

QU'EST CE QUI EXPLIQUE L'UTILISATION D'UNE STRUCTURE LINÉAIRE PAR LES PRÉDATEURS DU CARIBOU BORÉAL AINSI QUE SON COMPÉTITEUR APPARENT?



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Directeur : Louis Imbeau

Codirecteur : Osvaldo Valeria

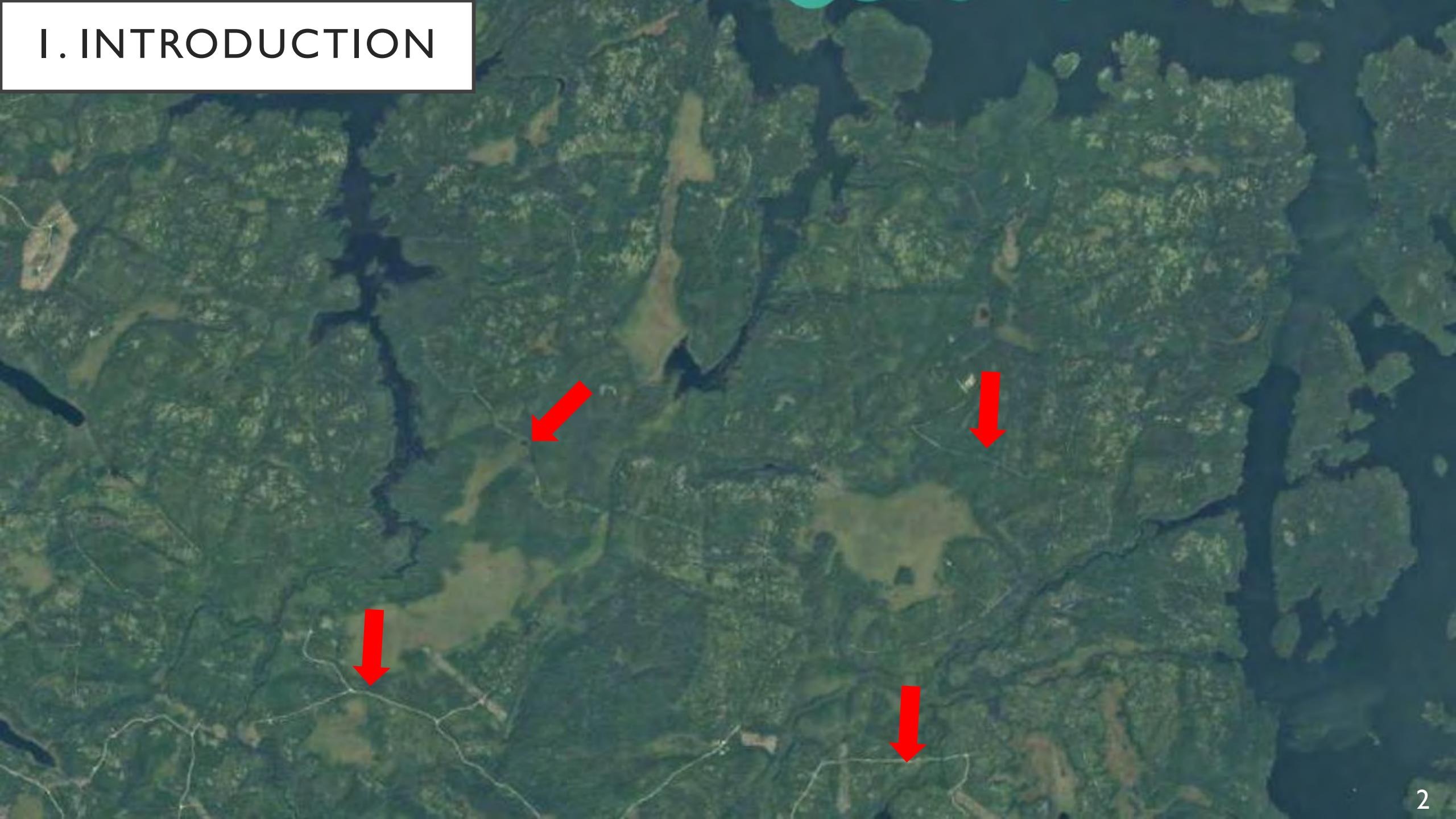
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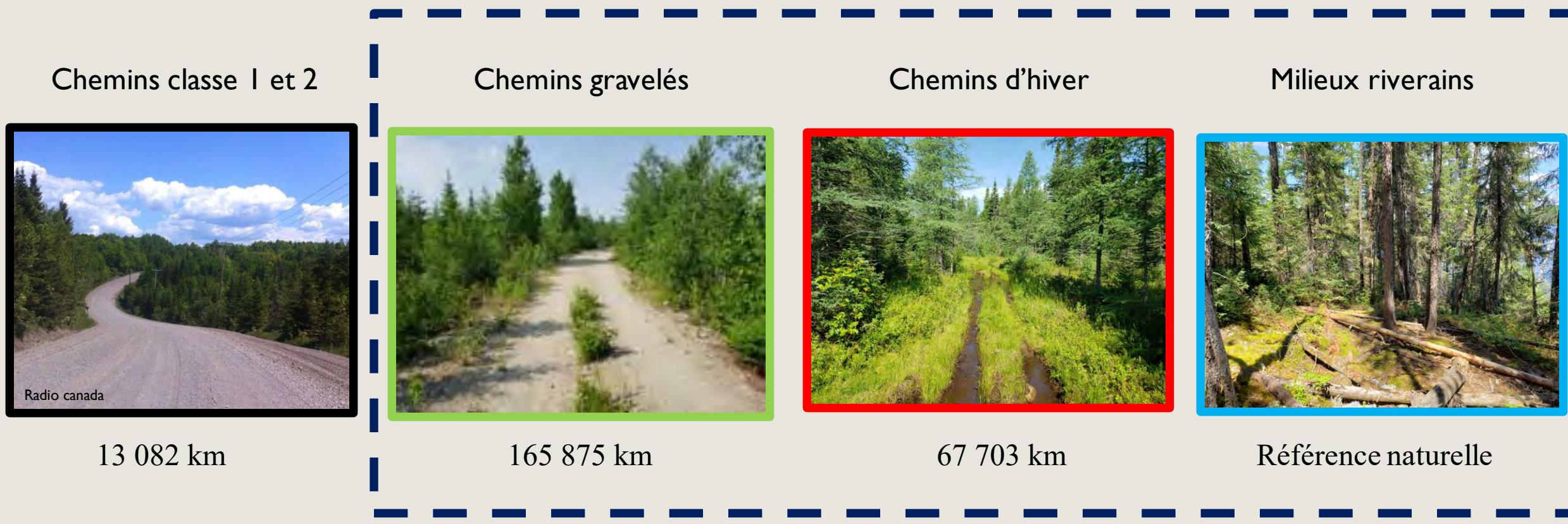


I. INTRODUCTION



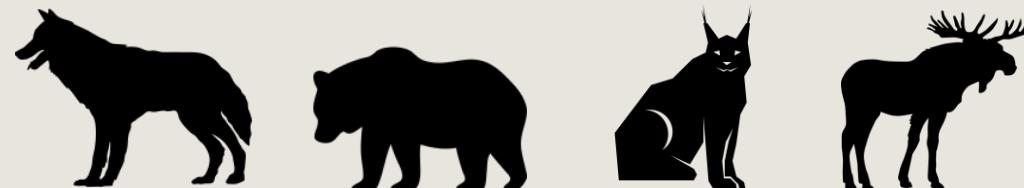
I. INTRODUCTION

476 721 km de chemins forestiers au Québec en 2020



I. INTRODUCTION

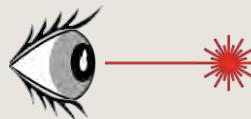
QU'EST CE QUI EXPLIQUE L'UTILISATION
D'UNE STRUCTURE LINÉAIRE PAR LES
PRÉDATEURS DU CARIBOU BORÉAL AINSI QUE
SON COMPÉTITEUR APPARENT?



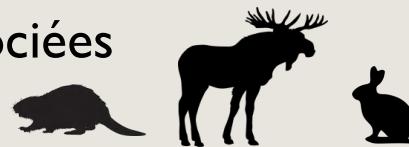
2. HYPOTHÈSES

Variables locales

La différence du couvert latéral entre le milieu environnant et la structure linéaire.



