Trembling aspen sprouting response to above ground disturbance on a reclaimed boreal oil sands site in Alberta, Canada

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Presentation Outline

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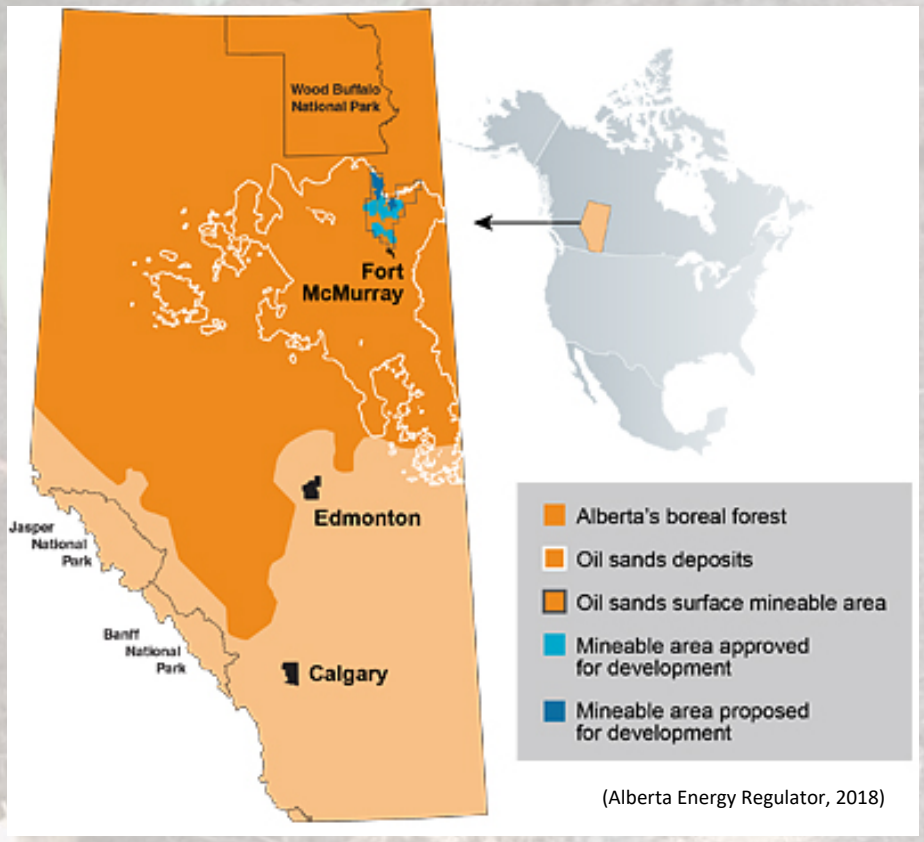
Alberta's Oil Sands

- 90,000 km^2 of oil sands deposits
- 4,800 km^2 of surface minable oil sands
- Lots of land to be reclaimed!



(Alberta Energy Regulator, 2018)

Reclamation Practices

- Forest floor mineral mix (FFMM) or peat mineral mix (PMM) soils
- Soil either directly placed or from stockpiles
- Soil placed at a depth of at least 0.3 m
- Conifer trees planted
- Deciduous trees left to seed in naturally

Reclamation Practices

Table 1. Oil sands reclamation goal, objectives, and criteria set by the Government of Alberta.

GOAL:	**The reclaimed soils and landforms are capable of supporting a diverse, self-sustaining, locally common boreal forest landscape, regardless of the end land use.**
Objective 1:	**Reclaimed landscapes are established that support natural ecosystem functions.**
Criteria	1.1 The landforms are integrated within and across lease boundaries. 1.2 The landforms have a natural appearance. 1.3 The landscape and its landforms incorporate watershed features such as surface drainage, lakes and wetlands. 1.4 The landforms have geotechnical stability. 1.5 Reclamation materials are placed appropriate to the landform. 1.6 Terrestrial and aquatic vegetation common to the boreal forest is established.
Objective 2:	**Natural ecosystem functions are established on the reclaimed landscape.**
Criteria	2.1 The reclaimed landforms have the required water quality. 2.2 The reclaimed landforms have the required water quantity. 2.3 Nutrient cycling is established on the reclaimed landscape. 2.4 Ecosystem productivity is established on the reclaimed landscape. 2.5 Reclaimed ecosystems display characteristics of resilience to natural disturbances.
Objective 3:	**Reclaimed landscapes support an equivalent land capability appropriate to the approved end land uses.**
Criteria	3.1 The reclaimed landscape provides for biodiversity. 3.2 The reclaimed landscape provides commercial forests. 3.3 The reclaimed landscape provides for fish and wildlife habitat. 3.4 The reclaimed landscape provides opportunities for traditional uses. 3.5 The reclaimed landscape provides opportunities for recreational uses.

