

# End of the road: Short-term responses of a large mammal community to forest road decommissioning



**UQAR**

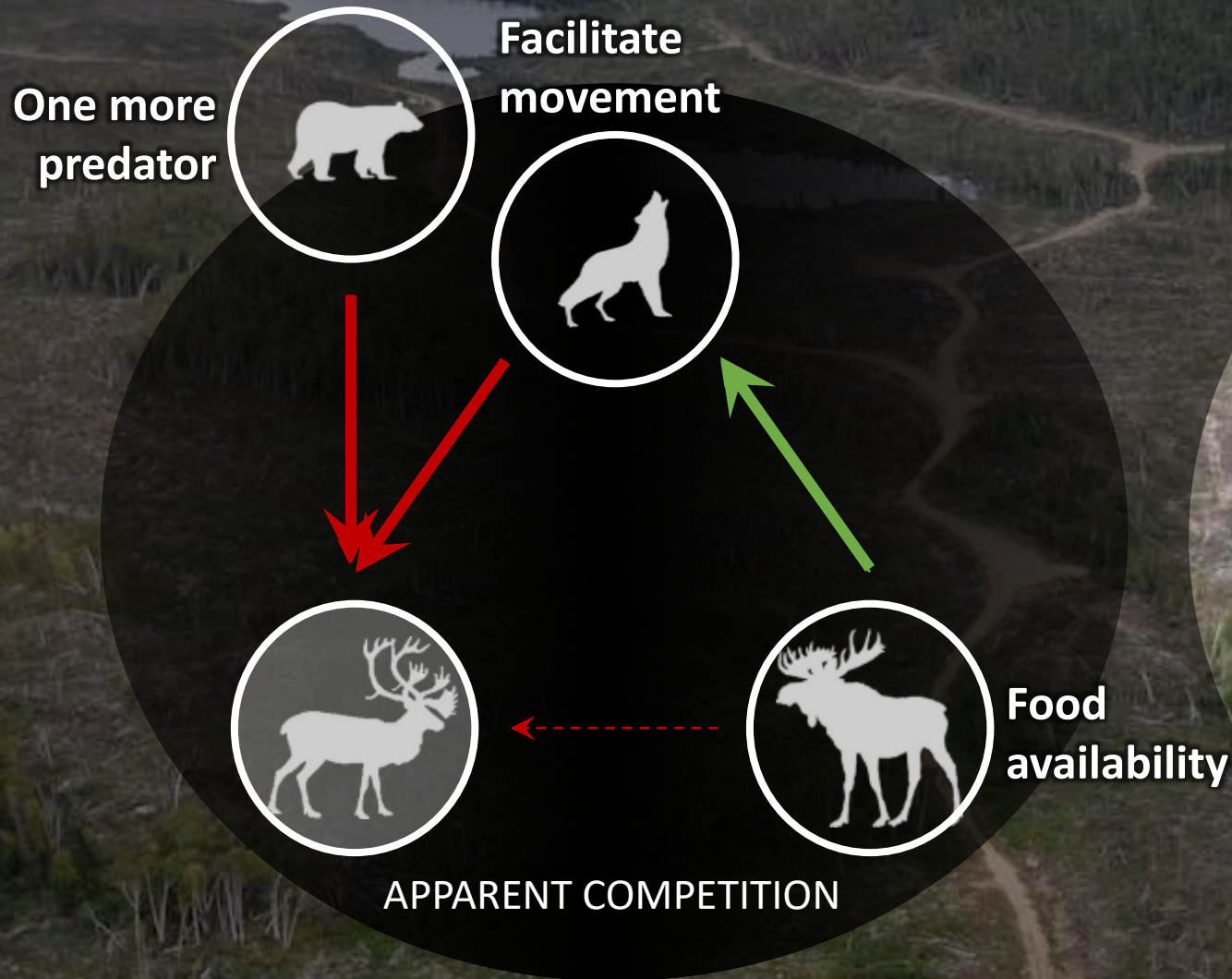
Rebecca Lacerte, Mathieu Leblond and Martin-Hugues St-Laurent  
CEF 2022



Environment and  
Climate Change Canada  
Environnement et  
Changement climatique Canada

# BOREAL CARIBOU

Anthropogenic disturbances



Should occupy less than 35% of the landscape to offer a 60% probability of maintaining a stable or increasing caribou population

Reduce disturbances in the landscape

Passive

Active

RESTORATION

# PASSIVE RESTORATION

Some studies on seismic lines,  
few on forest roads

## FOREST ROADS

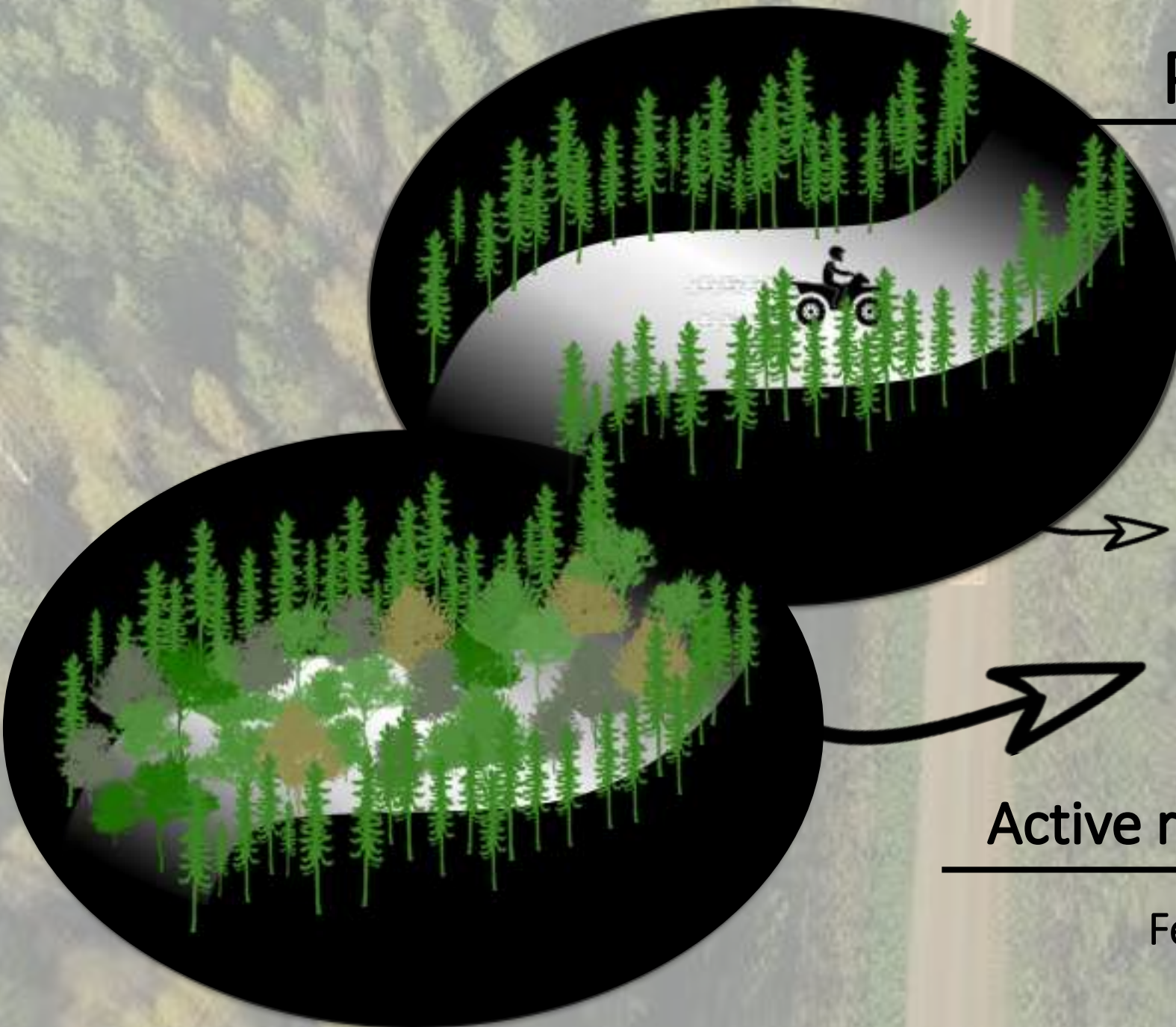
(St-Pierre et al. 2021)