L'utilisation des proies associées



La quantité de plantes comestible

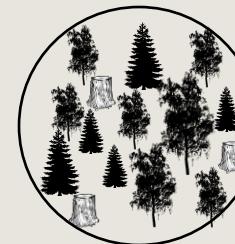


La circulation humaine



Variables paysage

Proportion de forêt en régénération (%)



Proportion de forêt dense (%)



Densité de chemins forestiers (km/km^2)

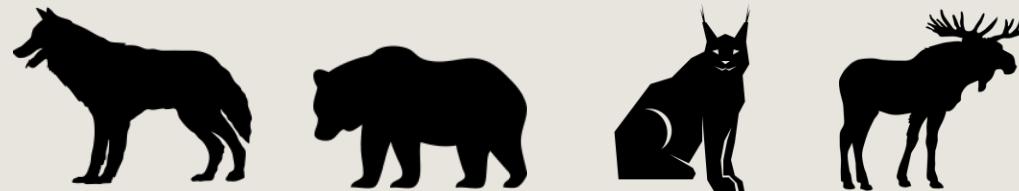


Distance à un chemin majeur (km)



2. HYPOTHÈSES

L'intensité d'utilisation sur 3 types de structures linéaires



Chemins gravelés



(+++)

Chemins d'hiver



(+)

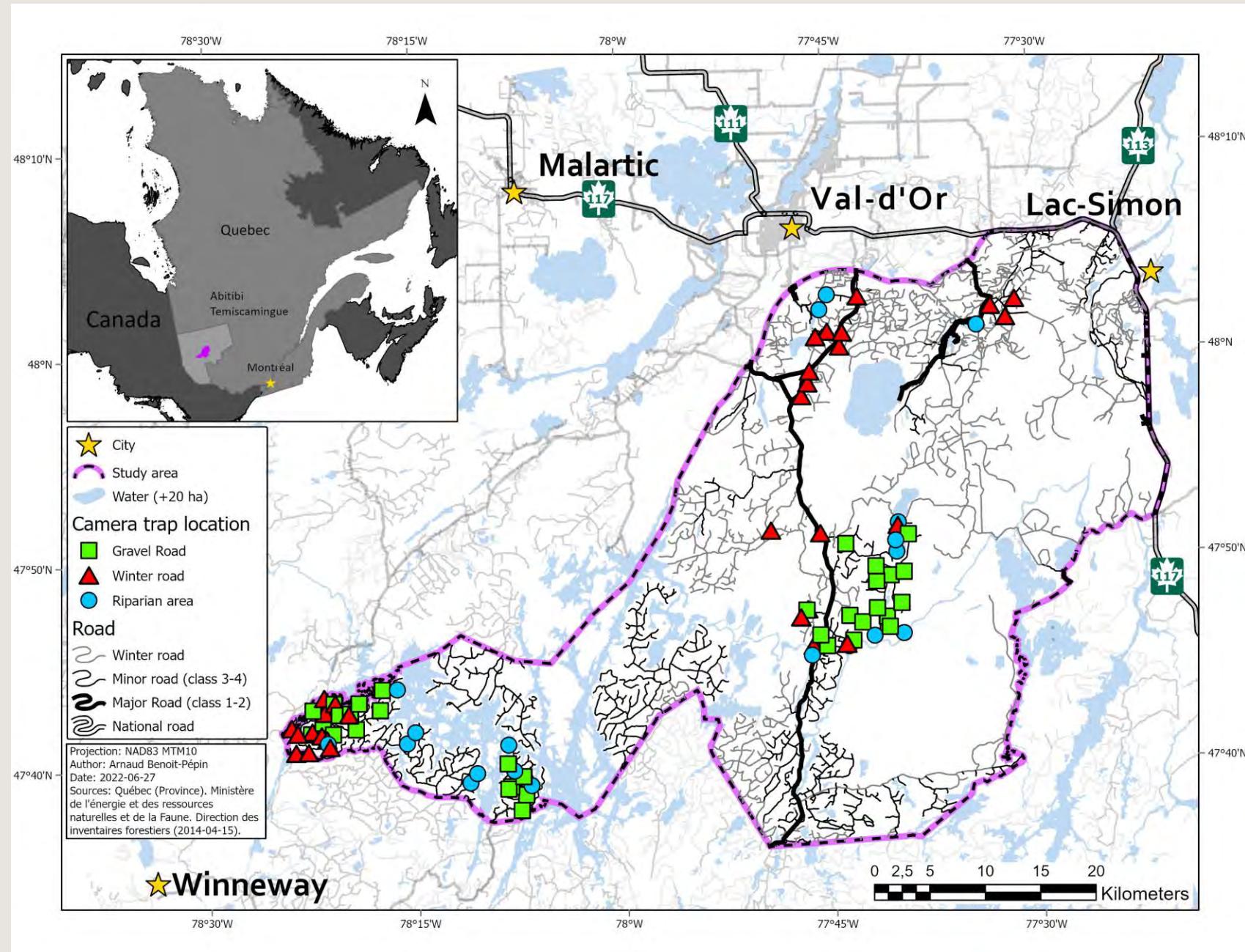
Milieux riverains



(+)

3. AIRE D'ÉTUDE

- Site faunique du caribou de Val-d'Or
- Superficie ~ 2100 km²
- Années 2020-2021
- Sélection de
 - 33 chemins gravelés
 - 28 chemins d'hiver
 - 19 milieux riverains
- 87 caméras de surveillance
 - Trophy Cam aggressor Brown
 - Trophy Cam HD Brown



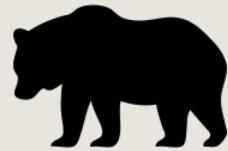
5. RÉSULTATS ET DISCUSSION

Année 2020-2021

13 495 jours d'échantillonnage



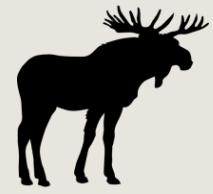
165
événements



393
événements



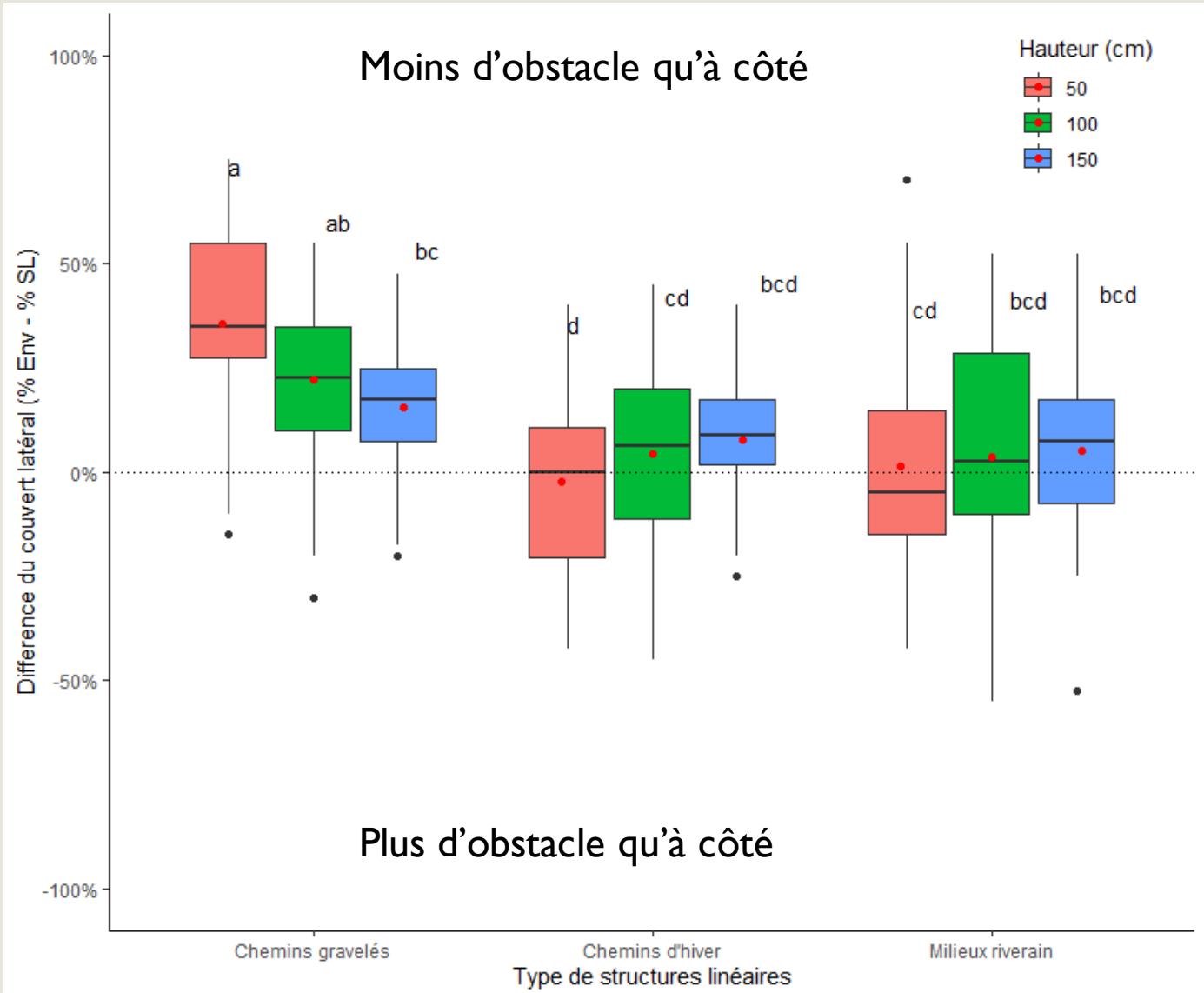
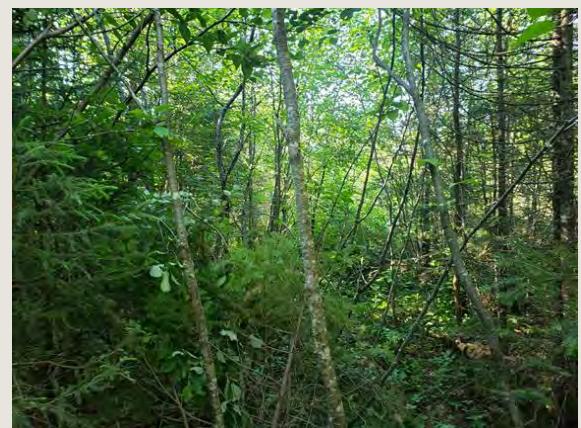
944
événements



