Extended density-dependent mortality in mature conifer forest: causes and implications for forest ecosystem management

Ecological Applications (in press)

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CRSNG NSERC
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RENEWABLE RESOURCES
Alberta Sustainable Resource Development
Alberta Innovates

General introduction

Lodgepole pine ecosystems

Distribution map:
Pinus contorta subsp. ***contorta***
Pinus contorta subsp. ***latifolia***
Pinus contorta subsp. ***murrayana***

General introduction

Lodgepole pine ecosystems increasingly affected by less severe disturbances

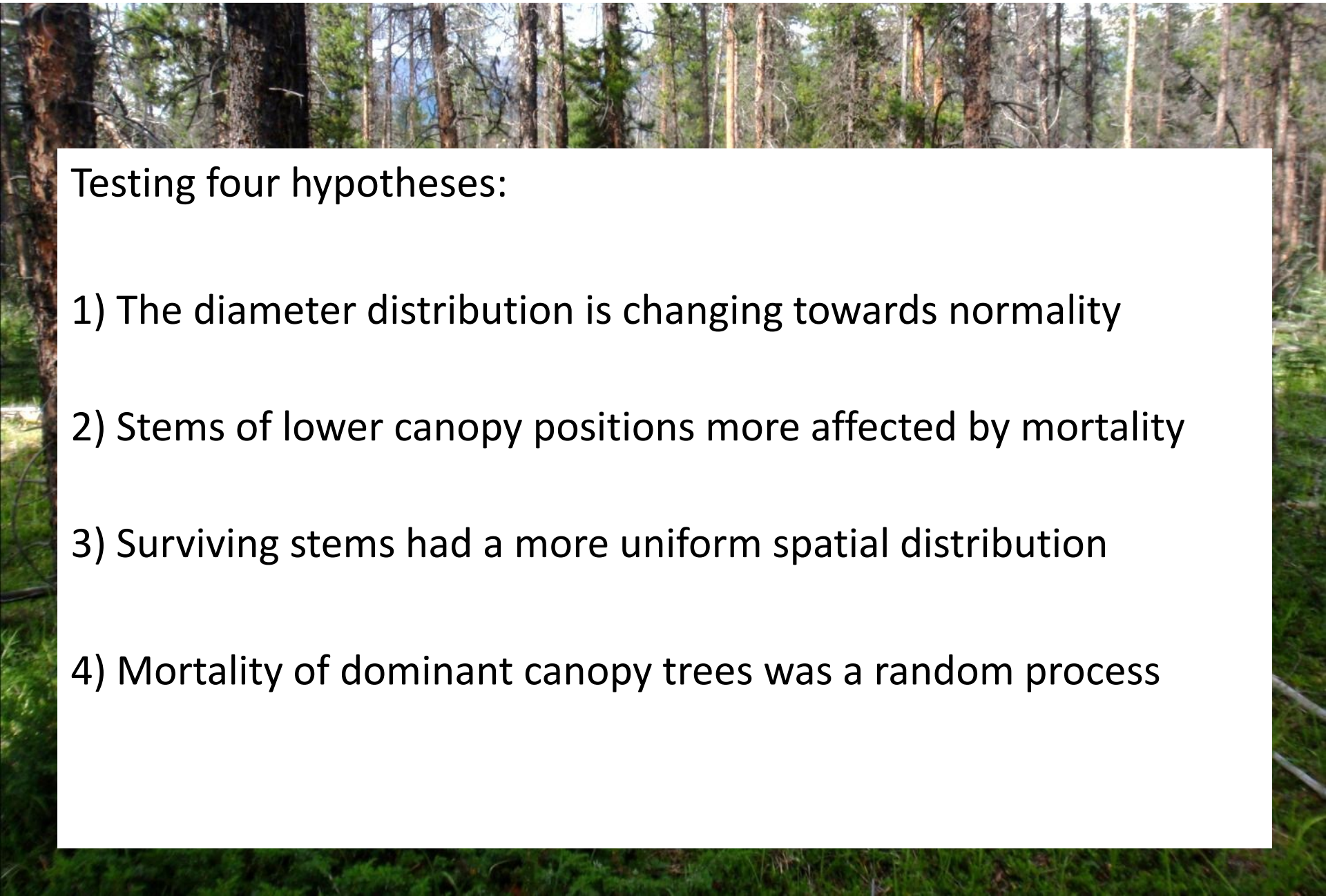
Recent Mountain Pine Beetle outbreak

Lower fire frequencies in recent decades

Rhemtulla et al 2002


2012

Process driving tree mortality in mature stands



Testing four hypotheses:

1) The diameter distribution is changing towards normality

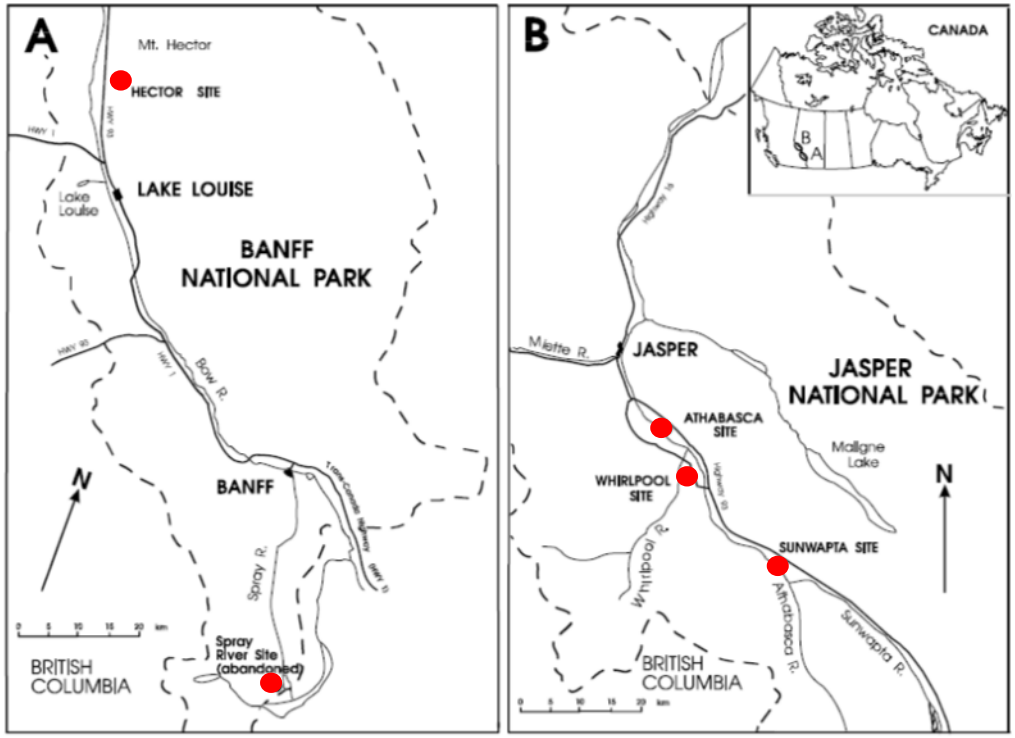
2) Stems of lower canopy positions more affected by mortality

