WORKING TOGETHER

17th NORTH AMERICAN CARIBOU WORKSHOP

2018

Ottawa

October 29 – November 2, 2018

WORKING TOGETHER

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Credits | Photos courtesy of Gerry Racey, unless noted otherwise

WELCOME

Dear Delegates,

Welcome to the 17th North American Caribou Workshop! We are delighted to have all of you in Canada's capital, Ottawa, and we hope that you enjoy your time here. We acknowledge that this conference is taking place on unceded Algonquin Anishnaabe territory, and we extend a special welcome to our Indigenous delegates.

Every year, caribou conservation becomes a more critical and pressing issue. We believe that we can accomplish more for caribou by working together than by working each alone. By making "Working Together" the theme of this year's conference, we hope to not only enable knowledge-sharing about caribou ecology, conservation, and recovery, but also to facilitate the sharing of ideas and concrete examples about how collaboration for caribou can be accomplished on the ground.

This year's delegates represent an unprecedented diversity of organizations, with significant representation from research institutions, Indigenous organizations and communities, all levels of government, industry, consulting firms, ENGOs, and other organizations. We encourage everyone to take advantage of this unique opportunity to ask lots of questions, absorb new points of view to respectfully consider when conducting future work, and expand collaborative networks. Everyone has a unique contribution to make to this conference and to caribou conservation; we value your participation.

This conference would not be possible without the generous financial contributions of sponsors or the time and effort put in by our partner organizations. We extend special thanks to our sponsors and partners (full list on pages 6 to 8), and invite you to take the time to meet with representatives from these organizations.

Thank you again for joining us at the 17th North American Caribou Workshop. We look forward to working with you towards a brighter future for caribou.

Warm regards,

Cheryl Ann Johnson | Chair
NACW 2018 Organizing Committee

CONFERENCE THEME

WORKING TOGETHER

Scientific and Indigenous Knowledge have well established that most caribou populations are experiencing declines across North America. Caribou is an iconic species and holds a special significance for all North Americans – its status concerns us all. In order to improve the likelihood of long-term persistence of this remarkably diverse species, an unprecedented level of commitment, collaboration and cooperation among groups involved in the conservation of caribou is required. Working together is of the utmost importance.

Under the unifying theme of 'Working Together', the conference will serve as a forum for knowledge-sharing and learning, providing opportunities for the expansion of networks and the fostering of new collaborations. Conference sessions and activities will contextualize how current collaborative caribou conservation, management and recovery efforts are helping to:

Translate Knowledge into Action

Incorporating Indigenous Knowledge and scientific information into current caribou recovery and management efforts and into effective policies.

Strengthen Livelihoods and Futures

Considering cultural links to caribou as well as socio-economic factors in recovery efforts and the resulting impacts on the people, communities and caribou conservation.

Find Innovative Solutions

Looking beyond the challenges and causes of population declines to generate new research that supports timely and appropriate on-the-ground solutions.

RESPECT

In keeping with our conference theme of 'Working Together,' the 17th North American Caribou Workshop works to promote a welcoming environment that is supportive and productive for all attendees, organizing committee members, contractors, staff, volunteers, exhibitors, and service providers. We expect that all delegates will:

- Treat everyone with courtesy;
- Be considerate of alternative viewpoints; and
- Be respectful in critiques of ideas.

Thank you for helping to make this conference a safe and collaborative forum for the exchange of research, knowledge, experience, and perspectives.