501
événements

5. RÉSULTATS ET DISCUSSION

Comparaison de la différence du couvert latéral



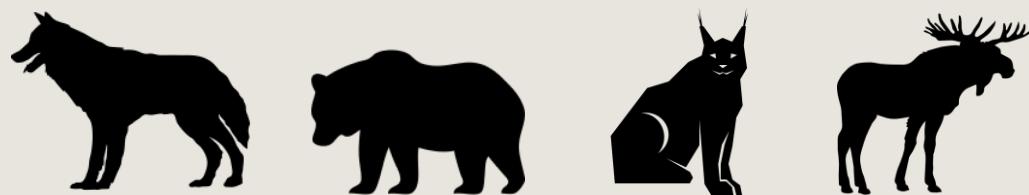
Laser rotatif Bosch
GRL900-20HVK



5. RÉSULTATS ET DISCUSSION

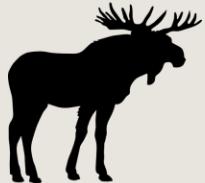
Différence du couvert latéral

Hypothèses



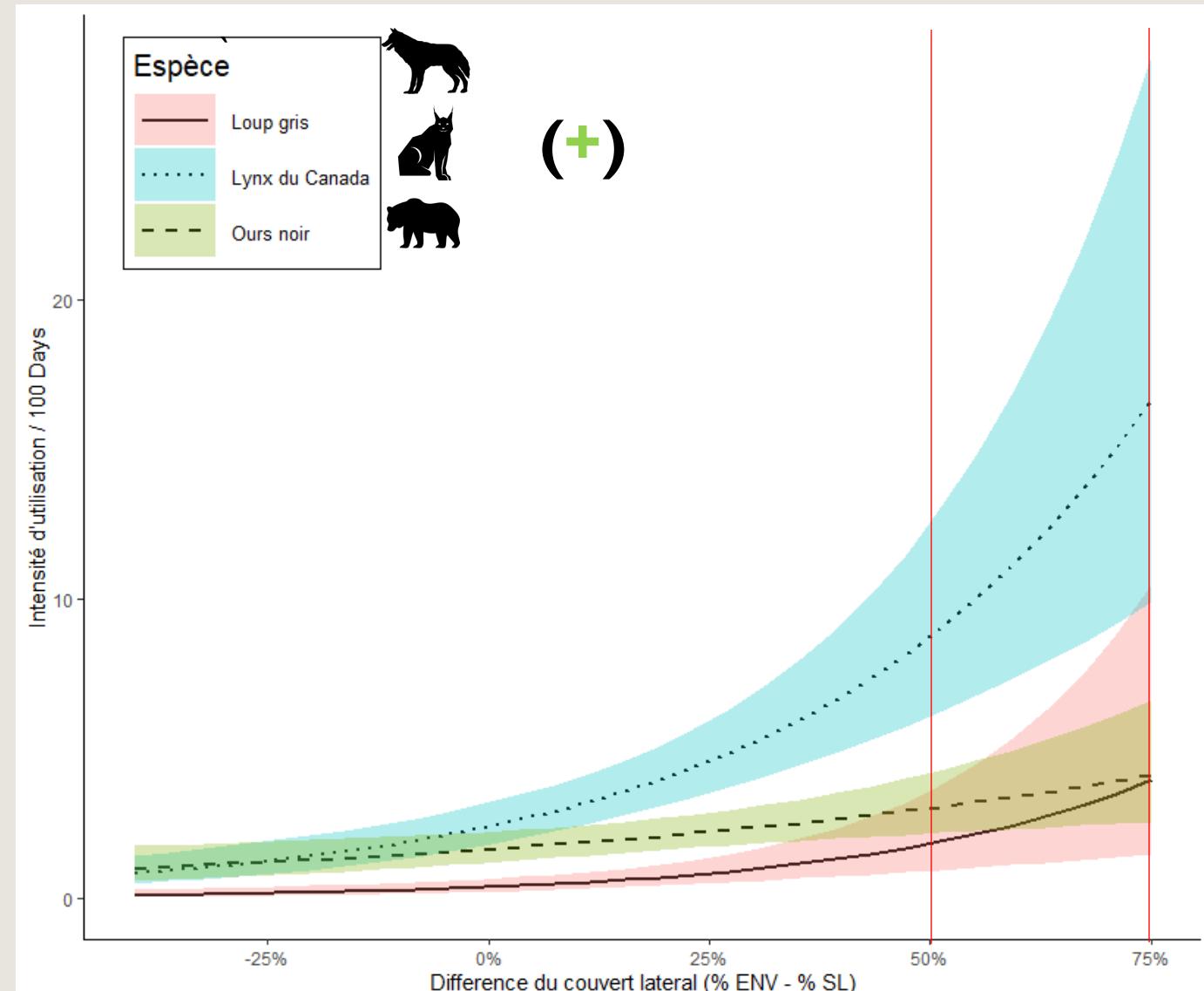
(+)

Résultats



(+/-)

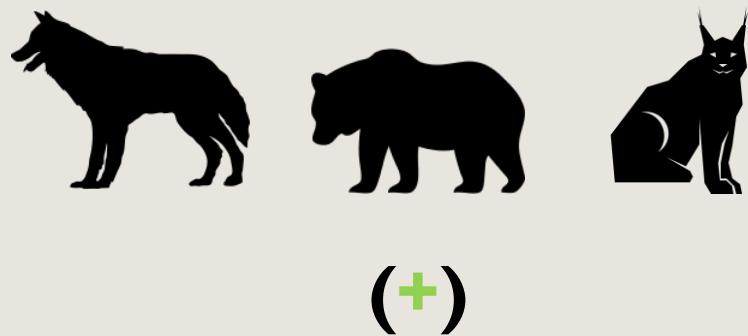
- La mesure qui répondait le mieux pour les prédateurs est à 50 cm.



5. RÉSULTATS ET DISCUSSION

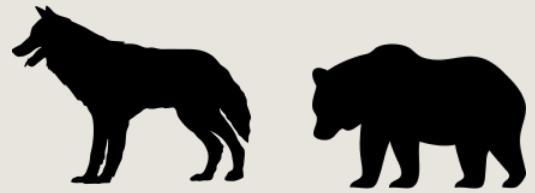
L'utilisation des proies associées

Hypothèses

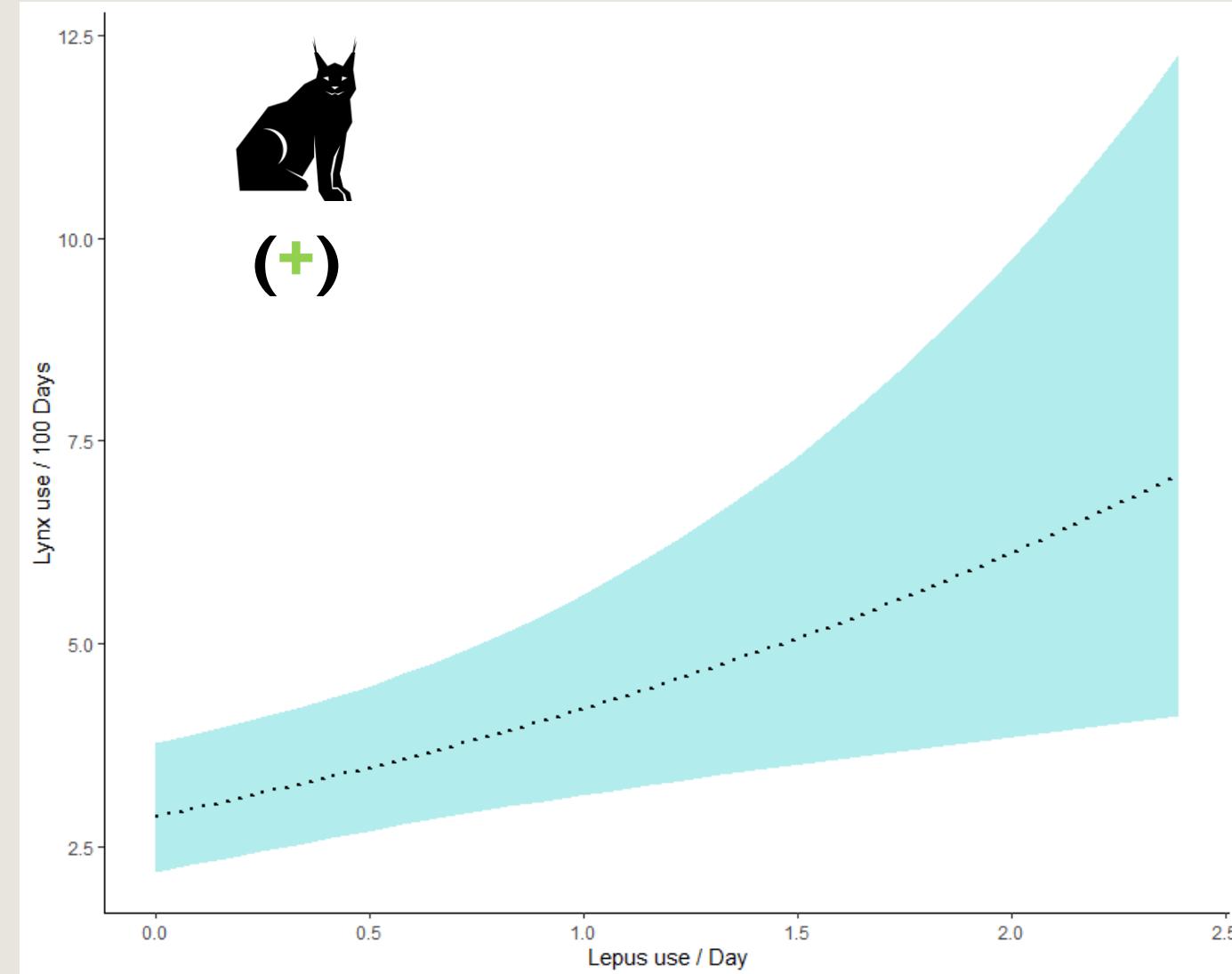


(+)

