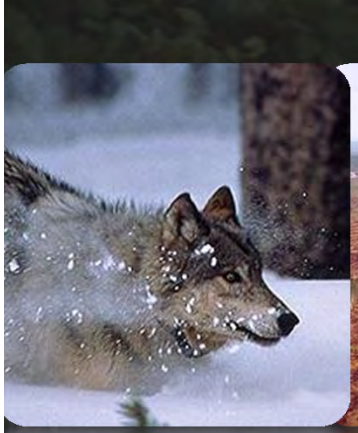
RÉPONSES COMPORTEMENTALES ET DÉMOGRAPHIQUES DU CARIBOU ET DE SES PRÉDATEURS À L'AMÉNAGEMENT FORESTIER :

SURVOL DE MON PROGRAMME DE RECHERCHE





Martin-Hugues St-Laurent

Professeur titulaire en écologie animale

Université du Québec à Rimouski

…et plusieurs collègues !

UQAR

CENTRE D'ÉTUDES NORDIQUES

CEN Centre for Northern Studies

Équipe de rétablissement du caribou forestier

BORÉAS

GROUPE DE RECHERCHE SUR LES ENVIRONNEMENTS NORDIQUES

cfr

Centre for Forest Research

COSEWIC

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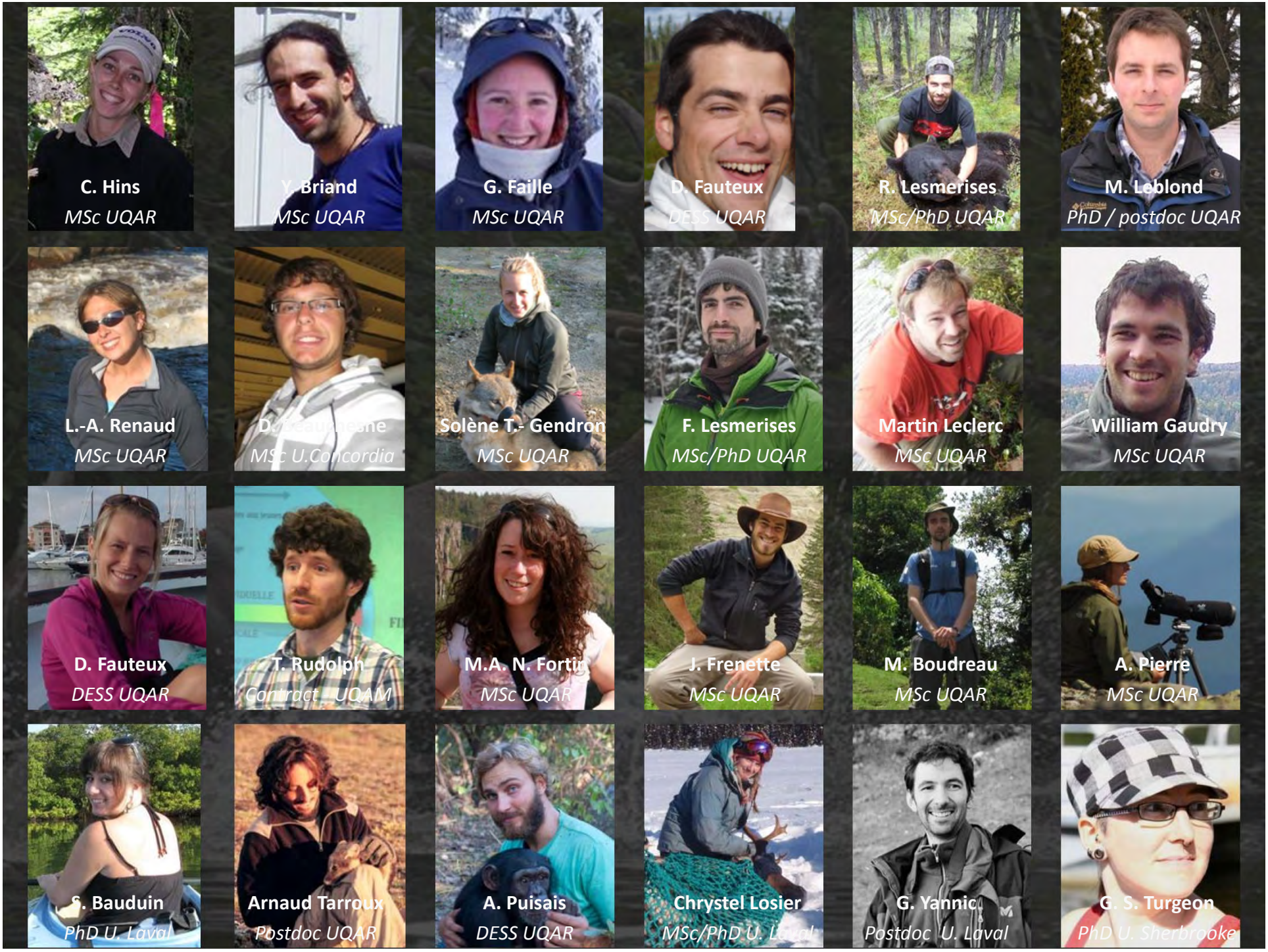
UQAR Développement durable, Environnement, Faune et Parcs Québec | Université Laval | UQÀM | UQAT Université du Québec en Abitibi-Témiscamingue | Concordia University | Université de Sherbrooke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Presentation outline

1. **Contextual framework**
2. **Objectives**
3. **Methods & results**
   - *Behaviour*
   - *Demography*
   - *Predator-prey relationships*
   - *Distribution*
4. **Conclusion**

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Laboratoire de gestion de la faune terrestre


Context and contextual framework

Rangifer populations are declining throughout their distribution range

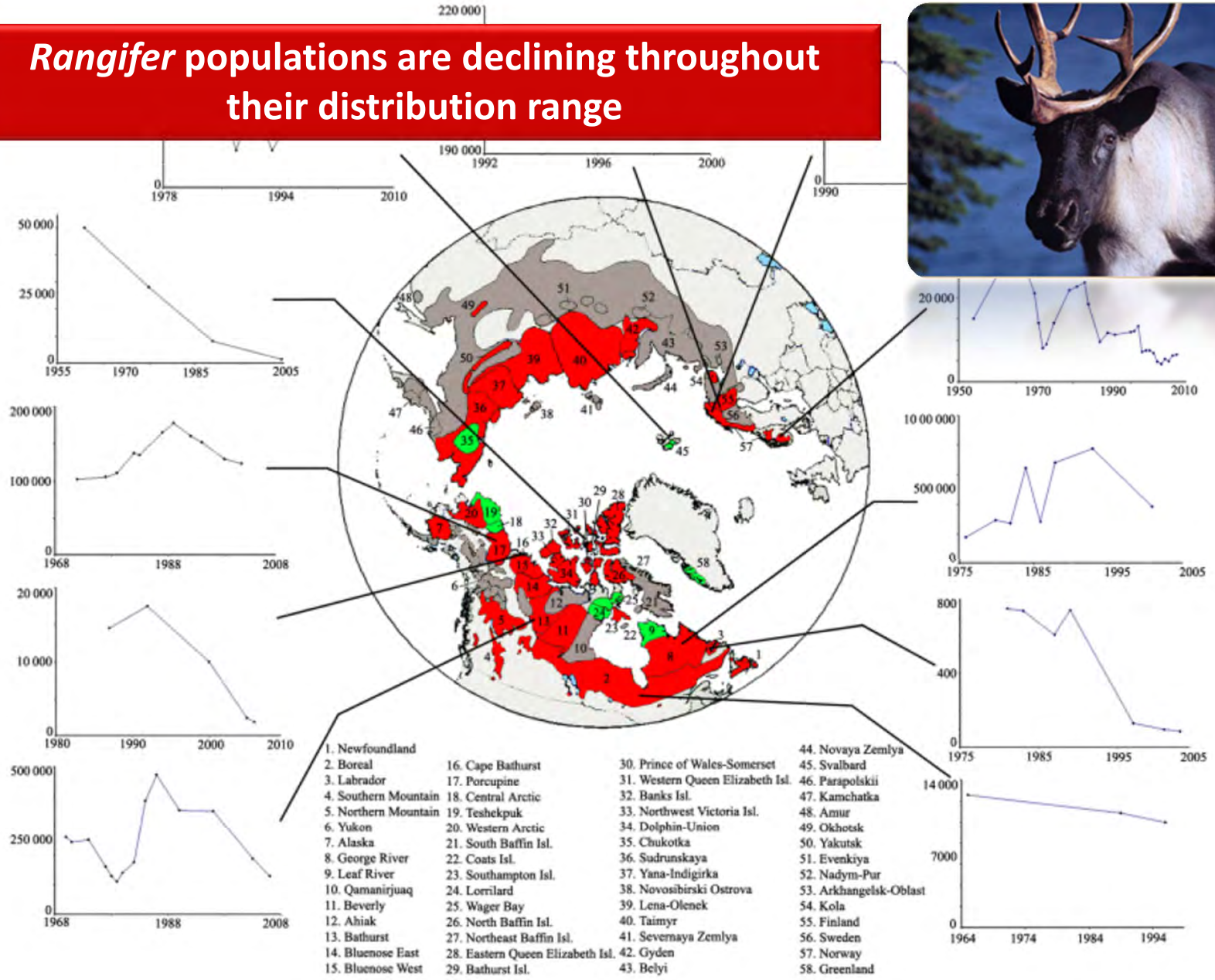


Fig. 2 Population trajectories of 58 major caribou and reindeer herds worldwide. Herd ranges depicted in red are in population decline and ranges depicted in green are experiencing population growth. Population data are unavailable for herd ranges illustrated in grey. Time series of population estimates for 11 caribou and reindeer populations are included to illustrate historical fluctuations in population size. The *x*-axis represents year of population estimate and the y-axis represents estimate of population size.

Vors & Boyce 2009, Global Change Biology 15: 2626-2633

COSEWIC (2011) Designatable Units for Caribou in Canada

Caribou Designatable Units

- Peary [DU1]
- Dolphin & Union [DU2]
- Barrenground [DU3]
- Eastern Migratory [DU4]
- Newfoundland [DU5]
- Boreal [DU6]
- Northern Mountain [DU7]
- Central Mountain [DU8]
- Southern Mountain [DU9]
- Torngat Mountain [DU10]
- Atlantic-Gaspésie [DU11]
- Dawson's [DU12]
- Historical Distribution