3) Surviving stems had a more uniform spatial distribution

4) Mortality of dominant canopy trees was a random process

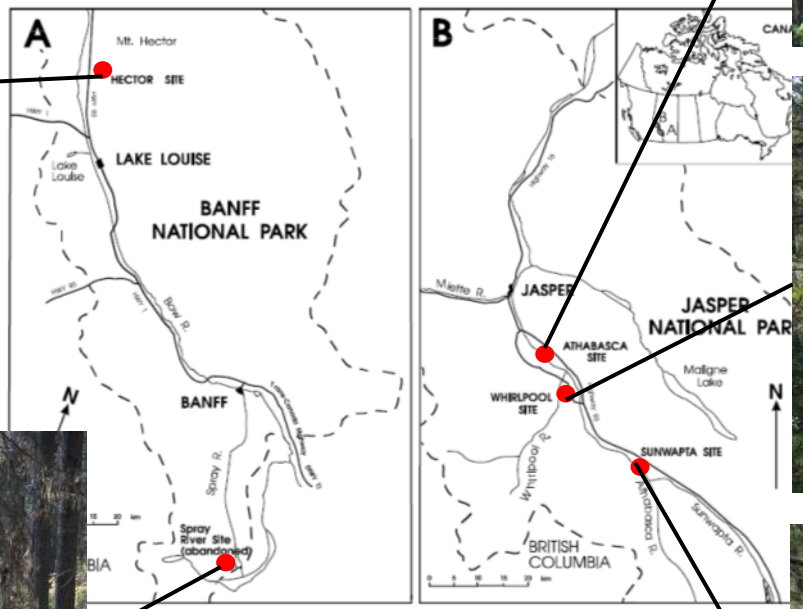
Methods: Study area and sites

Five 1 hectare permanent plots in Canadian Rockies



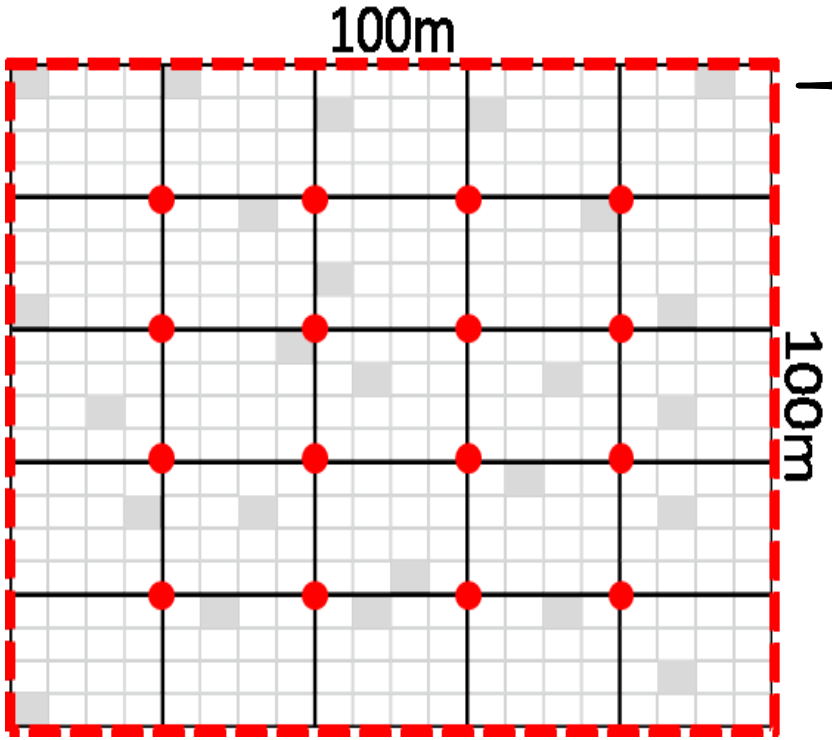
3 generation of UofA students 1967-1989-2012