22% without regeneration

Composed of deciduous  
instead of coniferous stands

**Active restoration seems necessary**

Few studies, especially on forest roads



# OBJECTIVE

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Assess regeneration of vegetation and use of roads by large mammals across four active restoration treatments

## HYPOTHESIS 1

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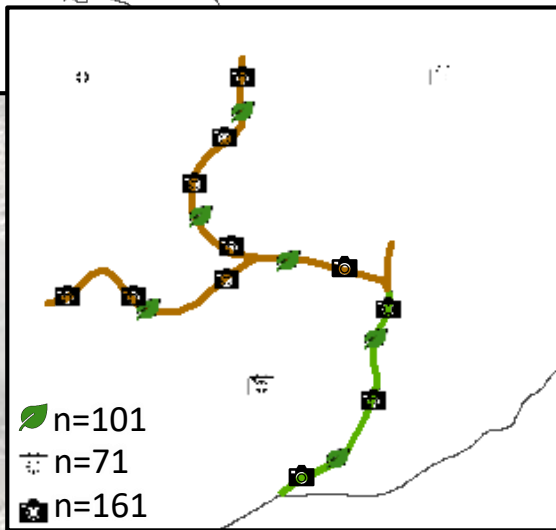
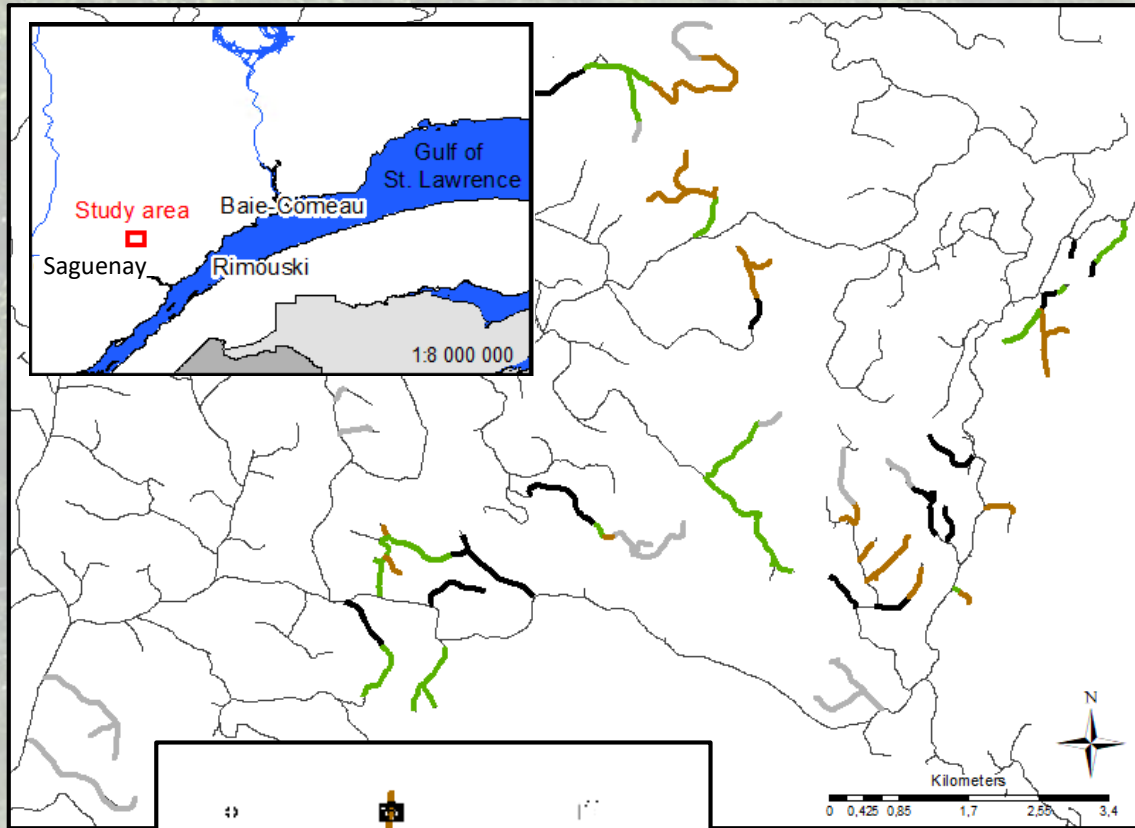
The establishment of vegetation on forest roads is influenced by treatment type, as well as by the environment surrounding road segments

## HYPOTHESIS 2

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The use of roads by mammals is influenced by treatment type, as well as by the environment surrounding road segments, and the distribution of other species

# METHODS



Count of all stems per species



Forest camera



Road camera

Space use by mammals



Land cover percentage

# TREATMENTS

CLOSED

Closing roads to traffic



# TREATMENTS

CLOSED

Closing roads to traffic

DECOMPACTED

Closing roads and decompacting the soil



# TREATMENTS

CLOSED

Closing roads to traffic

DECOMPACTED

Closing roads and decompacting the soil

PLANTED

Closing, decompacting,  
and planting black spruce trees







# TREATMENTS

**CLOSED**

Closing roads to traffic

**DECOMPACTED**

Closing roads and decompacting the soil

**PLANTED**

Closing, decompacting,  
and planting black spruce trees

**ENRICHED**

All of the above, and adding enriched  
soil at the base of planted spruce

A dirt road in a forest, showing different treatment sections. The road is a mix of brown and grey soil, with some sections appearing more compacted or enriched. The surrounding forest is lush with green trees and bushes.