ORGANIZING Committee

- **Cheryl Johnson**, Environment & Climate Change Canada | Chair
- **Erin Neave**, Environment & Climate Change Canada | Advisor
- **Salena Angelo**, Natural Resources Canada | Coordinator
- **Lindsay Crawford**, Environment & Climate Change Canada | Coordinator
- **Margaret Sawatzky**, Environment & Climate Change Canada | Coordinator
- **Al Arsenault**, John Wood Group PLC
- **John Cheechoo**, Inuit Tapiriit Kanatami
- **Megan Hazell**, John Wood Group PLC
- **Mathieu Leblond**, Environment & Climate Change Canada
- **Gita Ljubicic**, Carleton University
- **Eric Loring**, Inuit Tapiriit Kanatami
- **Micheline Manseau**, Environment & Climate Change Canada
- **Emmelie Paquette**, Carleton University
- **Deborah Simmons**, Sahtú Renewable Resources Board
- **Darren Sleep**, National Council for Air & Stream Improvement; Sustainable Forestry Initiative Inc
- **Kendra Tagoona**, Inuit Tapiriit Kanatami
- **Justina Ray**, Wildlife Conservation Society Canada
- **Rachel Vallender**, Environment & Climate Change Canada
- **Melissa Vance**, Environment & Climate Change Canada
- **John Virgl**, Golder Associates

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Environment and Climate Change Canada

Natural Resources Canada

In Partnership with:

Carleton University

Golder Associates

Inuit Tapiriit Kanatami

John Wood Group PLC

National Council for Air and Stream Improvement

Sahtú Renewable Resources Board

Sustainable Forestry Initiative

Wildlife Conservation Society Canada

CONFERENCE PROGRAM

- **Cheryl Johnson**, Environment & Climate Change Canada | Chair
- **Mathieu Leblond**, Environment & Climate Change Canada
- **Erin Neave**, Environment & Climate Change Canada
- **Amit Saxena**, Devon Energy Corp.
- **Darren Sleep**, National Council for Air & Stream Improvement; Sustainable Forestry Initiative Inc.
- **Melissa Vance**, Environment & Climate Change Canada

COMMUNICATIONS, SOCIAL EVENTS & CONFERENCE ACTIVITIES

- **Salena Angelo**, Natural Resources Canada
- **Lindsay Crawford**, Environment & Climate Change Canada
- **Margaret Sawatzky**, Environment & Climate Change Canada
- **Emmelie Paquette**, Carleton University

EVENT PLANNING & GRAPHIC DESIGN

David Dunlop & **Susan Ball-Dunlop**
D. R. Dunlop & Associates, Inc.

INDIGENOUS PARTICIPATION

- **Micheline Manseau**, Environment & Climate Change Canada | Chair
- **Walter Bezha**, Sahtú Renewable Resources Board
- **John Cheechoo**, Inuit Tapiriit Kanatami
- **Valérie Courtois**, Indigenous Leadership Initiative
- **Daniel Kanu**, Food Matters Manitoba
- **Gita Ljubicic**, Carleton University
- **Eric Loring**, Inuit Tapiriit Kanatami
- **Erin Neave**, Environment & Climate Change Canada
- **Michael Neyelle**, Sahtú Renewable Resources Board
- **Deborah Simmons**, Sahtú Renewable Resources Board
- **Kendra Tagoona**, Inuit Tapiriit Kanatami
- **Justina Ray**, Wildlife Conservation Society Canada

SPONSORSHIP

- **Megan Hazell,** John Wood Group PLC | Chair
- **Al Arsenault**, John Wood Group PLC
- **John Virgl**, Golder Associates
- **Darren Sleep**, National Council for Air & Stream Improvement; Sustainable Forestry Initiative Inc.

Thank You to Our SPONSORS

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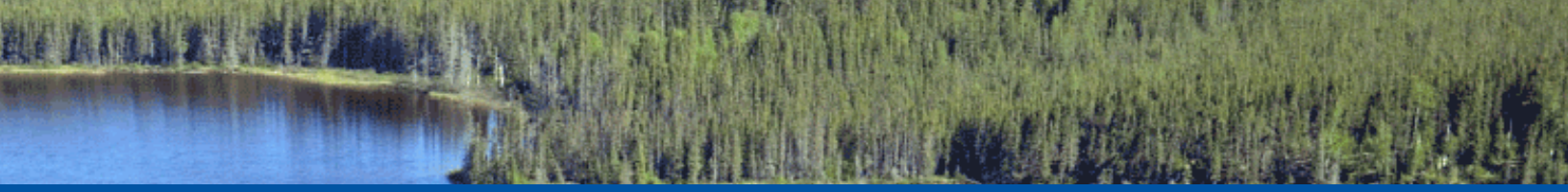
INUIT TAPIRIIT KANATAMI

