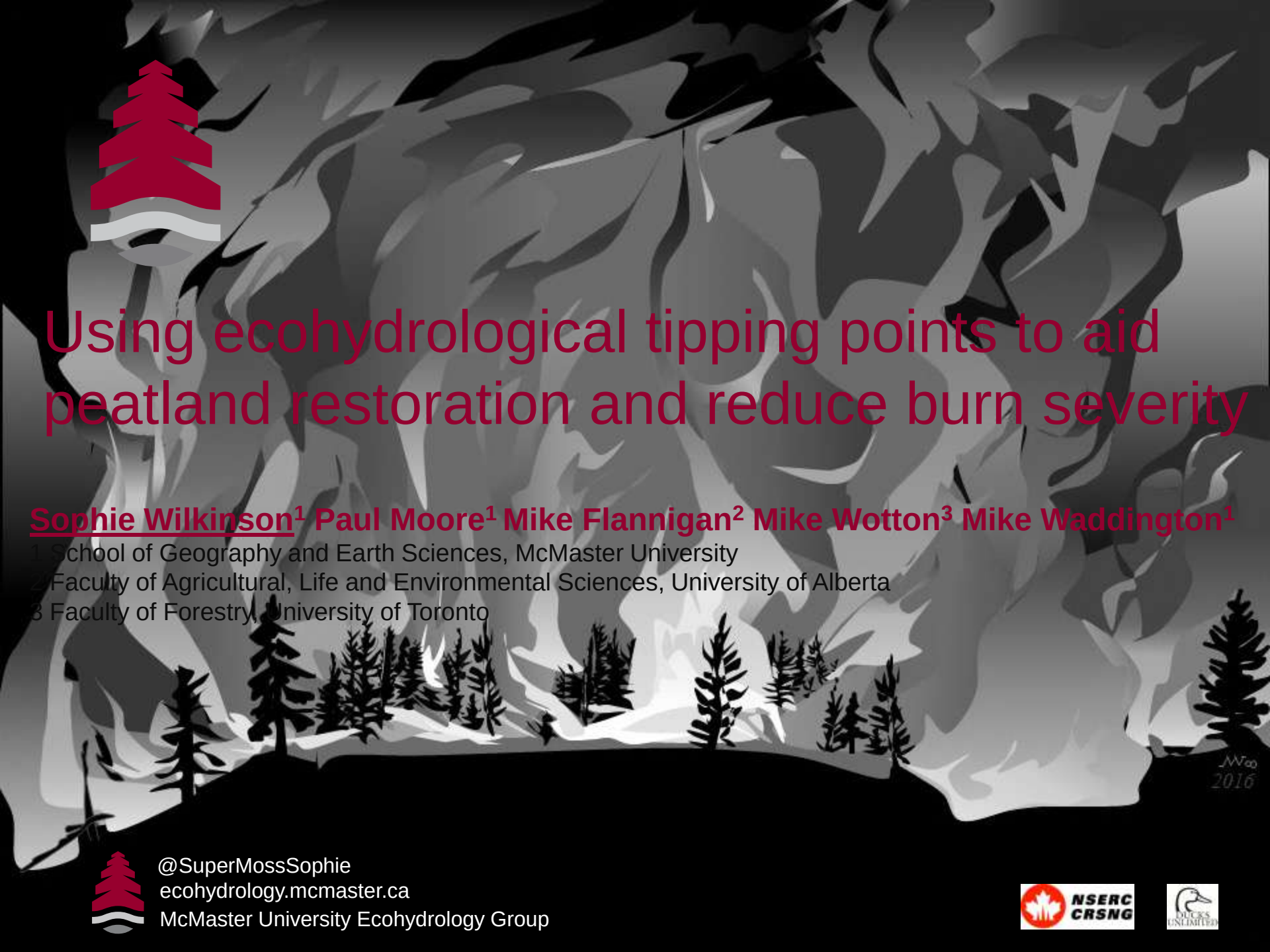

Using ecohydrological tipping points to aid peatland restoration and reduce burn severity

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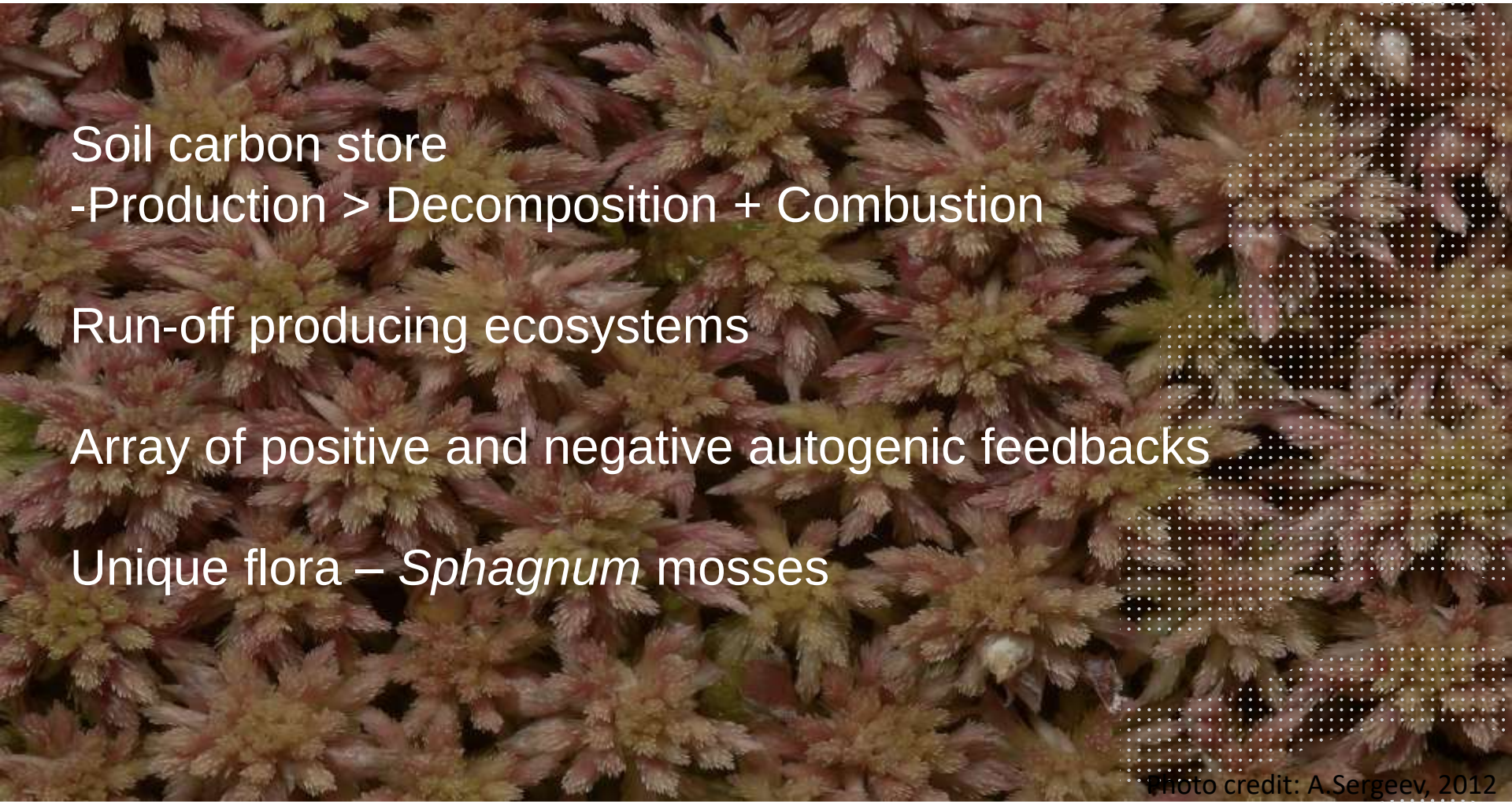
Peatland Ecosystem Services