Methods: Study area and sites



Methods: Sampling design

In each plot 400
5x5m quadrats

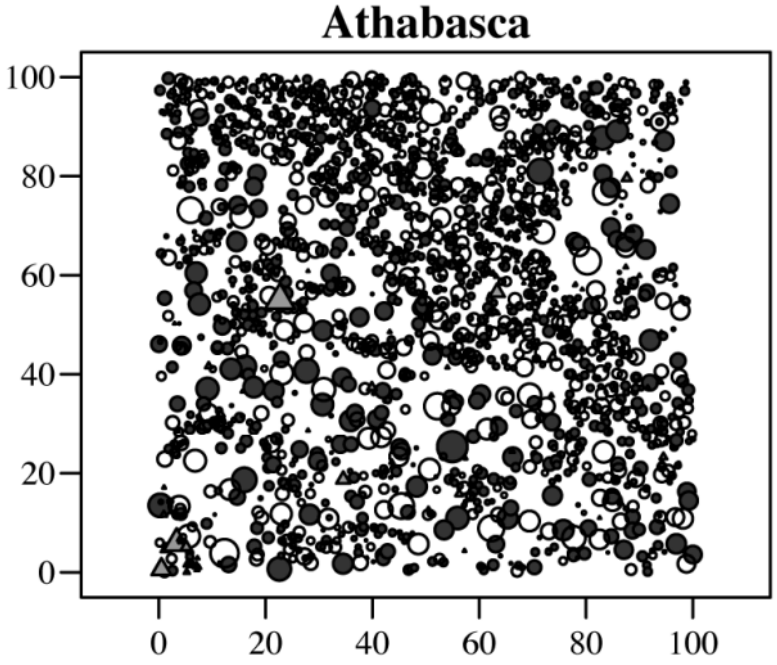


Data collected

Nbr of tree stems by species
& 3 inch size classes

Methods: Additional sampling 2010-2012

Stem mapped plots

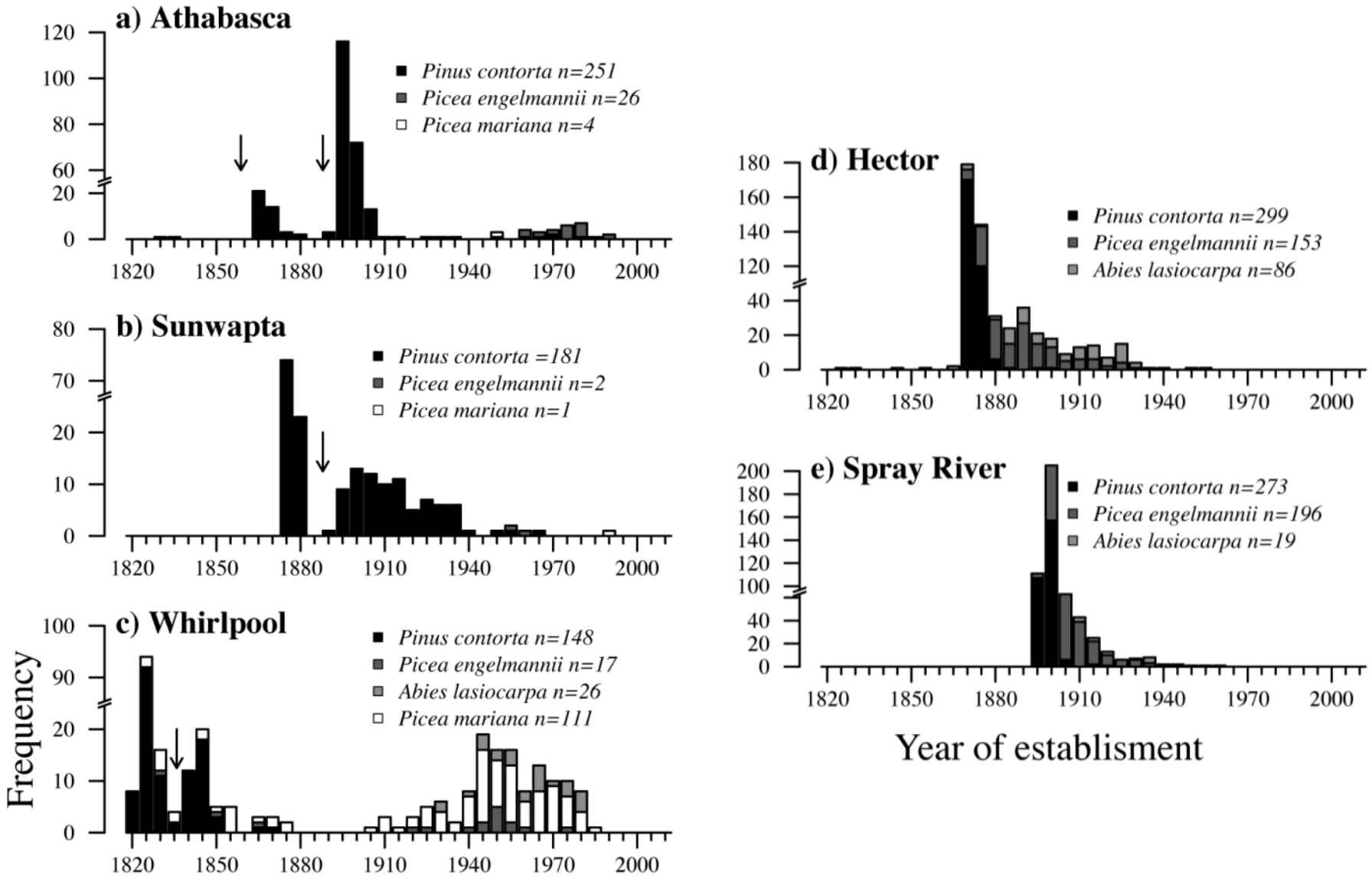


Mapped 33 216 stems!