CARIBOU • BIODIVERSITY • HISTORY • CULTURE • PARTNERSHIPS

WWF



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CONTRIBUTORS

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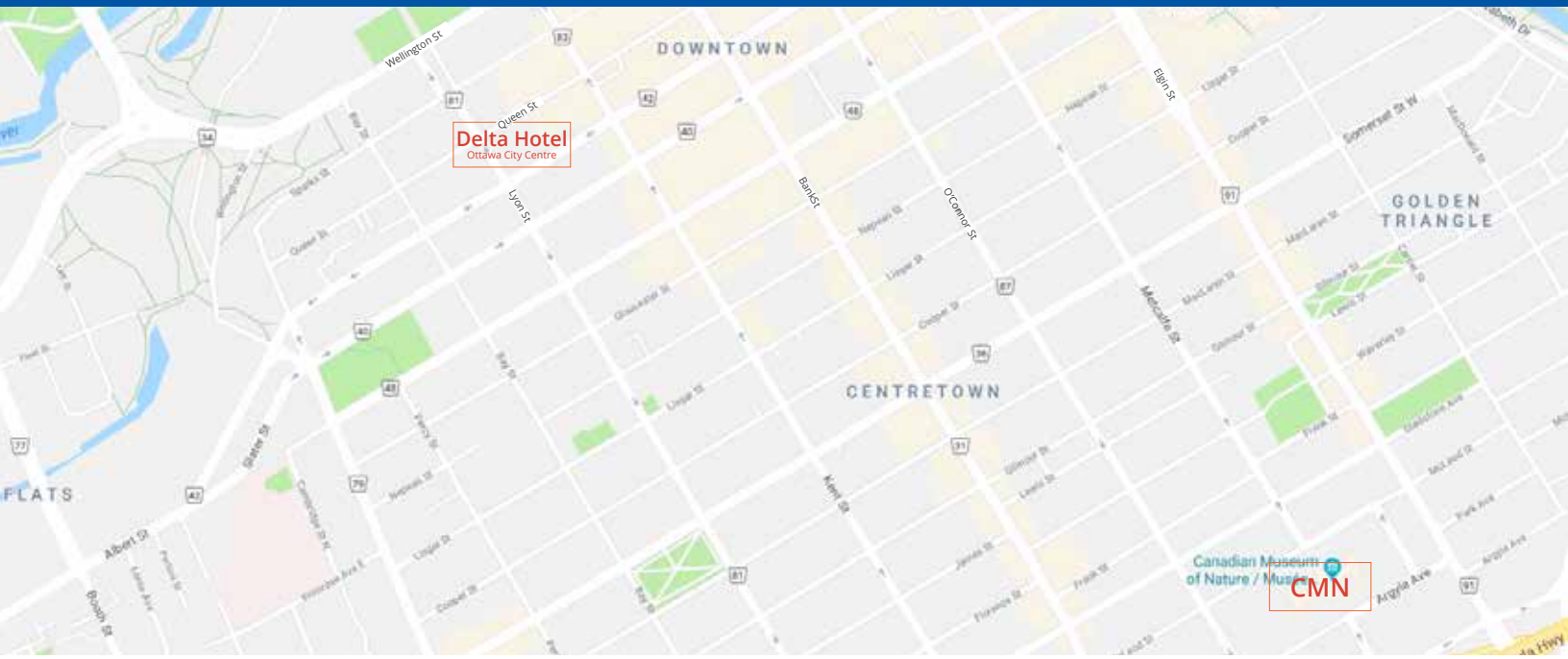
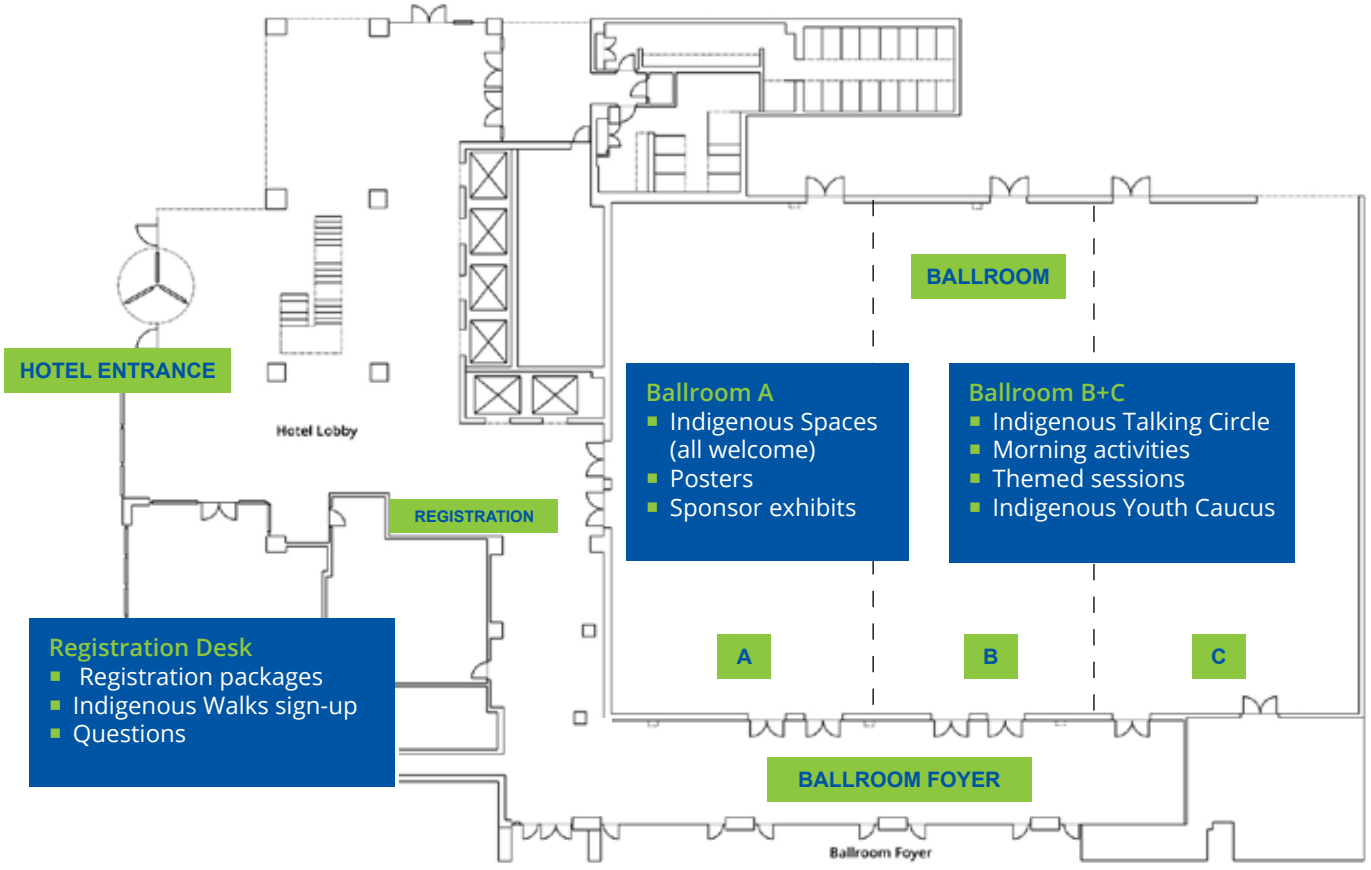
Notes