1 2 3 4 5 6 7 8 9 10 11 12

0 500 1,000 1,500 Kilometres

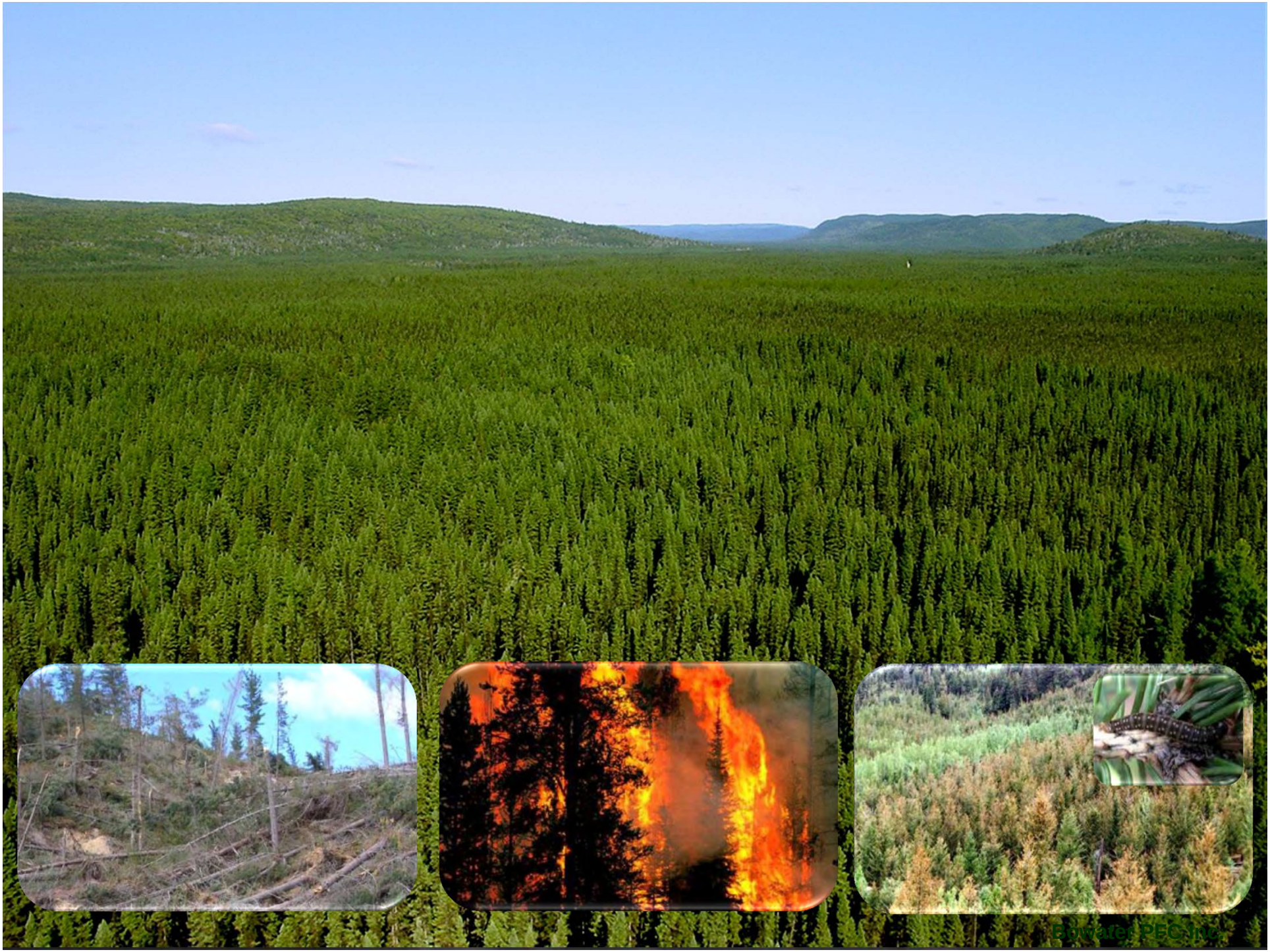
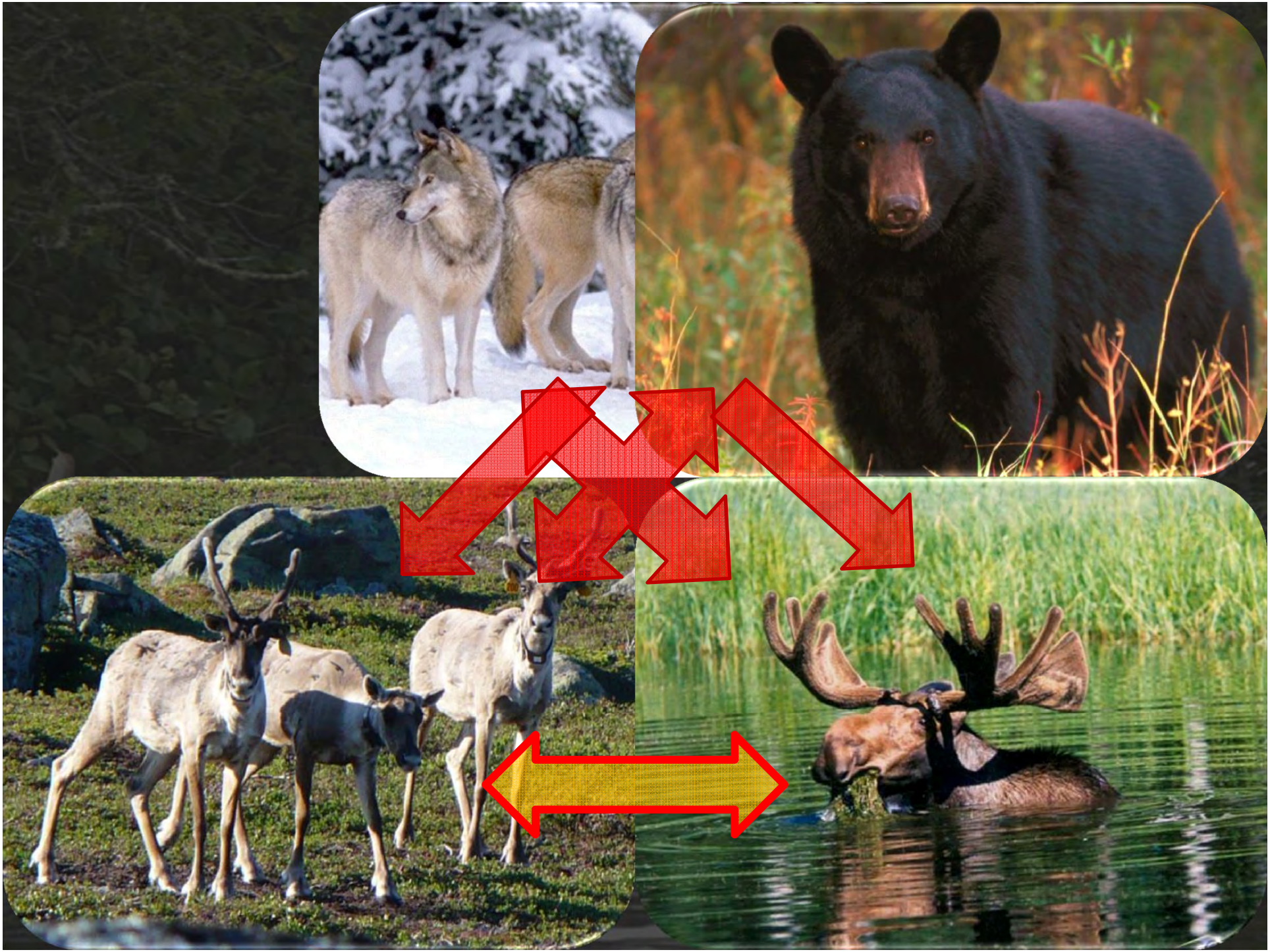

Bowater PFC Inc.


Image Landsat – Google Earth Sept. 2013

Apparent competition hypothesis between moose and caribou

A numerical response of wolf is expected after an increase in moose density, resulting in a higher predation pressure on caribou



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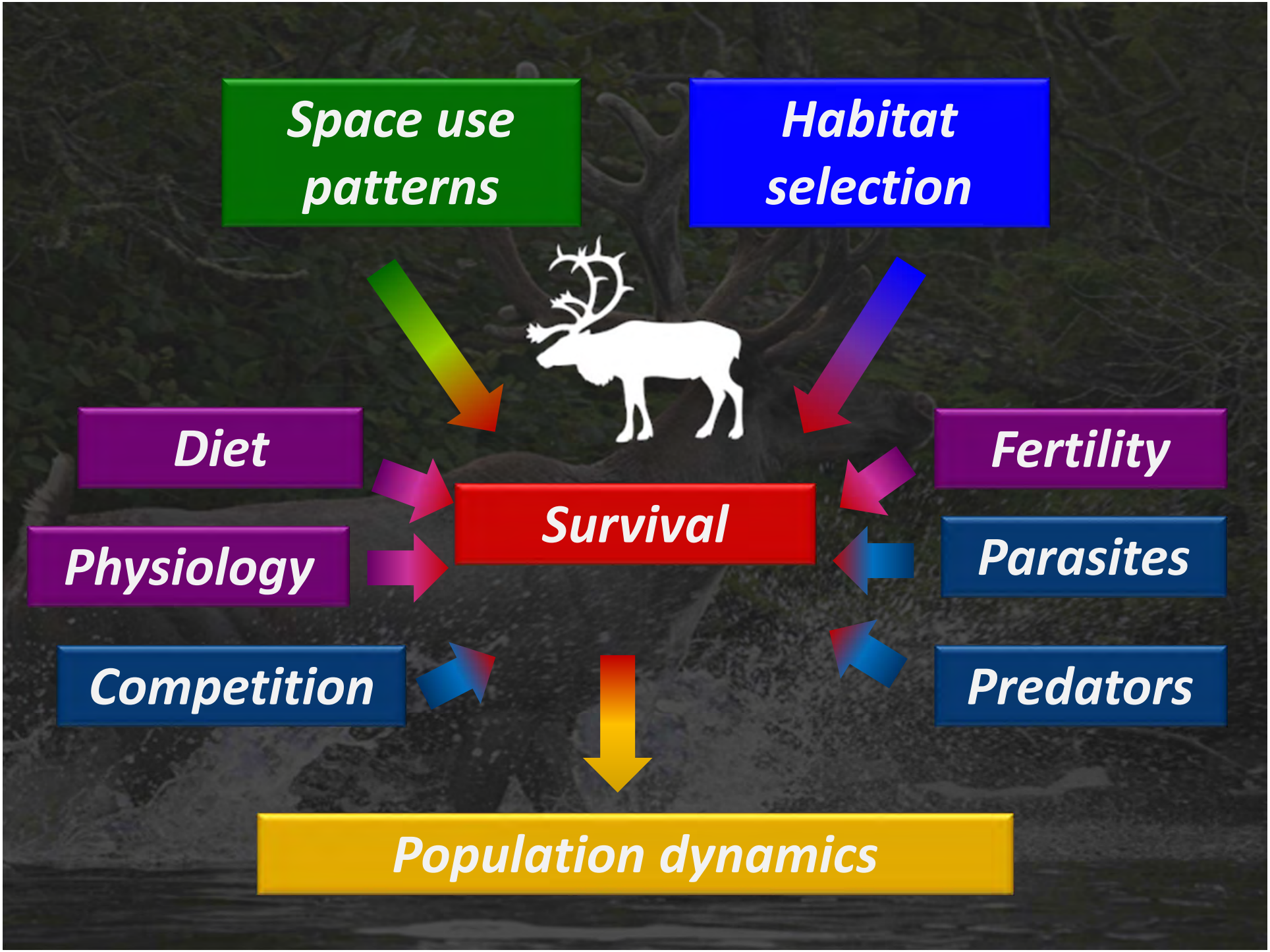
Objective of my research program

Assess and disentangle the cumulative impacts of anthropogenic disturbances on multiple facets of the ecology of large mammals


Space use patterns
Habitat selection
Diet
Fertility
Survival
Physiology
Parasites
Competition
Predators
Population dynamics

Explaining species' responses to disturbances…

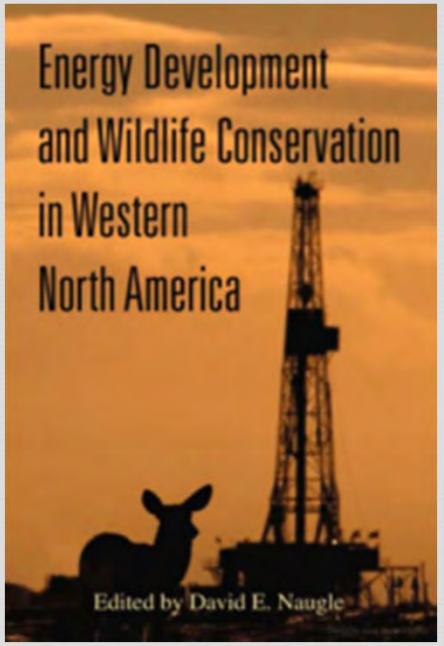
Chapter 3

Unifying Framework for Understanding Impacts of Human Developments on Wildlife

Chris J. Johnson and Martin-Hugues St-Laurent

Behavior --> Physiology --> Energetic/Nutrition --> Vital Rate --> Population --> Community

Biological Scale of Impact



Relative Magnitude of Effect

Single Obtuse ⟶ Single Acute ⟶ Cross-Sectoral Cumulative

Spatio-temporal Scale of Effect

Small Area – Short Duration ⟶ Large Area – Long Duration

Regulation of Effect

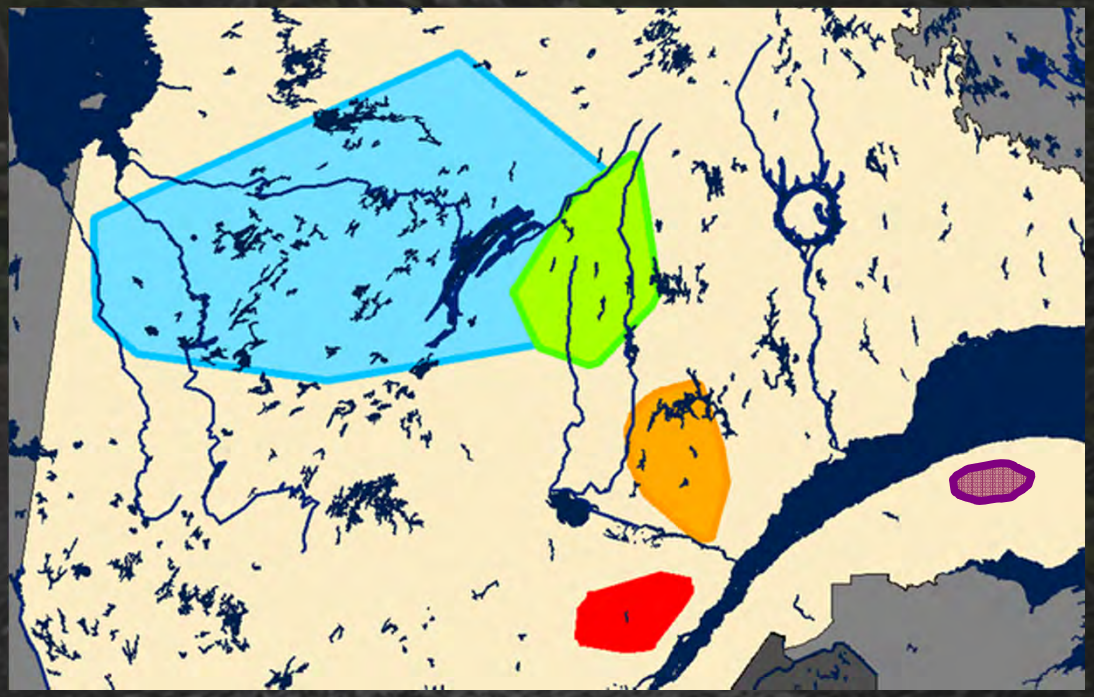
Effective Regulation ⟶ Certification/Best Practices ⟶ No Restrictions