# TREATMENTS

**CLOSED**

Closing roads to traffic

**DECOMPACTED**

Closing roads and decompacting the soil

**PLANTED**

Closing, decompacting,  
and planting black spruce trees

**ENRICHED**

All of the above, and adding enriched  
soil at the base of planted spruce

**CONTROL**

# REGENERATION

## ABUNDANCE

PARTIAL CANONICAL CORRESPONDENCE ANALYSIS

Number of stems

~

Treatments

+

Environmental variables

## OCCURENCE

MULTIPLE MIXED LOGISTIC REGRESSION

Presence/absence

~

Treatments



# USE BY MAMMALS

## HURDLE

### OCCURRENCE

MULTIPLE MIXED LOGISTIC  
REGRESSION

Presence/absence

### FREQUENCY OF USE

MULTIPLE MIXED  
NEGATIVE BINOMIAL

Number of events (presences)

~

Treatments

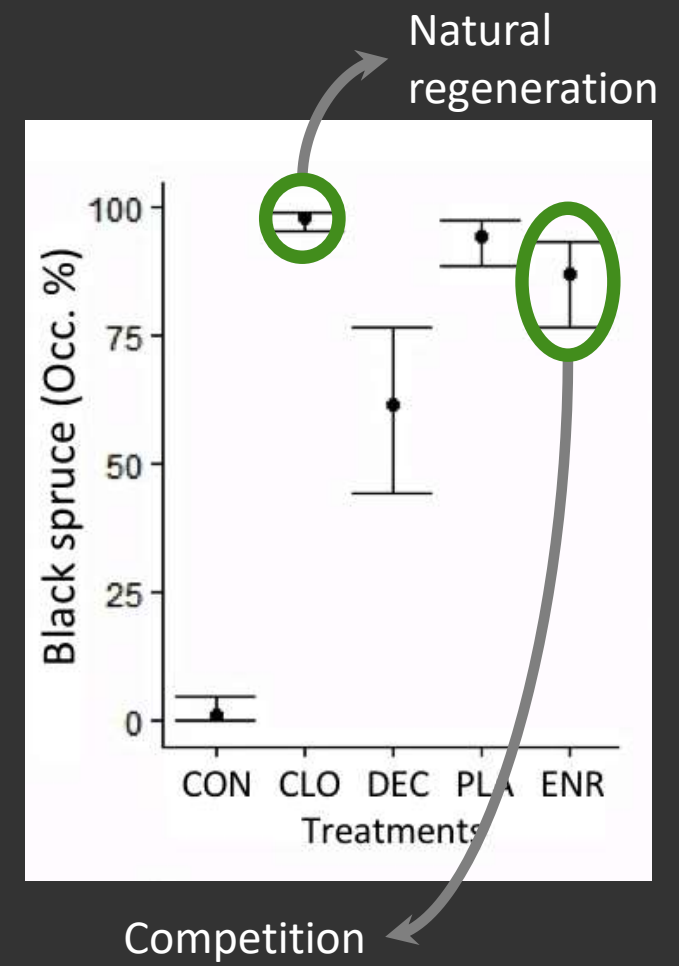
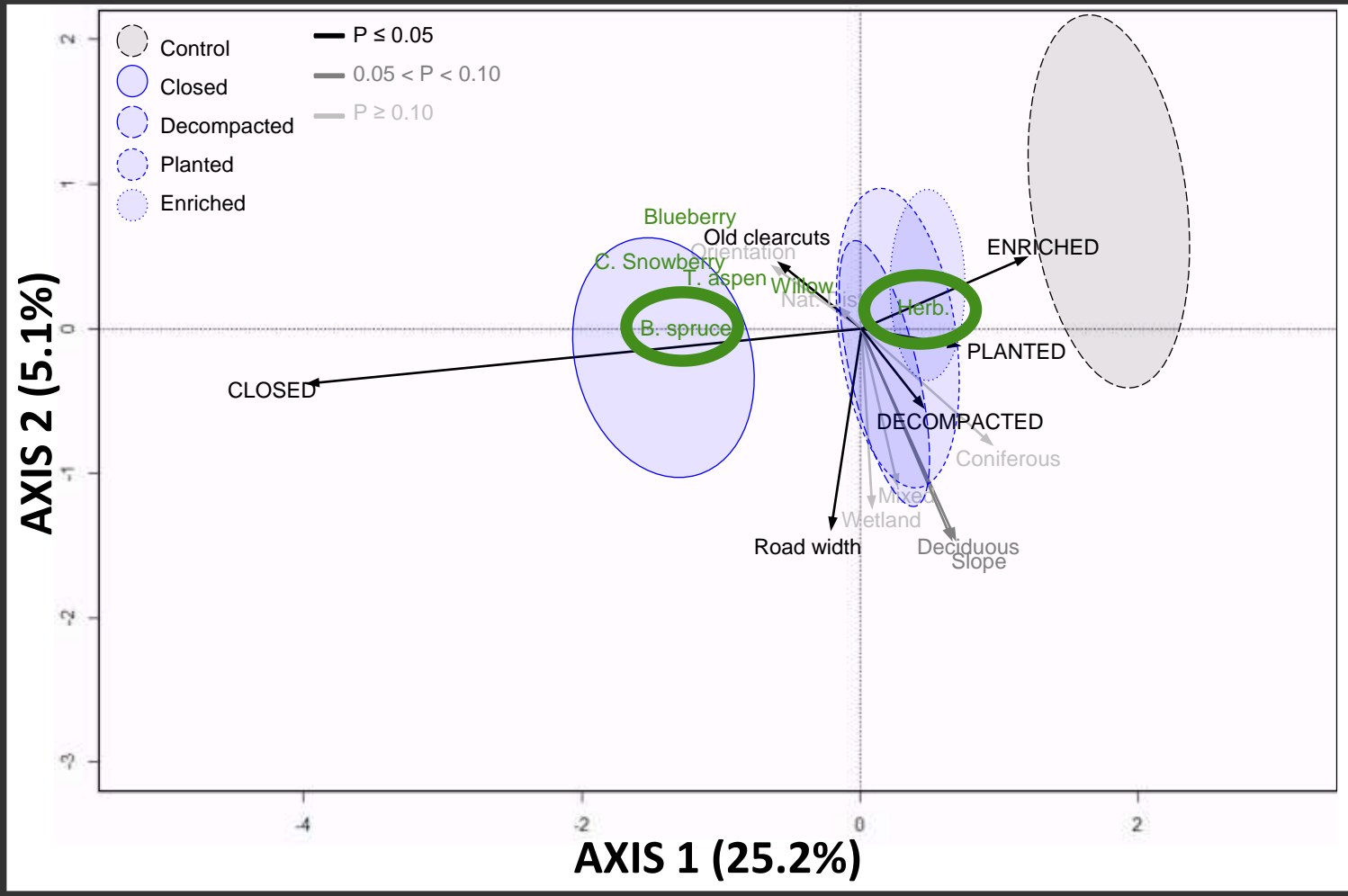
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Intensity of use by mammals