(Government of Alberta, 2013)

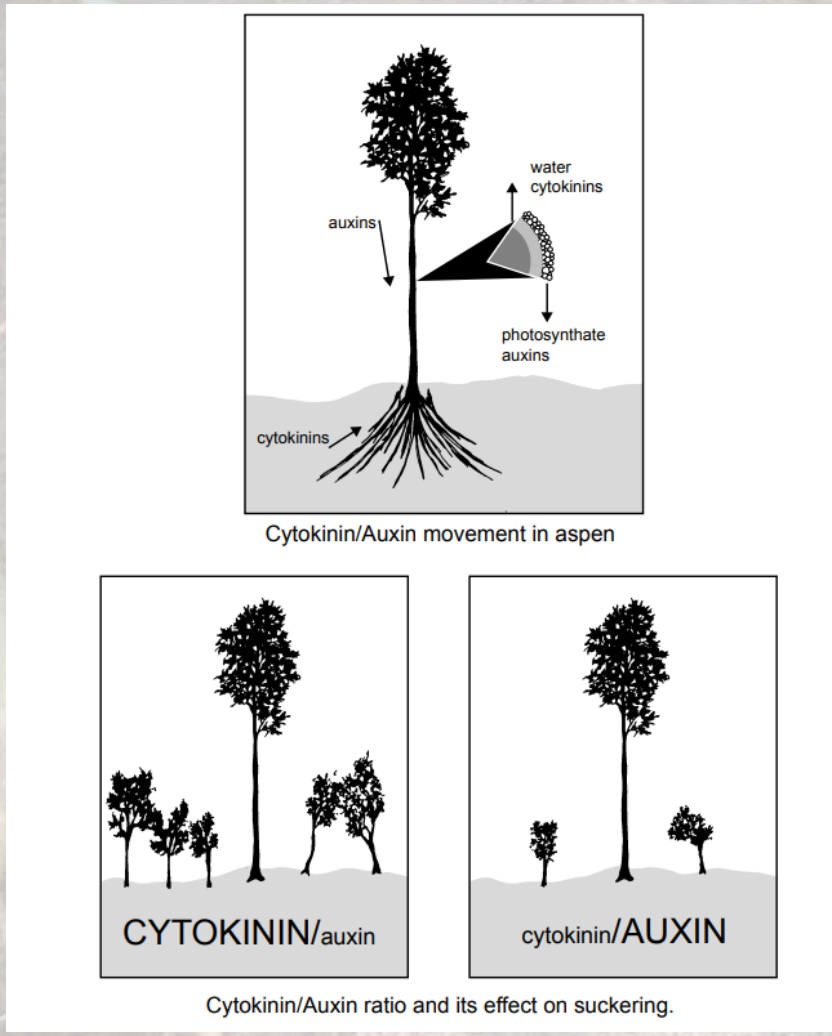
Why are Aspen Important?

- Most common deciduous tree
- Mesic uplands throughout the boreal
- Native early successional species
- Leaf litter aids in the development of a soil organic layer
- Leaves shade soil, mitigating water stress
- Encourage the development of a natural understory and soil-plant nutrient cycle

https://i.pinimg.com/originals/62/9c/a8/629ca895a3b0b24786f28c19c0254904.jpg

What We Already Know about Aspen Sprouting

- Root suckering is the primary form of reproduction, stump sprouts only occur in younger trees (<25 yrs.)
- Suckers are produced when a disturbance removes or kills the parent tree
- Sucker initiation is controlled by two hormones: auxin and cytokinin



(Miller, 1996)

What We Already Know about Aspen Sprouting

- Well developed root systems develop more suckers
- More vigorous trees develop more suckers
- Environmental factors that effect sucker initiation:
  - Soil temperature
  - Soil moisture
  - Soil nutrients
  - Competition


https://www.pinterest.ca/pin/406379566353639874/

What I’m Doing

Objective:

To determine if young aspen, which established on a reclamation site via seed, are capable of showing the same resiliency to disturbance as a natural aspen stand.