Résultats



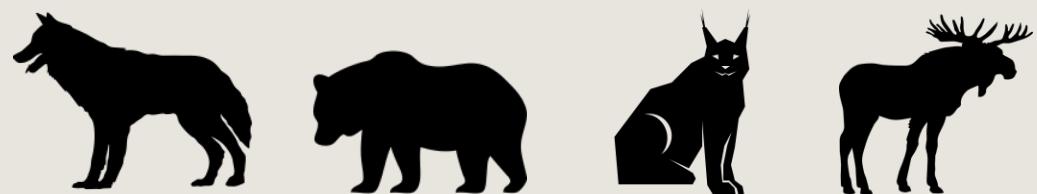
(+/-)



5. RÉSULTATS ET DISCUSSION

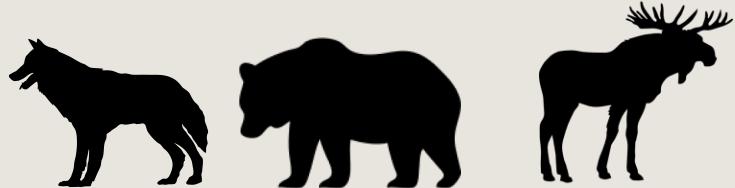
Proportion d'habitat favorable

Hypothèses

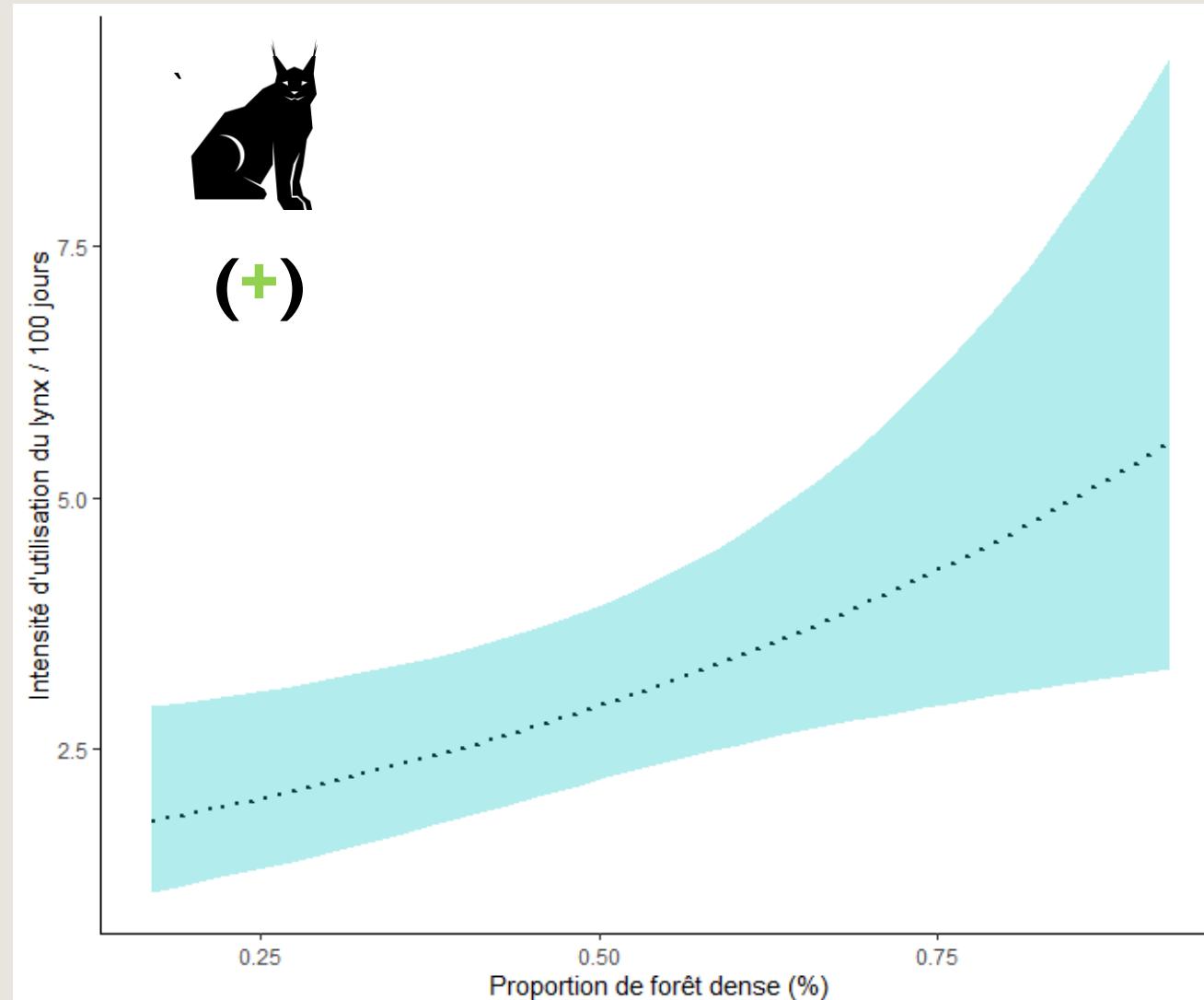


(+)

Résultats



(+/-)



5. RÉSULTATS ET DISCUSSION

Intensité d'utilisation selon le type de structures linéaires

Hypothèses

Chemins gravelés



(+++)

Chemins d'hiver



(+)

Milieux riverains



(+)

Résultats

Chemins gravelés



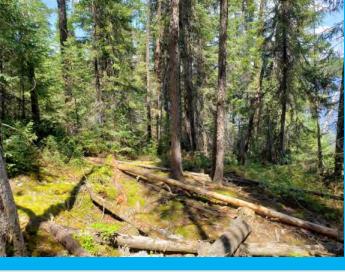
(+++)

Chemins d'hiver

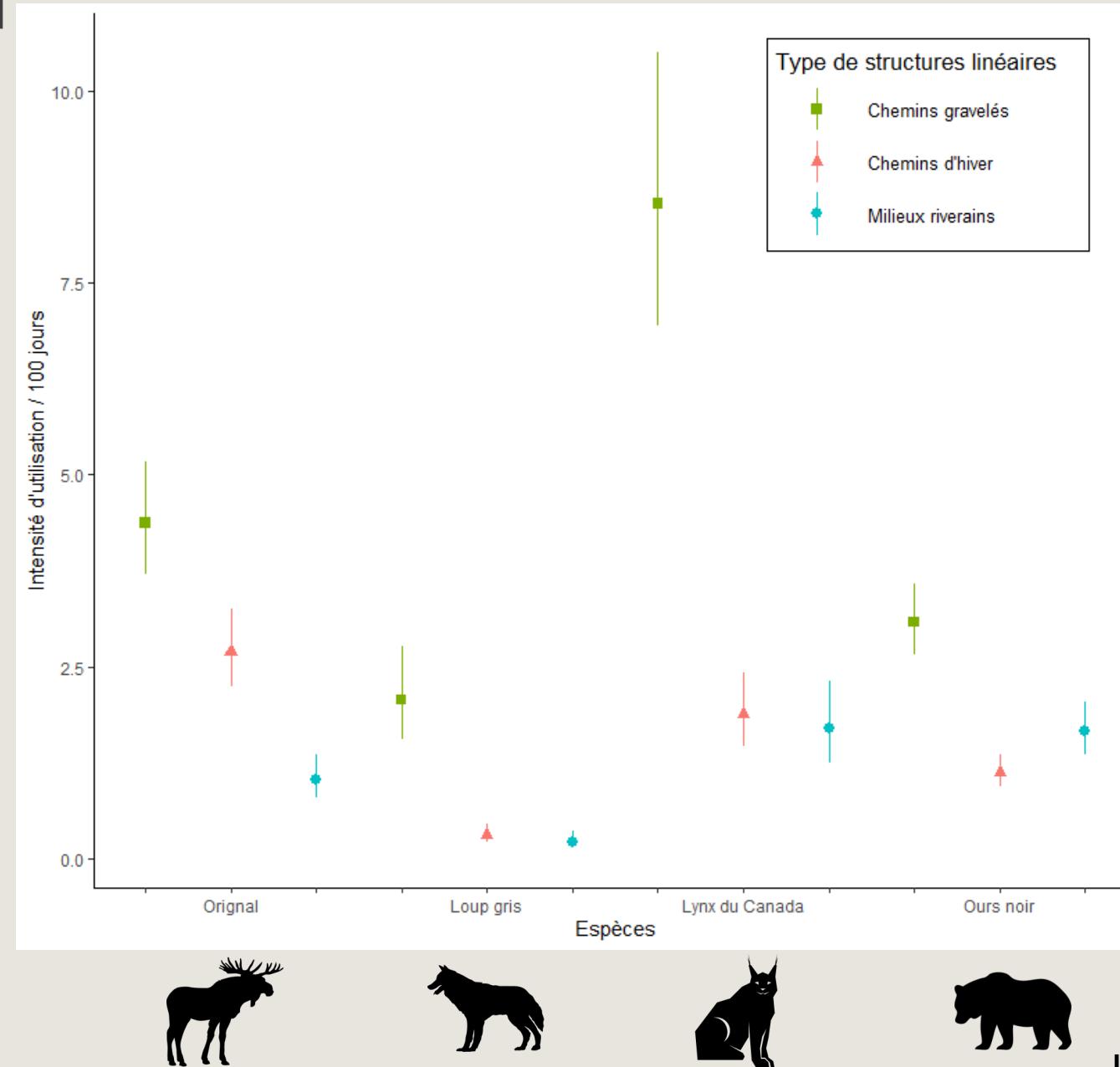


(+)