Dendrochronological survey

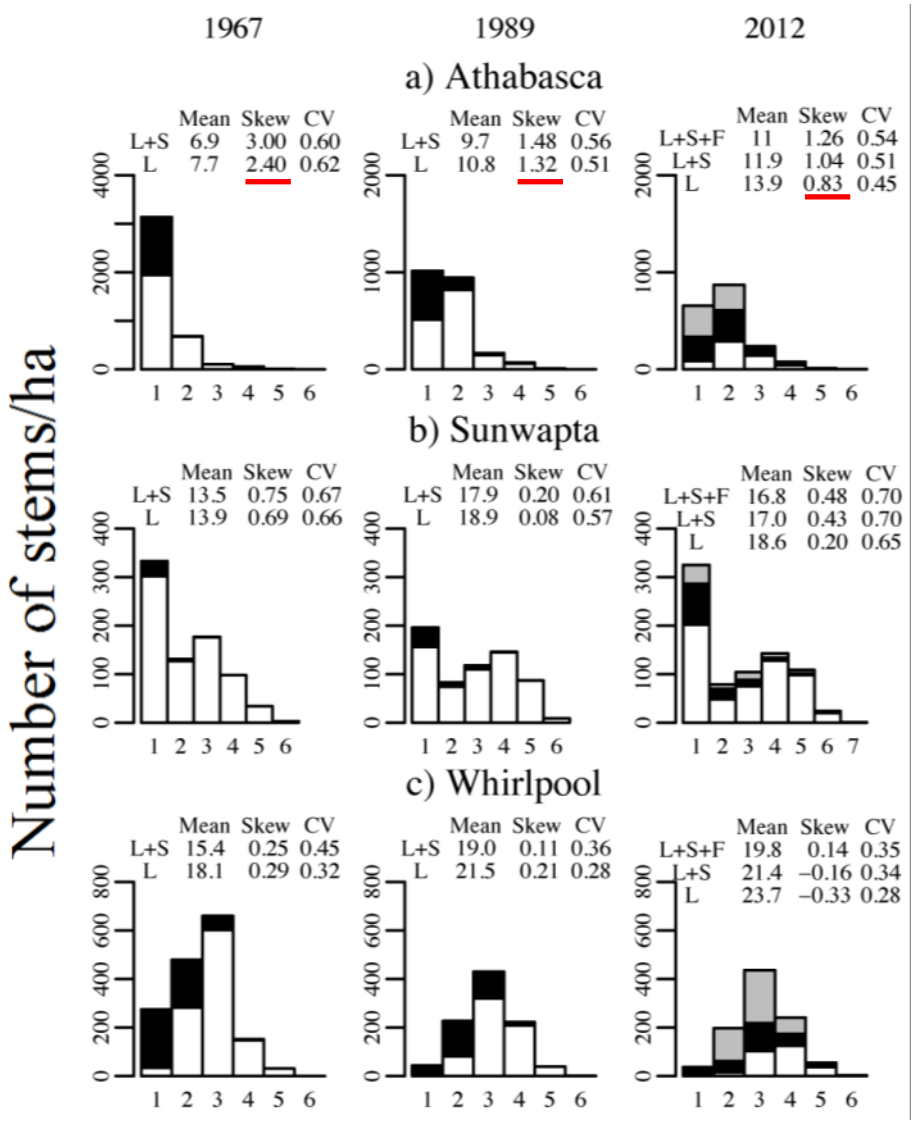
Cored 1794 trees and sampled 84 disks

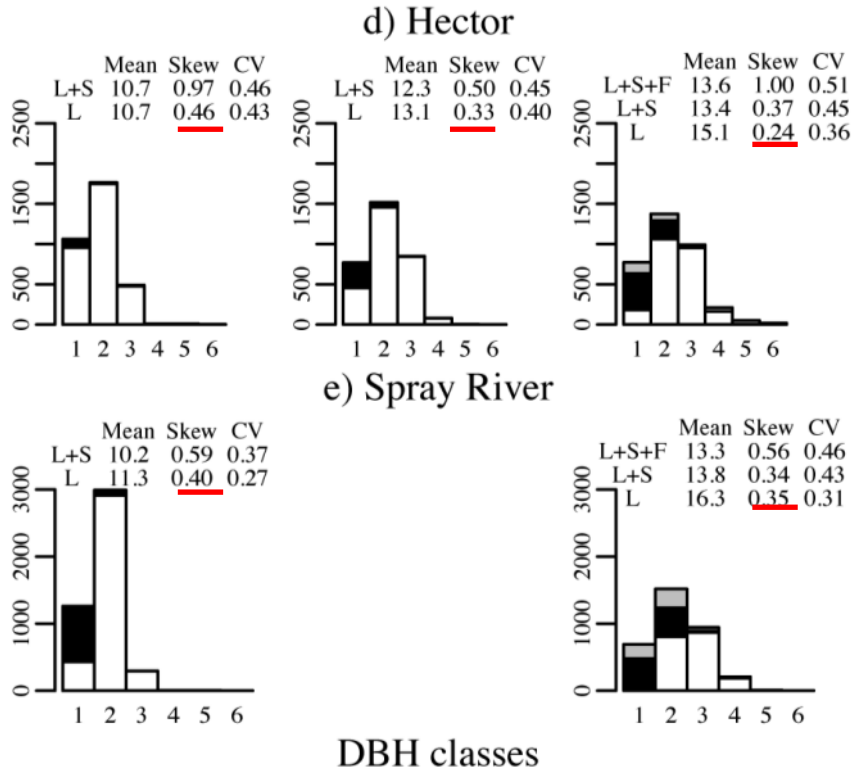
Results: Stand establishment



Results of Hypothesis 1 & 2

Diameter distribution changing towards normality





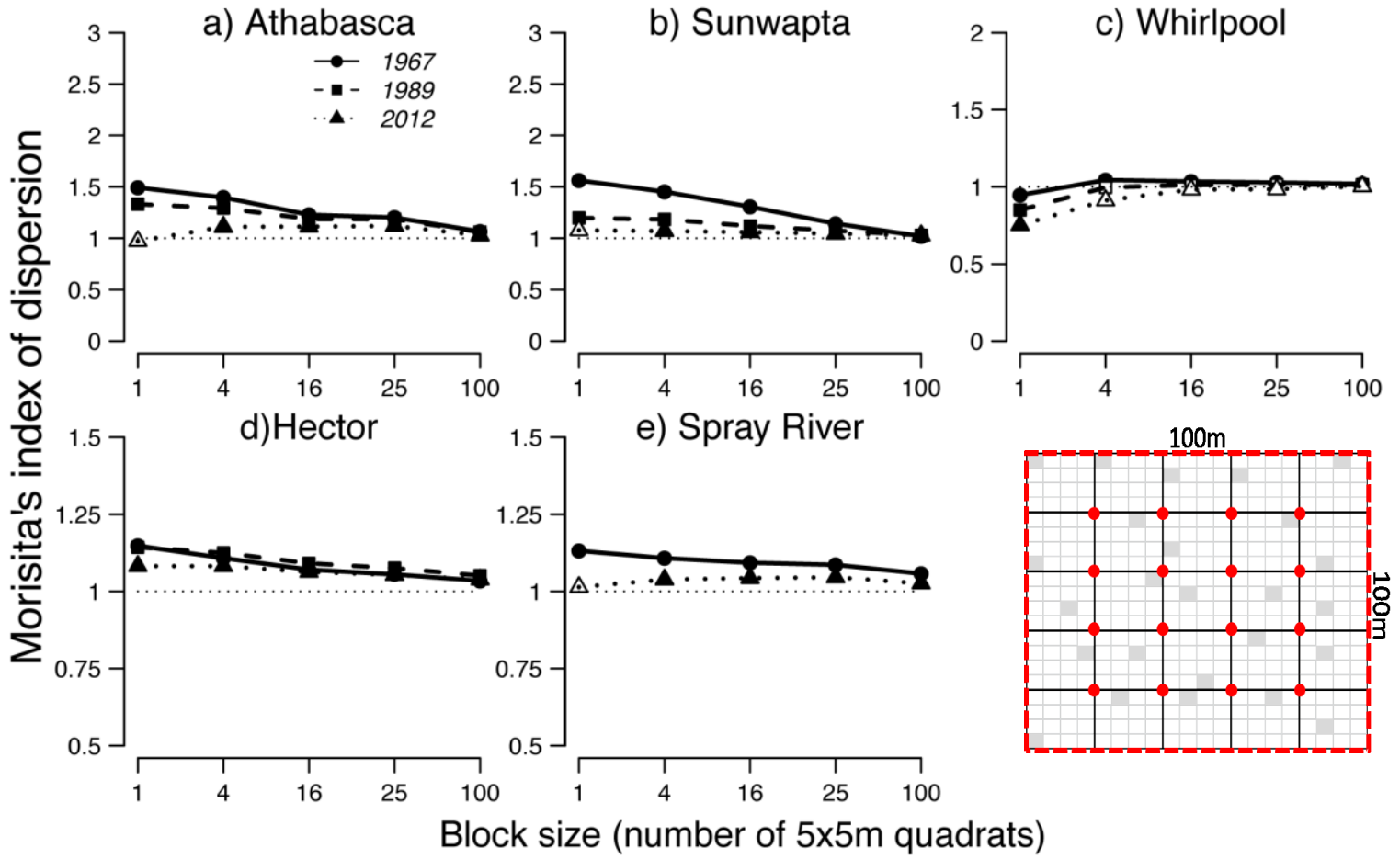