Soil carbon store
-Production > Decomposition + Combustion

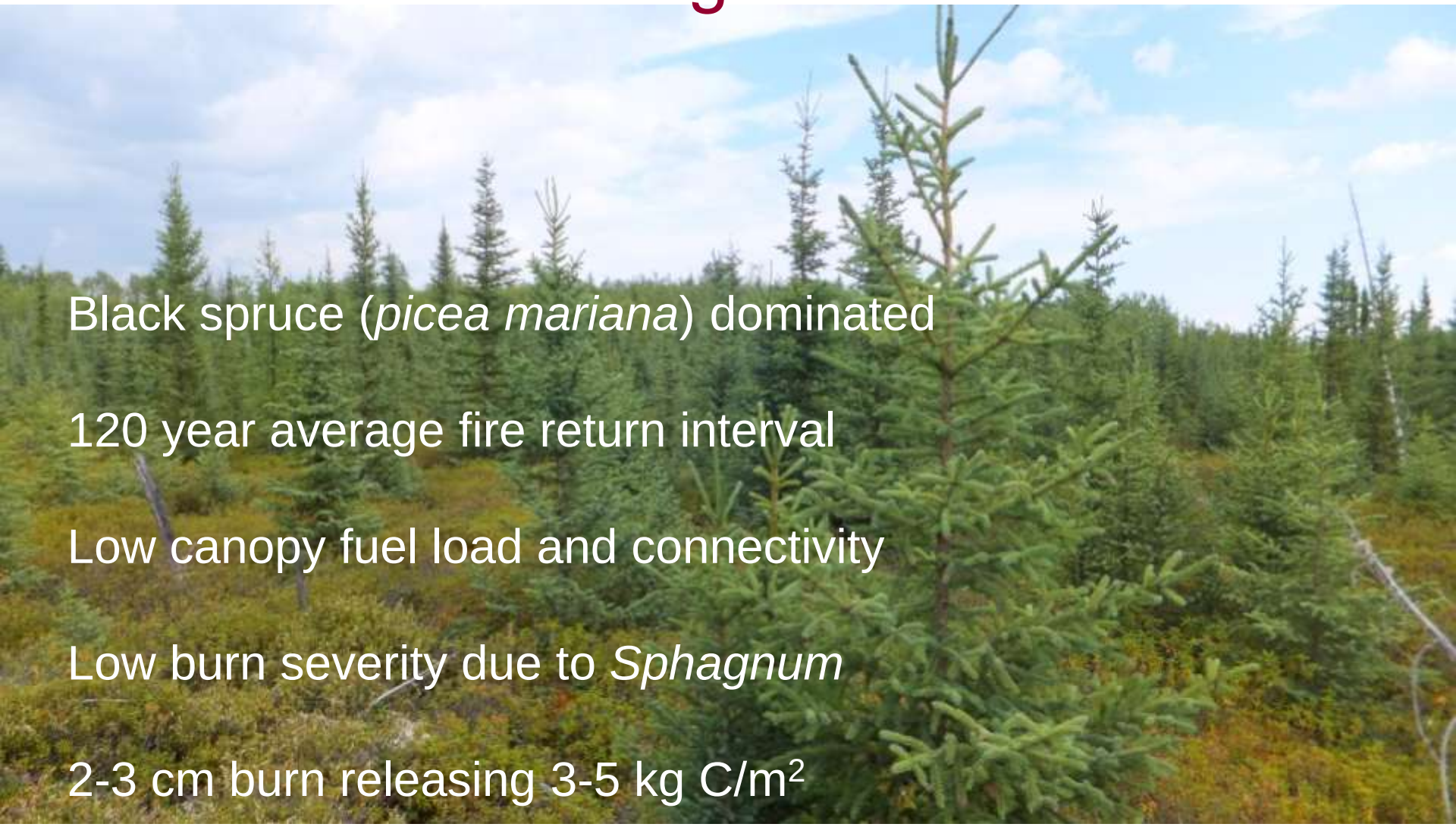
Run-off producing ecosystems

Array of positive and negative autogenic feedbacks

Unique flora – *Sphagnum* mosses

Photo credit: A.Sergeev, 2012

Alberta's Boreal Bogs



Black spruce (*picea mariana*) dominated

120 year average fire return interval

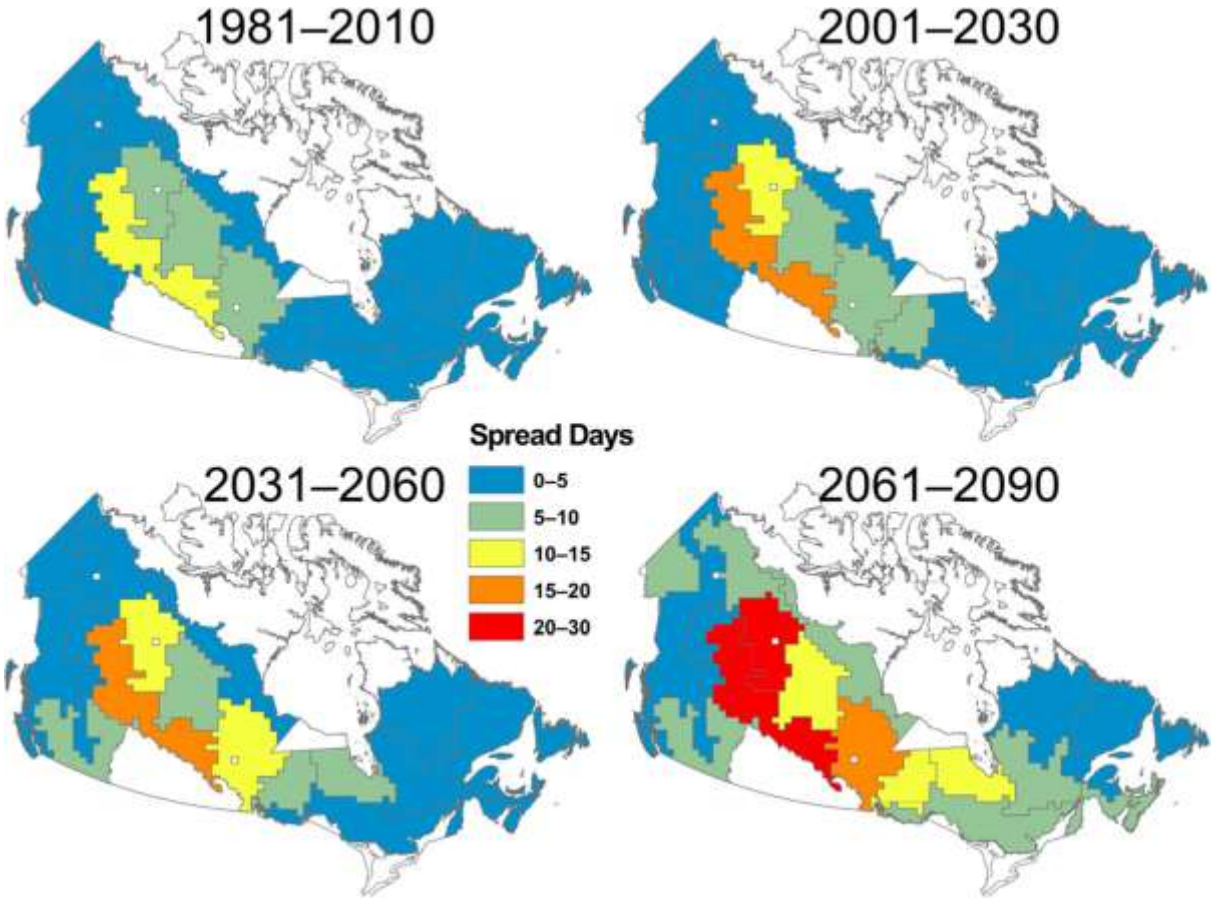
Low canopy fuel load and connectivity

Low burn severity due to *Sphagnum*