Milieux riverains



(+)



6. CONCLUSION

- Variables explicatives d'importance sont au niveau local
- Différence du couvert latéral entre le milieu environnant et la structure linéaire
- Les chemins gravelés qui favorisent la réponse fonctionnelle des prédateurs
- Prioriser le démantèlement des chemins gravelés
- Repenser la manière de construire les réseaux de chemins forestiers dans l'habitat du caribou



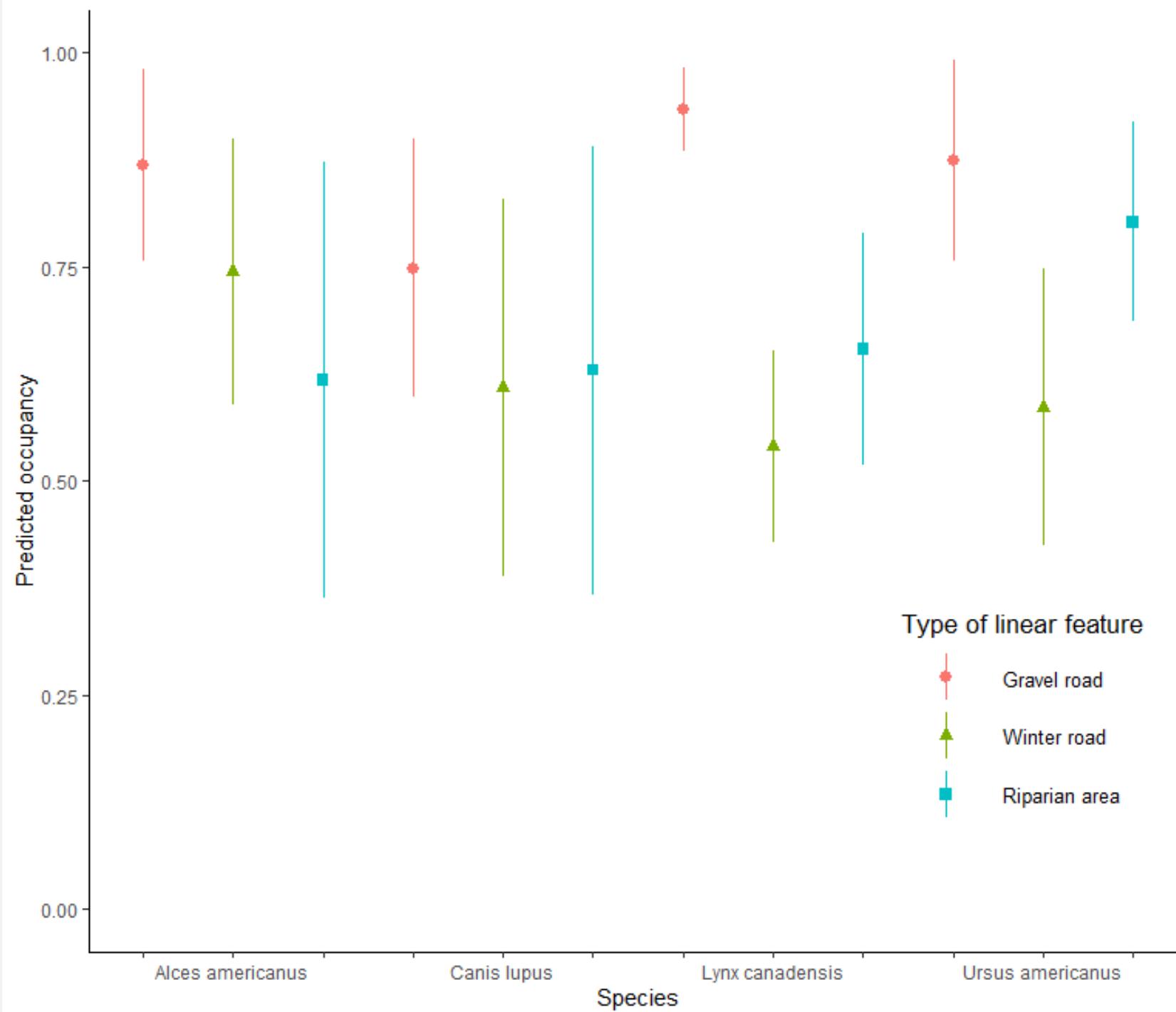


MERCI!
QUESTION?



NSERC
CRSNG





Collecte des variables de paysages

Proportion de forêt en
régénération (%)



250 m



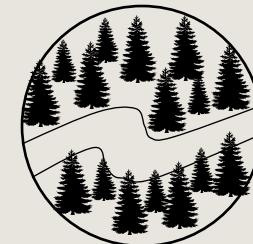
Proportion de forêt dense
(%)



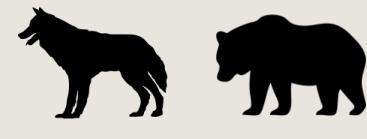
1000 m



Densité de chemins forestiers
(km/km²)



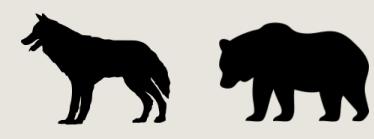
1000 m



Distance à un chemin supérieur
le plus près (km)