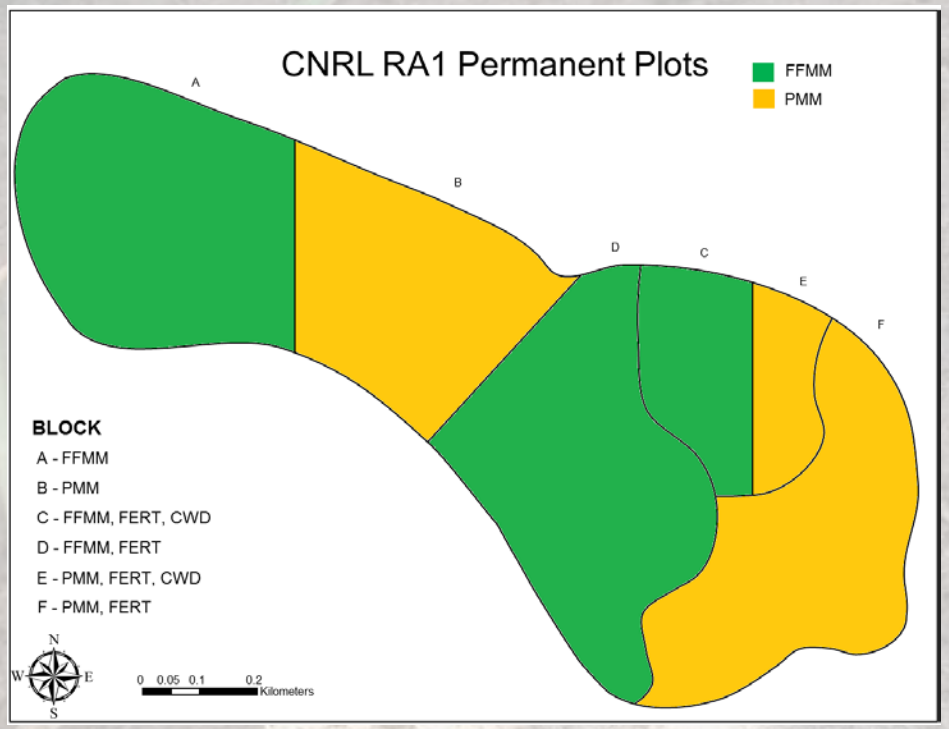
What I’m Doing

Research questions:

1. Does tree height have an effect on the amount of root suckers and stump sprouts produced?
2. Do environmental conditions, such as soil type and competition, have an effect on the number of root suckers and stump sprouts produced?

Study Area

- Reclamation Area Northwest of Fort McMurray, Alberta
- 88.6 ha overburden dump
- Reclaimed in 2011
- Divided into blocks with different treatments
- Sites selected based on soil type and tree size



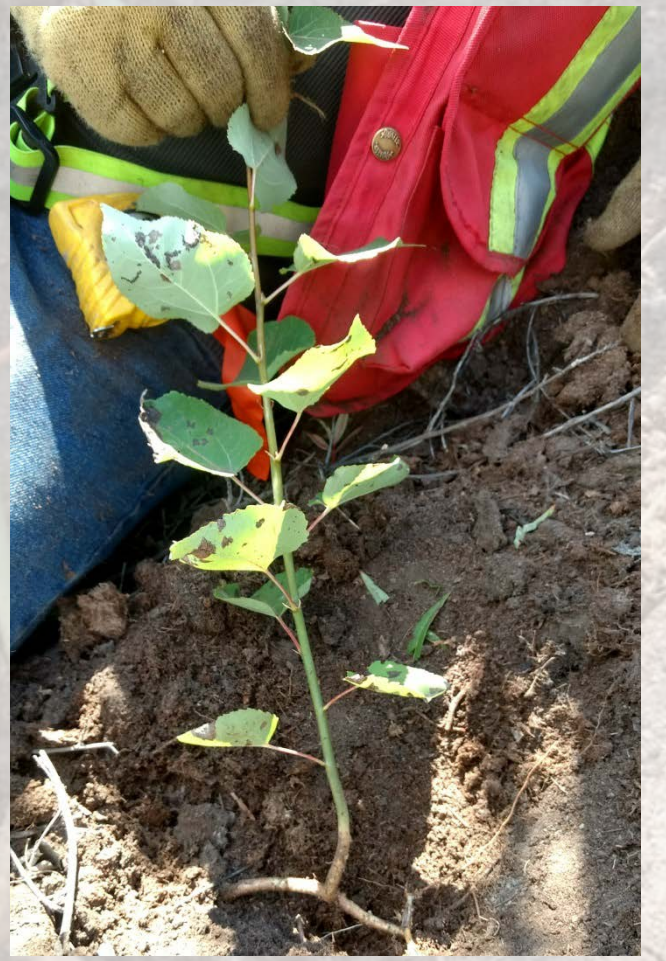
Methods – May 2017

- Cut down aspen trees to mimic an above down disturbance (3 height classes, different soil types, varying levels of competition)
- Recorded tree height, bole diameter, and collected a cookie (all cut trees were 6 years old)