Methods

Philippe Henry

Study areas

- ✓ **Telemetry surveys in 5 different study sites**
  - *Jamésie*
  - *Lac-Saint-Jean*
  - *Saguenay*
  - *Charlevoix*
  - *Gaspésie*



- ✓ **Study areas**
  - *Objectives*
  - *Disturbance types and disturbance levels*
  - *Predators and alternative prey*

Highly disturbed study areas

According to Environment Canada's methodology

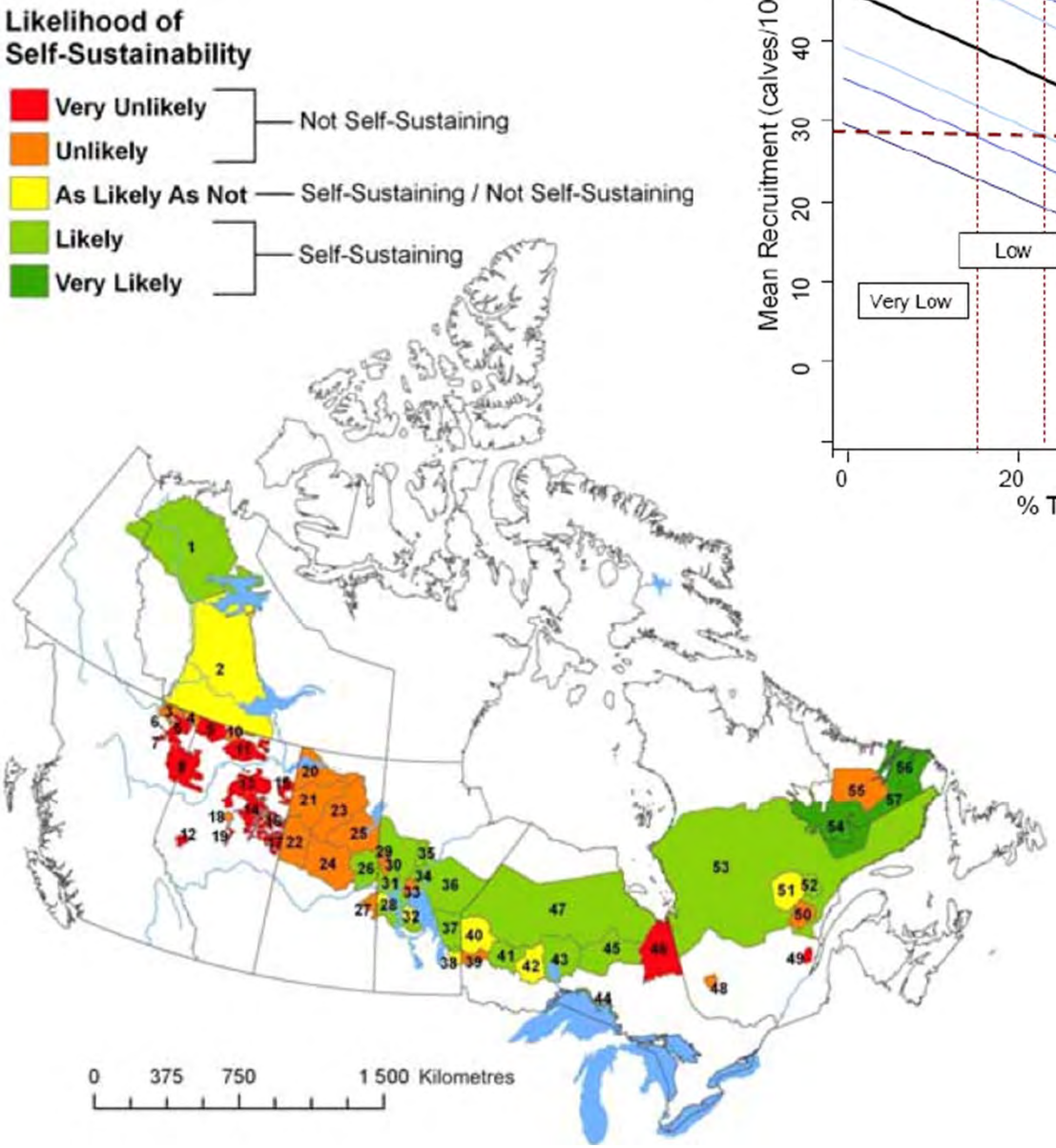
Tableau 2. Composition du secteur couvert par les sept différentes hardes de caribou suivies par télémétrie GPS entre 2004 et 2012 en termes de proportion de couvert forestier et de densité de structures anthropiques linéaires pérennes. Les différentes catégories d'habitat sont présentées au tableau 1.

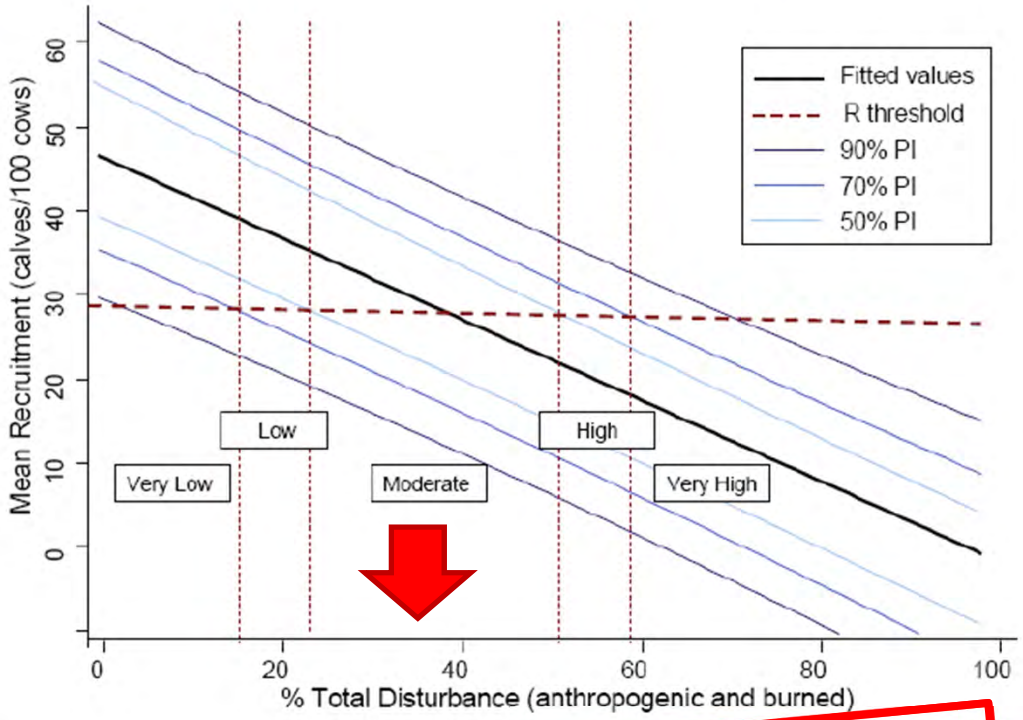
Variable	Assinica	Charlevoix	Cœurs	Nottaway	Piraube	Portneuf	Témiscamie
LTE (km/km^2)	0,026	0,048	0,021	0,024	0,000	0,016	0,002
Route primaire (km/km^2)	0,039	0,063	0,052	0,019	0,060	0,039	0,043
Route secondaire (km/km^2)	0,366	0,987	1,844	0,245	0,517	1,656	0,323
Conifère mature (%)	6,4	31,1	28,6	4,1	38,7	29,6	8,6
Lande ouverte à lichen (%)	32,5	0,9	0,2	41,2	6,7	1,0	34,9
Dénudé humide (%)	2,0	1,4	1,1	3,7	5,7	1,6	1,3
Mixte-Feuillu (%)	14,7	12,5	5,7	14,0	2,8	5,6	12,7
Coupe récente (%)	1,3	6,8	10,6	0,8	12,2	9,5	2,6
Coupe en régénération (%)	3,1	12,6	16,6	2,6	5,8	14,1	3,9
Régénération (%)	3,0	24,4	24,0	1,3	2,5	18,9	1,0
Perturbation naturelle (%)	23,6	4,5	1,7	21,7	11,2	4,2	19,9
Eau (%)	10,1	4,3	10,5	7,7	10,4	14,6	9,8
Autre (%)	0,1	1,1	0,8	2,7	4,0	0,8	5,3
Disturbed habitat	55,0	99,6	98,5	47,5	63,3	90,1	45,7

* Calcul effectué selon les paramètres définis par Environnement Canada (2008) en y incluant les épidémies sévères de moins de 50 ans et en ajoutant une zone tampon de 500 m autour des perturbations anthropiques, ce qui explique les proportions très élevées observées dans le territoire de certaines hardes.

From Lesmerises, Dussault, Drapeau & St-Laurent 2013

EC 2011


Likelihood of
Self-Sustainability
Very Unlikely
Unlikely
Not Self-Sustaining
As Likely As Not
Self-Sustaining / Not Self-Sustaining
Likely
Very Likely
Self-Sustaining
0 375 750 1 500 Kilometres


Mean Recruitment (calves/100 cows)
0
10
20
30
40
50
60
Fitted values
R threshold
90% PI
70% PI
50% PI
Low
High
Very Low
Moderate
Very High
0
20
40
60
80
100
% Total Disturbance (anthropogenic and burned)


Scientific Review
for the Identification of
Critical Habitat for Woodland Caribou
(Rangifer tarandus caribou), Boreal Population, in Canada
Canada


N996CG
R44
Mark Gocke, WGFD


1817
HyVent


Results
Nicolas Bradette

Range fidelity

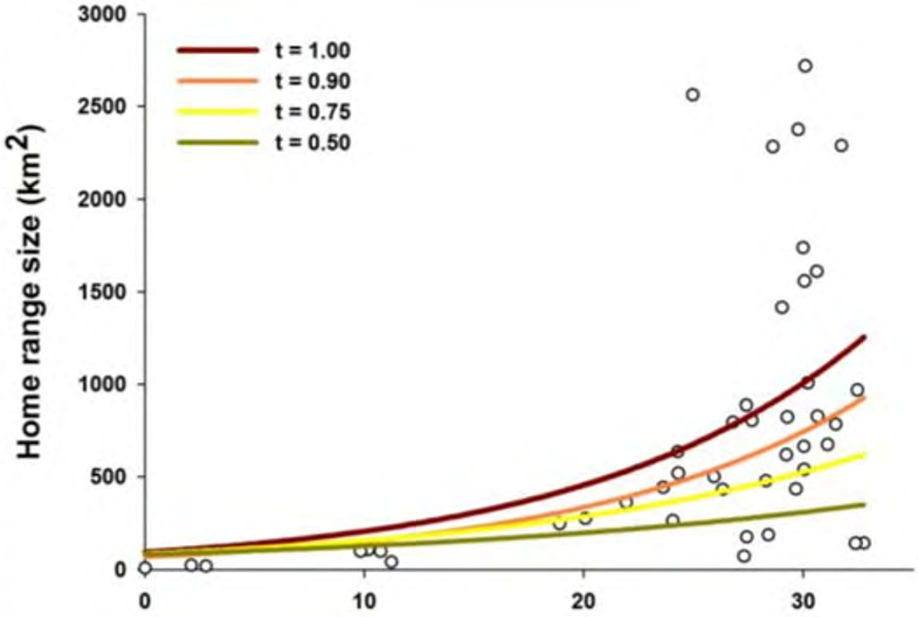
Geneviève Faille
(MSc 2006-2009)

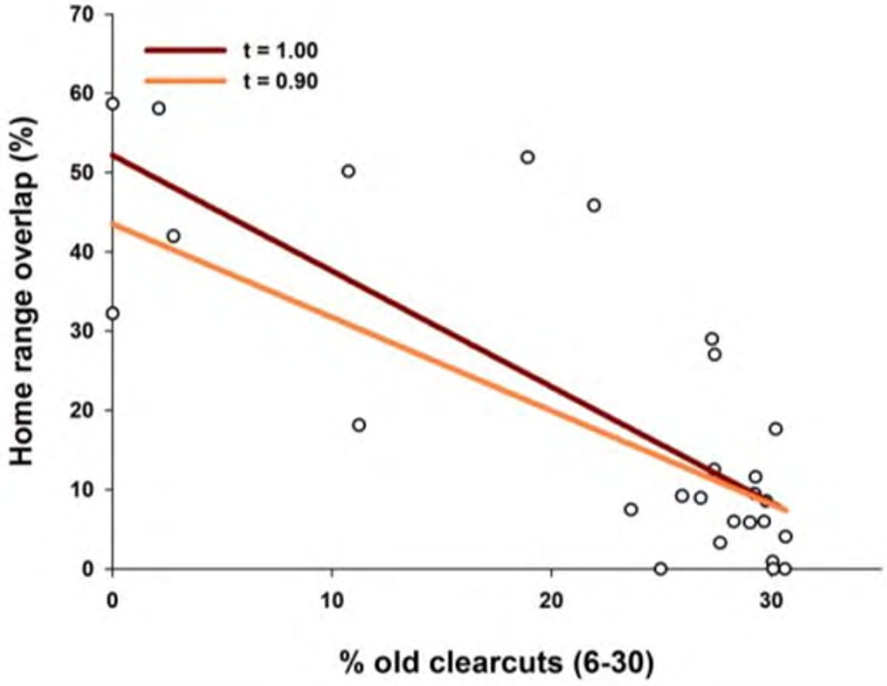
Objective

- Determine if woodland caribou display fidelity to their seasonal home ranges;
- Investigate the relationships between habitat disturbances and home-range fidelity of females;

Range fidelity

Clearcuts increase home range size and decrease range fidelity, leading caribou females to use unknown habitats where they do not know the distribution of resources and risk…





Contents lists available at ScienceDirect

Biological Conservation

journal homepage: www.elsevier.com/locate/biocon

Range fidelity: The missing link between caribou decline and habitat alteration?