↓



Analyse statistique

Comparaison des caractéristiques des structures linéaires

- Type de structure linéaire analysée

32 chemins gravelés

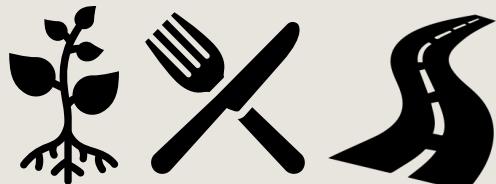
27 chemins d'hiver

19 milieux riverains

- ANOVA à deux facteurs pour



- ANOVA à un facteur pour



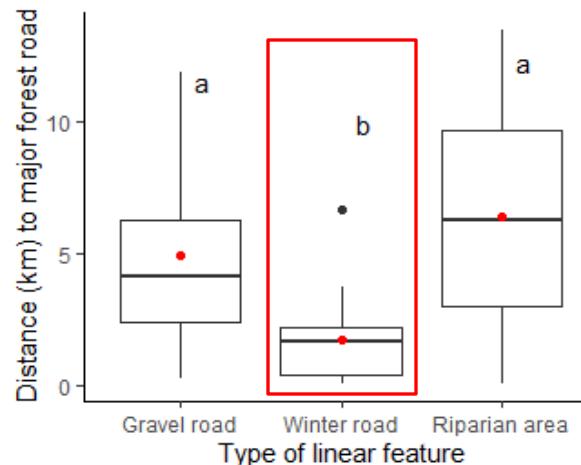
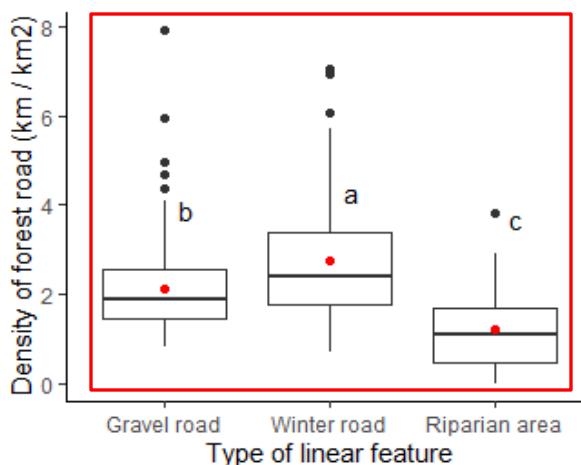
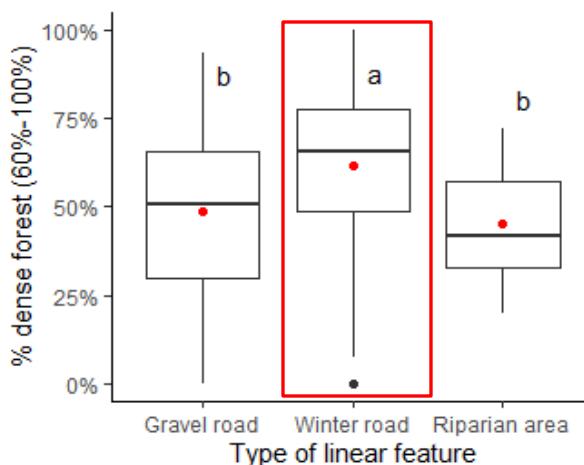
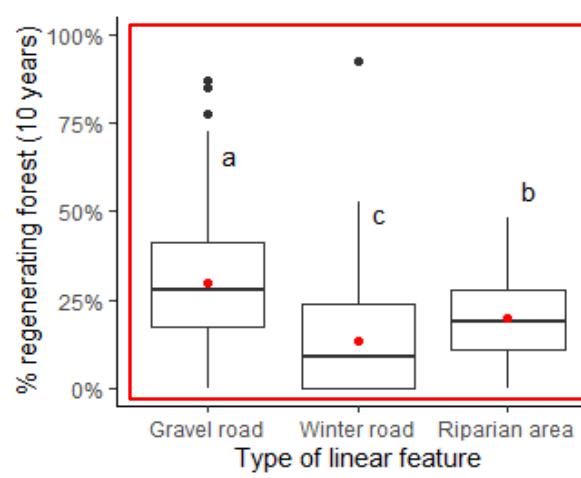
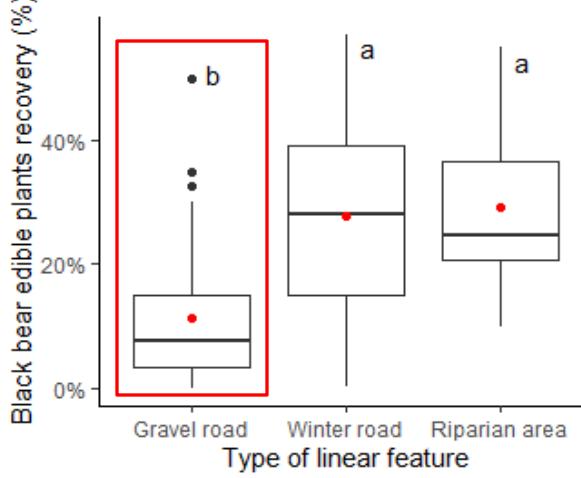
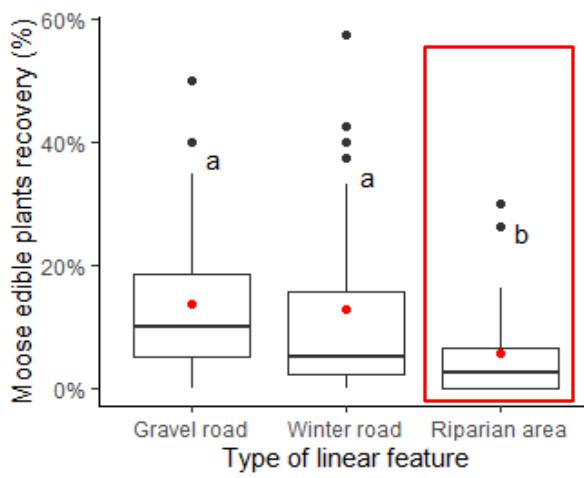
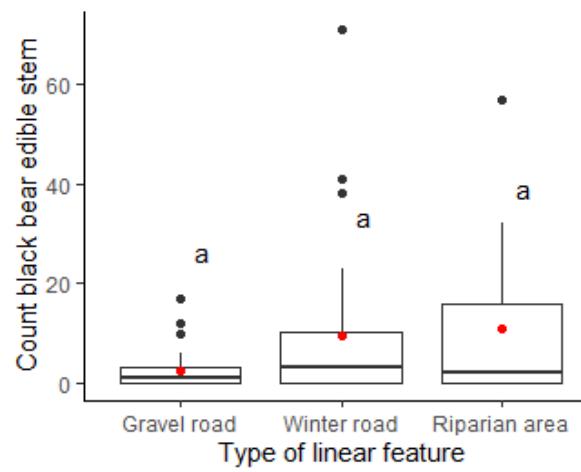
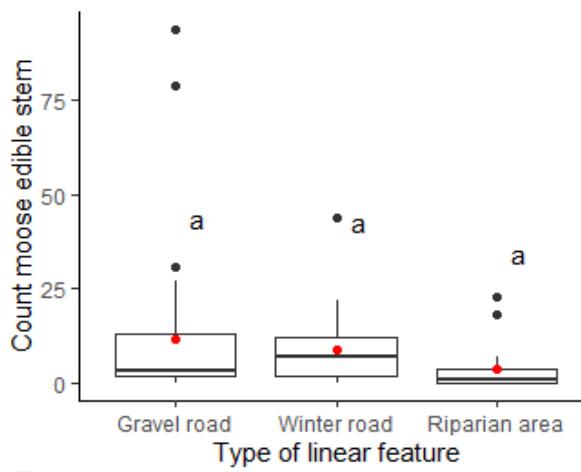
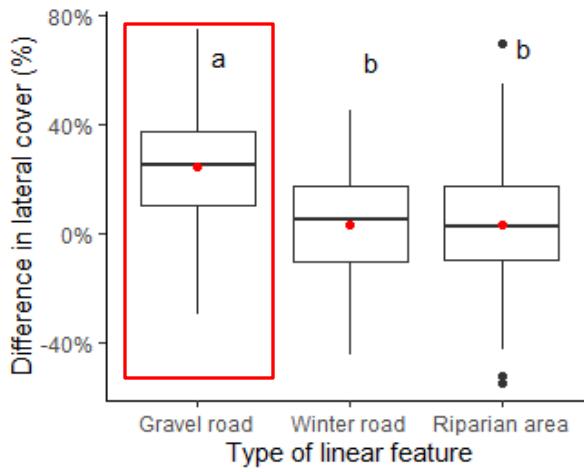
- Test de Tukey

4. MATÉRIEL ET MÉTHODES

Analyse statistique

Modèles d'intensité d'utilisation

- Période d'analyse de 2020-2021
 - 27-22 caméras sur chemins gravelés
 - 24-27 caméras sur chemins d'hiver
 - 16-17 caméras sur les milieux riverains.
- Analyse de voisinage (test de Moran)
- Modèle linéaire généralisé à effet mixte (`glmer()`) avec un offset de l'effort d'échantillonnage (nbr de jour / caméra).
- Effet fixe et aléatoire de l'identifiant de la structure linéaire selon l'année
- Régression Poisson comme distribution d'analyse.
- 2 groupes de modèles.
- Critère d'information d'Akaike
- Calcul par une inférence multimodèles en utilisant le package `AICcmodavg`.
- Estimation de l'effet des variables avec la fonction `Shrinkage()`
- Prédiction avec la fonction `modavgPred()` adaptée par Mazerolle (2020)



effect, (-) for a negative effect, (+/-) for varying effects and (NA) indicates that the covariate was not used in the occupancy model for that species.

Group	Description	Abbreviation	Species-specific effect	Hypothesis	
Local	Difference in lateral cover between the surrounding area and the linear feature (%)	LC	(+) Wolf (+) Lynx (+) Black bear (+) Moose	The variation of difference in lateral cover between the surrounding area and the linear feature could reflect the use of linear feature. Occupancy increases with increasing difference in lateral cover (Abrahms et al 2016).	
	Count of edible stem (\geq 1m)		(NA) Wolf (NA) Lynx (+) Black bear (+) Moose	Black bear tracks the availability of the most digestible plants (Mosnier et al 2008). Moose preferentially forages in high productivity scrubland-early successional forest (Crum N. J. and al 2016 ; Dussault et al. 2005; Bjorneraa et al. 2011, 2012; van Beest et al. 2012).	
	Edible plants (\leq 1m) recovery on the linear feature (%)		(NA) Wolf (NA) Lynx (+) Black bear (+) Moose	Black bear tracks the availability of the most digestible plants (Mosnier et al 2008). Moose preferentially forages in high productivity scrubland-early successional forest (Crum N. J. and al 2016 ; Dussault et al. 2005; Bjomeraas et al. 2011, 2012; van Beest et al. 2012).	
Species interaction	Intensity of human use (count/sampling effort)	Homo	(-) Wolf (-) Lynx (-) Black bear (-) Moose	For all species, local human activity can cause avoidance of road and surrounding areas (V. Oberosler et al 2017).	
	Intensity of prey use (count/sampling effort)		(+) Wolf (+) Lynx (NA) Black bear (NA) Moose	Predators such as wolf and lynx are positively related to prey density (Fuller, 1989 ; Fuller et al. 2003 ; King T. W. 2020).	
	Proportion of dense stand (50%-100% cover) in 1000 m radius		(NA) Wolf (+) Lynx (NA) Black bear (NA) Moose	Dense to closed canopy coniferous, mixed and deciduous are important components of lynx habitat in northern boreal forest (poole K.G and al 1996).	
Landscape feature	Proportion of regeneration stand (10 years) in 250 m radius	RS	(+) Wolf (NA) Lynx (+) Black bear (+) Moose	Wolf selects regenerating stands based on its prey habitat preference (i.e. moose) (houle and al 2009). Black bear and moose select regenerating stand for forage opportunities (Brodeur et al 2008 : Mosnier et al 2008).	
	Density of small forest road (all class) in 250m radius for Alces and 1000m radius for Canis, Ursus and Lynx		(+/-) Wolf (+/-) Lynx	Density of anthropogenic linear feature can negatively affect lynx and wolf occupancy (Marrote R. R and al, 2020 ; Mech et al. 1988, Mladenoff et al. 1995, Jedrzejewski et al. 2008) or positively improve movement and hunting (Fisher J. 2018 ; Dickie 2020 ; Thurber et al. 1994, Paquet et al. 1996, Whittington et al. 2008).	
			(-/-) Black bear (-) Moose	Bears are attracted towards roads to facilitate movement (Dickie 2019) or perceived this type of landscape as a risk due to high level of human disturbance (Gould et al 2019; Hostetler and al 2009). Moose tends to avoid road networks (Laurian et al. 2008, Jiang et al. 2009, Grosman et al. 2011, Beyer et al. 2013 ; Thomas. J 2018).	
Distance (km) to a major forest road	NR		(+/-) Wolf	Distance to a major road have a positive spatial effect favor movement (McKenzie et al., 2012 ; St-Laurent et Gosselin (2020)) However, in regions with high level of human activity, wolves tend to avoid anthropogenic disturbance (Lesmerises F. and al 2012) .	
			(-) Lynx	Major road may negatively affect lynx due to habitat loss, fragmentation and mortality risk (Walpole A and al 2012 ; Bayne E. and al 2008).	
			(+) Black bear	Black bear have a high tolerance of human activity, especially since roads are often correlated with high quality food (Ladle A. and al 2018).	
			(-) Moose	Disturbed areas can be attractive to moose because it represents a refuge habitat for his predator (Rempel et al. 1997 ; Muhly 2019)	

Table 3. Multimodel inference explaining the intensity of use according to the linear feature (gravel road, winter road and the raparian area) characteristics by Gray wolf, Black bear, Canada lynx and Moose in Val-d'Or caribou wildlife site, western of Québec, Canada in 2020 and 2021. Estimates of the fix effect explanatory variables on the intensity of use (λ) are presented with their 95% confidence intervals. All candidate models were used for multimodel inference.