Methods – August 2017

- 3.99 m radius plot was setup around each cut aspen tree
- Suckers and stump sprouts were counted
- Overall plant community composition was estimated

Root Sucker vs. Seedling



Results

Results - Suckers

- More suckers on PMM
- Larger trees produced more suckers on PMM
- Many factors could explain differences in soil type

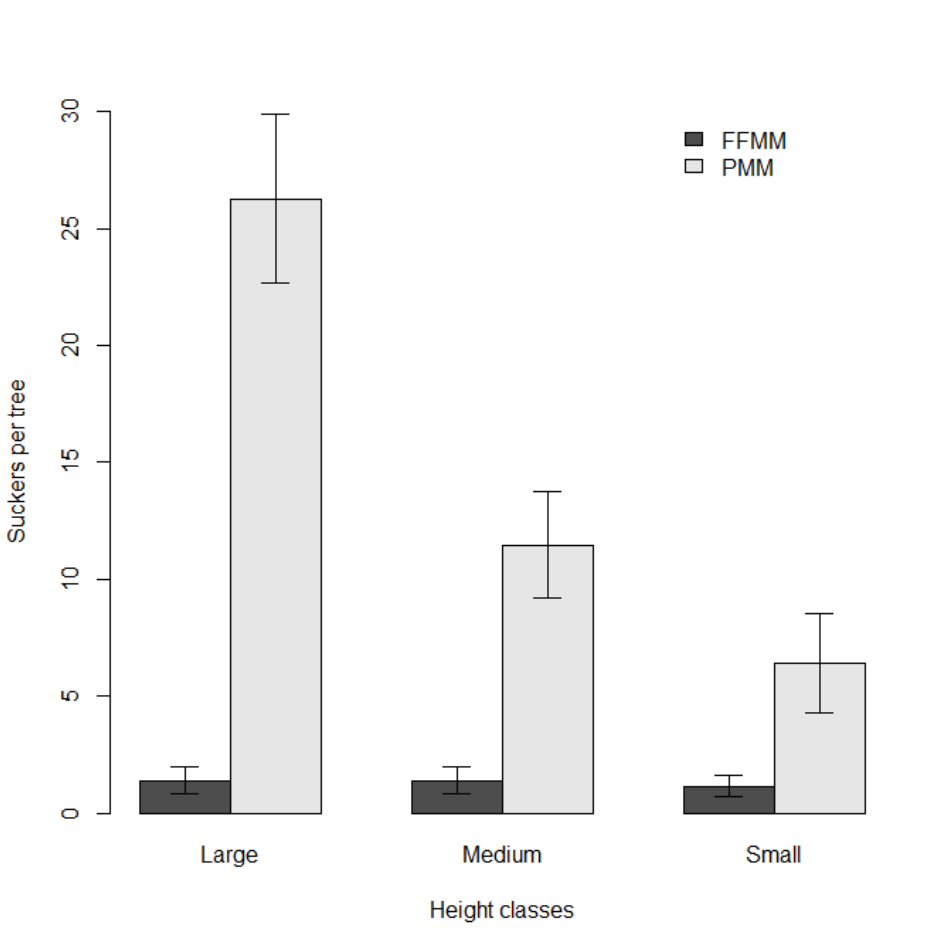


Figure 1. The average number of suckers produced by each height class and on the different soil types.

Results –Sucker Initiation

- PMM has greater sucker initiation
- Taller trees have greater sucker initiation
- Higher covers of surrounding cover decrease sucker initiation

Table 2. Logistic regression model parameters relating to the presence/absence of suckers produced by aspen trees, there were no significant interactions.

