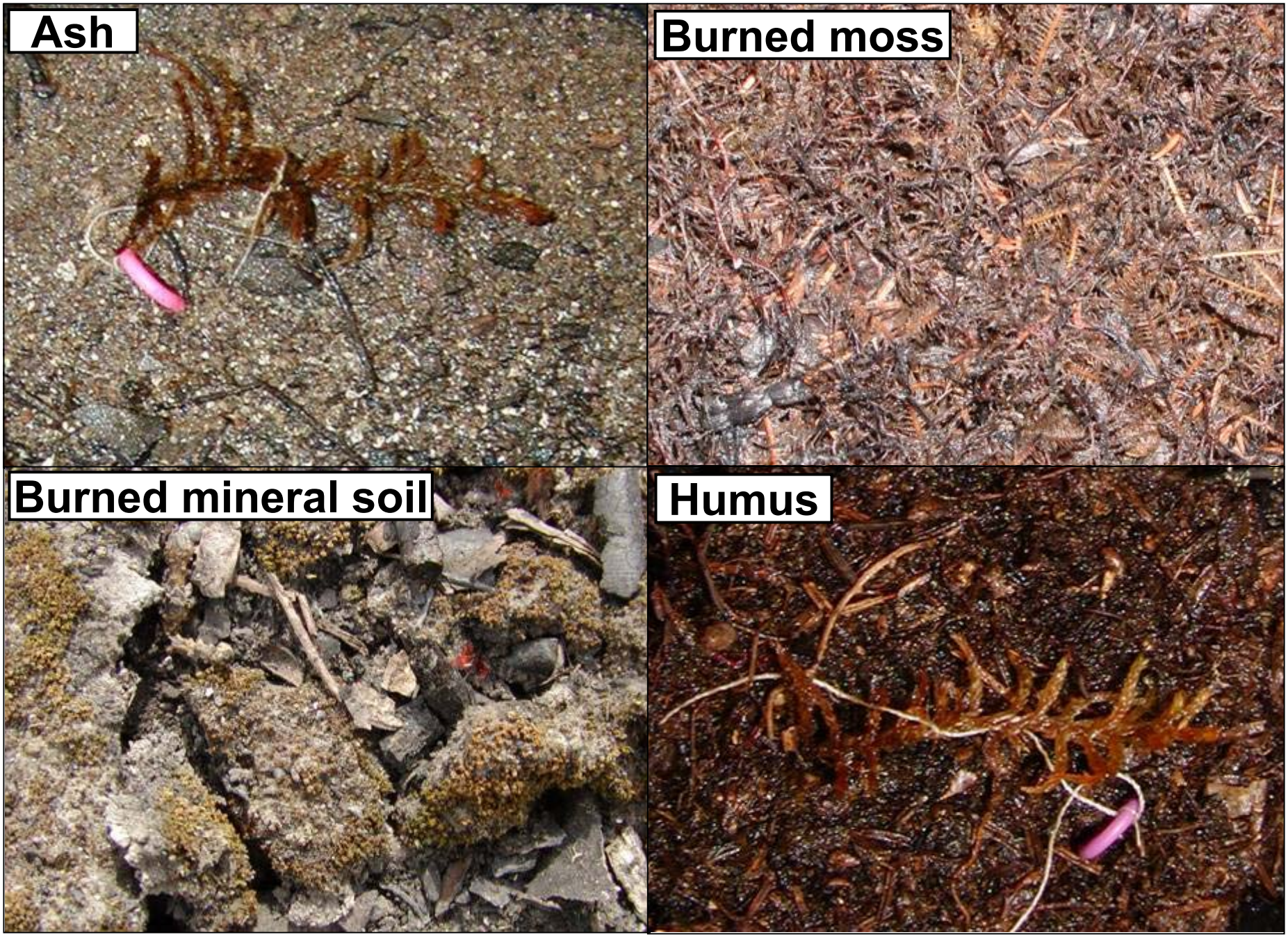
- Available substrates
  - **Early successional:** mineral-based; high pH, low nutrients, dry c.f. **Late successional:** high OM, low pH, high nutrients, moist
- Limited tolerance for low humidity, increased water loss
  - High exposure in early successional (open) stands
- Reproduction primarily asexual (vegetative propagation); delays dispersal of propagules
- Interactions between substrate, stand age, reproductive strategy

HYPOTHESIS 1: Establishment and growth of feather mosses is controlled by available substrates