2-3 cm burn releasing 3-5 kg C/m^2

Boreal Stressors

Enhanced fire regime



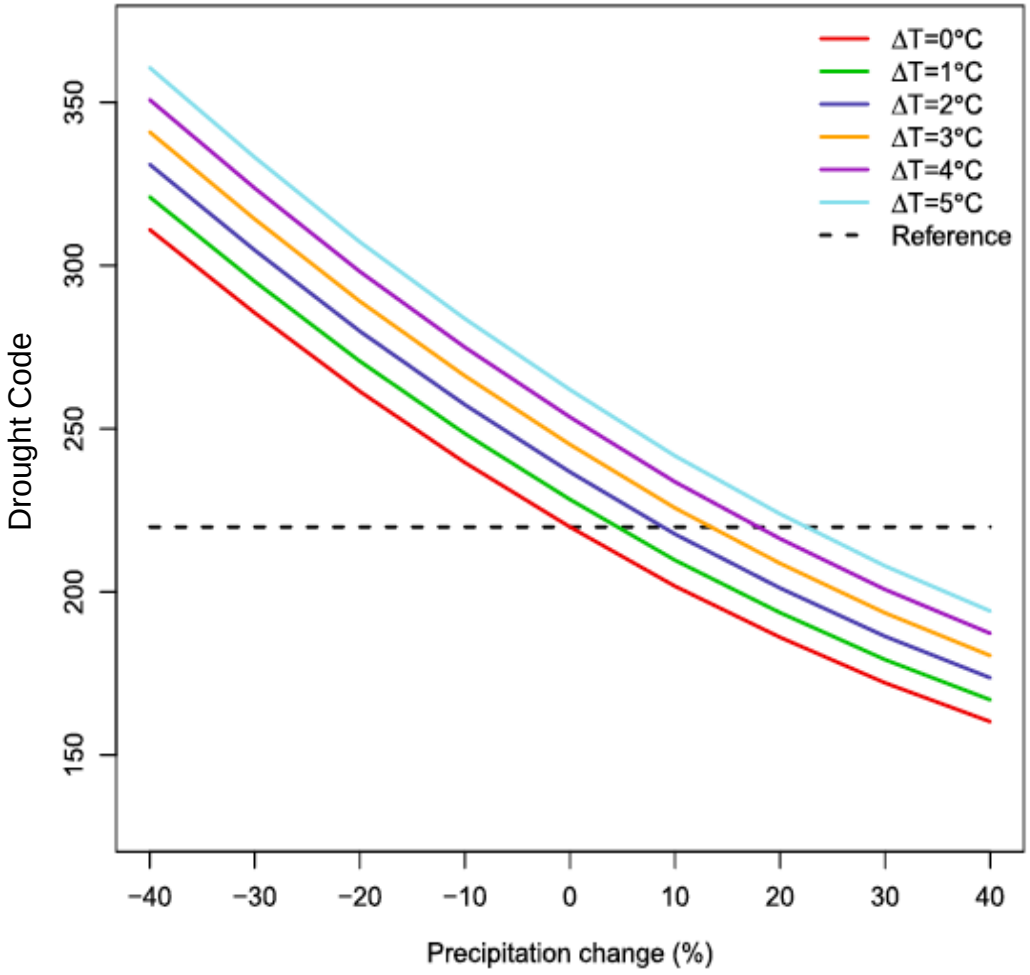
Median number of spread days per year by fire zone and time-period.
Wang et al 2015

Boreal Stressors

Drier peatlands

Drier

Wetter



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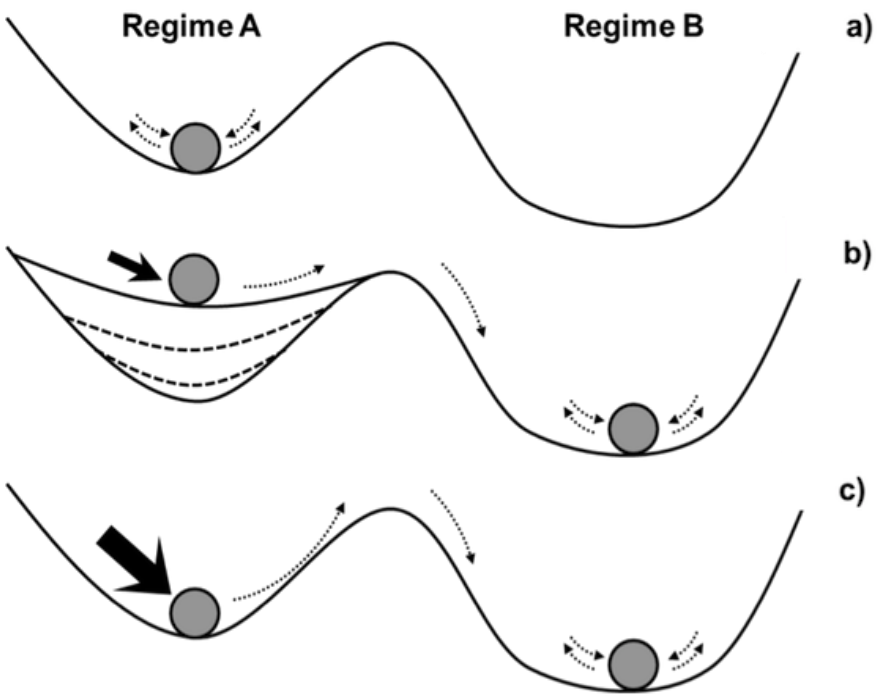
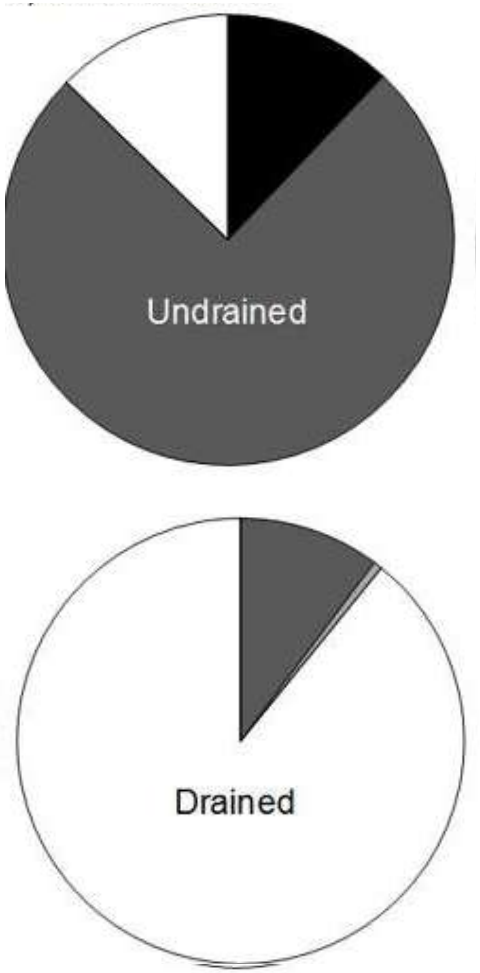
Mean seasonal DC as a function of temperature increase and precipitation change.
Flannigan et al 2013