Variable	Likelihood ratio	S.E.	*p*
Soil - PMM	7.75	0.608	<0.001
Height	1.01	0.004	0.035
Total Cover	-1.04	0.014	0.004
AIC: 85.907			

Results –Sucker Abundance

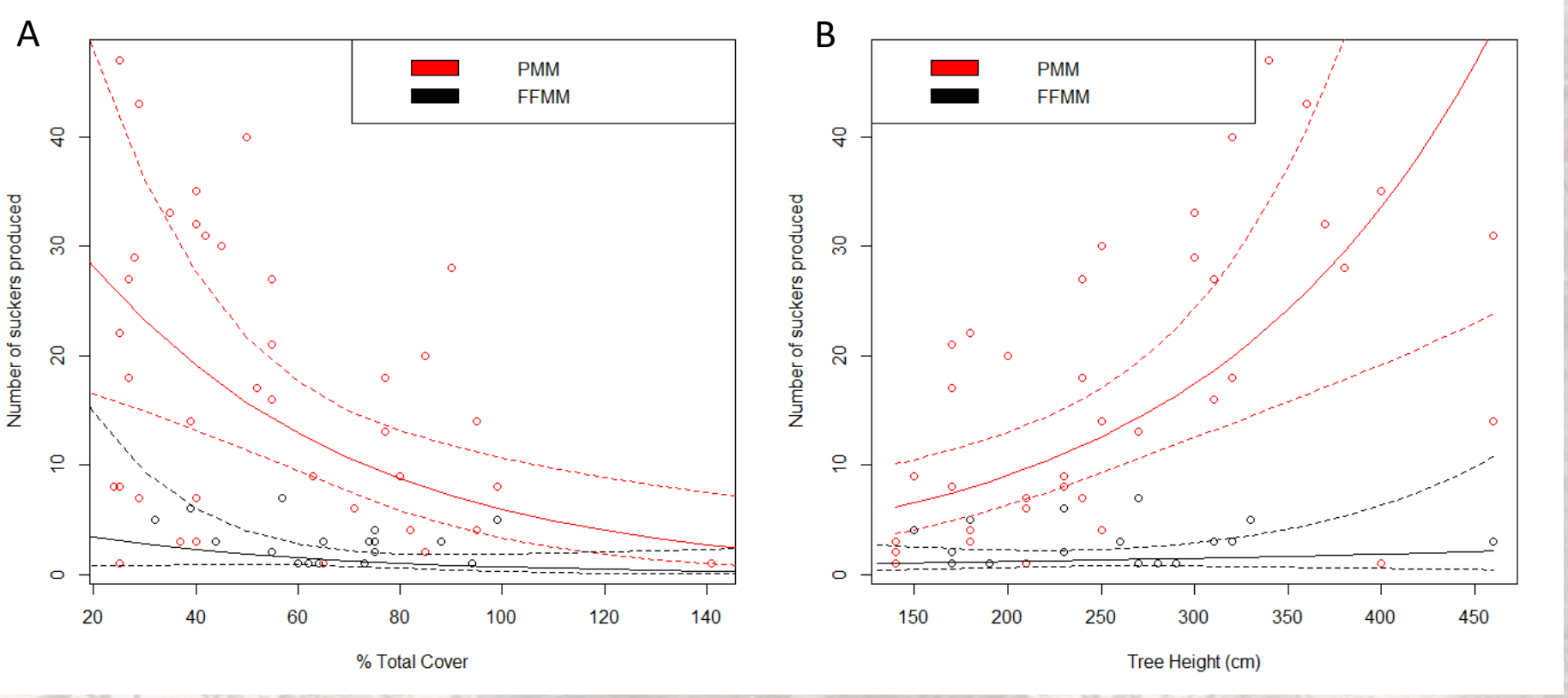
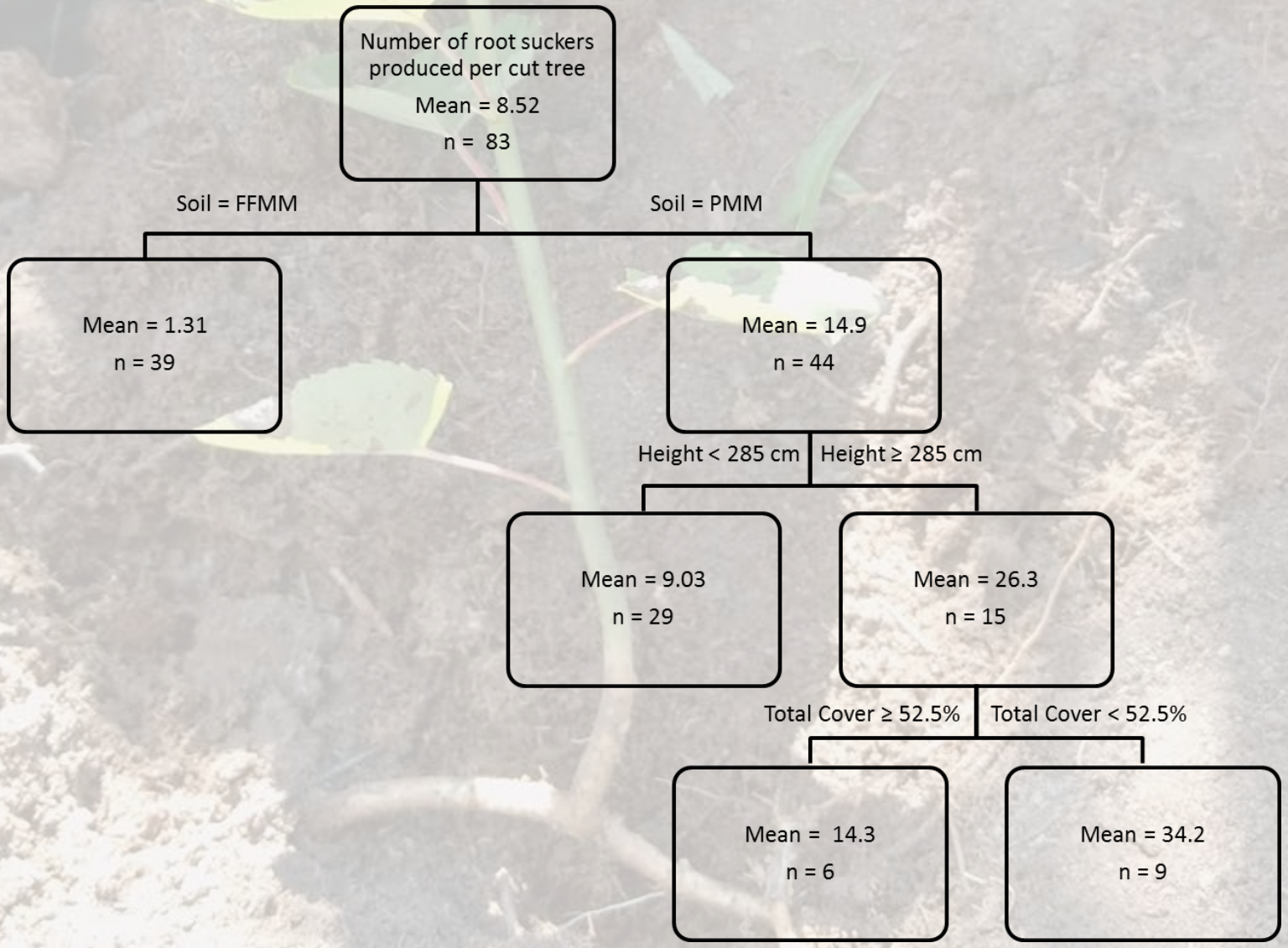