Parameters ¹	Estimate	SE	Lower limit	Upper limit	Parameters ¹	Estimate	SE	Lower limit	Upper limit
Canis lupus					Lynx canadensis				
LC_50cm	0.78	0.18	0.42	1.14	LC_50cm	0.75	0.1	0.54	0.96
NR	0.42	0.18	0.06	0.78	NR	-0.17	0.14	-0.45	0.11
DR_1000m	0.23	0.19	-0.14	0.6	DR_1000m	-0.25	0.11	-0.47	-0.03
RS_250m	-0.08	0.17	-0.42	0.25	DS_1000m	0.17	0.13	-0.09	0.42
Homo.I	0.33	0.14	0.05	0.6	Homo.I	0.09	0.09	-0.09	0.26
Alces.I	0.42	0.15	0.12	0.73	Lepus.I	0.22	0.09	0.03	0.4
Castor.I	0.31	0.13	0.06	0.57					
Ursus americanus					Alces americanus				
LC_50cm	0.27	0.1	0.08	0.46	LC_150cm	0.29	0.13	0.03	0.54
NR ²	0.18	0.11	0.01	0.36	NR	-0.02	0.09	-0.2	0.15
DR_1000m	-0.05	0.09	-0.22	0.12	DR_250m	0.07	0.11	-0.13	0.28
RS_250m	0.03	0.08	-0.12	0.18	RS_250m	0.14	0.13	-0.12	0.4
Homo.I	-0.1	0.09	-0.28	0.09	Homo	-0.12	0.13	-0.38	0.14
Alces.I	0.07	0.08	-0.08	0.23	EPR	0.08	0.1	-0.11	0.28
EPR	-0.08	0.08	-0.24	0.08	ES	0	0	-0.01	0.01
ES	-0.01	0.01	-0.03	0.01					

1 : LC = Difference in lateral cover between the surrounding area and the linear

NR = Near distance (km) to a major forest road (classe 1 and 2)

DR = Density (km) of small forest road (classe 3, 4 and winter road)

RS = Proportion of regeneration stand (0-20 years)

DS = Proportion of dense forest (class A-B)

2 : Confidence level = 90%

Homo.I = Homo sapiens count / Day

Alces.I = Alces americanus count / Day

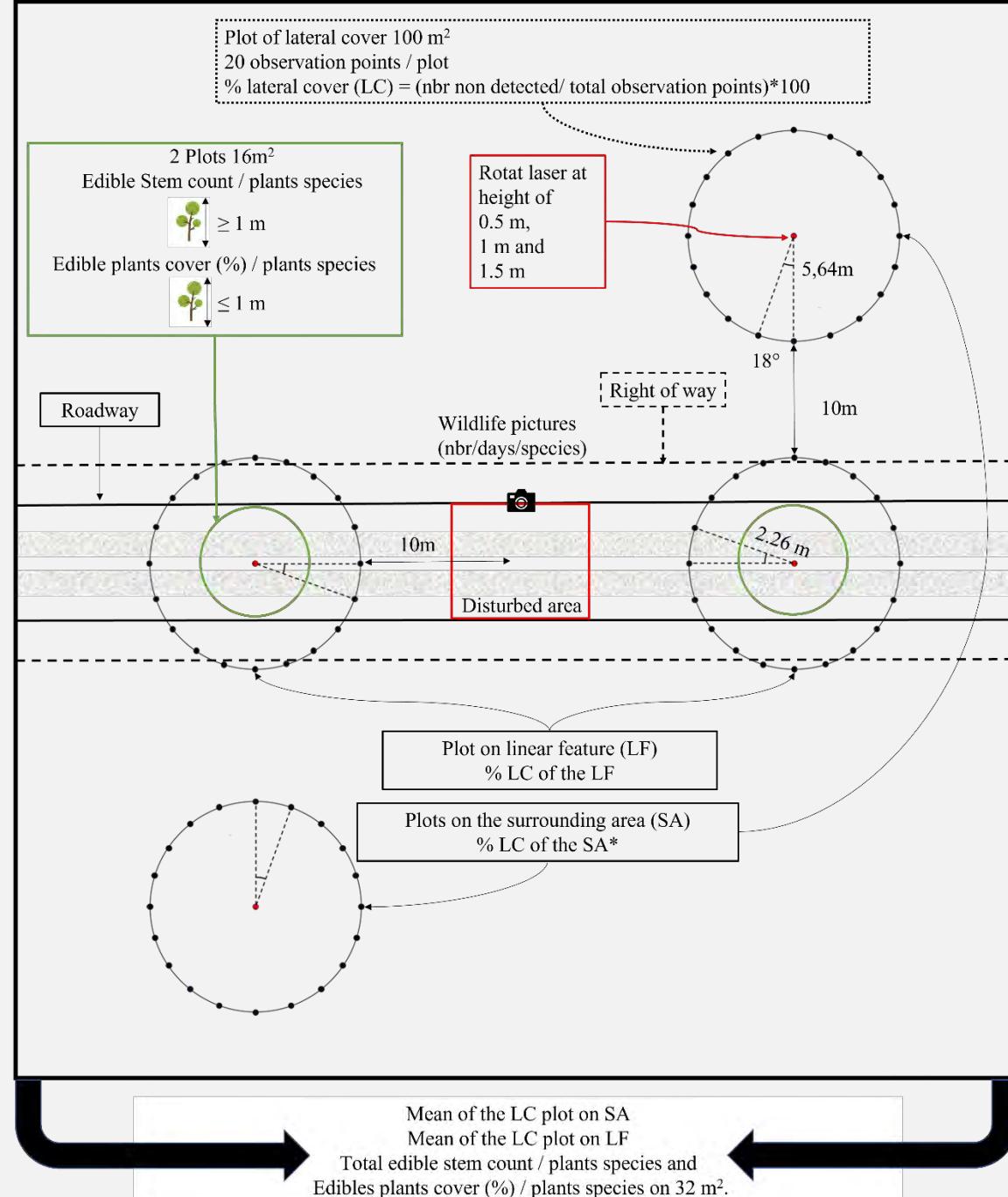
Lepus.I = Lepus americanus count / Day

EPR = Edible plants (< 1m) recovery

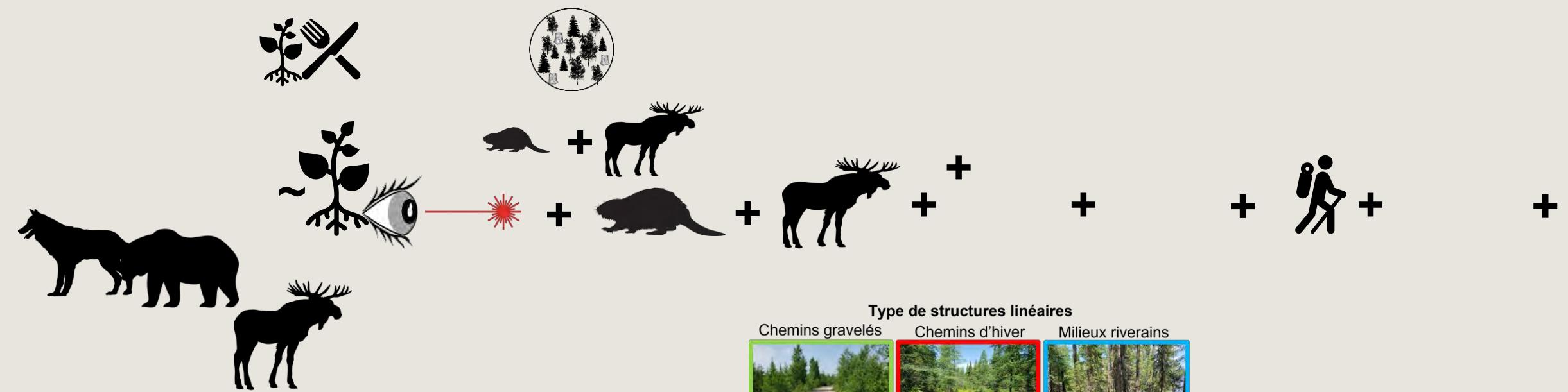
ET = Count of edible stem (> 1m)

Table 3. Multimodel inference explaining the intensity of use according to the linear feature (gravel road, winter road and the raparian area) by Gray wolf, Black bear, Canada lynx and Moose in Val-d'Or caribou wildlife site, western of Québec, Canada in 2020 and 2021. Estimates of the fix effect explanatory variables on the intensity of use (λ) are presented with their 95% confidence intervals. All candidate models were used for multimodel inference.