Over time diameter distribution became more normal due to mortality in lower size classes except for Sunwapta and Whirlpool

Higher mortality in lower canopy position as well (Hypothesis 2)

Results: Hypothesis 3

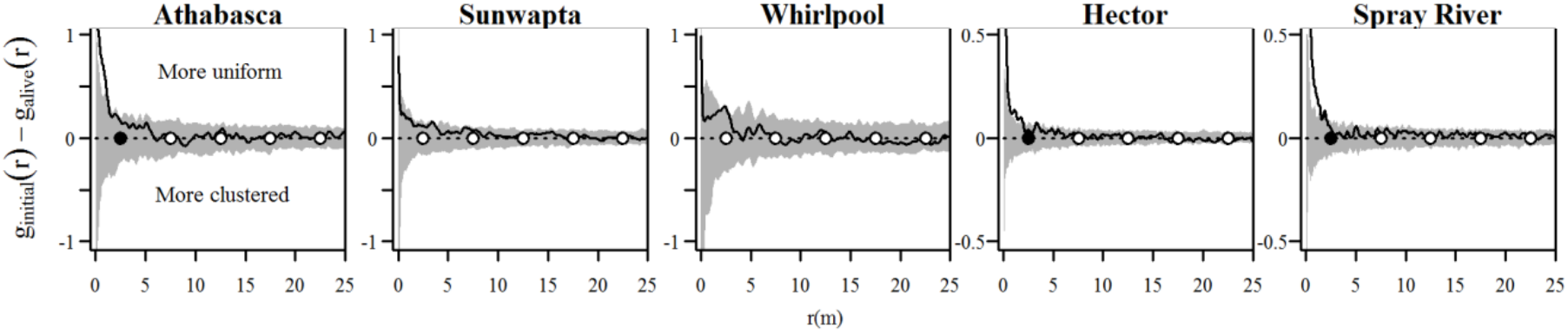
Surviving stems more uniformly spaced

The morisita index : spatial distribution of living stem moving towards uniformity over time