Geneviève Faille [a], Christian Dussault [b,*], Jean-Pierre Ouellet [a], Daniel Fortin [c], Réhaume Courtois [b], Martin-Hugues St-Laurent [a], Claude Dussault [d]

Anthropogenic disturbances vs. home range size

David Beauchesne
(MSc 2009-2011)

Objective

- Assess the influence of disturbances on caribou movements.

Disturbances vs. home range size

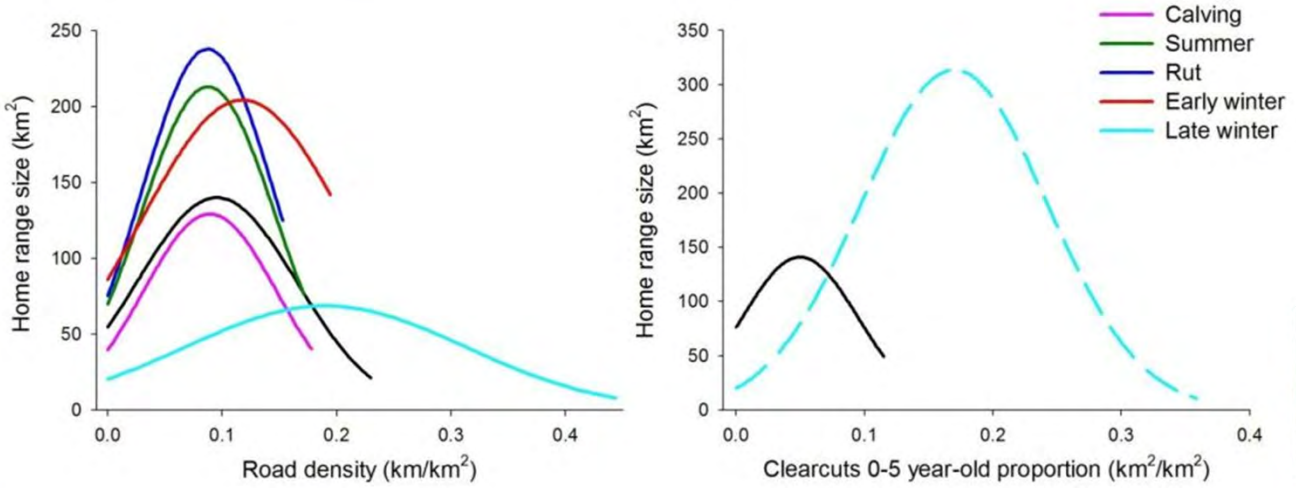
Contents lists available at ScienceDirect

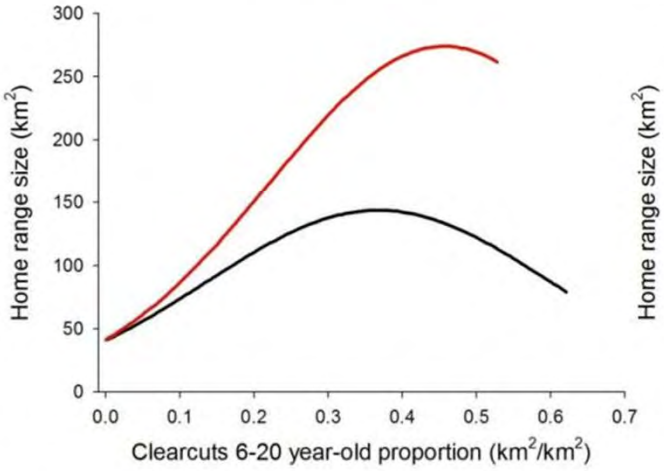
Biological Conservation

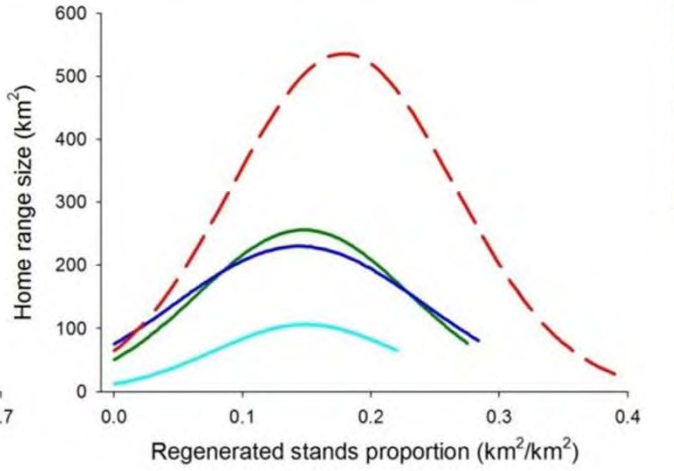
journal homepage: www.elsevier.com/locate/biocon

Thresholds in the capacity of boreal caribou to cope with cumulative disturbances: Evidence from space use patterns

David Beauchesne [a,1], Jochen A.G. Jaeger [b], Martin-Hugues St-Laurent [c,*]





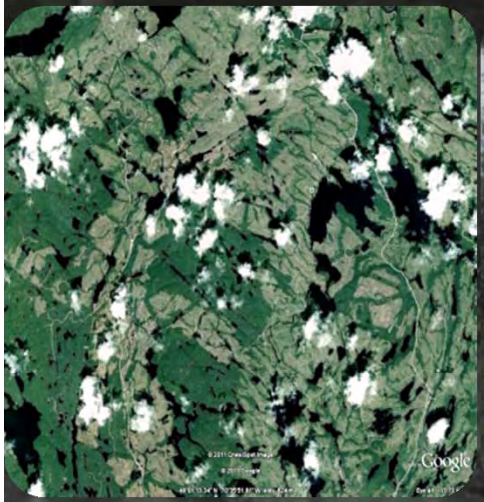


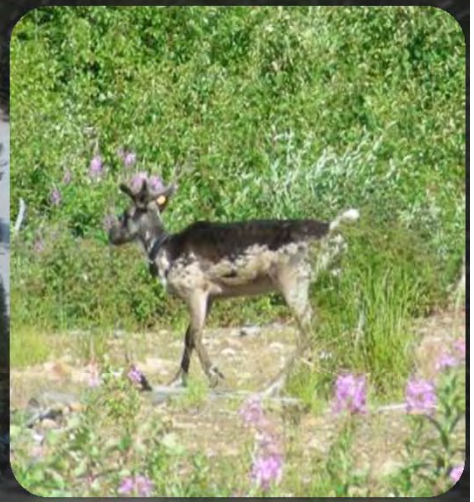
Residual forest patches

Objective

- Determine the extent of mature forest required by caribou and identify which landscape features influence the use of these residual forest patches.

Rémi Lesmerises
(MSc 2008-2011)





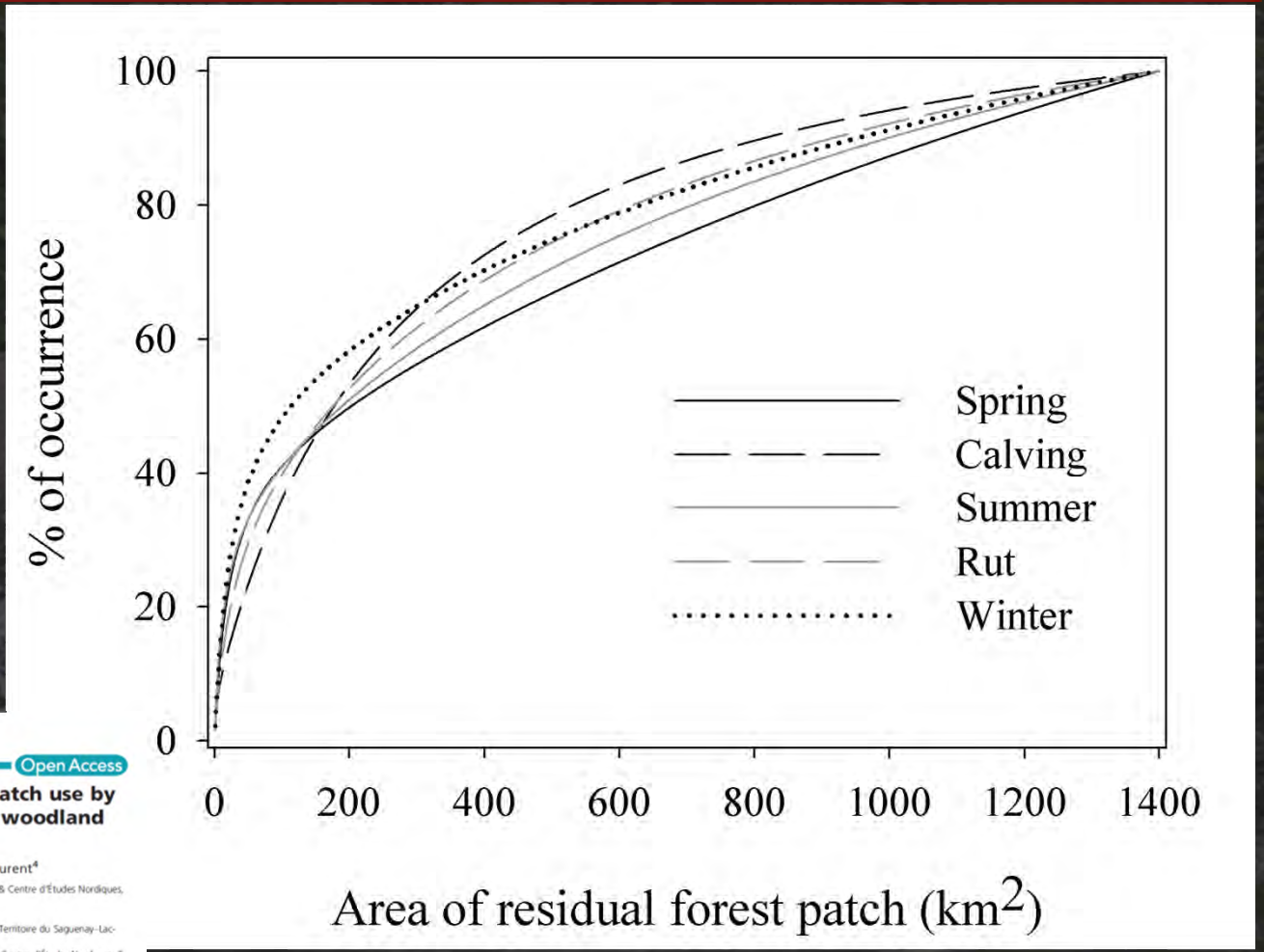
Residual forest patches

The occurrence probability decrease with an increase in road, cabin and cutover density in the surrounding of a forest remnant

	Year	logArea	Mixed	Cutover	Open	Regen	Coniferous	Coniferous^2	Wetland	Wetland^2	Road	Cabin
Spring												
Estimate	**-0.109**	**1.548**		1.053	-1.004	**-3.668**	0.205	-3.753	**-33.836**	**177.008**	**-0.636**	**-1.361**
± 95% CI	0.077	0.205		1.684	2.380	1.638	5.114	7.639	13.259	70.782	0.328	0.834
Estimate	**-0.109**	**1.558**	-0.253	0.926	-1.250	**-3.764**	-0.776	-2.778	**-34.527**	**178.233**	**-0.643**	-1.340
± 95% CI	0.077	0.206	0.498	1.700	2.424	1.649	5.442	7.835	13.326	70.788	0.328	0.831
Calving												
Estimate	**-0.199**	**1.629**		**1.981**	**3.723**	0.020	**8.075**	-5.632	-8.166	29.694	**-0.507**	**-0.362**
± 95% CI	0.090	0.222		1.438	1.623	1.376	4.234	5.975	10.030	46.729	0.174	0.344
Summer												
Estimate	**-0.245**	**1.570**		**1.230**	0.894	**-1.962**	**11.186**	**-9.069**	-8.965	13.859	**-0.274**	-0.183
± 95% CI	0.074	0.205		1.047	1.241	1.035	3.309	4.658	9.048	53.063	0.079	0.229
Rut												
Estimate	**-0.171**	**1.566**	**-2.798**	-1.178	-0.267	**-4.400**	**5.435**	-6.029	1.216	13.148	**0.813**	**-2428**
± 95% CI	0.090	0.221	1.046	1.290	1.566	1.494	5.256	7.381	9.674	43.864	0.299	0.814

Residual forest patches

Forest remnants should be larger than what is currently proposed (50 – 200 km^2) to ensure their use by woodland caribou



Ecology and Evolution
Open Access

The influence of landscape matrix on isolated patch use by wide-ranging animals: conservation lessons for woodland caribou

Rémi Lesmerises[1], Jean-Pierre Ouellet[2], Claude Dussault[3] & Martin-Hugues St-Laurent[4]

[1]Département de Biologie, Chimie et Géographie, Université du Québec à Rimouski, Groupe de recherche BORÉAS & Centre d'Études Nordiques, 300 Allée des Ursulines, Rimouski, QC G5L 3A1, Canada
[2]Bureau du recteur, Université du Québec à Rimouski, 300 Allée des Ursulines, Rimouski, QC G5L 3A1, Canada
[3]Ministère des Ressources naturelles et de la Faune du Québec, Direction de l'expertise Énergie-Faune-Forêts-Mines-Territoire du Saguenay-Lac-Saint-Jean, 3950 boul. Harvey, 3e étage, Jonquière, QC G7X 8L6, Canada
[4]Département de Biologie, Chimie et Géographie, Université du Québec à Rimouski, Groupe de recherche BORÉAS, Centre d'Études Nordiques & Centre d'Étude de la Forêt, 300 Allée des Ursulines, Rimouski, QC G5L 3A1, Canada

Range disturbance & demography

Objective

- Evaluate the condition of the habitat, the level of disturbance and the impacts on the population growth rate.