Ecohydrological Tipping Points



Ecohydrological Tipping Points



Source: Kettridge et al. (2015) Nature Scientific Reports

WTD - Afforestation Feedback

Positive Ecohydrological Feedback

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WTD - Afforestation Feedback
Positive Ecohydrological Feedback
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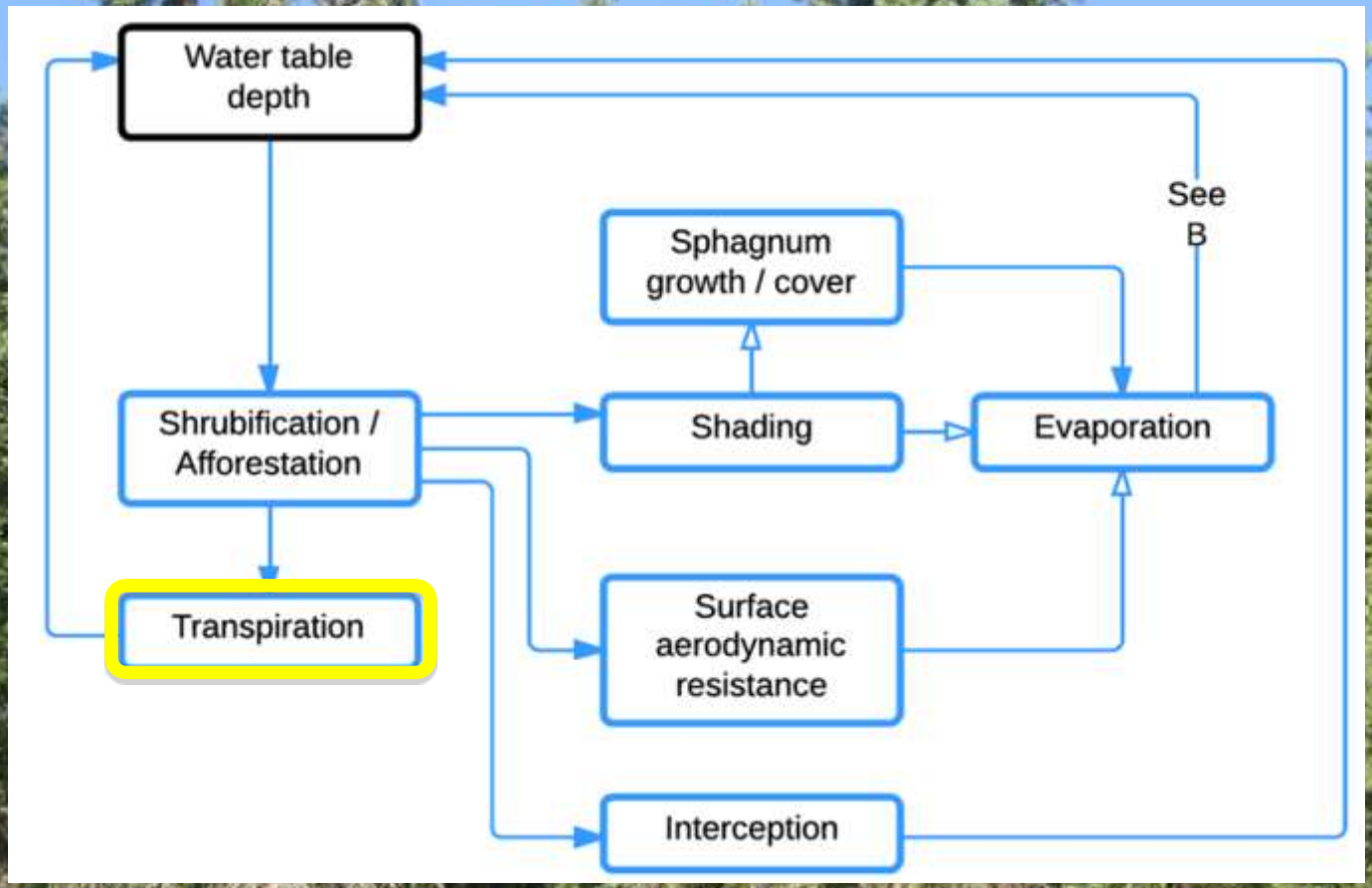
WTD - Afforestation Feedback