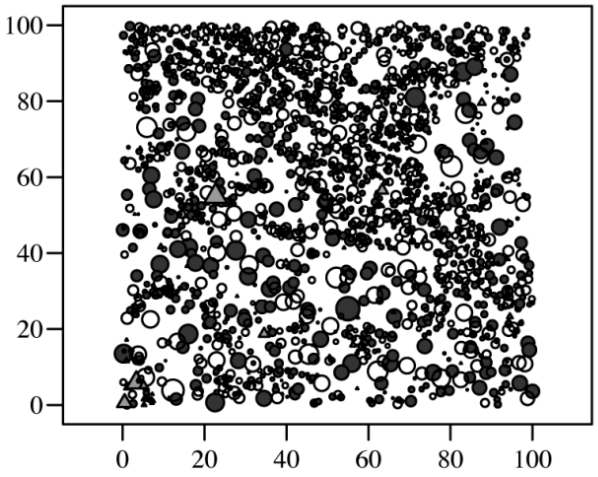
Results: Hypothesis 3

Surviving stems more uniformly spaced



Pattern of surviving trees more uniform in Athabasca, Hector, and Spray River

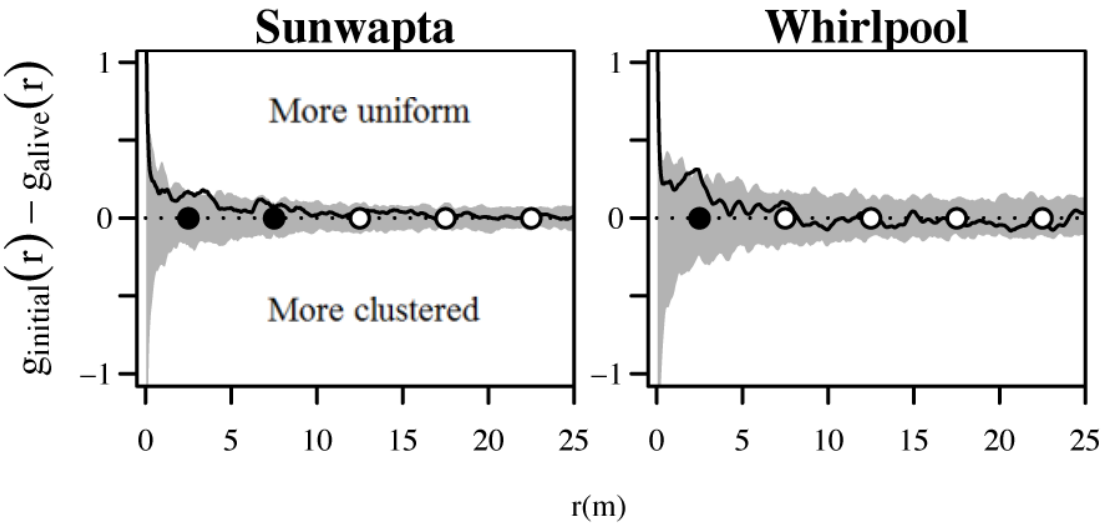
Mortality seemed random in Sunwapta and Whirlpool



Results: Hypothesis 3

Surviving stems more uniformly spaced

When recent windthrow mortality and ingrowth accounted for results are similar to other plots