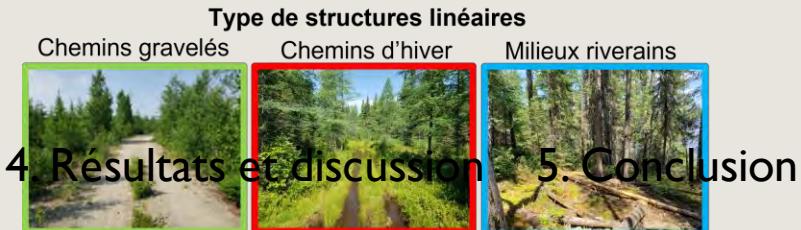
Parameters ¹	Estimate	SE	Lower limit	Upper limit	Parameters ¹	Estimate	SE	Lower limit	Upper limit
Canis lupus									
Type_LF_R	-5.78	0.43	-6.63	-4.94	Lynx canadensis				
Type_LF_W	0.25	0.46	-0.65	1.16	Type_LF_R	-4.23	0.28	-4.78	-3.68
Type_LF_G	2.05	0.44	1.19	2.92	Type_LF_W	0.2	0.31	-0.4	0.81
Year	-0.12	0.32	-0.75	0.51	Type_LF_G	1.72	0.3	1.13	2.3
					Year	0.15	0.23	-0.29	0.6
Ursus americanus									
Type_LF_R	-4.07	0.19	-4.43	-3.7	Alces americanus				
Type_LF_W	-0.38	0.21	-0.79	0.03	Type_LF_R	-4.56	0.24	-5.03	-4.09
Type_LF_G	0.58	0.19	0.2	0.96	Type_LF_W	0.86	0.25	0.37	1.36
Year	0.36	0.16	0.05	0.67	Type_LF_G	1.42	0.25	0.93	1.91
					Year+B5:F24	0.07	0.18	-0.28	0.41



*For the rapieren area, we put, on the surrounding area, the LC plots on the same side at the opposite of the water body.



I. Introduction 2. Hypothèse 3. Méthode



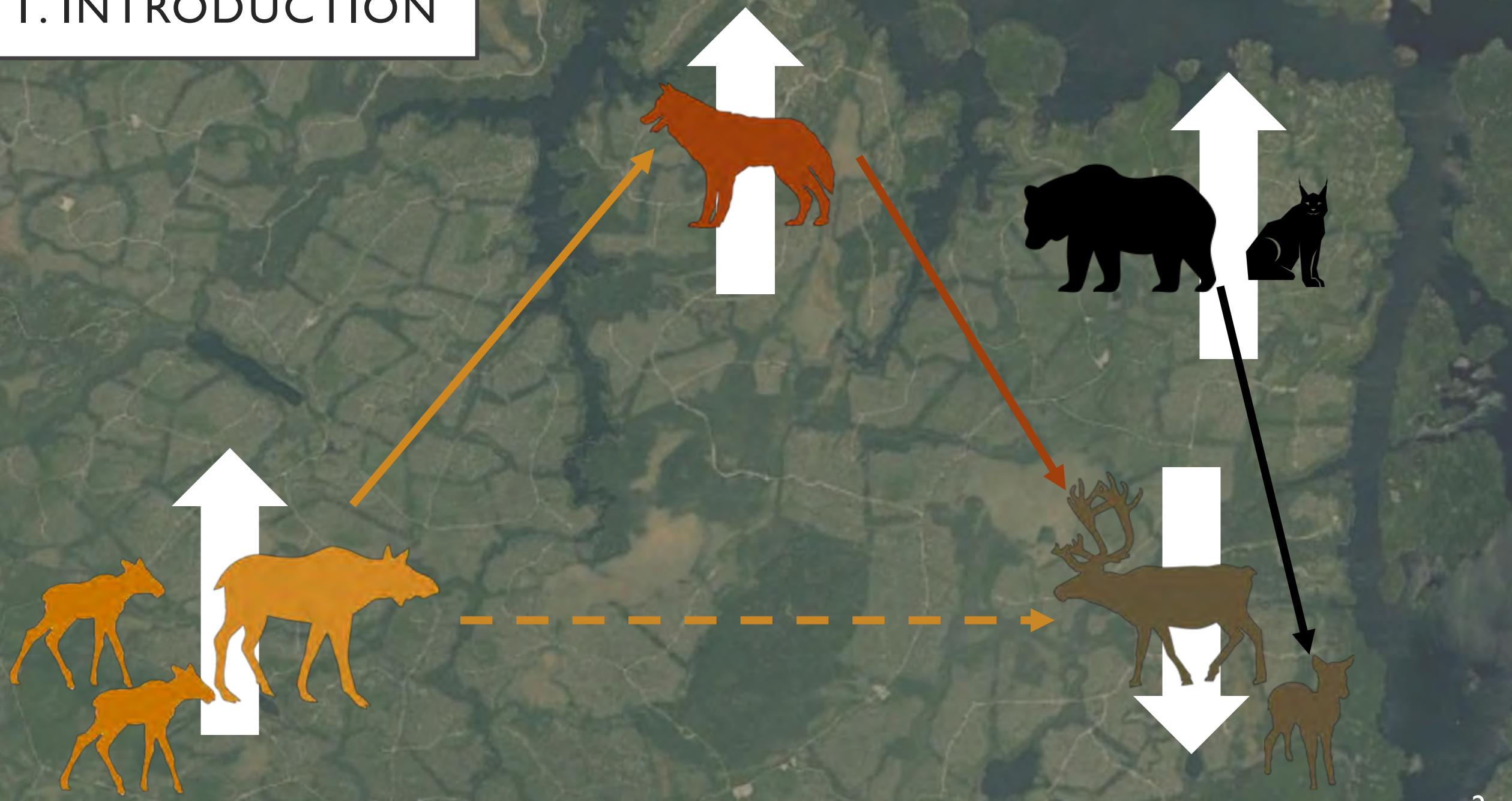
I. INTRODUCTION

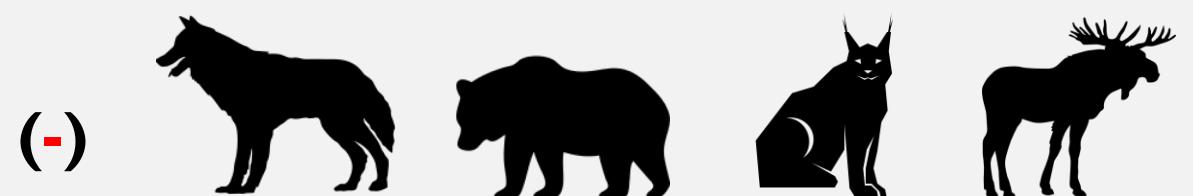
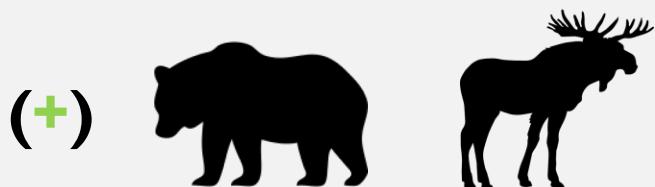
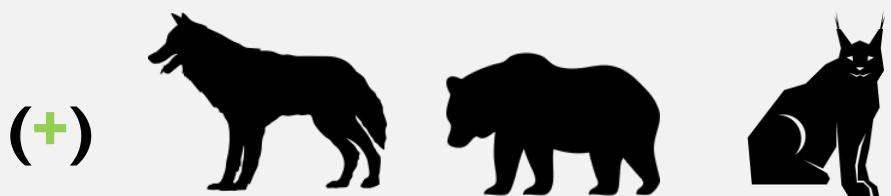
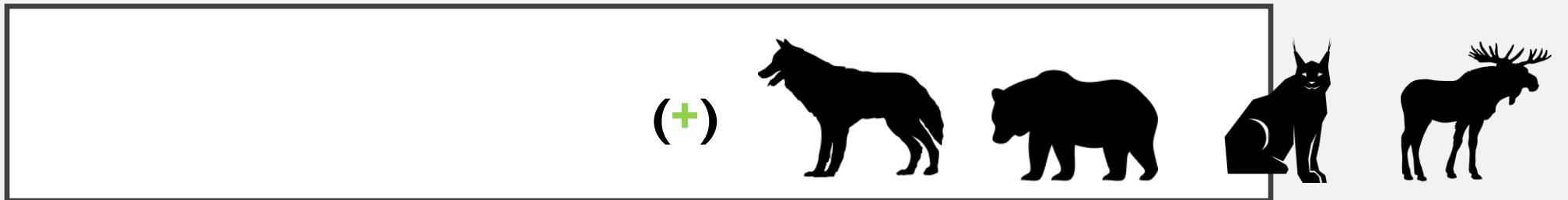


Problématiques des structures linéaires anthropiques



I. INTRODUCTION





2. HYPOTHÈSES

Variables paysage

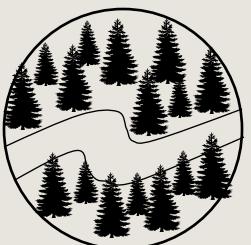
Proportion de forêt en régénération (%)



Proportion de forêt dense (%)



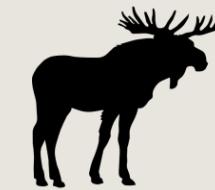
Densité de chemins forestiers (km/km²)



Distance à un chemin majeur (km)



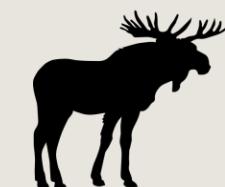
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