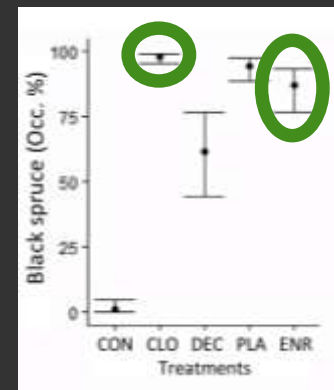
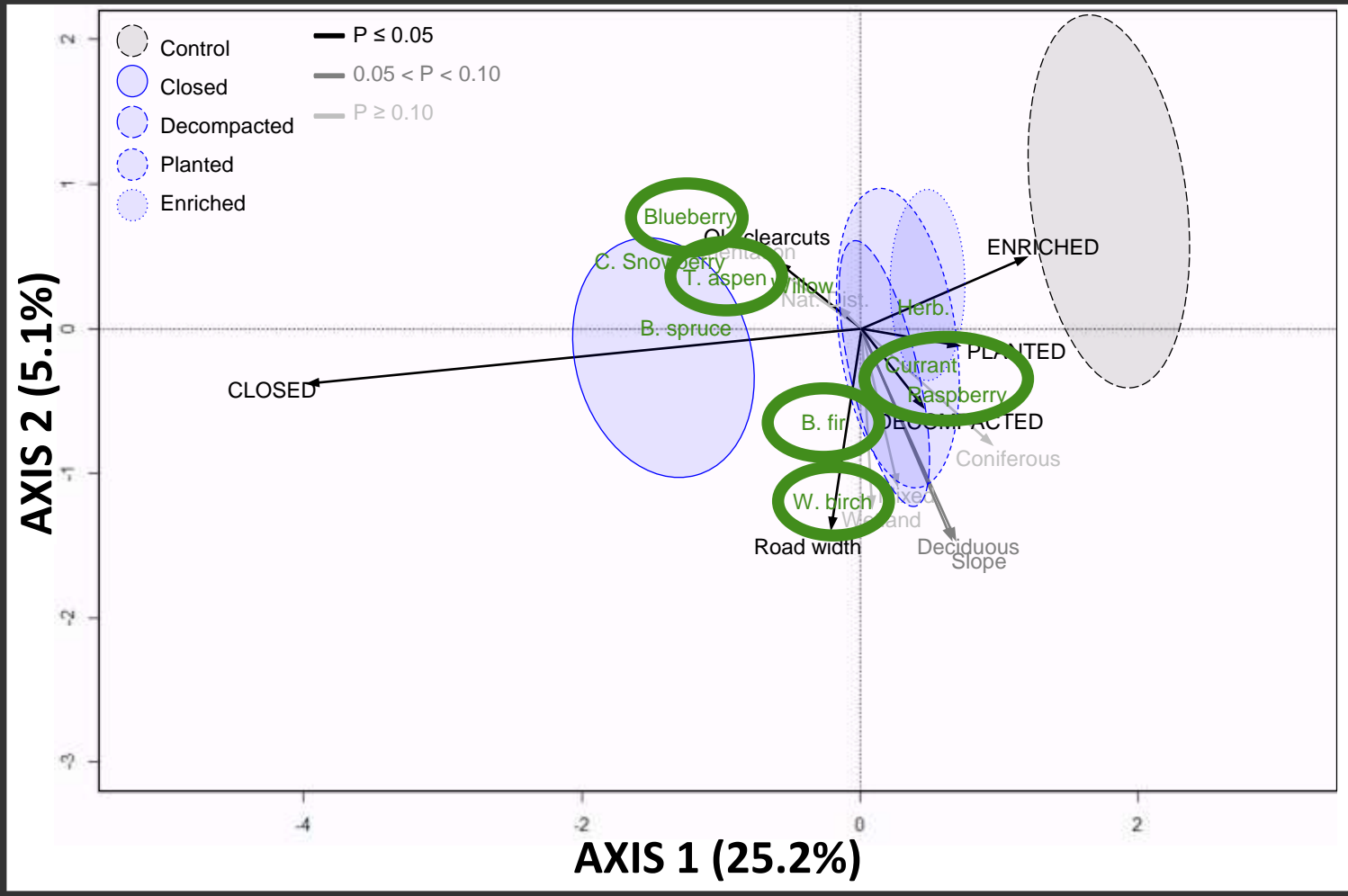
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Environmental variables