1. Compare the establishment potential and growth of fragments of 2 feather mosses on burned and unburned substrates

Pleurozium schreberi

Ptilium crista-castrensis


Ash
Burned moss
Burned mineral soil
Humus

2 FRAGMENT SIZES

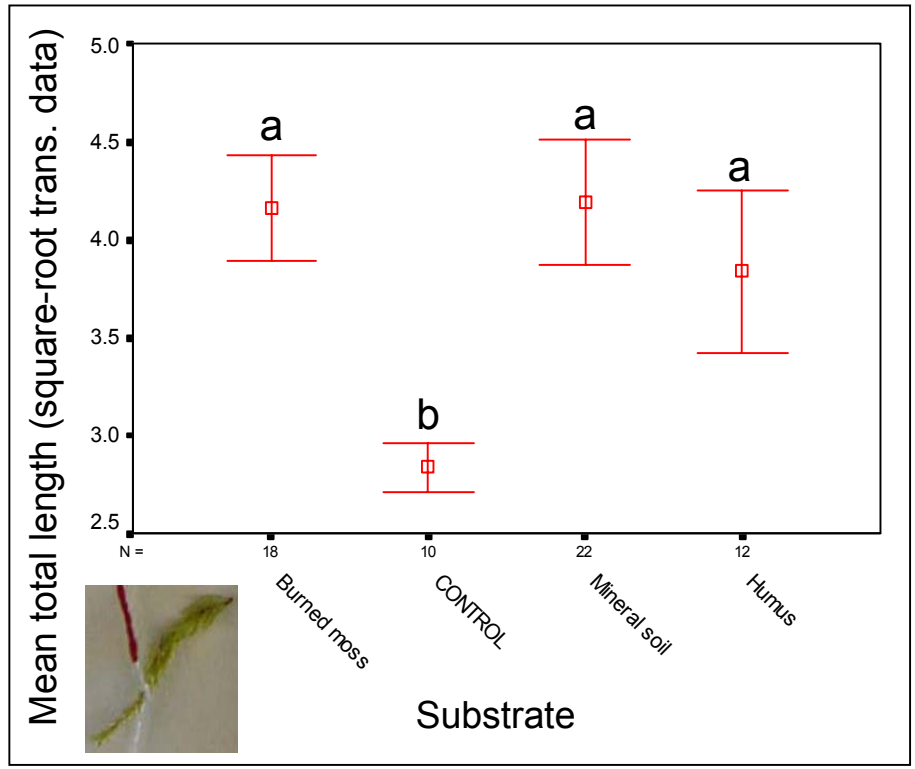
Large: branching, ~ 4 cm long, cut with scissors

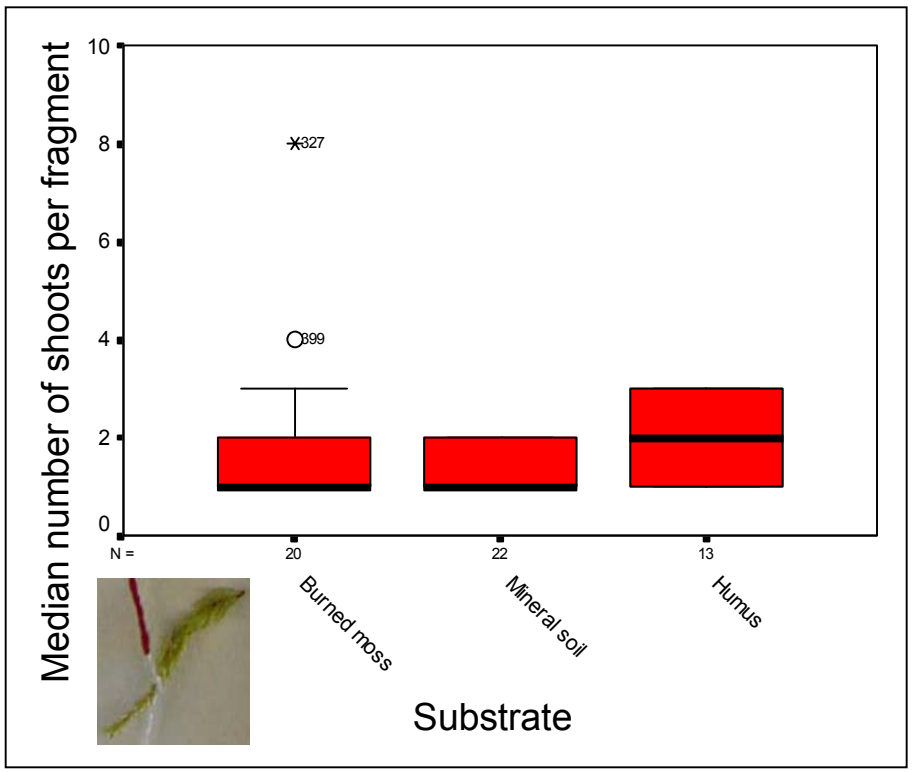
Small: unbranched, mean lengths: *Ptilium* 5.6 mm *Pleurozium* 8.2 mm, dislodged using a soil sieve

- 2.5” square plastic pots
  - 24 or 36 = 1 ‘block’
- 5 blocks per stand in:
  - SMALL frags: 3 early- & 1 late-successional stand
  - LARGE frags: 1 late-successional stand
- Sunk into humus on forest floor
- Fragments tied to paper clips
- SMALL - 12 months
  LARGE - 3 months

SMALL: Total length of fragments with living shoots

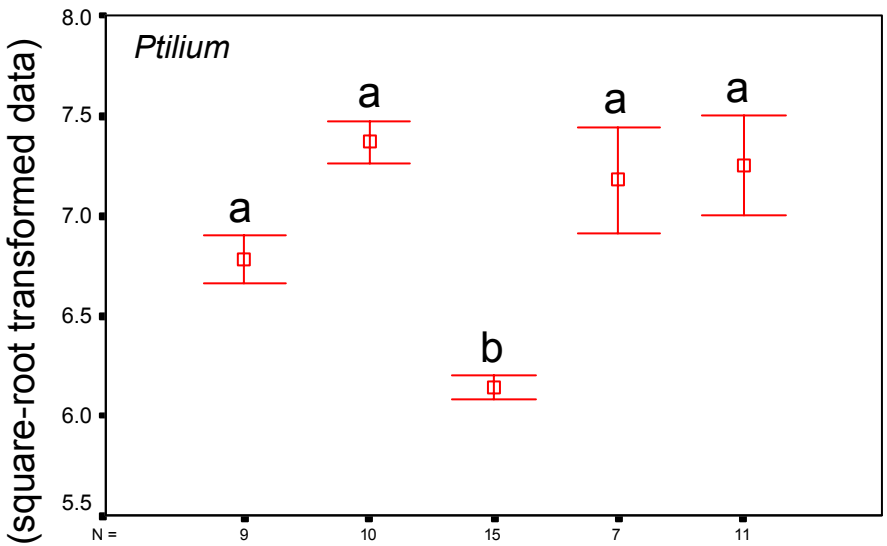
- Only 2 *Pleurozium* fragments on ash and 2 *Ptilium* fragments total with growth
- Fragments on all substrates significantly longer than initial length (P<0.05)