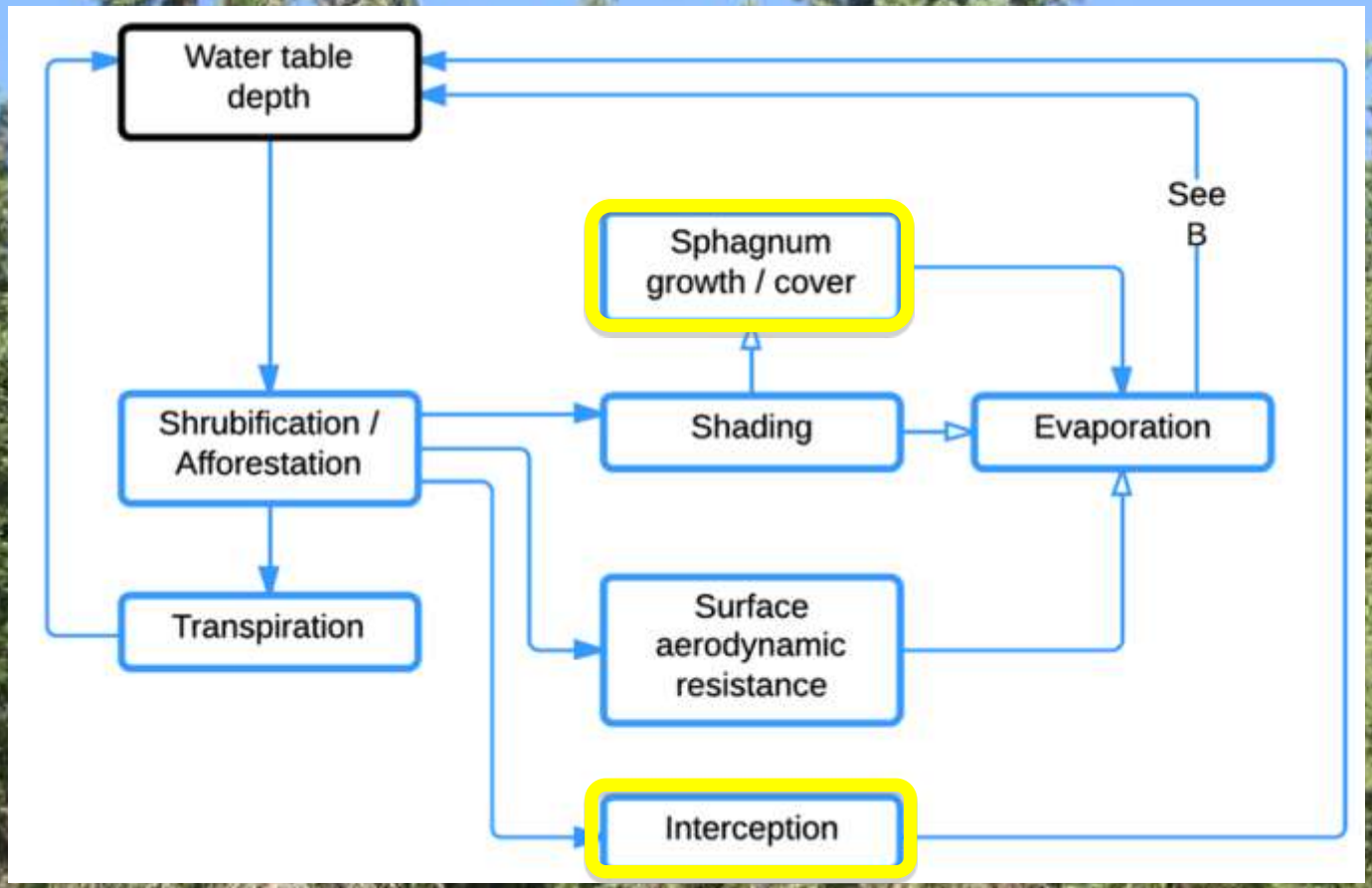
Positive Ecohydrological Feedback



Source: Waddington *et al.*, 2015

WTD - Afforestation Feedback

Positive Ecohydrological Feedback



Source: Waddington *et al.*, 2015

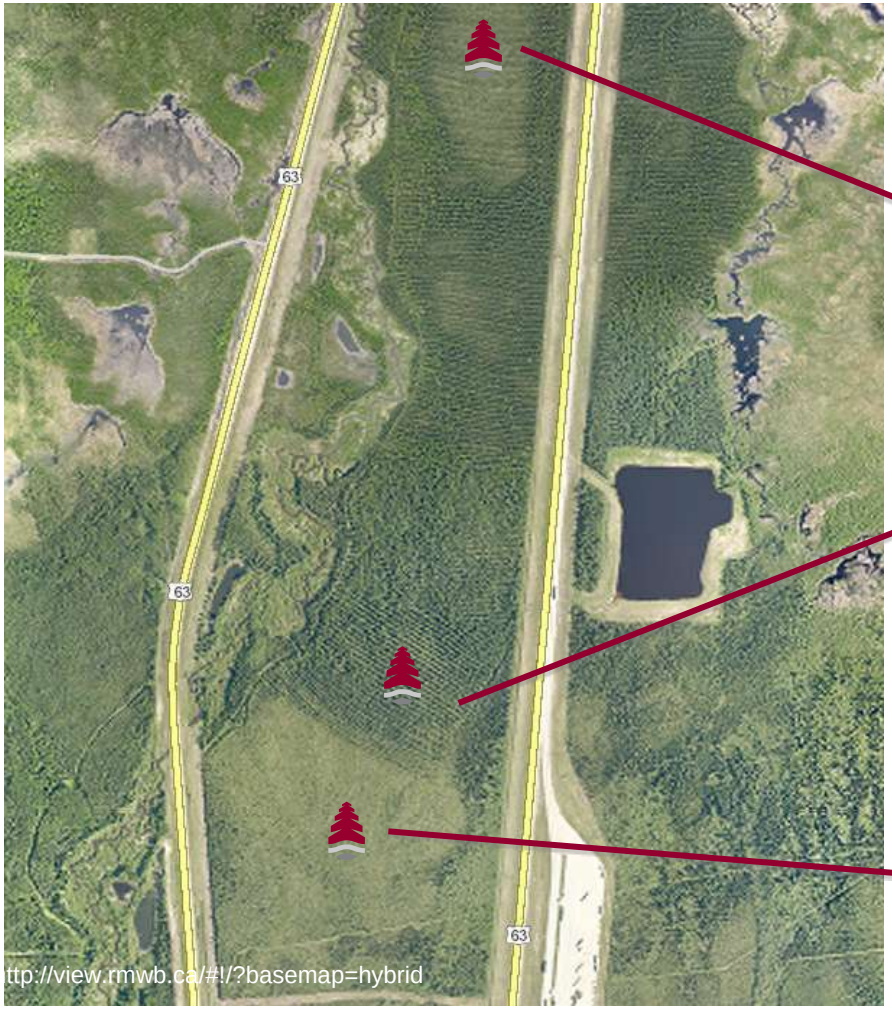
Research Objectives

1) Assess the difference in black spruce stand characteristics along a hydrological gradient

2) Characterize peat burn severity along a hydrological gradient

3) Quantify ecohydrological tipping points to high peat burn severity to aid restoration and adaptive management

Study Site



Hydrologic gradient

Moderately Drained
18 m ditch spacing

Heavily Drained
9 m ditch spacing

Undrained-
> 30 m from ditch

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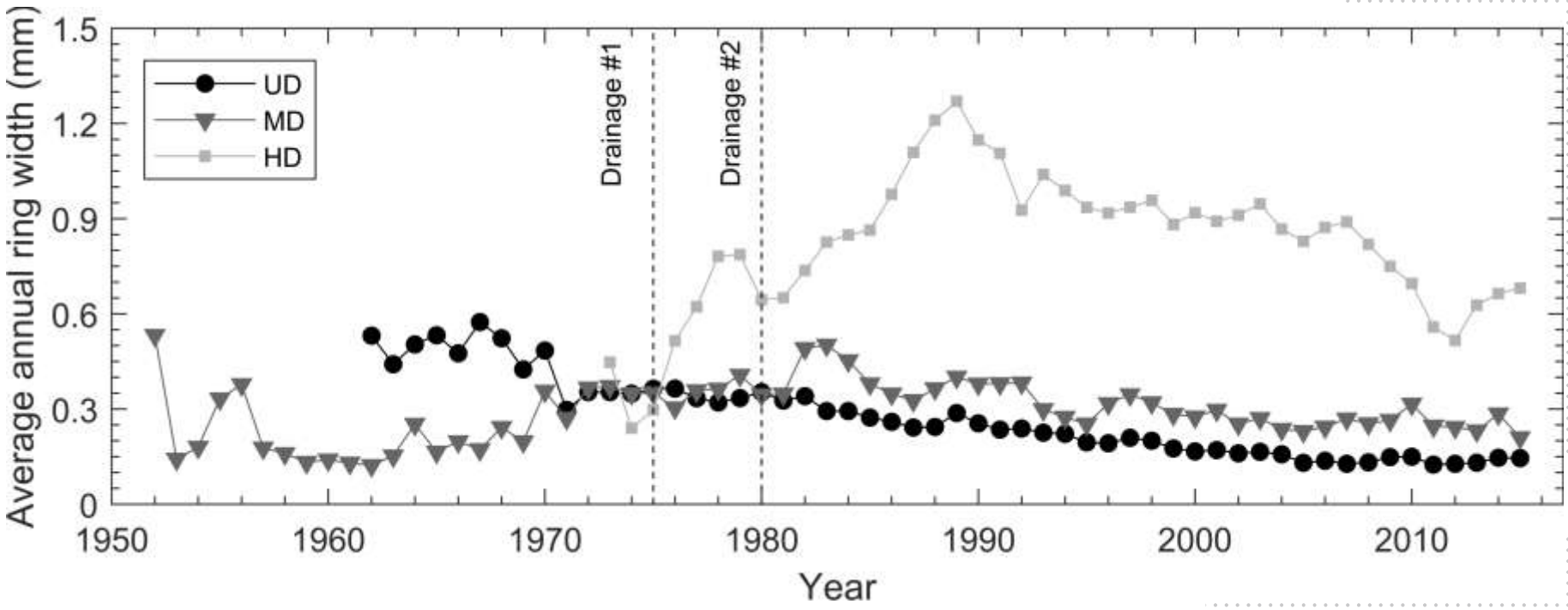
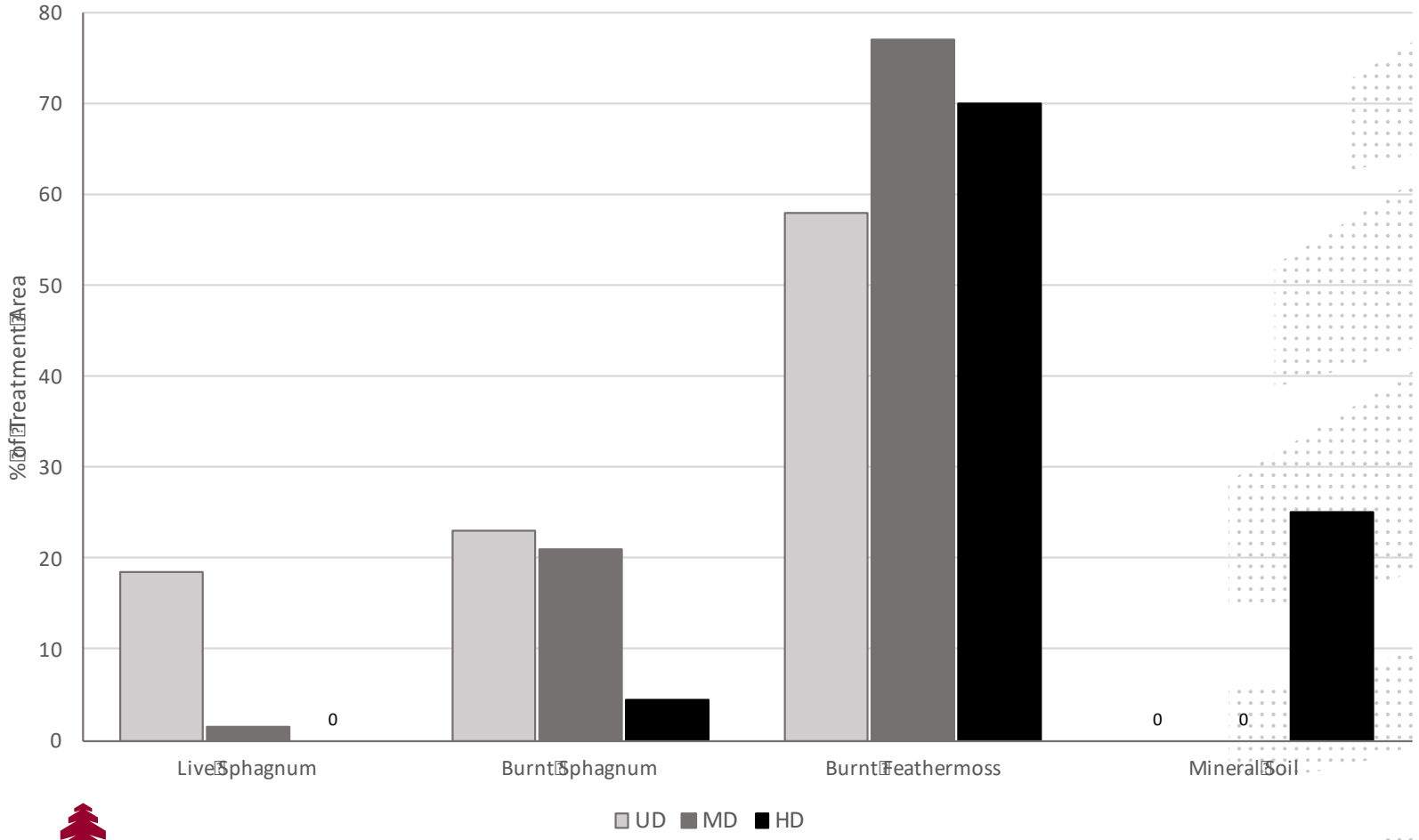
Drainage Enhanced Afforestation