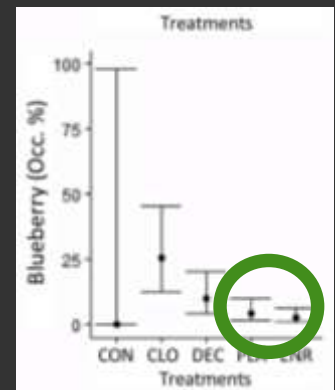
# RESULTS & DISCUSSION



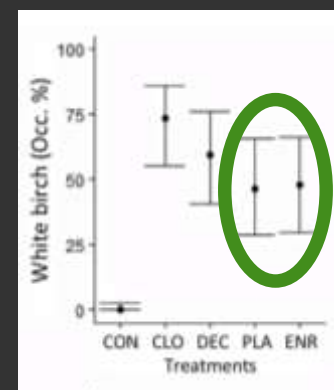
# RESULTS & DISCUSSION



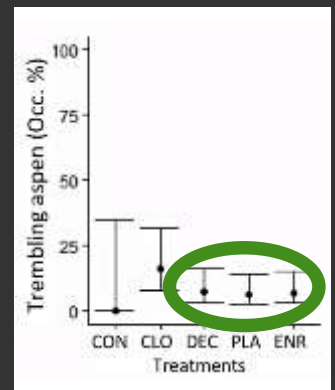
B. spruce



Blueberry



W. birch



T. aspen



Competing with black spruce  
Moose and bear diet

# RESULTS & DISCUSSION

## EFFECT OF ROAD DECOMMISSIONING TREATMENTS



PLANTED

*Occurrence*

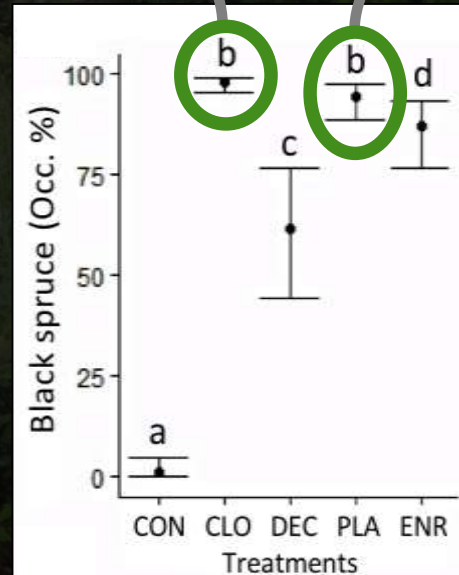
*Frequency*

+

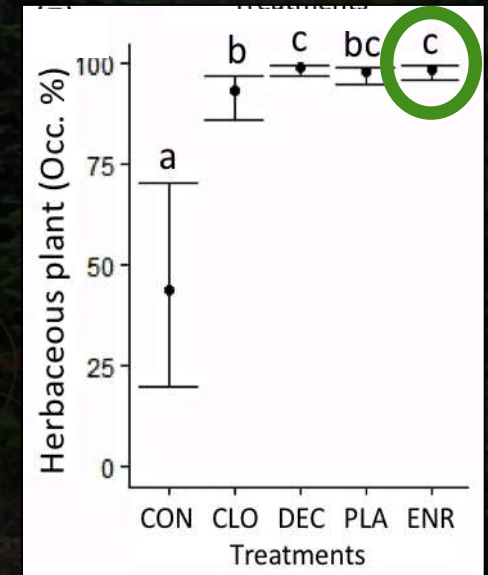


Natural regeneration

Competition



Black spruce



Herbaceous

# RESULTS & DISCUSSION

## EFFECT OF ROAD DECOMMISSIONING TREATMENTS



PLANTED

*Occurrence*

*Frequency*

+



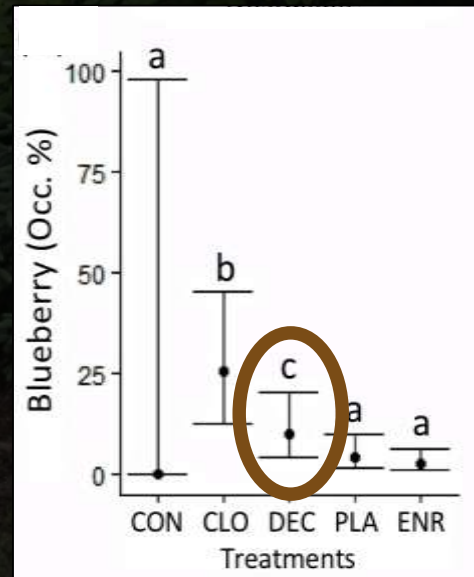
**Non-significant trend**  
Used decompacted treatment more  
0.72 vs.  $\leq 0.59$  events/100 camera-days



Increase food resources for bears

*Partial canonical correspondence analysis*

↑  
Currant  
Raspberry



Blueberry

# RESULTS & DISCUSSION

## EFFECT OF ROAD DECOMMISSIONING TREATMENTS



PLANTED

*Occurrence*

*Frequency*

+



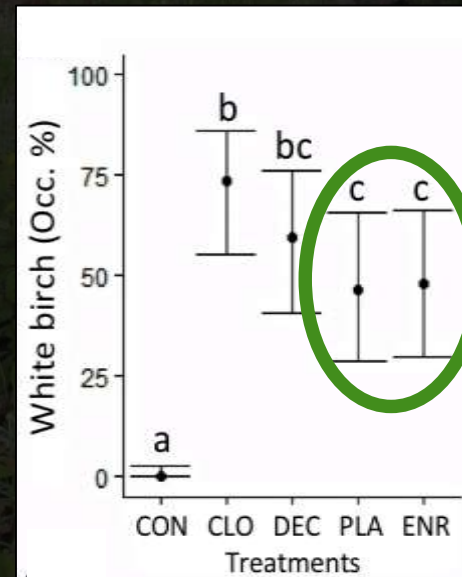
**Non-significant trend**  
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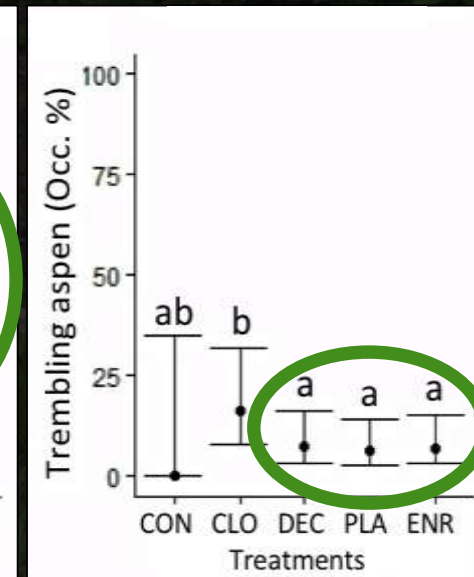
PLANTED

-

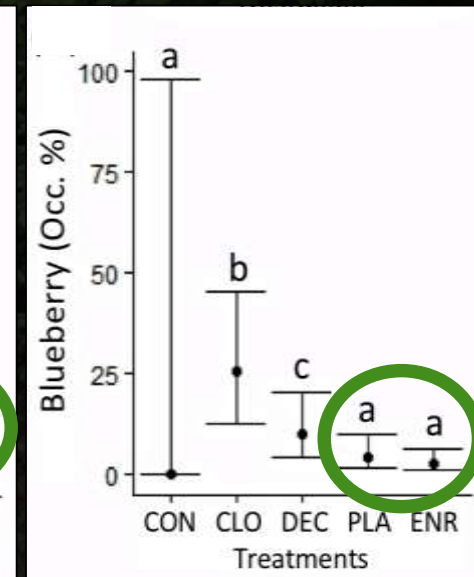
Less attractive to predators and alternate prey  
Reduce predation risks