Tyler Rudolph
(2011-2012)

STATUS of WOODLAND CARIBOU
(*Rangifer tarandus caribou*)
in the JAMES BAY REGION of
NORTHERN QUEBEC

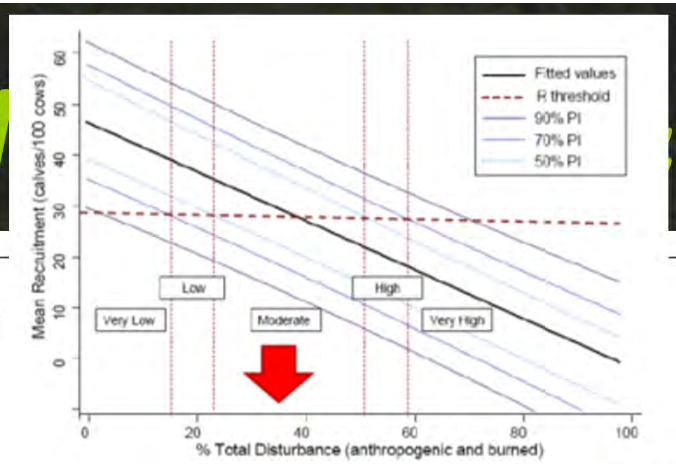
PRESENTED TO THE
Ministère des Ressources naturelles et de la Faune du Québec
AND THE
Grand Council of the Crees (Eeyou Istchee)

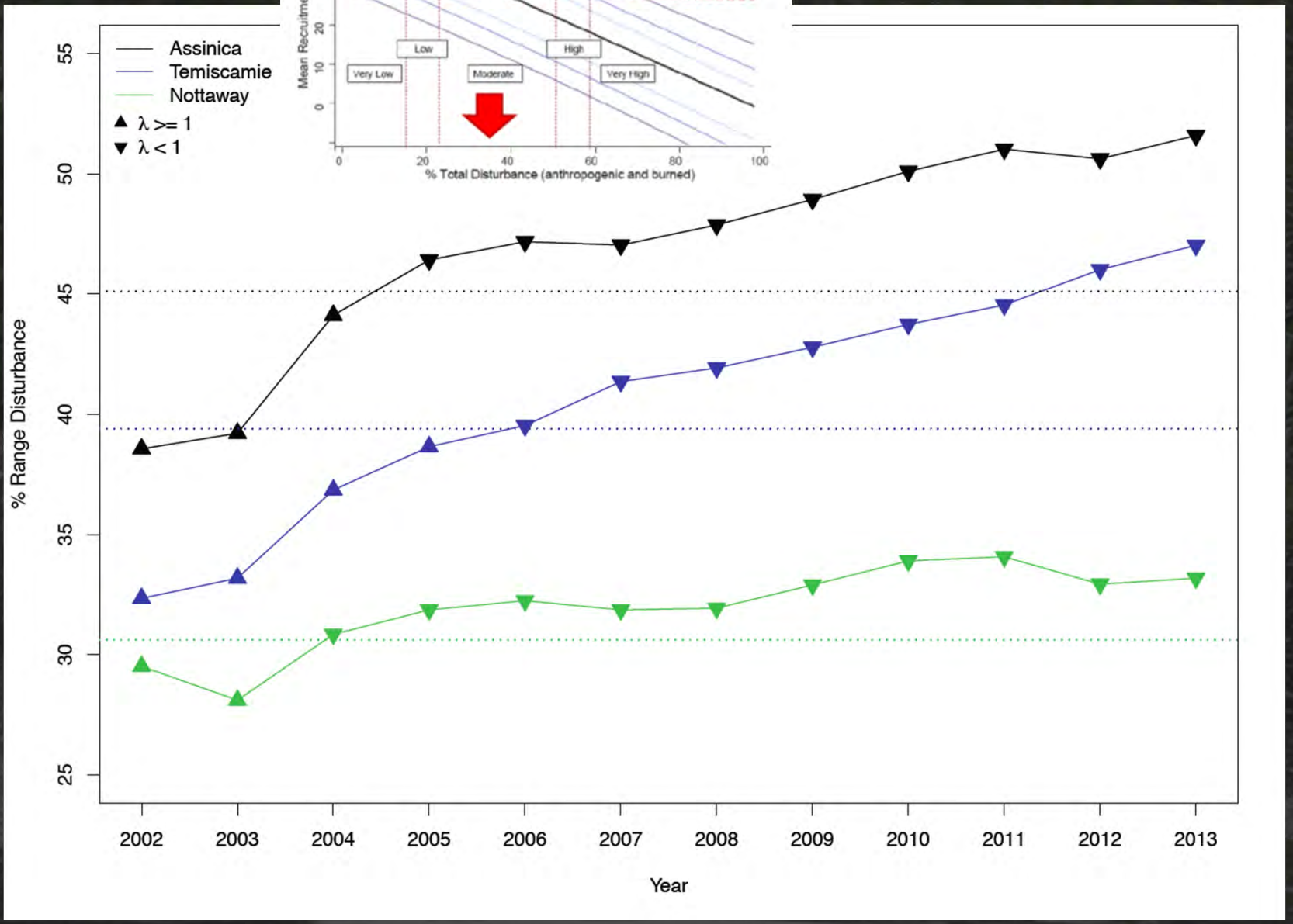
BY
Tyler D. Rudolph, M.Sc., UQAM
Pierre Drapeau, Ph.D., UQAM
Martin-Hugues St-Laurent, Ph.D., UQAR
Louis Imbeau, Ph.D., UQAT

WOODLAND CARIBOU RECOVERY TASK FORCE
SCIENTIFIC ADVISORY GROUP
NORD-DU-QUÉBEC

September 2012

Range d demography





Female survival & habitat selection

Objective

- Evaluate the link between functional responses in habitat selection of female caribou and their survival.

Chrystel Losier
(MSc 2011-2013)

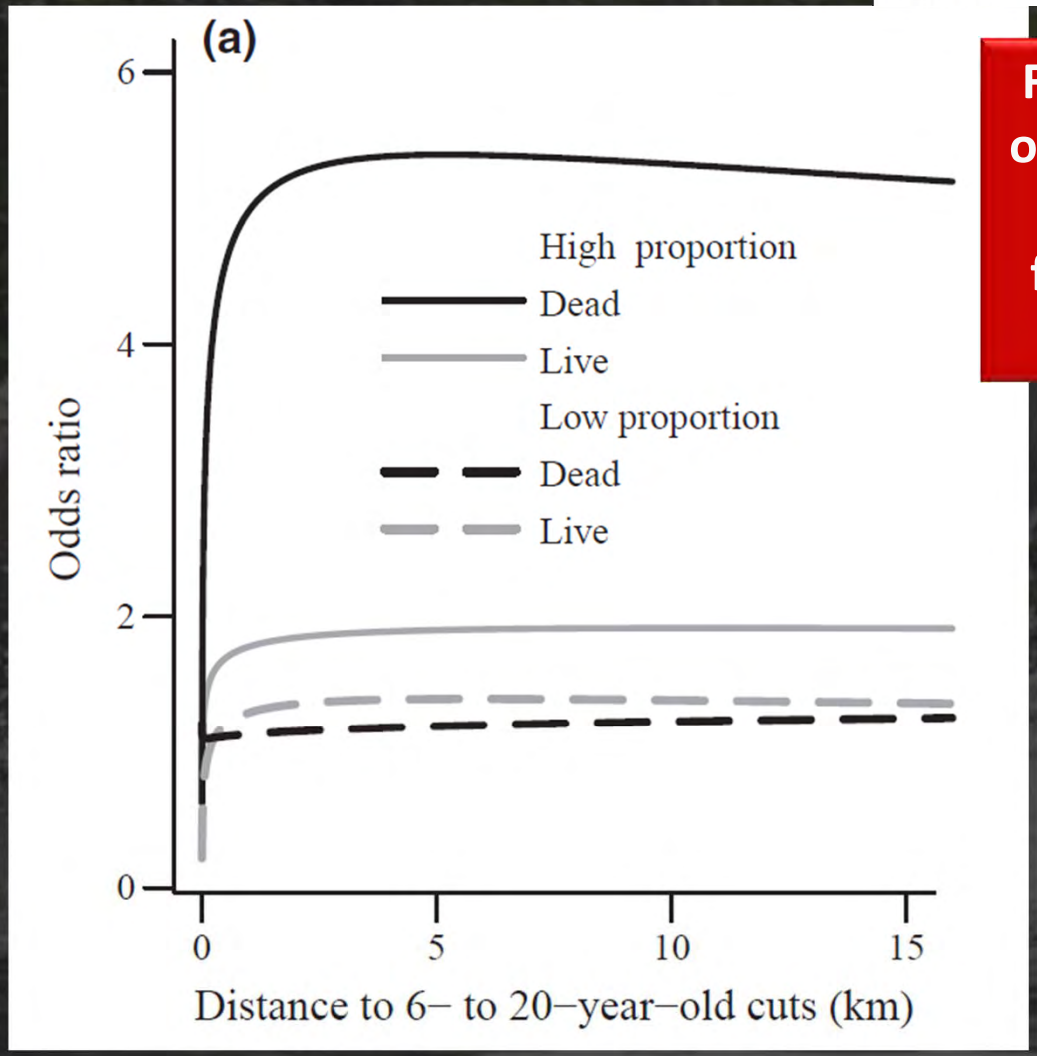
Female survival & habitat selection

50 YEARS WITH IMPACT Journal of Applied Ecology British Ecological Society

Journal of Applied Ecology 2015 doi: 10.1111/1365-2664.12400

Adjustments in habitat selection to changing availability induce fitness costs for a threatened ungulate

Chrystel L. Losier[1,2], Serge Couturier[1], Martin-Hugues St-Laurent[2,3,4], Pierre Drapeau[2,5], Claude Dussault[6], Tyler Rudolph[2,5], Vincent Brodeur[7], Jerod A. Merkle[1,2] and Daniel Fortin[1,2]*



Females that died had higher odds of occurring near regenerating cuts, and these odds were even higher for individuals with a home-range largely comprised of cuts.

Apparent competition between moose and caribou

Solène Tremblay-Gendron
(MSc 2009-2011)

Objective

- Determine how prey spatial distribution could impact wolf movements and if wolf predation on caribou is opportunistic or not.