Hydrology impacts tree productivity



Post-fire Ground Cover

Loss of *Sphagnum* and exposure of mineral soil in HD treatment



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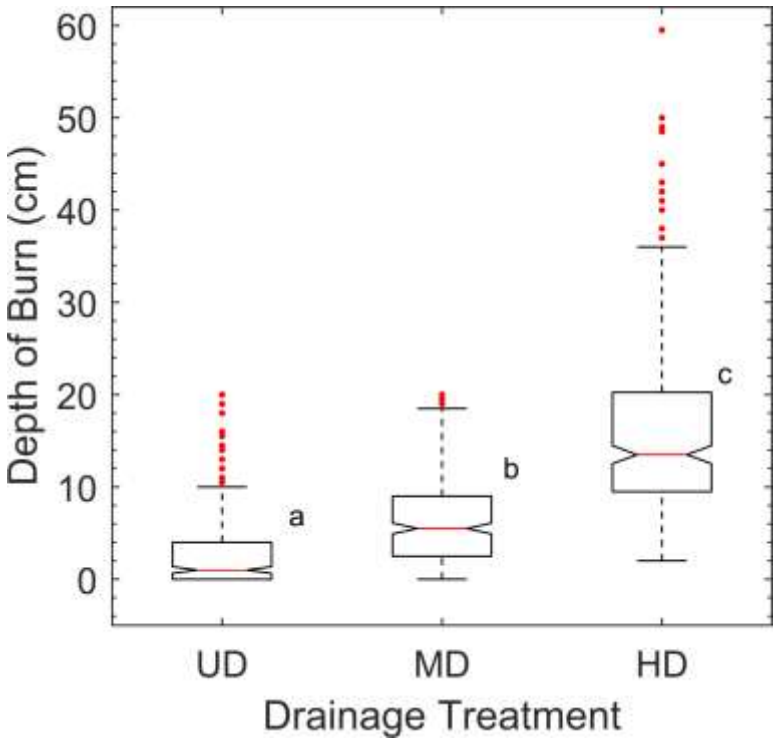
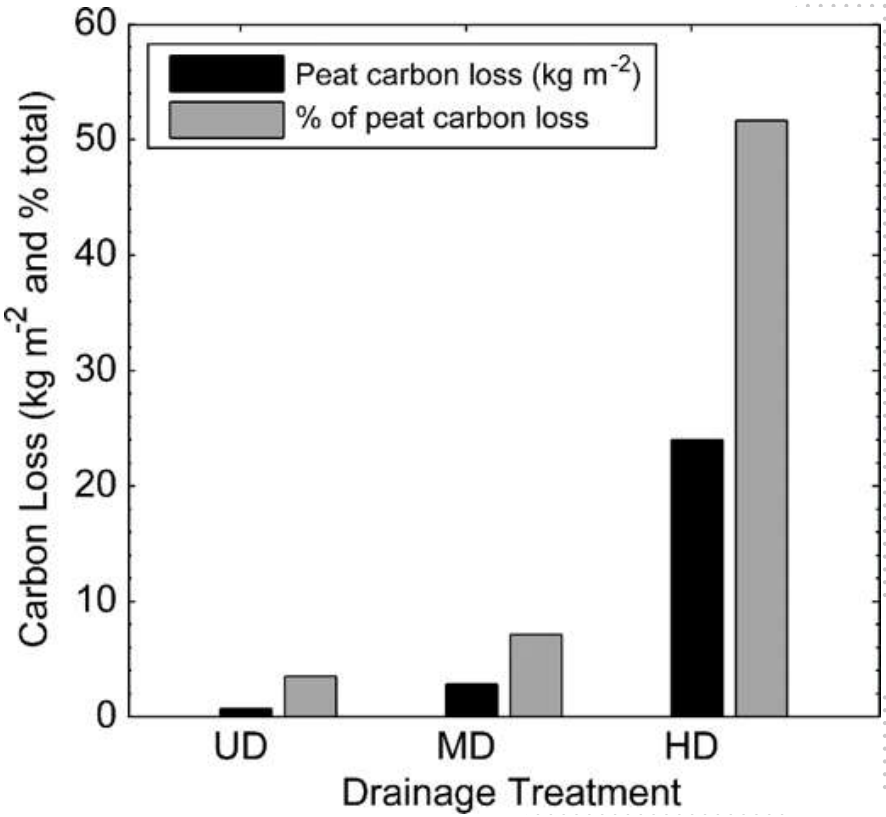
Peat Burn Severity

Significant difference in burn severity
Irreversible peat carbon loss





Undrained Burn Severity

Live *Sphagnum* and vegetation recovery

Moderately-drained Burn Severity

Damaged *Sphagnum* and little recovery

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Heavily-drained Burn Severity