White birch



Trembling aspen



Blueberry






# RESULTS & DISCUSSION

## EFFECT OF THE SPACE USE BY OTHER MAMMALS

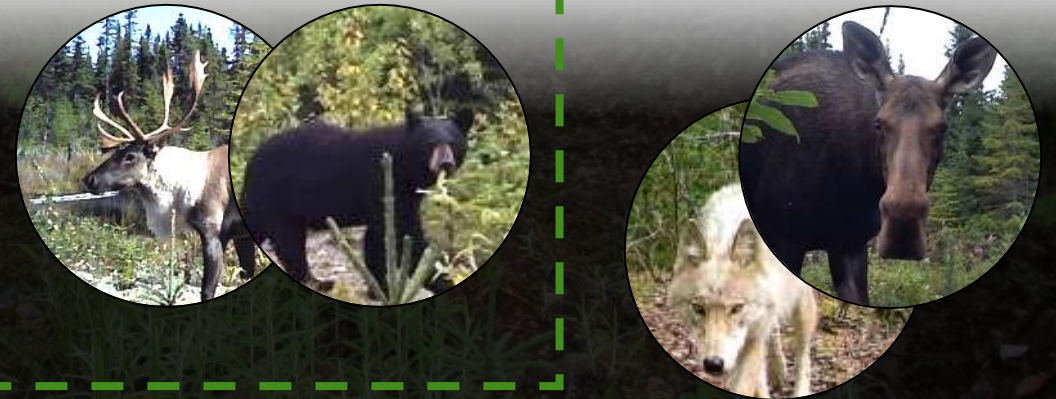


# RESULTS & DISCUSSION

## EFFECT OF THE ENVIRONMENT SURROUNDING ROADS

	<i>Occurrence</i>	<i>Frequency</i>
 CONIFEROUS WETLANDS	+	+
 WETLANDS		+
 NAT. DIST. CLEARCUTS ROAD	+	-

Roads surrounded by wetlands may represent a high predation risk



# TAKE HOME MESSAGES

WHAT IS THE BEST TREATMENT TO RESTORE WOODLAND CARIBOU HABITAT?



**CLOSED,  
DECOMPACTED  
& PLANTED**



Black spruce

Should lead to the establishment of a forest cover dominated by black spruce



Food resources for bears and moose (and wolves)



CLOSED



DECOMPACTED



ENRICHED

# IMPLICATIONS FOR CARIBOU

Most effective treatment to restore caribou habitat: PLANTED TREATMENT

Must combine  
decommissioning with

## Conservation strategies

- Habitat protection
- Disturbance level management
- And others e.g. translocation, predator control



Vegetation cover and composition – and the response of mammals – are likely to change over time

Must be applied on large area

\$\$\$  
~2 175 CAN\$/km

To reduce costs over a large area, what types of forest roads need to be restored?

St-Pierre et al. 2021

UQAR



Environment and Climate Change Canada  
Environnement et Changement climatique Canada



FAEP



# THANK YOU!

Conseil de la Première Nation des Innus Essipit

*Marc St-Onge*

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Members of the

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Help with statistical analysis