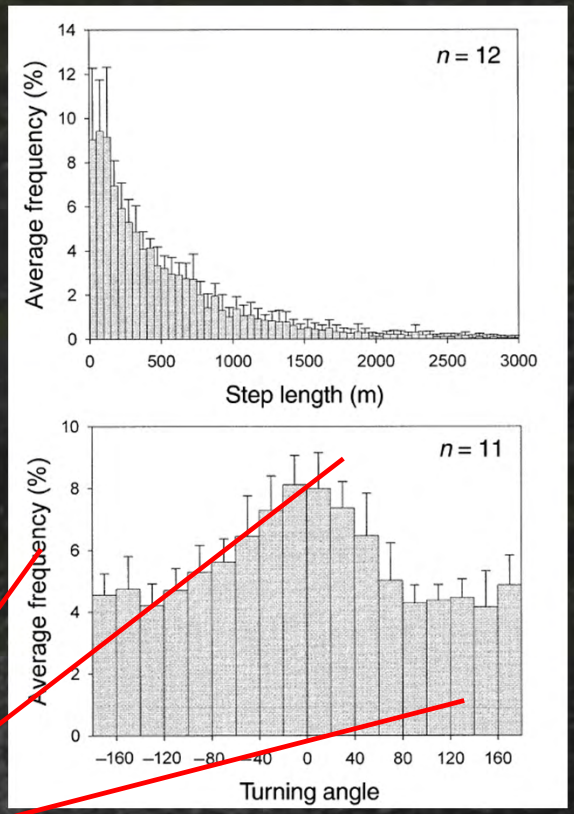
Wolf predation on moose & caribou

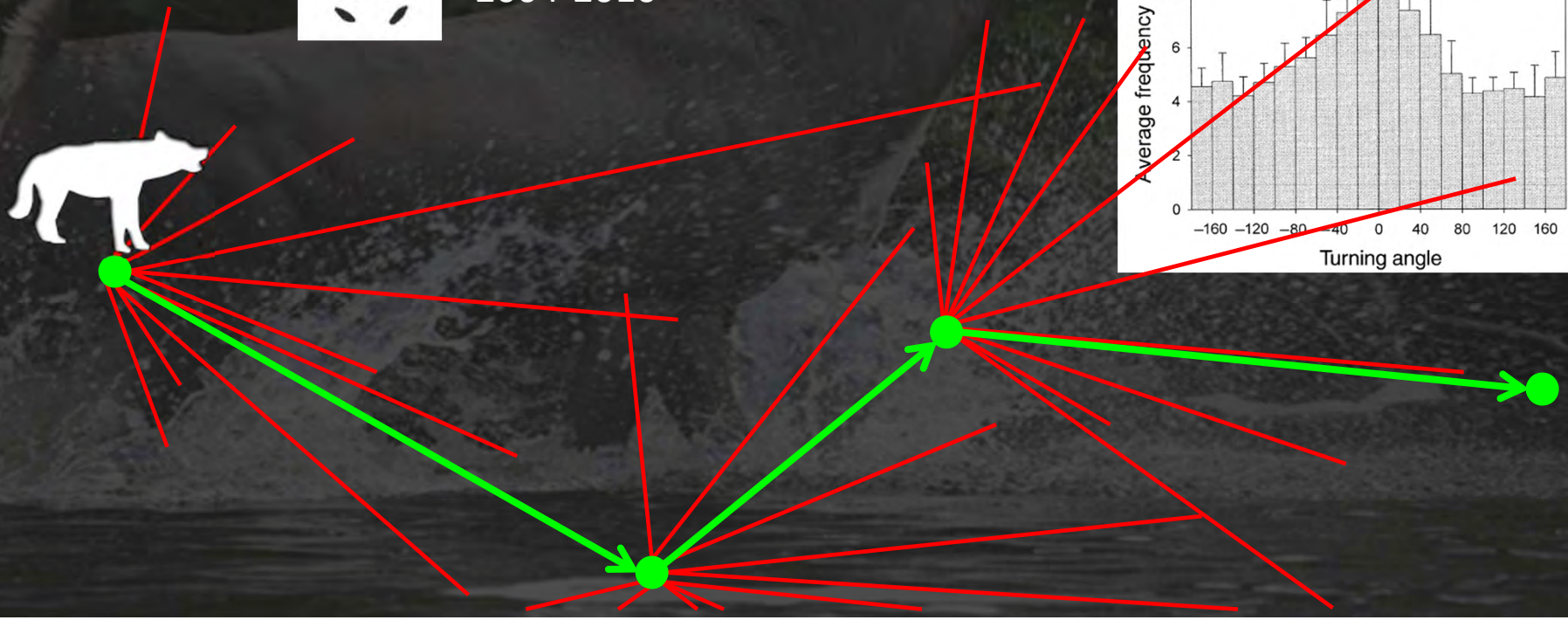
Telemetry surveys

27 wolves
2005-2010

77 moose
1996-1999
2003-2006

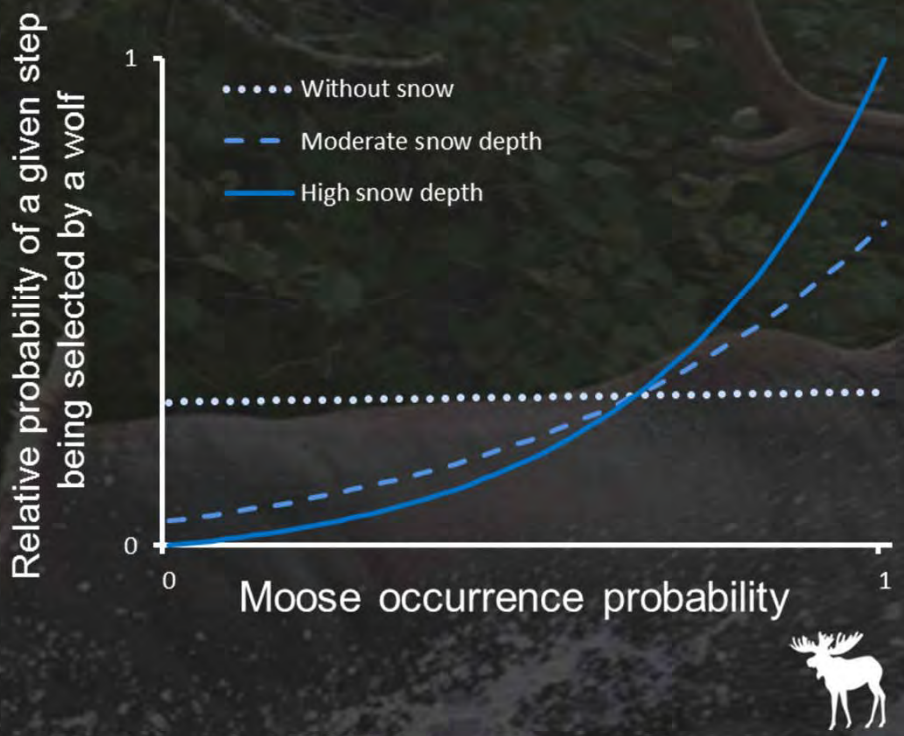
42 caribou
2004-2010

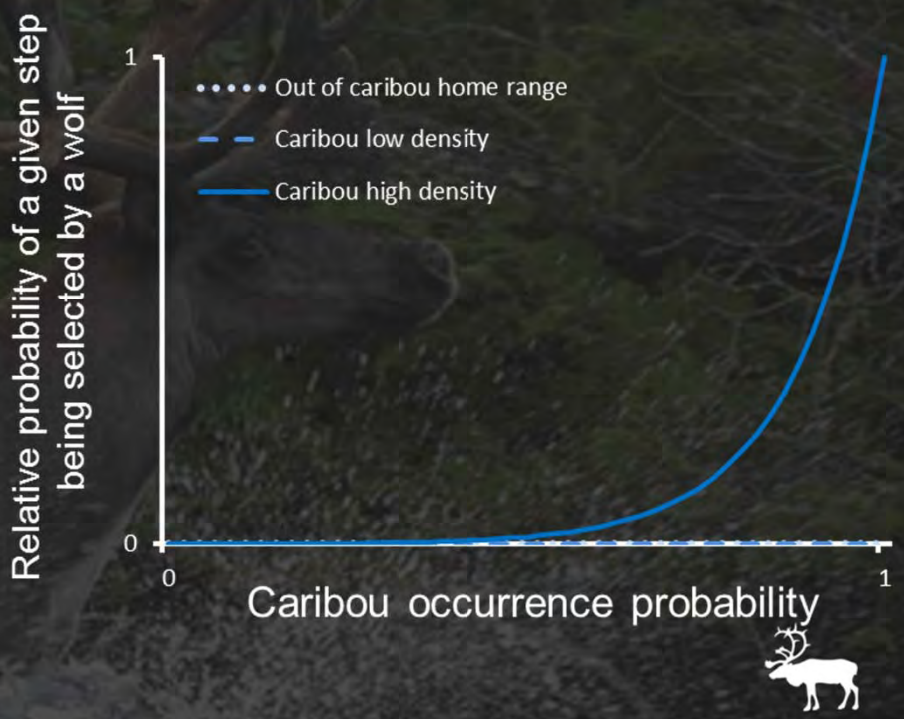




Wolf predation on moose & caribou

Tremblay-Gendron, Dussault, Fortin & St-Laurent
(*submitted to Ecology*)





Wolves were most of all seeking for habitat conditions increasing prey vulnerability

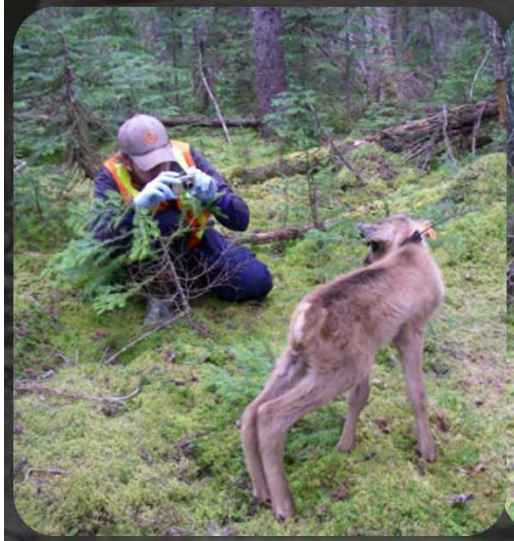
Wolves' focus appeared to switch from moose to caribou when local caribou densities were high

Calf survival

Objective

- Estimate calf survival and investigate if habitat selection strategies of female caribou towards disturbances influenced their calf's survival

Martin Leclerc
(MSc 2010-2012)



Calf survival & predation rate

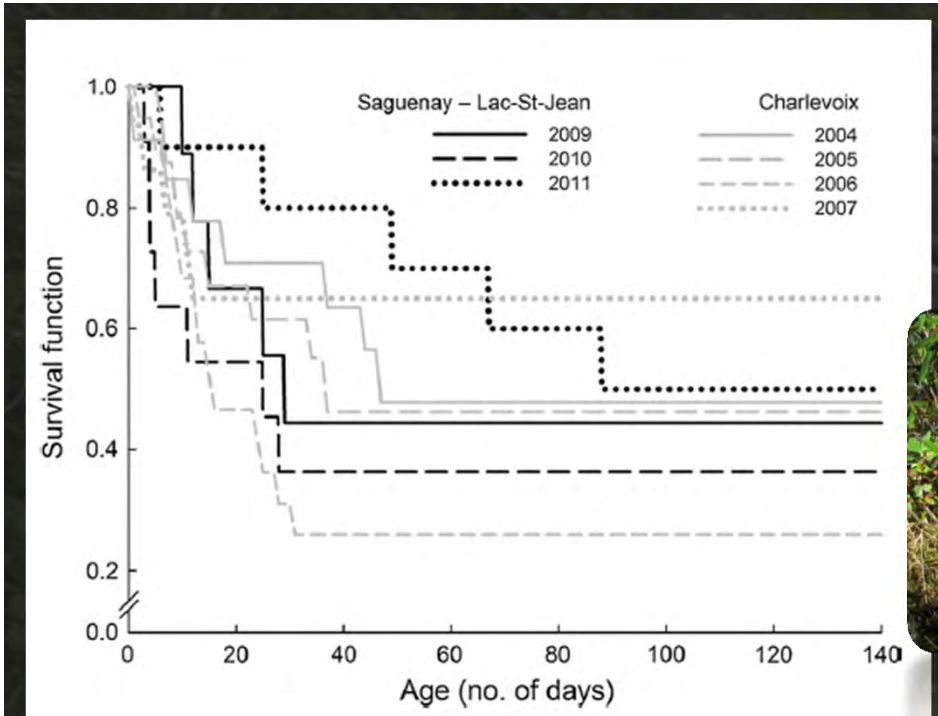


Fig. 1 Survival functions of caribou (*Rangifer tarandus caribou*) calves monitored in Saguenay–Lac-St-Jean (2009–2011; $n = 30$) and in Charlevoix (2004–2007; $n = 64$; Pinard et al. 2012) for the first 140 days of life. Detailed information on calf survival for the Char- [illegible] et al. (2012)

Calf survival was 53 % and 43 % after 30 and 90 days following birth

Table 2 Survival rate and mortality agent of caribou calves ($n = 30$) monitored during their first 140 days of life from 2009 to 2011 in Saguenay–Lac-St-Jean, Québec, Canada

Variable	Year			Total
	2009	2010	2011	
No. of calves	9	11	10	30
Survival rate	44.4 %	36.4 %	50.0 %	43.3 %
Mortality agent (n)				
Black bear	3	2	4	9 (52.9 %)
Wolf	0	0	0	0 (0.00 %)
Unknown predator	2	0	1	3 (17.6 %)
Drowning	0	1	0	1 (5.88 %)
Unknown[a]	0	4	0	4 (23.5 %)

[a] Mortalities of unknown cause occurred when the carcass was seemingly untouched and there was no evidence of predation

53 % of calves that died were killed by black bear, which was responsible of ~75% of the predation events