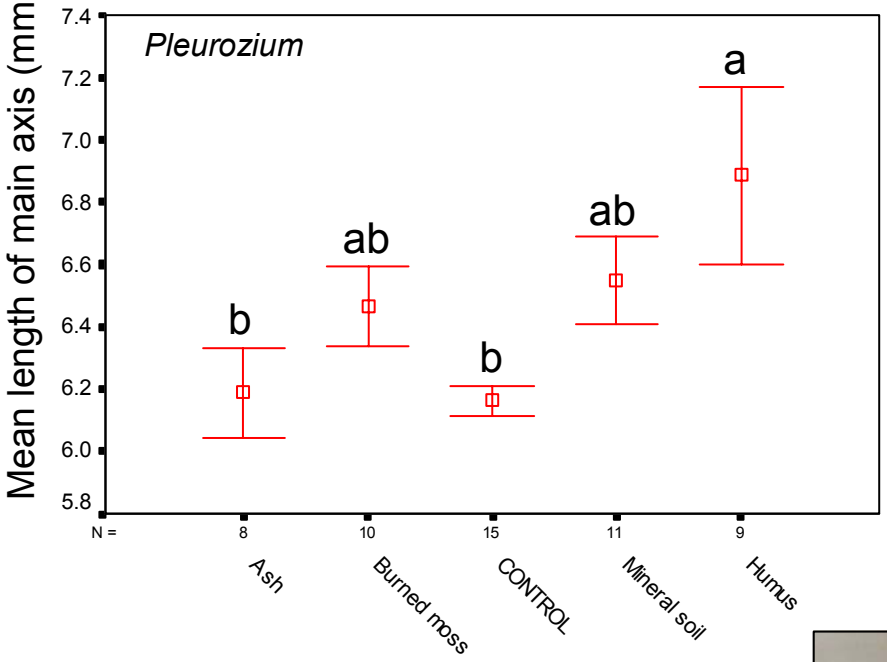


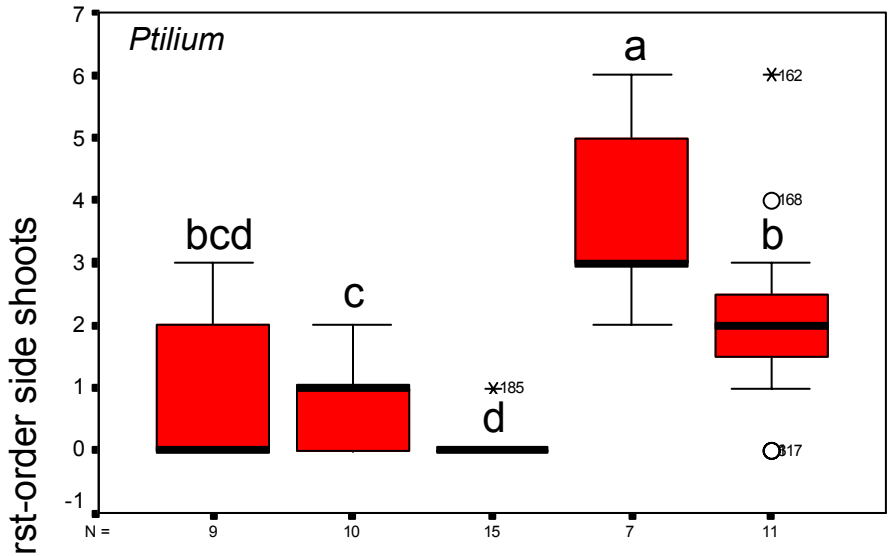


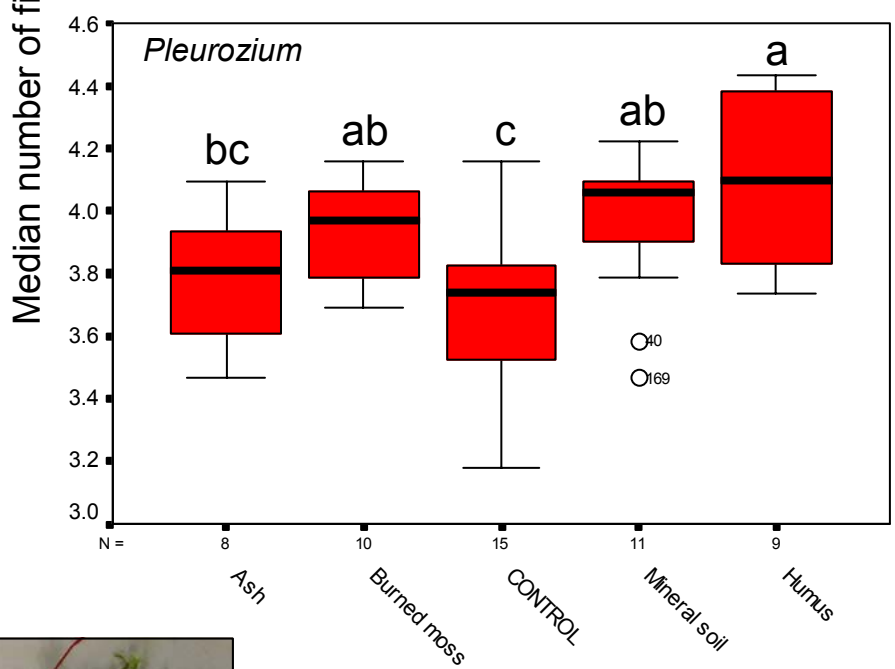
shoots per fragment

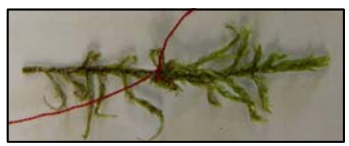
- Few shoots; no difference between substrates


Ptilium
a
a
b
a
a
8.0
7.5
7.0
6.5
6.0
5.5
N =
9
10
15
7
11


Pleurozium
b
ab
b
ab
a
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
5.8
N =
8
10
15
11
9
Ash
Burned moss
CONTROL
Mineral soil
Humus
Substrate
Mean length of main axis (mm) (square-root transformed data)

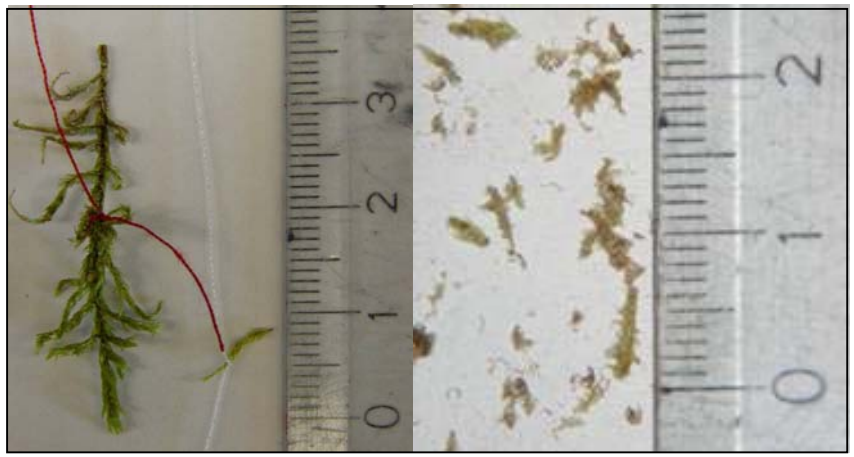

Ptilium
bcd
c
d
a
b
162
168
185
117
7
6
5
4
3
2
1
0
-1
N =
9
10
15
7
11


Pleurozium
bc
ab
c
ab
a
40
169
4.6
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.0
N =
8
10
15
11
9
Ash
Burned moss
CONTROL
Mineral soil
Humus
Substrate
Median number of first-order side shoots



HYPOTHESIS 2: Establishment and growth of feather mosses is controlled by limited tolerance for exposure (low humidity, increased water loss)

1. Compare the establishment potential and growth of fragments of 2 species sown in recently burned (open) stands
2. Test for differences between 3 fragment sizes
   - LARGE, SMALL, MULCH