Conference MAP & FLOOR PLANS



LOBBY Level

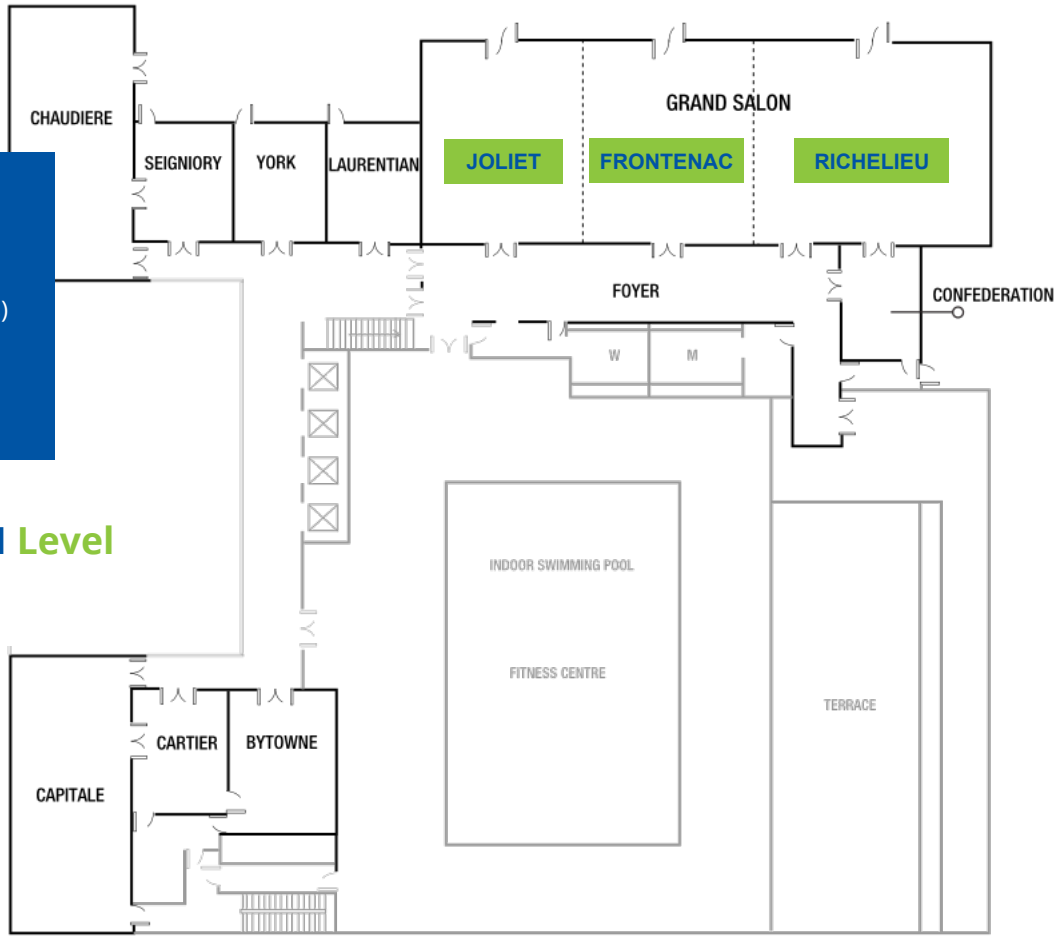


Joliet Room
Indigenous Filming
(limited access)

Frontenac Room
Media Room (limited access)