Habitat selection and calf survival

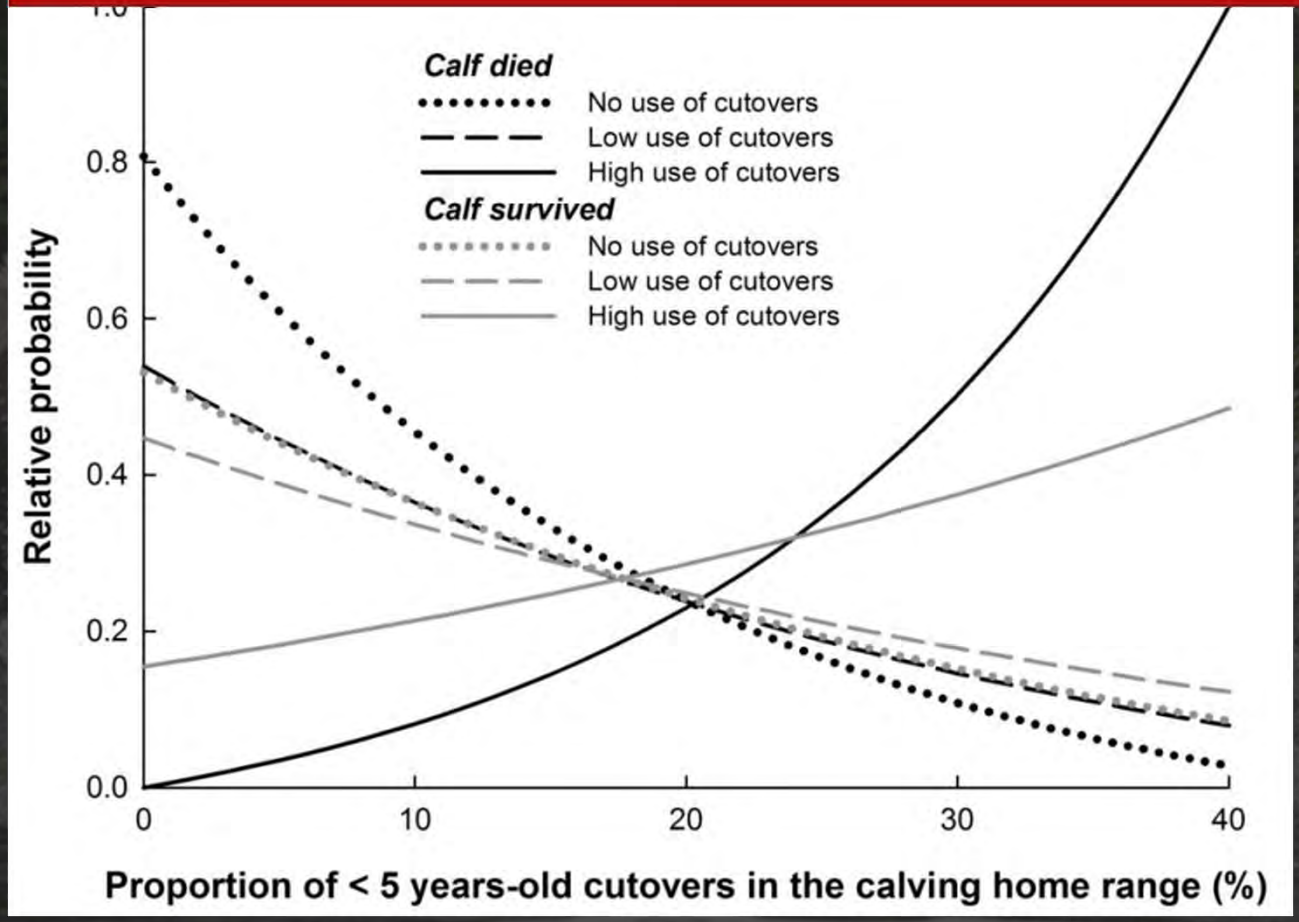
CONSERVATION ECOLOGY - ORIGINAL RESEARCH

Behavioural strategies towards human disturbances explain individual performance in woodland caribou

Martin Leclerc · Christian Dussault · Martin-Hugues St-Laurent

Oecologia (2014) 176:297–306
DOI 10.1007/s00442-014-3012-9

The probability that a female lose its calf to predation was not influenced by habitat composition of her annual home range…



… but decreased with an increase in proportion of open lichen woodland within her calving home range

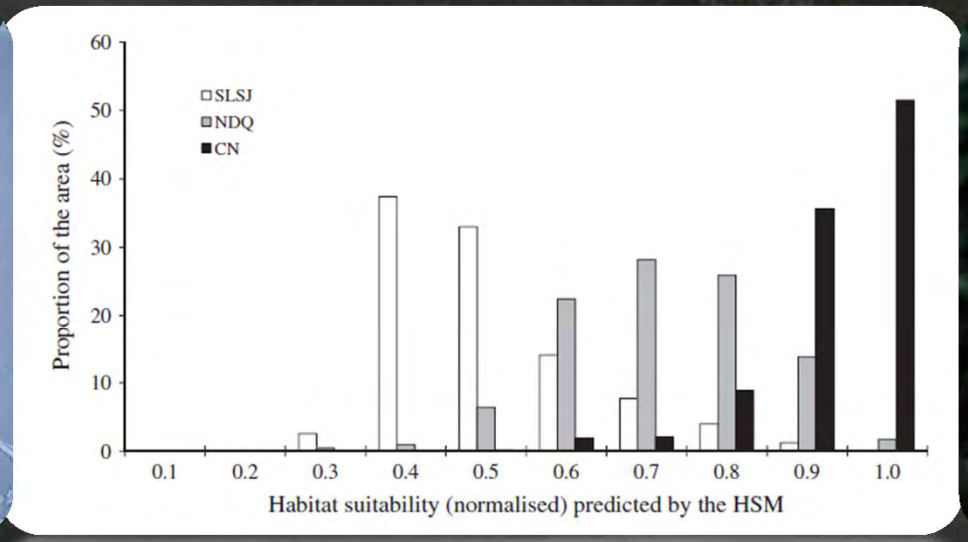
Using <5 years-old cutovers became detrimental when the proportion of <5 years-old cutovers within a calving home range reach high levels

Habitat quality and predator-prey relationships

Mathieu Leblond
(Postdoc 2013-2014)

Objective

- Build a habitat suitability model.



Development and validation of an expert-based habitat suitability model to support boreal caribou conservation

Mathieu Leblond [a,*], Christian Dussault [b], Martin-Hugues St-Laurent [c]

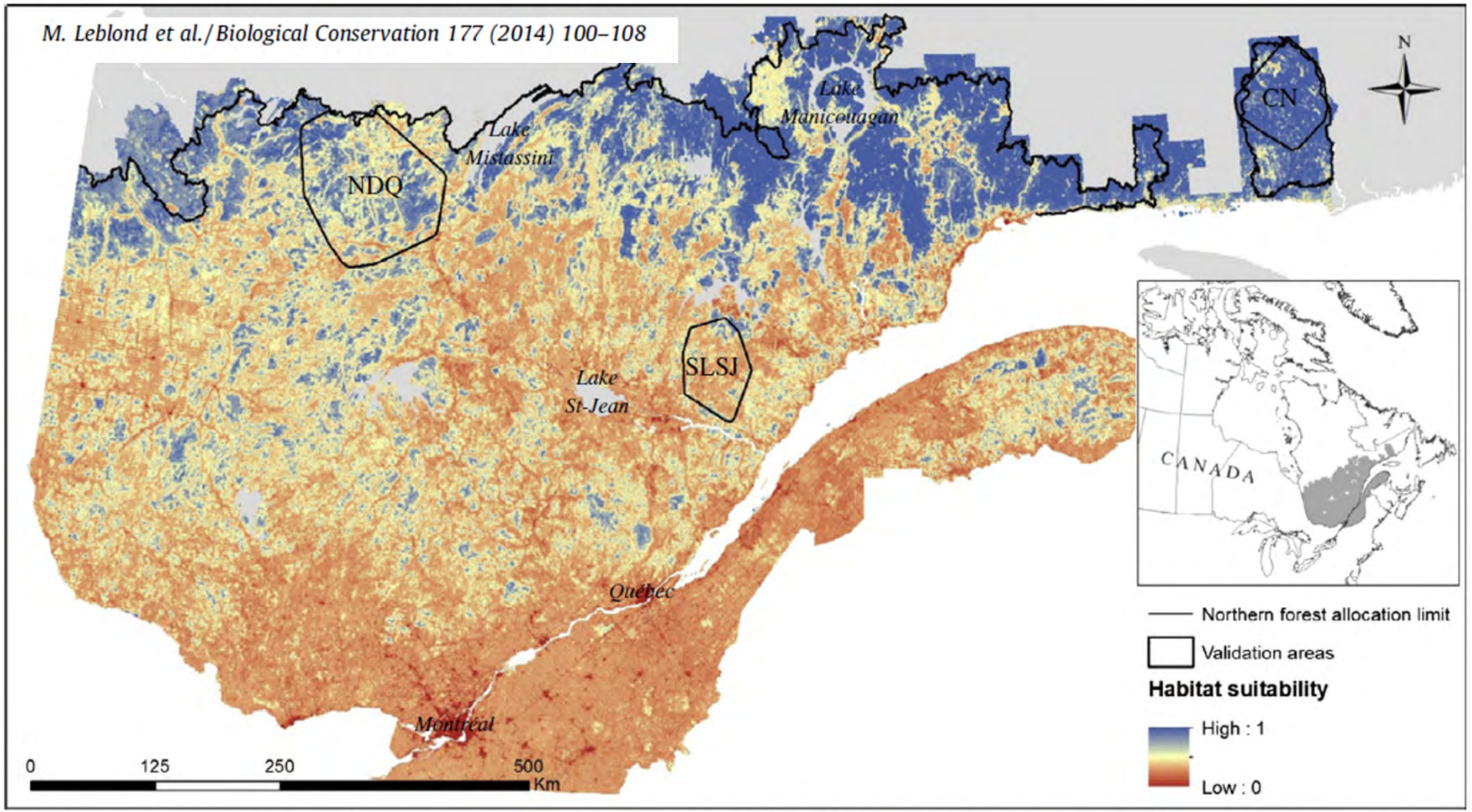
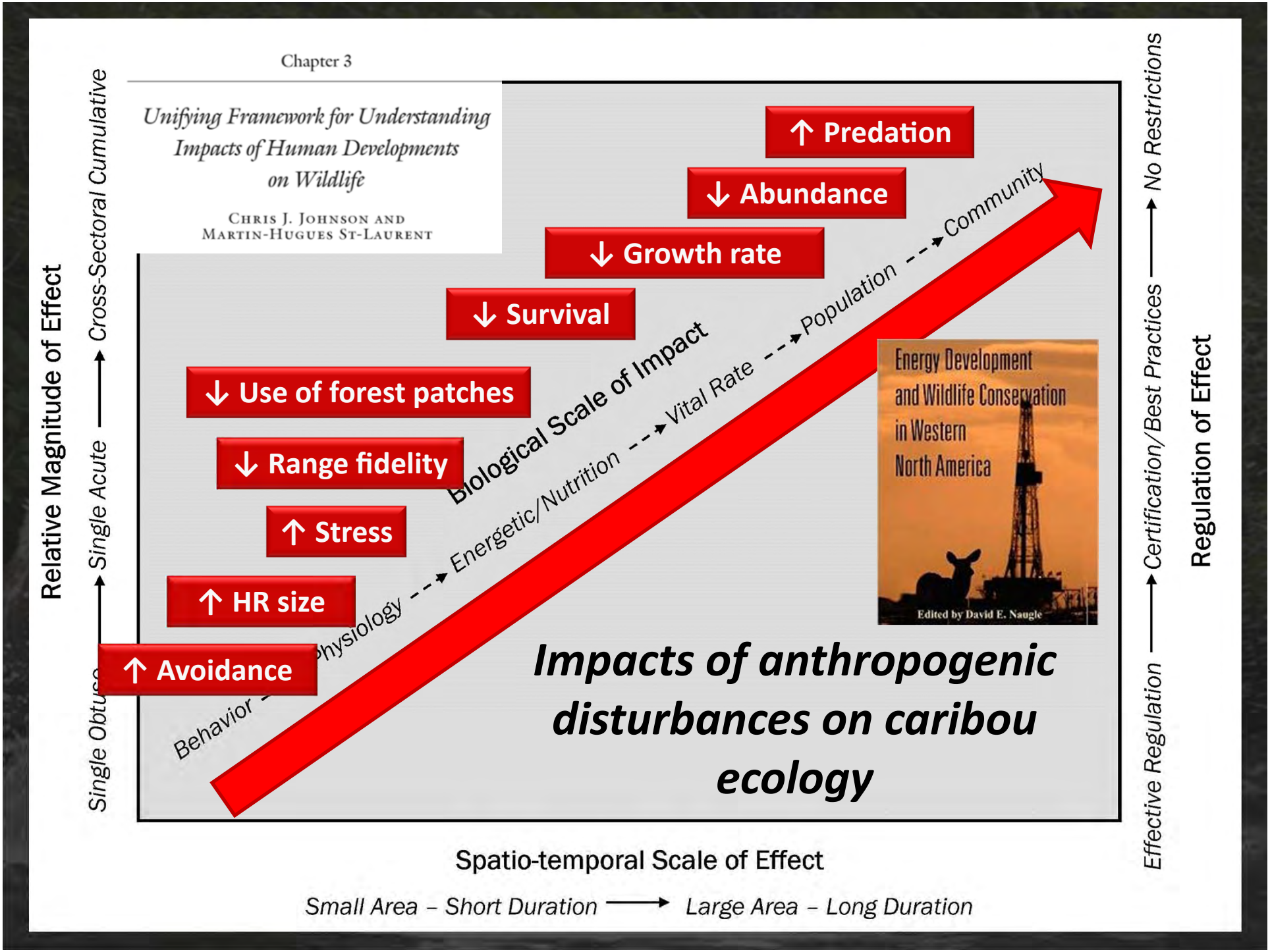