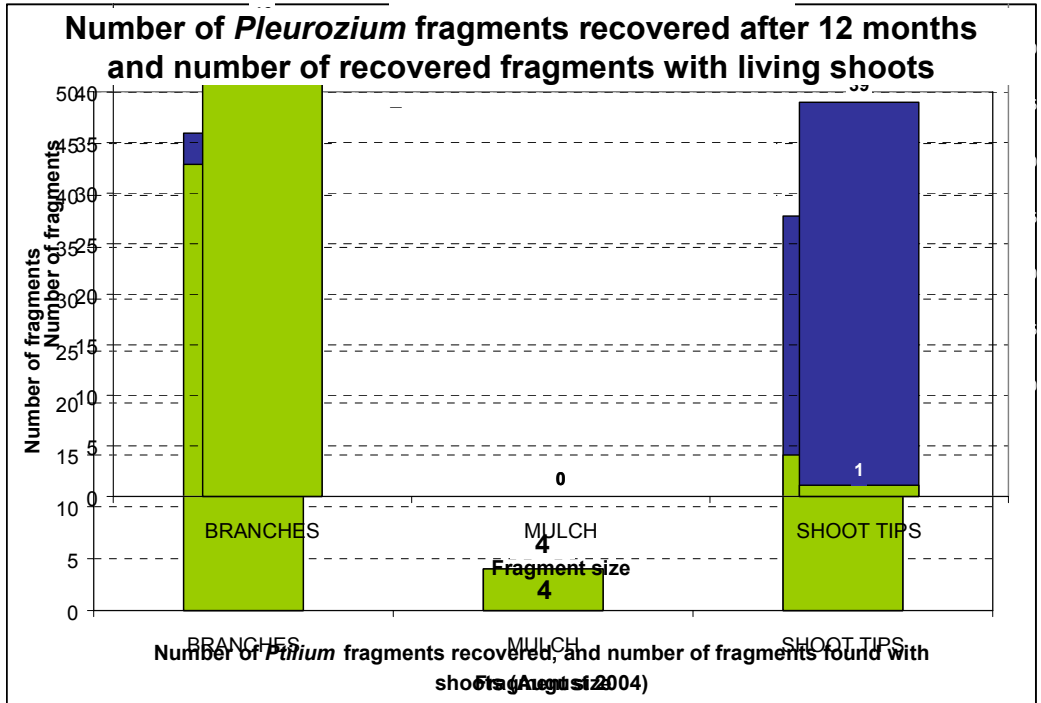


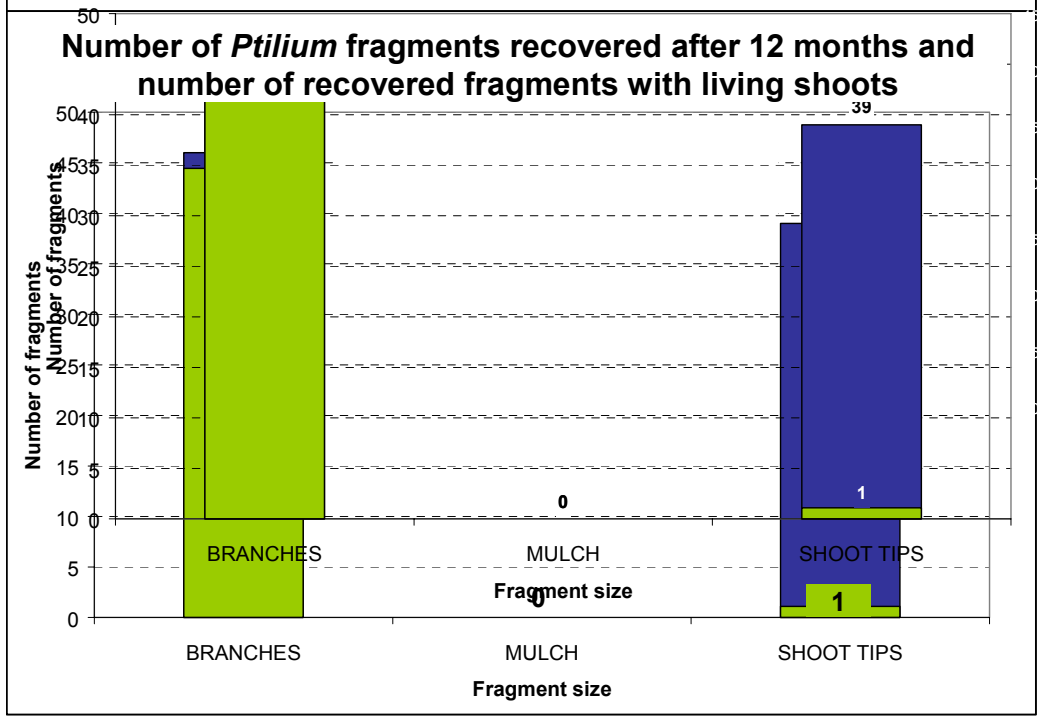
- Soil surface excavated to ~ 2.5 cm and replaced with humus
- 5 blocks in 5 stands
  - 4 recently burned (open)
  - 1 late-successional
- 4 x 4 blocks marked out using plastic frame
- Fragments pinned/spread within squares
- Number of fragments with living shoots recorded after 12 months

Living shoots (all stands)

- Growth found in few MULCH replicates
- Few SMALL fragments had living shoots
- Almost all LARGE fragments had living shoots

Number of fragments recovered
Number of fragments with shoots





OBJECTIVE 1: PRELIMINARY CONCLUSIONS

- Establishment and growth on burned/mineral substrates and in open stands possible

Therefore…

- Timing of establishment of feather mosses primarily a function of dispersal limitation, but…
- Exposure and substrate influence timing thorough interactions with fragment size
  - Larger fragments likely to be more successful, but…
  - Fewer of them
  - Long distance saltation dispersal = long process (which may be accompanied by loss of viability)
  - Other vectors may be quicker – rare event?

OBJECTIVE 1 – PRELIMINARY CONCLUSIONS

- Suggests establishment by fragments is increasingly rare at greater distances from fire boundary
  - Spread from boundaries of fire and residuals limited
  - In the middle of large burns, post-fire recolonisation likely to be slow
- Do distant colonies establish from fragments?
  - may occur primarily through spores
- Recolonisation likely to be faster post-logging
  - source of propagules *in situ*
  - would compress intermediate successional stages and constrain opportunities of species associated with them

RESEARCH OBJECTIVES

1. Successional dynamics in boreal moss communities
   A. Describe short-term variations in composition, diversity and species distribution in early-successional communities
   B. Test hypotheses about controls on timing of establishment of late-successional feather mosses
   C. Generate a model of species change over time

2. Implications for wider forest community
   - Effects of moss on post-fire recruitment of selected conifer species

RESEARCH OBJECTIVES

Post-fire recruitment is influenced by early successional conditions

- Burned feather moss remains = ‘biological legacy’
  - ‘persisting living and dead structures’ left by disturbances’ (Franklin et al. 2002)

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RESEARCH OBJECTIVES

Post-fire recruitment is influenced by early successional conditions

- Burned feather moss remains = 'biological legacy'
  - 'persisting living and dead structures' left by disturbances (Franklin et al. 2002)
  - Dry; elevate seeds and seedlings
- Previous studies indicate living moss carpets can enhance seed germination and seedling survival
  - Moist; cover; moss-cyanobacteria associations might enhance seedling growth compared with open soil – N fixation
- Potential influence on understory and canopy spatial structure and composition