Summary of results and conclusion

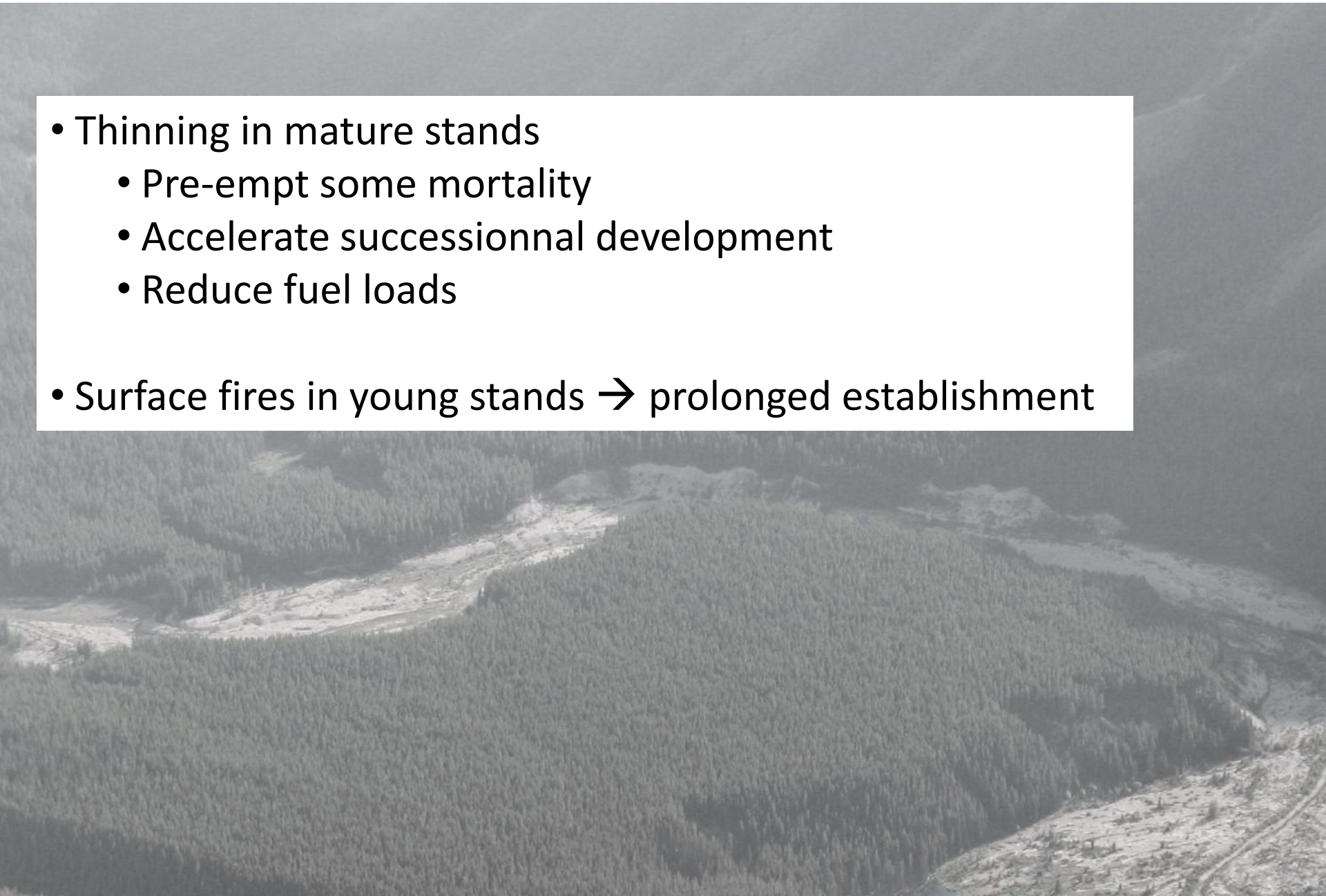
- Our results suggest that density-dependent mortality was still occurring
  - Diameter distribution changed towards normality.
  - Lower canopy positions had higher mortality levels
  - Surviving trees more uniformly distributed

Summary of results and conclusion

- Stands studied between 111-186 yrs old in 2012
- Delayed establishment and slow growth are the two proposed mechanisms explaining these results

Mortality of dominant/co-dominant trees

Management implications



- Thinning in mature stands
  - Pre-empt some mortality
  - Accelerate successionnal development
  - Reduce fuel loads

- Surface fires in young stands → prolonged establishment

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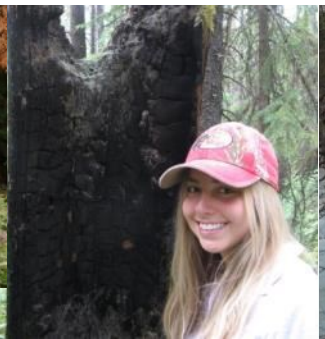

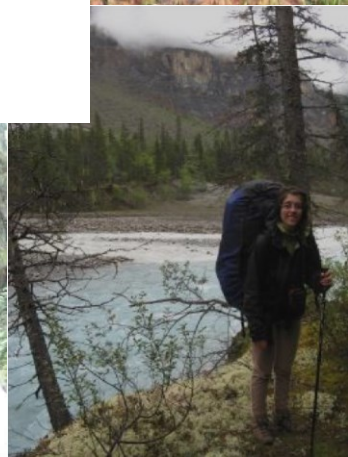


Thanks for listening
Questions?