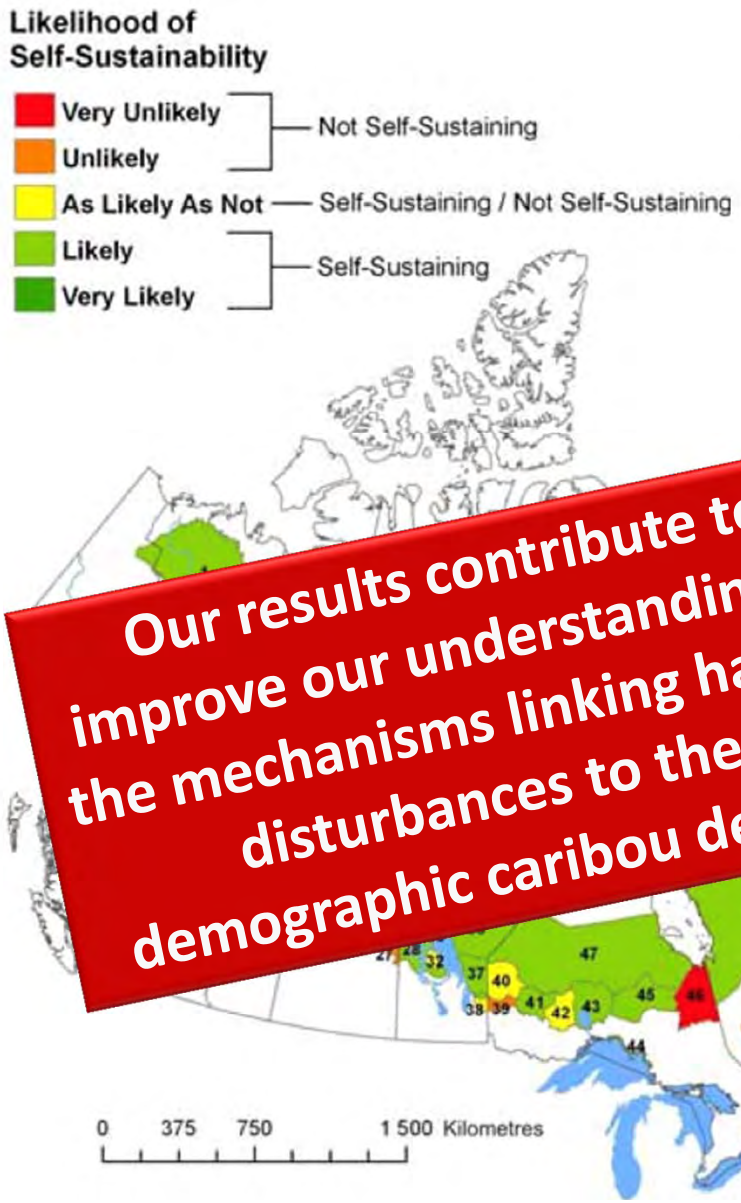
Fig. 1. Mapped results of the expert-based habitat suitability model developed for boreal caribou in Québec using forest inventory data available below the northern forest allocation limit. We validated the HSM using telemetry data in 3 distinct validation areas, Saguenay–Lac-St-Jean (SLSJ), Nord-du-Québec (NDQ), and Côte-Nord (CN).

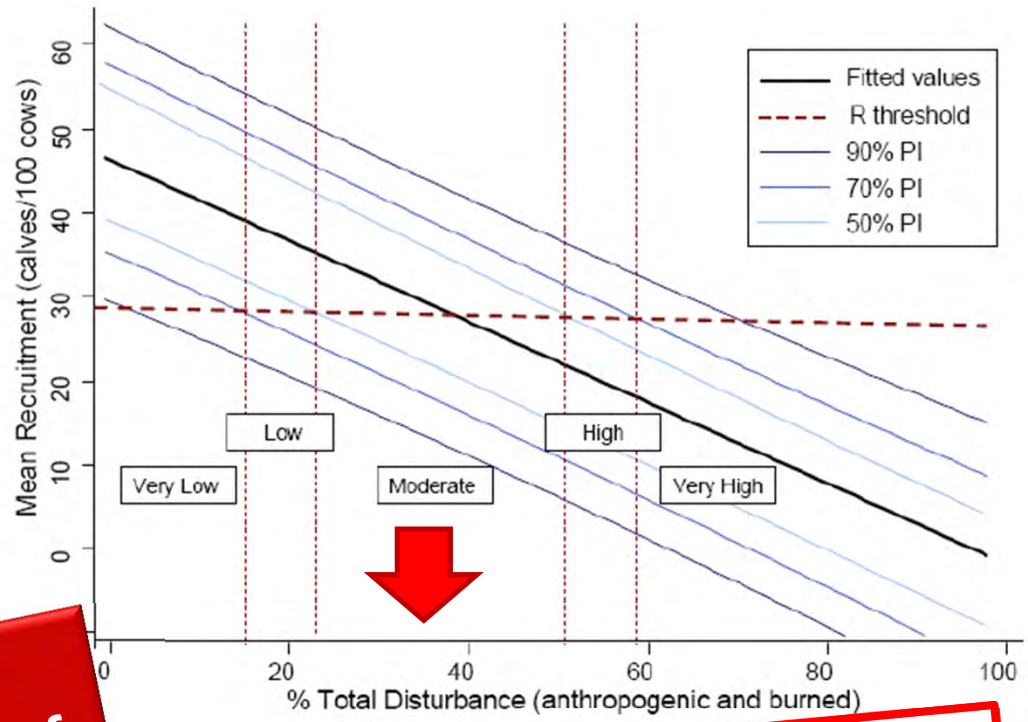
Conclusions

Nicolas Bradette


Chapter 3
Unifying Framework for Understanding Impacts of Human Developments on Wildlife
Chris J. Johnson and Martin-Hugues St-Laurent
↑ Predation
↓ Abundance
↓ Growth rate
↓ Survival
↓ Use of forest patches
↓ Range fidelity
↑ Stress
↑ HR size
↑ Avoidance
Biological Scale of Impact
Behavior
Physiology
Energetic/Nutrition
Vital Rate
Population
Community
Energy Development and Wildlife Conservation in Western North America
Edited by David E. Naugle
Impacts of anthropogenic disturbances on caribou ecology
Relative Magnitude of Effect
Single Obtuse
Single Acute
Cross-Sectoral Cumulative
Spatio-temporal Scale of Effect
Small Area – Short Duration
Large Area – Long Duration
Effective Regulation
Certification/Best Practices
No Restrictions
Regulation of Effect

EC 2011

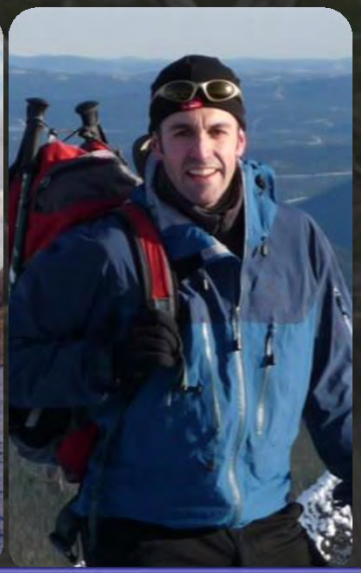




Our results contribute to improve our understanding of the mechanisms linking habitat disturbances to the demographic caribou decline

Research program 2012-2017





Collaborators: Mélinda Lalonde & Daniel Chouinard (MFFP)

Impacts of ecosystem-based management on multiple facets of Gaspésie caribou ecology

Canada Foundation for Innovation
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Fonds de recherche sur la nature et les technologies
Québec

Research program 2013-2018

Collaborator: Ariane Massé (MFFP)

Factors determining population dynamics of woodland caribou in boreal forests of Québec

Fonds de recherche sur la nature et les technologies Québec

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D. Desjardins, C.J. Johnson, M. L'Italien, C. Isabel, P. Henry, R. Chabot, M.-H. St-Laurent, A. Gagnon, D. Grenier, S. Gravel.

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Produits forestiers

CGF
Consortium en foresterie
Gaspésie–Les-Îles
Affilié à l'UQAR

CENTRE D'ÉTUDES NORDIQUES
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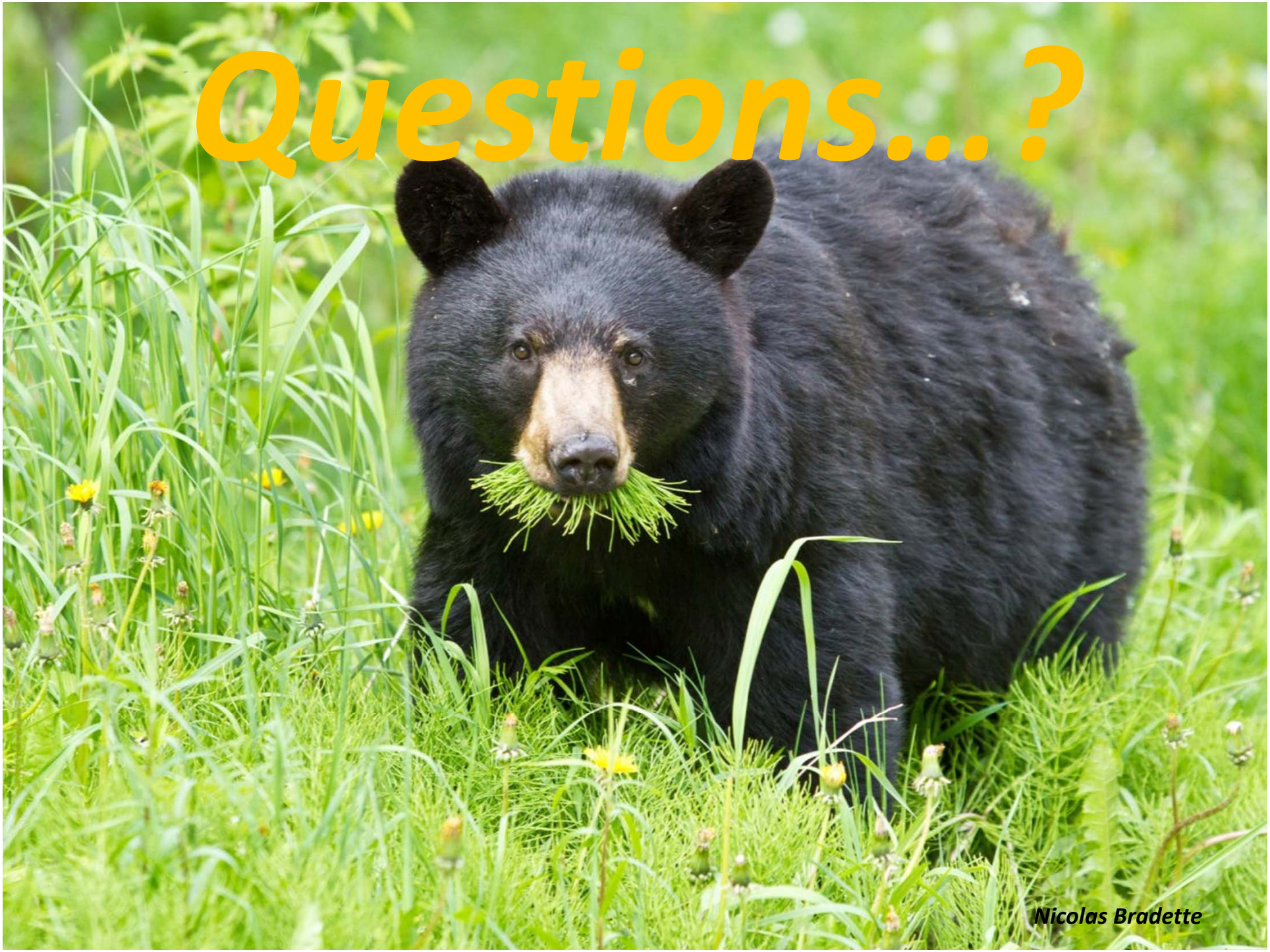
UNIVERSITY OF NORTHERN BRITISH COLUMBIA

Équipe de rétablissement du caribou forestier


Questions…?
Nicolas Bradette