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*François Rousseu*

Field assistants

*Naomy Bédard*

*Kloé Chagnon-Taillon*

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# COST ESTIMATE



**CLOSED**

~193 \$/Closing



**DECOMPACTED**

~747 \$/km



**PLANTED**

~2 175 \$/km

**Planting**

~1 428 \$/km

~525 \$/km to purchase the plants



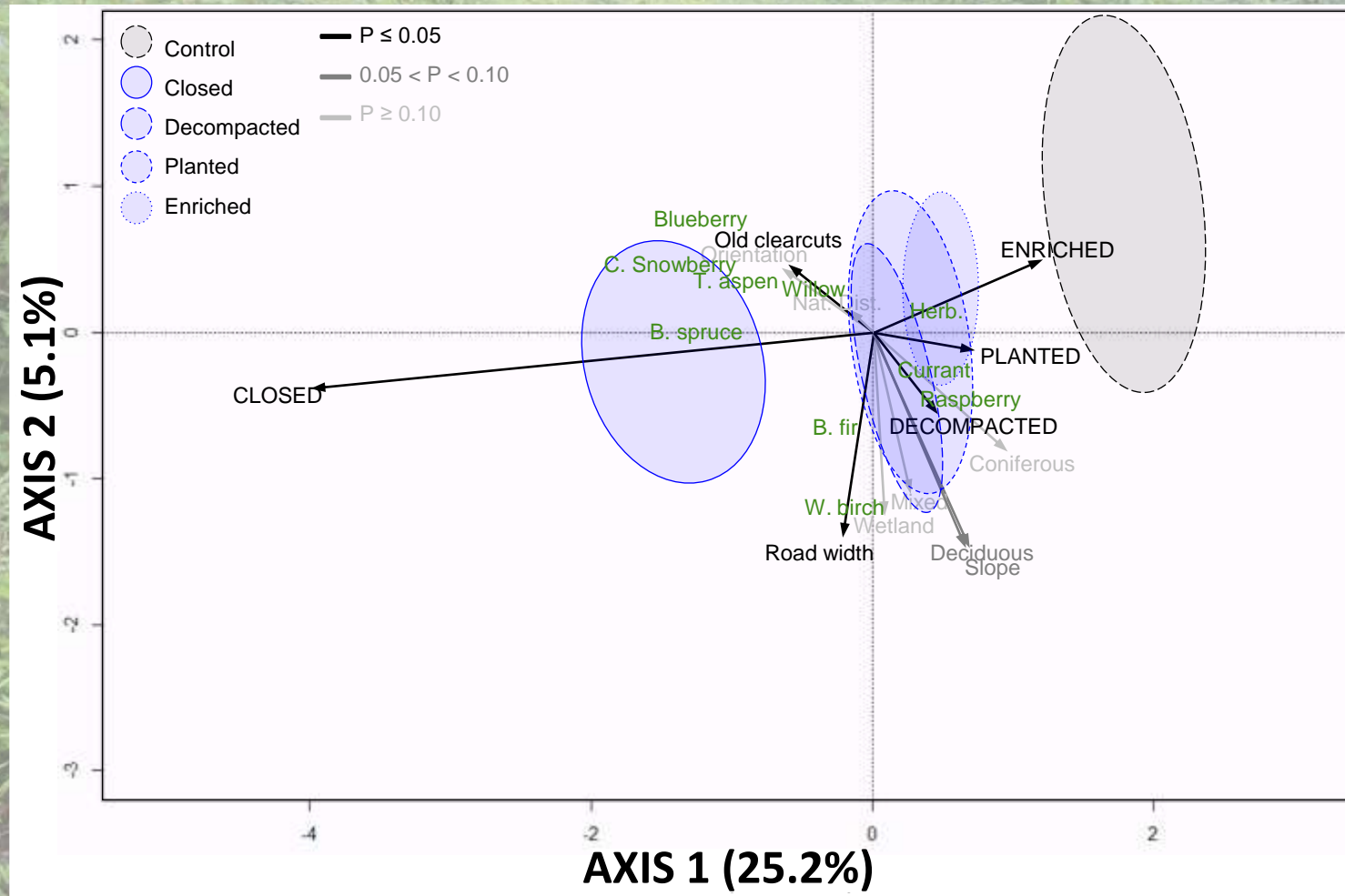
**ENRICHED**

~3 348 \$/km

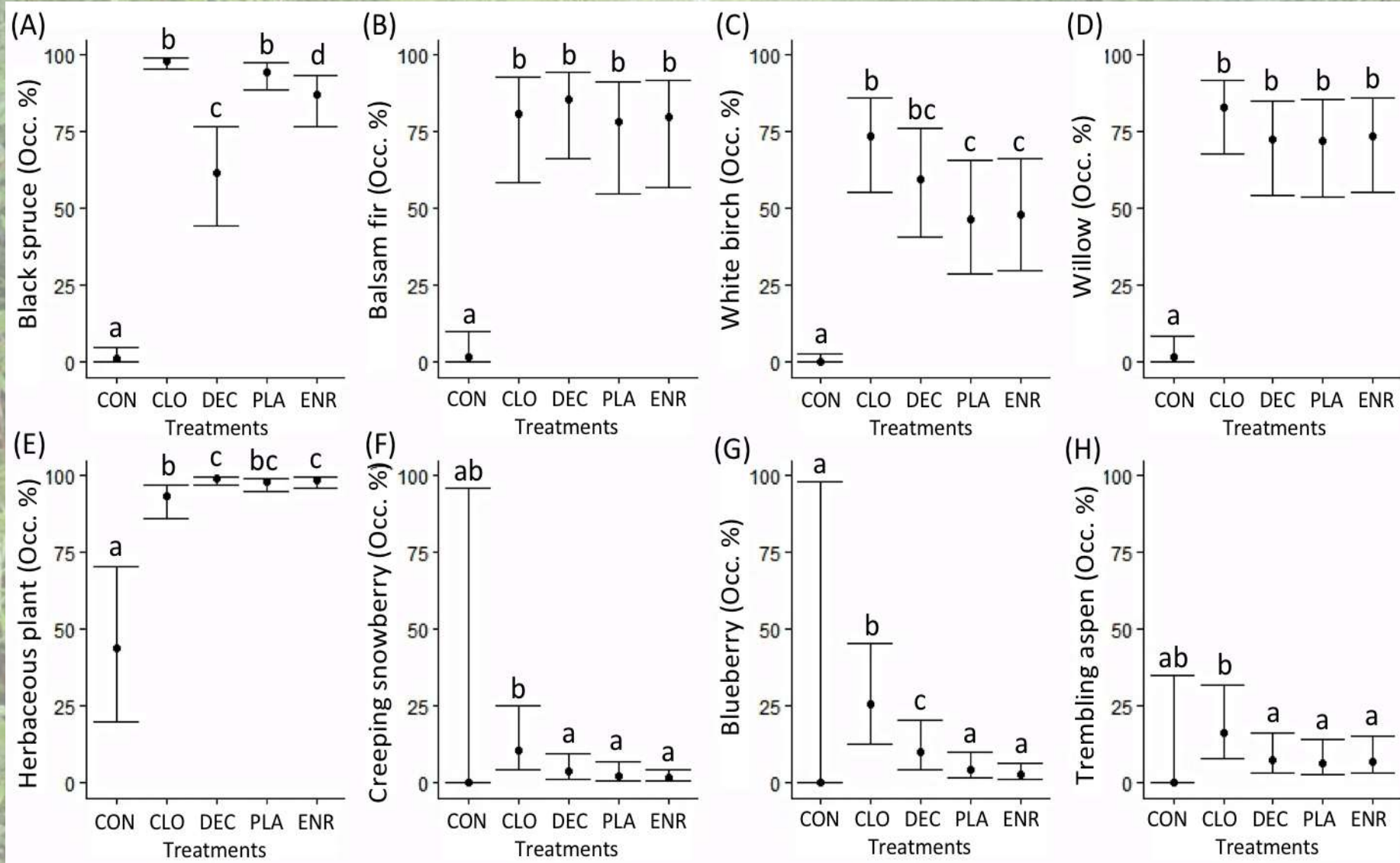
**Organic soil**

~1 773 \$/km

# Partial canonical correspondence analysis



# Multiple mixed logistic regression





# Occurrence and frequency of use

Variables	Boreal caribou				Gray wolf		Black bear				Moose			
	Occ.		Freq.		Occ.		Occ.		Freq.		Occ.		Freq.	
	$\beta$	95% CI	$\beta$	95% CI	$\beta$	95% CI	$\beta$	95% CI	$\beta$	95% CI	$\beta$	95% CI	$\beta$	95% CI
<i>Treatments</i>														
Intercept	-4.55	[-6.48: -2.61]	-4.27	[-5.16: -3.38]	-4.16	[-6.21: -2.12]	-1.82	[-2.58: -1.07]	-3.72	[-4.19: -3.24]	0.60	[-0.06: 1.13]	-3.02	[-3.28: -2.76]
Decompacted	0.54	[-1.24: 2.32]	0.91	[-0.10: 1.93]	–	–	0.35	[-0.63: 1.33]	0.26	[-0.34: 0.86]	-0.15	[-0.87: 0.58]	-0.15	[-0.52: 0.21]
Planted	0.30	[-1.50: 2.10]	<b>1.38</b>	<b>[0.40: 2.37]</b>	–	–	0.78	[-0.21: 1.76]	-0.12	[-0.71: 0.48]	-0.03	[-0.77: 0.71]	-0.38	[-0.77: 0.00]
Enriched	-1.36	[-3.41: 0.69]	0.95	[-0.36: 2.25]	–	–	-0.20	[-1.22: 0.82]	-0.32	[-1.06: 0.41]	0.01	[-0.73: 0.75]	-0.05	[-0.42: 0.32]
<i>Other species</i>														
Use by caribou	–	–	–	–	–	–	<b>0.31</b>	<b>[0.03: 0.59]</b>	–	–	–	–	–	
Use by wolf	–	–	–	–	–	–	–	–	–	0.25	[-0.21: 0.71]	<b>0.10</b>	<b>[0.01: 0.20]</b>	
Use by bear	–	–	–	–	–	–	–	–	–	0.31	[-0.04: 0.66]	-0.00	[-0.11: 0.11]	
Use by moose	–	–	–	–	<b>0.57</b>	<b>[0.02: 1.12]</b>	0.12	[-0.19: 0.44]	–	–	–	–	–	
Local bear density	<b>0.90</b>	<b>[0.23: 1.57]</b>	–	–	–	–	–	–	–	–	–	–	–	
Local moose density	<b>-4.91</b>	<b>[-8.80: -1.02]</b>	–	–	–	–	–	–	–	–	–	–	–	
<i>Land cover types<sup>a</sup></i>														
Wetland	-1.58	[-3.20: 0.05]	<b>1.09</b>	<b>[0.10: 2.08]</b>	–	–	–	–	<b>0.19</b>	<b>[0.01: 0.37]</b>	–	–	–	
Deciduous forest	–	–	–	–	–	–	–	–	-0.16	[-0.42: 0.10]	–	–	–	
Coniferous forest	<b>1.44</b>	<b>[0.75: 2.12]</b>	<b>0.63</b>	<b>[0.32: 0.94]</b>	–	–	–	–	–	–	–	–	–	
Natural disturbances	–	–	–	–	–	–	–	–	–	–	<b>0.37</b>	<b>[0.04: 0.71]</b>	–	
Recent clearcuts	–	–	–	–	–	–	–	–	–	–	<b>0.28</b>	<b>[-0.00: 0.57]</b>	–	
Road density	–	–	–	–	–	–	–	–	–	–	<b>-0.32</b>	<b>[-0.59: -0.06]</b>	–	
<i>Concomitant variables</i>														
Local caribou density	<b>1.05</b>	<b>[0.45: 1.66]</b>	<b>-0.97</b>	<b>[-1.97: -0.02]</b>	–	–	–	–	–	–	–	–	–	