Figure 2. (A) Observed number of suckers produced over a range of total ground cover (%) on both soil types with a fitted zero-truncated negative binomial GLM curve (solid line) and 95% confidence bands (dotted lines). (B) Observed number of suckers produced over a range of tree heights (cm) on both soil types with a fitted zero-truncated negative binomial GLM curve (solid line) and 95% confidence bands (dotted lines).

Operational Results - Suckers



Results – Stump Sprouts

Table 5. Logistic regression model parameters relating to the presence/absence of stump sprouts produced by aspen trees.

Variable	Likelihood ratio	S.E.	*p*
Tree Cover	-1.86	0.254	0.014
Soil – PMM: Tree Cover	1.69	0.251	0.036
AIC: 61.012			

Conclusions

1. Does tree height have an effect on the amount of root suckers and stump sprouts produced?
    - Larger trees generally produce more suckers
    - Tree size does not effect the number of stump sprouts produced


Large


Medium


Small

Conclusions

2. Do environmental conditions, such as soil type and competition, have an effect on the number of root suckers and stump sprouts produced?
    - PMM produces more suckers
    - Greater amounts of surrounding competition decrease the amount of suckers
    - Competition from surrounding trees decreases stump sprout production

https://www.organicgardeningsolutions.com.au/products/sphagnum-peat-moss

Conclusions

- Young aspen on a reclamation site are capable of responding to a disturbance as they would in a natural stand

However…

- Further research should be done to determine the vigor and survival rates of suckers on reclaimed areas

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Thank you!
Any Questions?