Assess the impact of:

- *BURNED MOSS*
- *LIVING CARPETS OF EARLY SUCCESSIONAL MOSS*

…on seed germination, and short-term survival and growth of seedlings of selected boreal tree species

BURNED MOSS - METHODS (SEEDLINGS)

- Seeds of *Picea glauca* and *Larix laricina* pre-germinated on moist filter paper in Petri plates.
- 10 germinants per species planted in 20 4-inch pots of burned moss, mineral soil or humus subsoil
- Pots in a growth chamber, watered every 3 days.
- Survival recorded periodically; mean dry weight and height after 97 days

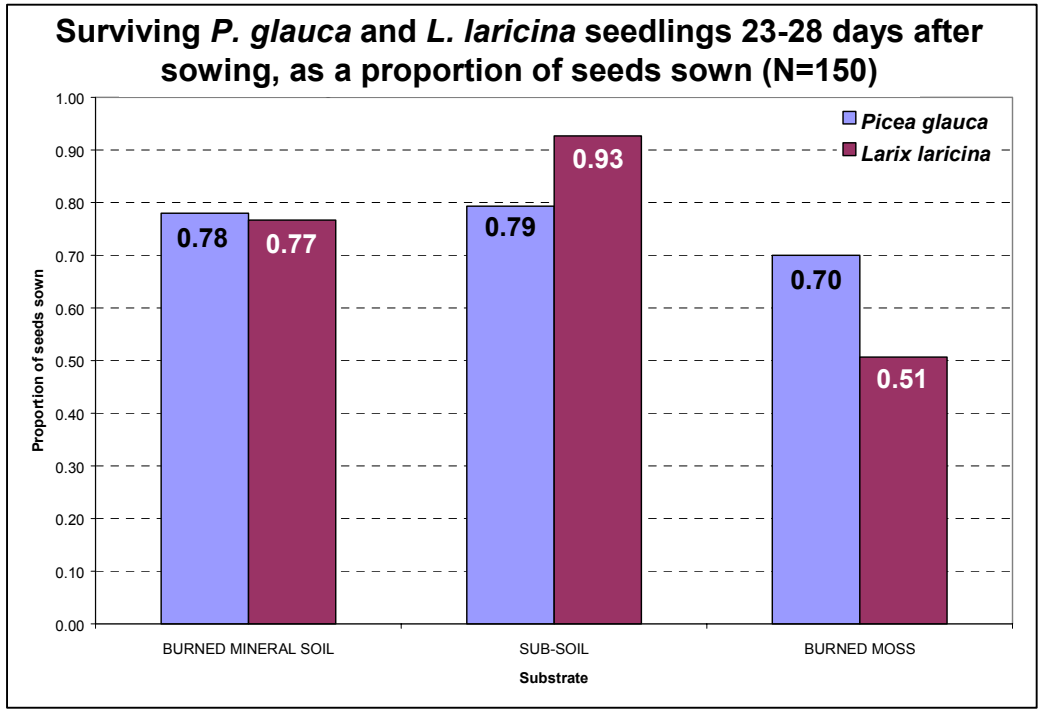
SEEDLING SURVIVAL

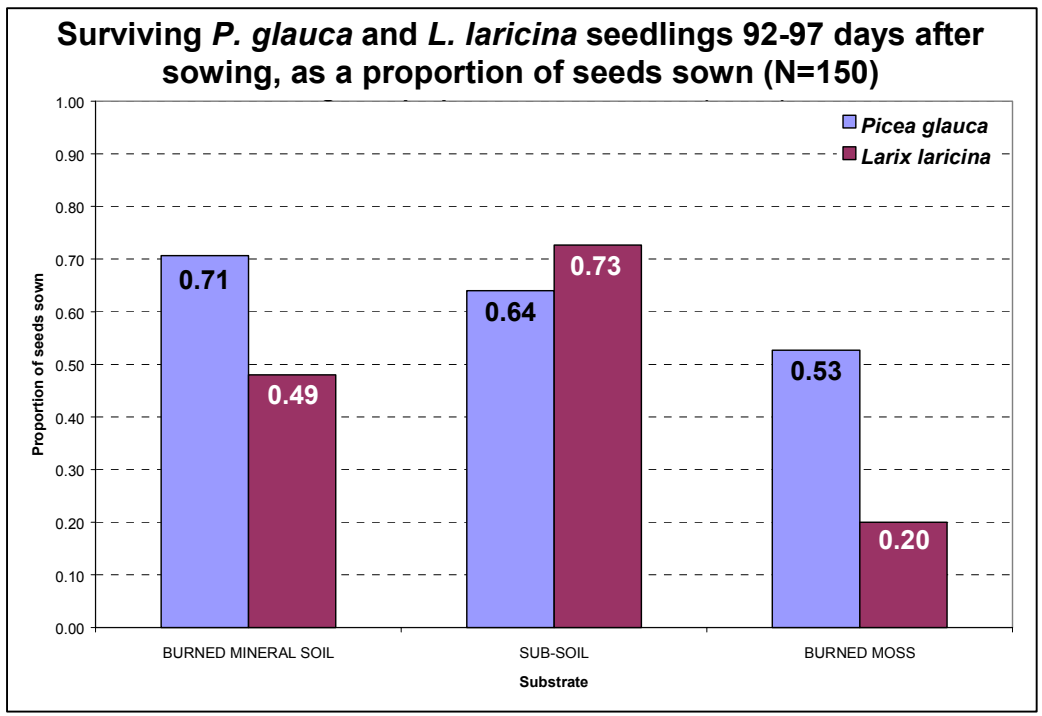
Between 28 and 97 days after sowing:

- For both species, survival declined most on burned moss
  - *L. laricina* 51% to 20%
  - *P. glauca* 70% to 53%

At 97 days:

- *L. laricina* survival lowest on burned moss, highest on humus
- *P. glauca* survival lowest on burned moss, highest on mineral soil





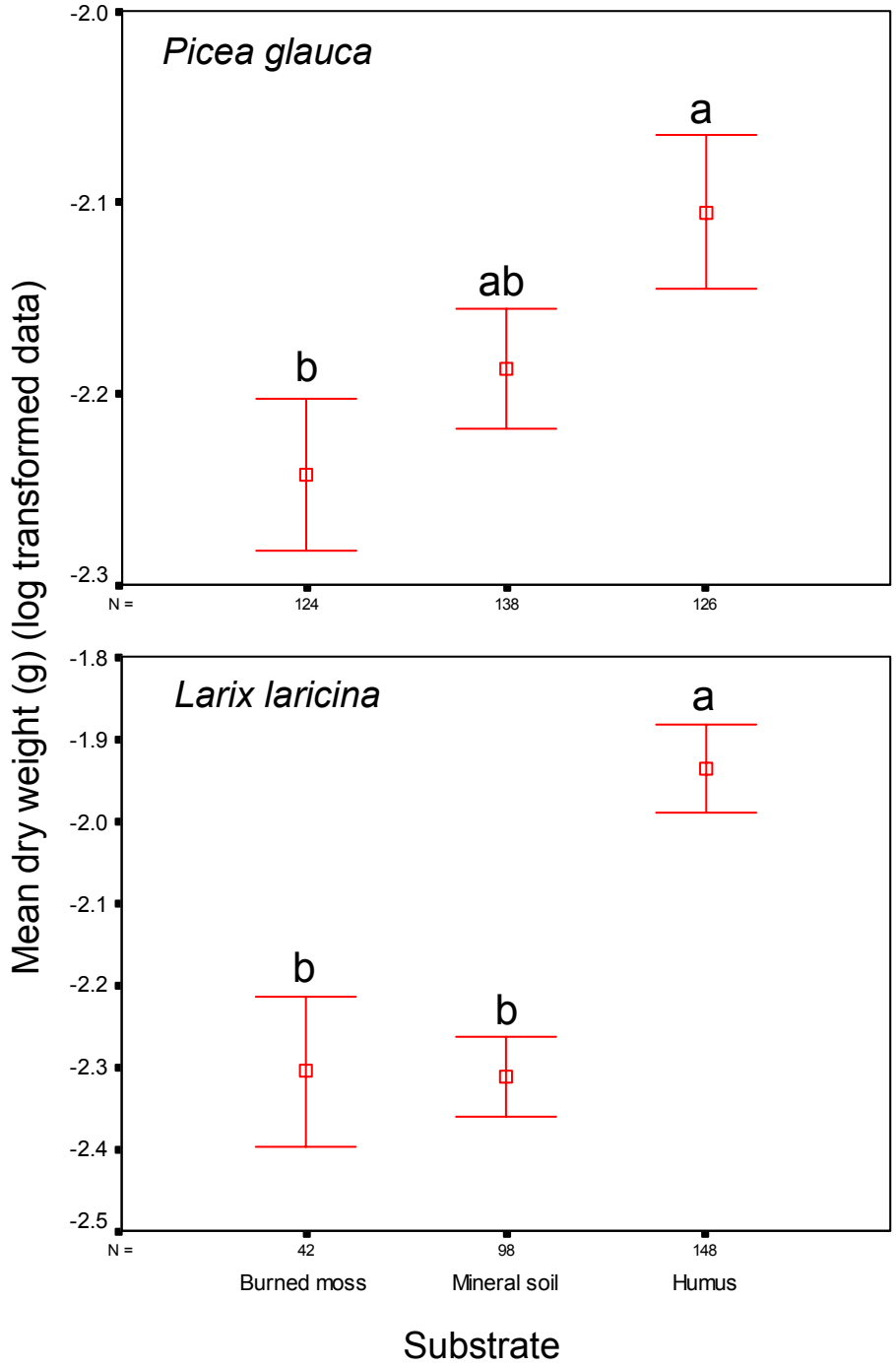
SEEDLING GROWTH

Mean dry weight

- Both species: burned moss significantly different from humus but not mineral soil (P<0.01)

Mean height

- *P. glauca* - no significant difference between substrates
- *L. laricina*: burned moss significantly different from humus but not mineral soil (P<0.01)



PRELIMINARY CONCLUSIONS

- Burned feather mosses are a poor substrate for survival of seedlings, esp. of *L. laricina*.
  - Conditions more amenable in growth chamber?
  - NO SEEDLINGS on burned moss in field trial!
- Optimum growth of successful germinants will not occur on burned moss
- *L. laricina* likely to form minor component of canopy in stands where burned moss had high cover

LIVE MOSS - METHODS

- Pilot study in field – low germination
- Seeds of *P. glauca*, *L. laricina* and *P. mariana* (black spruce) sown in trays on 3 treatments:
  - *Moss present*
  - *Moss cleared*
  - *Open soil*