Local bear density	–	–	–	–	–	–	-0.13	[-0.47: 0.22]	0.00	[-0.20: 0.21]	–	–	–	
Local moose density	–	–	–	–	–	–	–	–	–	–	–	-0.07	[-0.22: 0.07]	
Sampling effort	-0.31	[-0.96: 0.35]	Offset	Offset	0.21	[-0.54: 0.97]	0.29	[-0.03: 0.61]	Offset	Offset	0.24	[-0.01: 0.49]	Offset	
Road segment ID	0.76	NA	0.00	NA	0.93	NA	0.37	NA	0.00	NA	0.09	NA	0.23	NA
<i>Model fit</i>														
AUC	–	0.93	–	–	–	0.90	–	–	–	–	–	0.66	–	
R <sup>2</sup> marginal	–	–	–	0.50	–	–	–	–	–	0.17	–	–	0.08	

# Radius buffer ( $\Delta AIC_c$ )

Radius buffer	Boreal caribou		Gray wolf		Black bear		Moose	
	Occ.	Freq.	Occ.	Freq.	Occ.	Freq.	Occ.	Freq.
<i>Undisturbed</i>								
250 m	9.97	8.29	–	–	1.06	<b>0.00</b>	–	<b>0.00</b>
500 m	3.49	9.23	–	–	<b>0.00</b>	2.34	<b>0.00</b>	0.22
1 km	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	–	1.30	3.67	–	1.26
<i>Disturbed</i>								
250 m	17.84	6.39	2.61	–	<b>0.00</b>	2.94	<b>0.00</b>	<b>0.00</b>
500 m	15.34	<b>0.00</b>	1.04	–	0.30	0.57	10.40	0.38
1 km	<b>0.00</b>	–	<b>0.00</b>	–	–	<b>0.00</b>	–	0.45

# Events/100 cameras-days [CI 95%]

Treatments	Boreal caribou		Gray wolf		Black bear		Moose	
Closed	0.20	[0.11: 0.33]	0.11	[0.05: 0.21]	0.40	[0.26: 0.56]	3.74	[3.30: 4.22]
Decompacted	0.52	[0.38: 0.70]	0.06	[0.02: 0.13]	0.72	[0.55: 0.93]	2.73	[2.38: 3.11]
Planted	0.76	[0.58: 0.98]	0.06	[0.02: 0.14]	0.59	[0.43: 0.79]	2.05	[1.74: 2.40]
Enriched	0.23	[0.14: 0.35]	0.00		0.25	[0.15: 0.37]	2.98	[2.61: 3.38]
Local density	0.34	[0.26: 0.45]	0.00		0.04	[0.02: 0.09]	0.79	[0.65: 0.94]

# Occurrence and frequency of use

Variables	Radius	$\bar{X} \pm SD$	Range	Model		Description
				Occ.	Freq.	
Wetlands	250-m	0.40±1.30	0–9.25	–	Bear, moose	Bogs, fens, swamp, and sphagnum coniferous forests (%)
	500-m	0.69±1.44	0–8.73	Bear, moose	–	
	1-km	0.71±1.03	0–4.16	Caribou, wolf	Caribou	
Deciduous forests	250-m	1.14±4.43	0–33.24	–	Bear, moose	Deciduous stands of all age classes (%)
	500-m	1.17±3.35	0–17.39	Bear, moose	–	
Coniferous forests	1-km	21.01±8.29	5.81–43.52	Caribou	Caribou	Coniferous stands >20 years old (%)
Natural disturbances	250-m	11.95±13.60	0–55.71	Bear, moose	Moose	Fires, windthrows, and insect epidemics (%)
	500-m	16.12±12.72	0–43.11	–	Caribou	
	1-km	17.68±10.78	0.87–47.20	Caribou, wolf	Bear	
Recent clearcuts	250-m	57.99±20.62	7.52–99.95	Bear, moose	Moose	Clearcuts ≤ 20 years old (%)
	500-m	46.58±15.98	8.17–89.42	–	Caribou	
	1-km	39.11±13.44	16.32–69.72	Caribou, wolf	Bear	
Road density	250-m	3.35±1.04	1.40–6.50	Bear, moose	Moose	Density of forest roads (km/km <sup>2</sup> )
	500-m	2.36±0.75	0.80–4.25	–	Caribou	
	1-km	1.86±0.54	0.75–3.01	Caribou, wolf	Bear	