No *Sphagnum* and lack of peat for recovery

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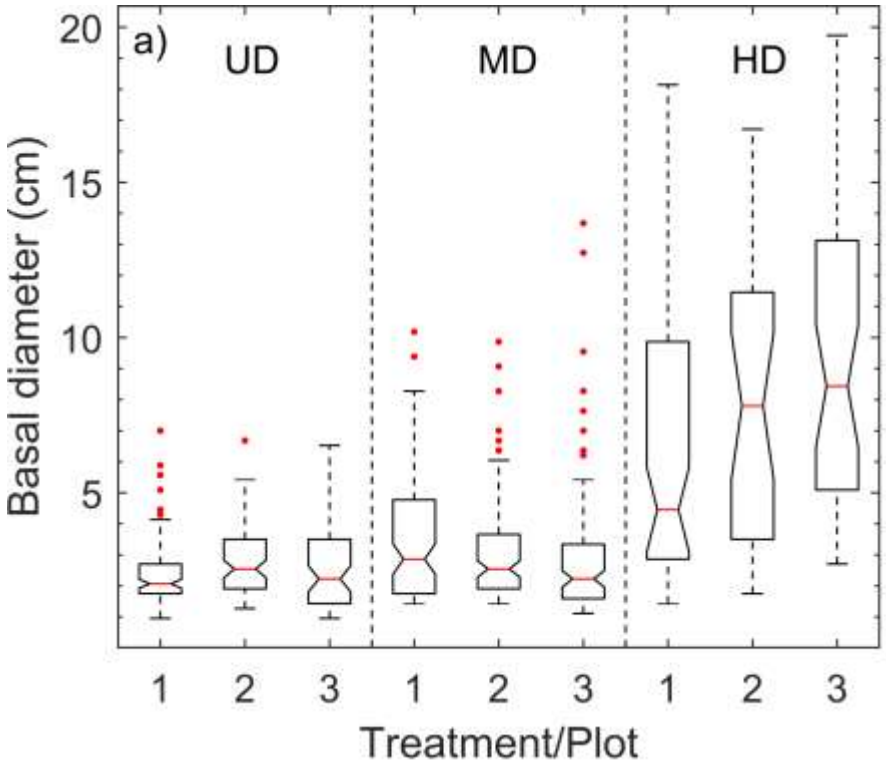
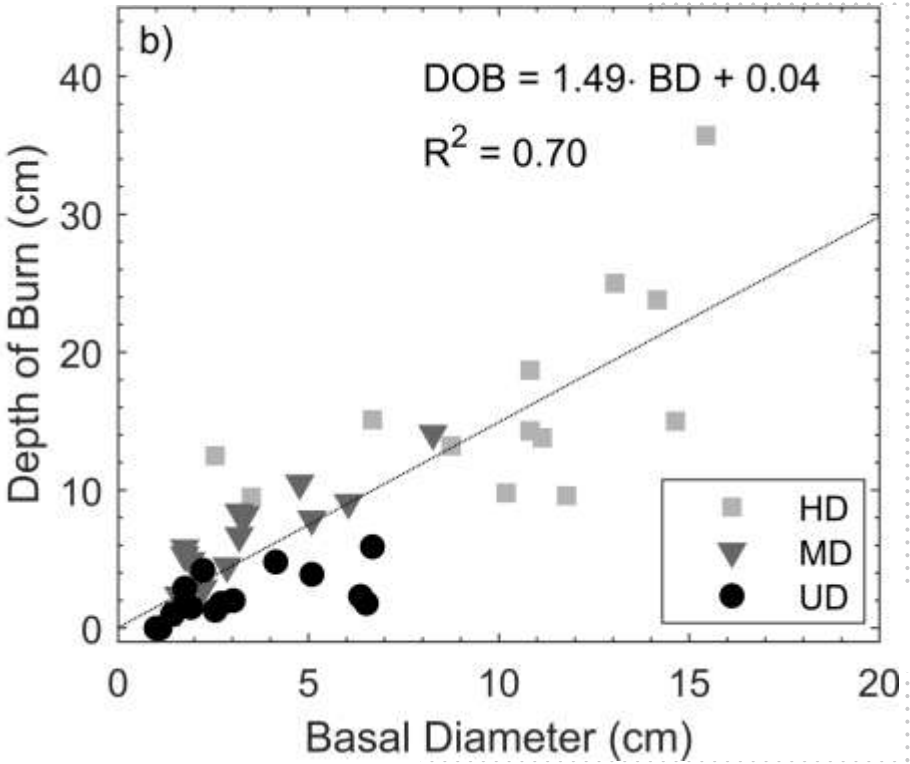
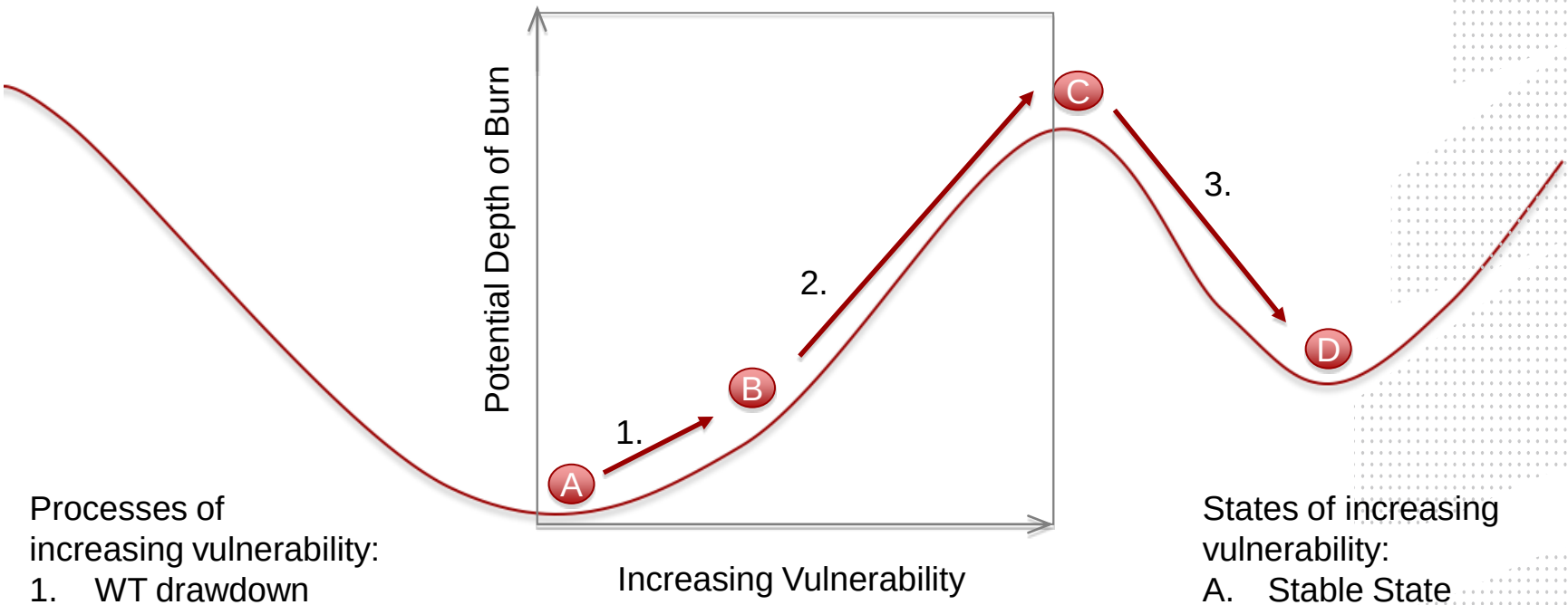
Burn Severity and the Tipping Point

Positive correlation between basal diameter and burn severity





Ecohydrological Tipping Point



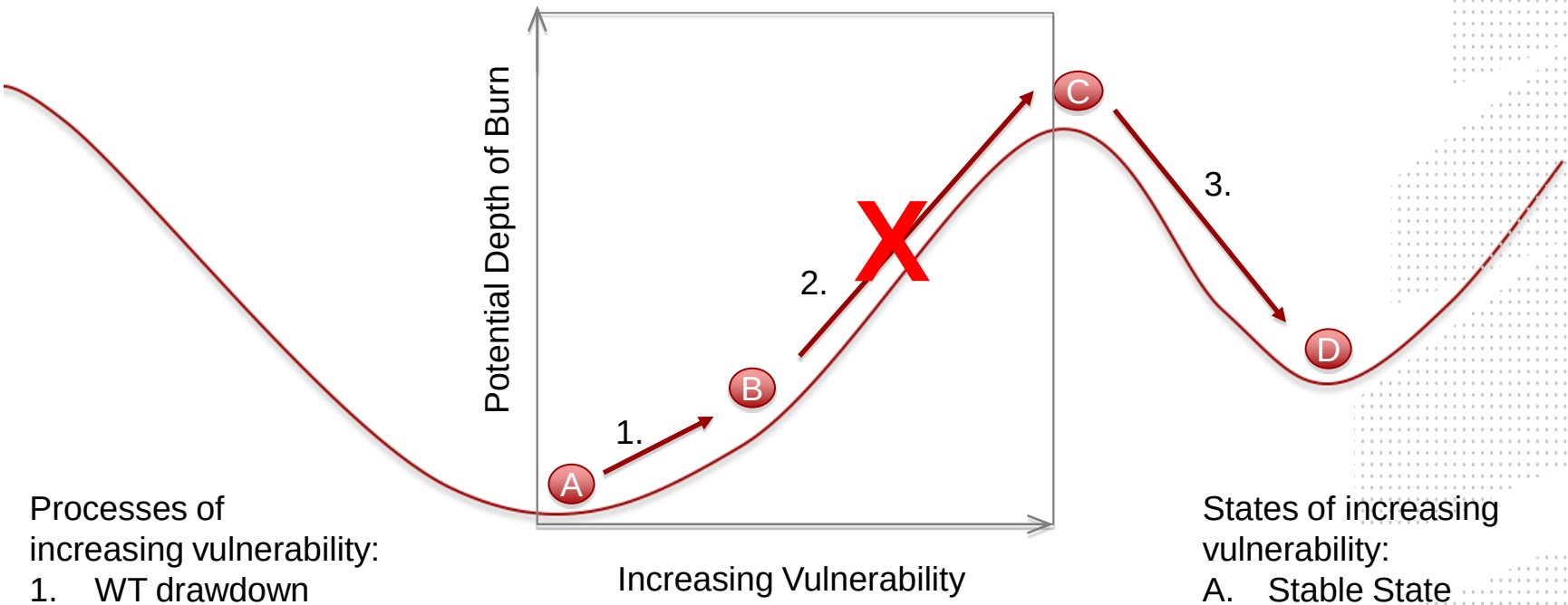
Processes of increasing vulnerability:

1. WT drawdown
2. WTD-Afforestation Positive Feedback
3. Regime Shift

States of increasing vulnerability:

A. Stable State
B. Disrupted State
C. Tipping Point
D. Alternate Stable State

Ecohydrological Tipping Point



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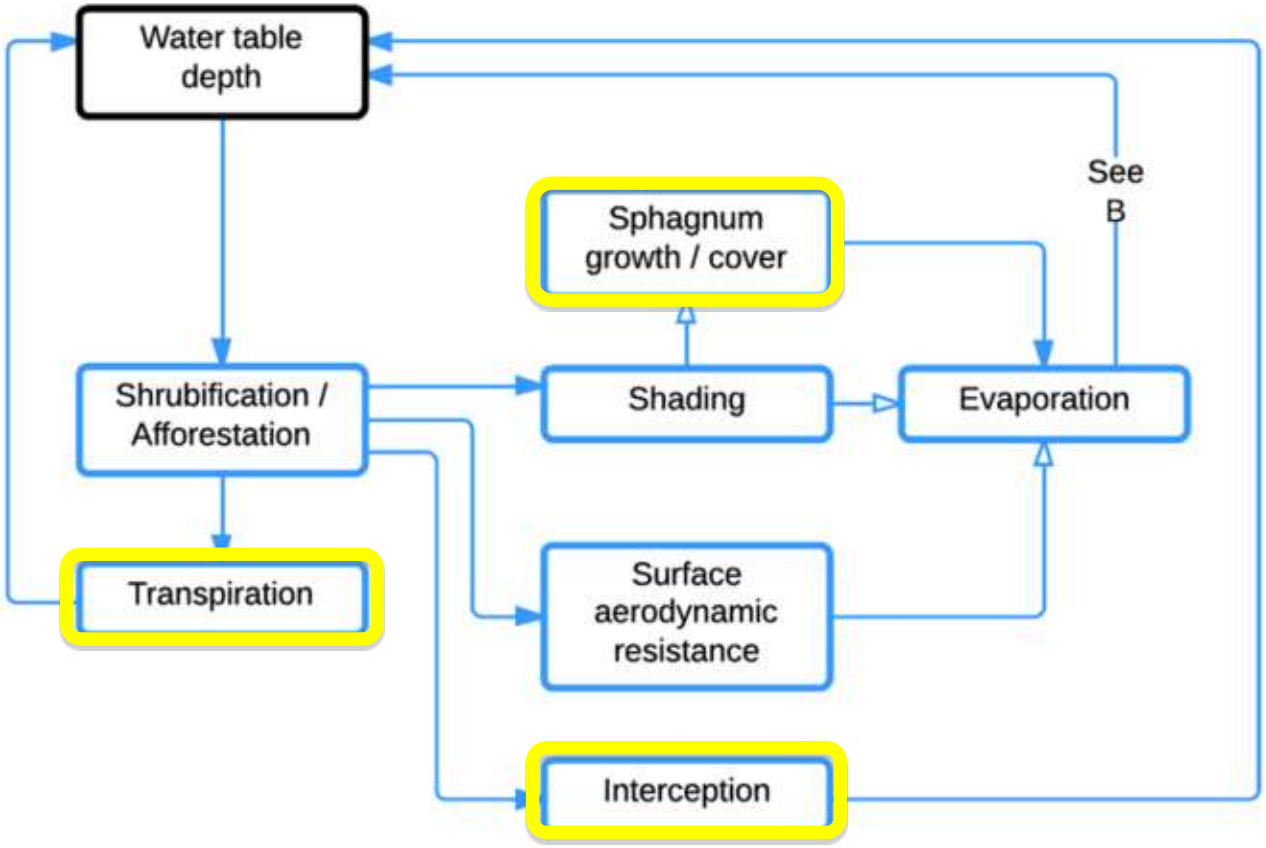


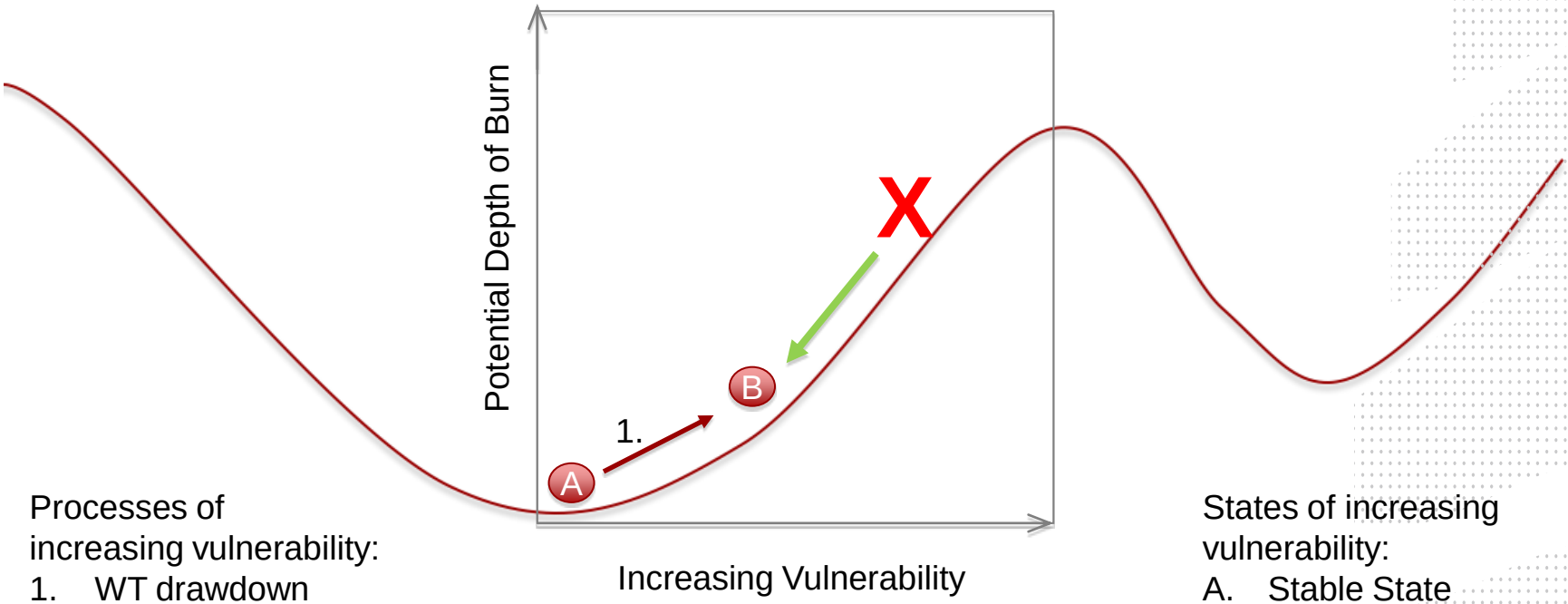
Management Options

Transpiration: Remove trees

Sphagnum cover: Remove trees and transplant *Sphagnum*

Interception: Remove trees and transplant *Sphagnum*

Ecohydrological Tipping Point



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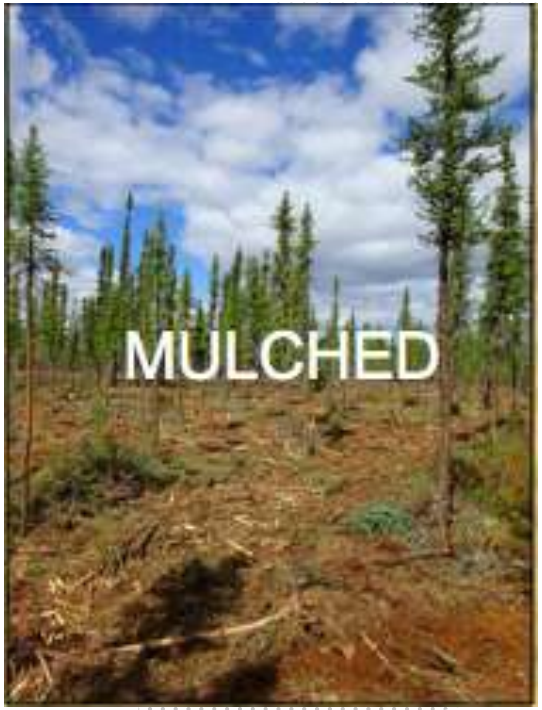
Adaptive Management – Tree Removal



Adaptive Management Test – Prescribed Burn

Peat C loss (Kg C/m^2)

Natural = 0.84

Thinned = 0.34

Sphagnum Restoration - Transplants

Sphagnum regeneration usually begins after ~10 years

Transplants could expedite recovery and carbon accumulation

Pre-burn transplants may reduce burn severity and carbon loss

Summary

1) Drying of a black spruce peatland enhanced the WTD-afforestation feedback

2) Tipping point to high severity peat burn is bounded by the MD and HD treatment stand characteristics

3) Ecohydrological tipping point identification can aid peatland restoration and adaptive management decisions

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