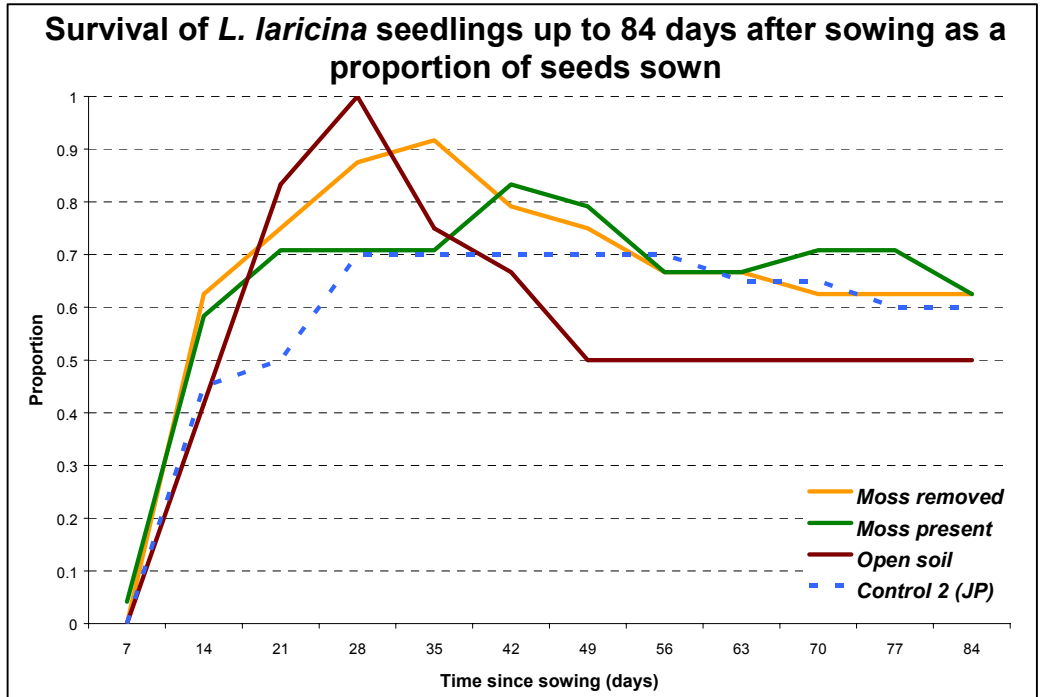
- Controls sown on filter paper and Jiffy Pots©
- Germination and survival data collected weekly (ongoing)

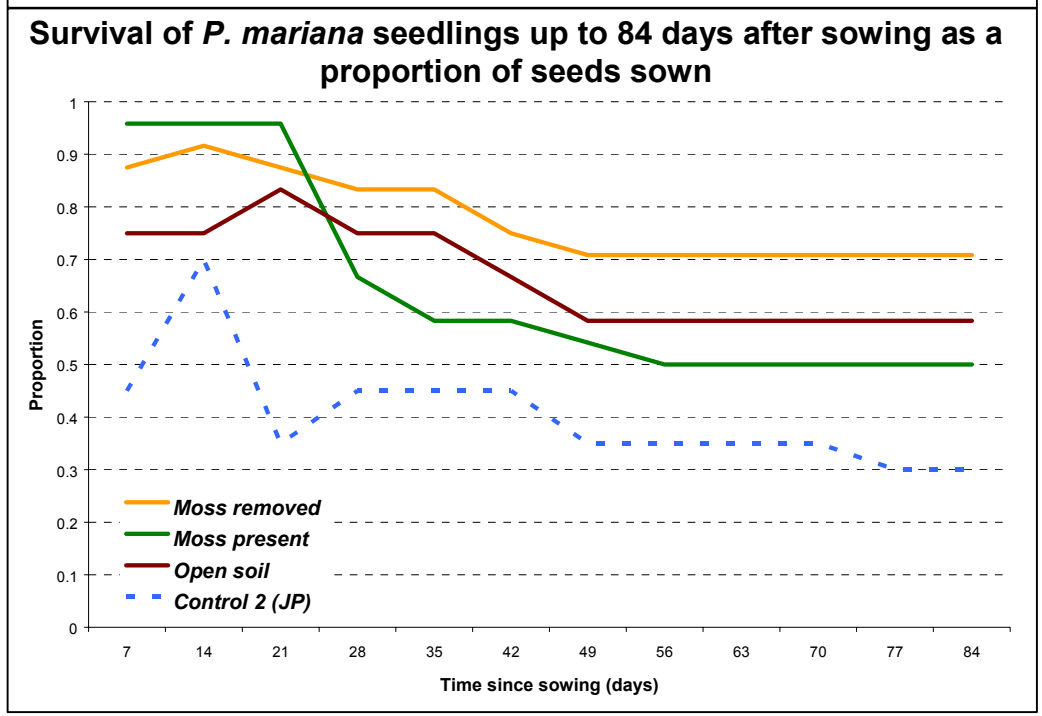
Germination – All species

- Very high on all treatments
- Little difference between treatments

Seedling survival

- Little difference between treatments for *P. glauca*
- *L. laricina* – germination highest but survival lowest on *Open soil*
- *P. mariana* – germination highest but survival lowest on *Moss present*





PRELIMINARY CONCLUSIONS

- Little difference between treatments
  - No effect on germination and survival?
  - Differences moderated in growth chamber?
- Effects on growth to be determined…
- Mortality of *L. laricina* seedlings might be lower in presence of early successional moss carpets?
- Mortality of *P. mariana* seedlings might be greater in moss patches?

ACKNOWLEDGEMENTS

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