Richelieu Room
- Indigenous Youth Caucus
- Climate Change 101

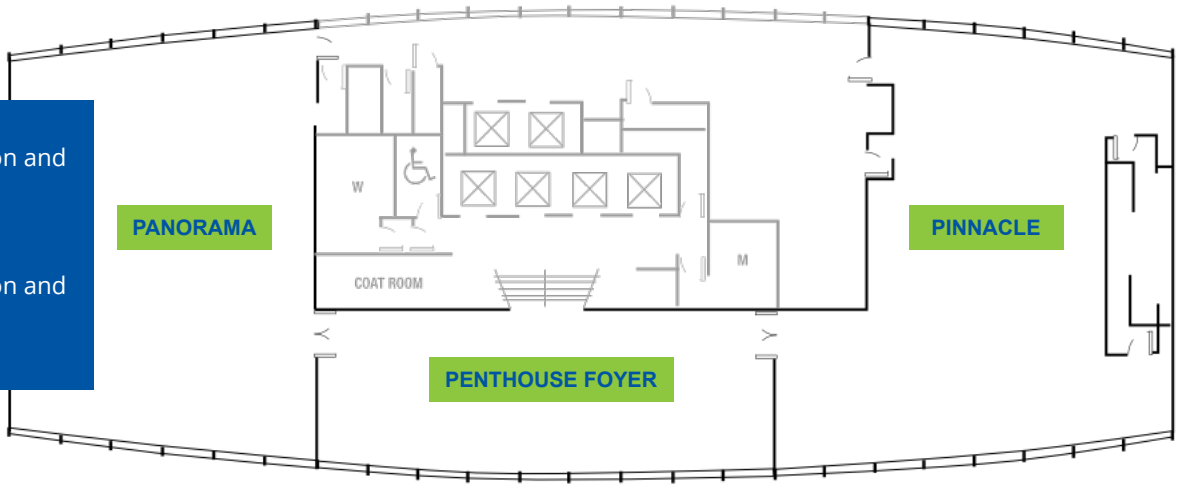
CONVENTION Level



PENTHOUSE Level

Panorama Room
- Opening Reception and Poster Session
- Themed Sessions

Pinnacle Room
- Opening Reception and Poster Session
- Themed Sessions



PROGRAM SNAPSHOT

	SUNDAY October 28	MONDAY October 29	TUESDAY October 30	Wednesday October 31	THURSDAY November 1	Friday November 2
MORNING	Public Programming	Pre-Conference Workshops	Opening Prayer and Welcome	Invited Storyteller and Announcements	Invited Storyteller and Announcements	Post-Conference Activities
			Plenary Session | Armchair Panel	Themed Sessions	Themed Sessions	
AFTERNOON			Themed Sessions			
					Closing Event and Business Meeting	
EVENING		Opening Reception & Poster Session and Indigenous Youth Caucus	Indigenous Walks, Making Connections and Indigenous Youth Caucus	Banquet	Public Programming	

PLEASE NOTE. Most 17th North American Caribou Workshop sessions and activities take place at the Delta Hotel Ottawa City Centre, at 101 Lyon Street, with the exception of the following:

- Public Programming (Sunday and Thursday) at the Canadian Museum of Nature (240 McLeod St.)
- Banquet (Wednesday) at the Canadian Museum of Nature (transportation provided)
- Post-conference activities at various locations (transportation provided)

Conference AGENDA

SUNDAY, OCTOBER 28, 2018

PRE-CONFERENCE PUBLIC PROGRAMMING

10:00 – 16:00 Family Friendly Public Programming . . ***Connexions Space, Arctic Gallery**, 4th Floor, Canadian Museum of Nature*

REGISTRATION

17:00 – 20:00 Registration . . . . . ***Registration Desk**, Lobby, Delta Hotel*

PRE-CONFERENCE | PUBLIC PROGRAMMING

The Canadian Museum of Nature welcomes everyone to this family-oriented event celebrating caribou from both ecological and cultural perspectives. Visit the 'touch and feel' station to interact with caribou hoofprints, antlers, and more; chat with experts at the 'science station' about caribou ecology; and visit the 'cultural station' to discuss the importance of caribou to Indigenous peoples.

Admission to the Museum of Nature is $14.50 for adults and $12.50 for students. Admission includes access to not only the caribou event but also to all the exhibits at the Museum, such as the Arctic, Fossil, Water, Earth, Nature Live, Mammal, and Bird Galleries. Access to additional special exhibits such as Butterflies in Flight are available at extra cost.

Photo courtesy of Great Canadian Wildlife Adventures

Conference AGENDA

MONDAY, OCTOBER 29, 2018

REGISTRATION

07:30 – 20:30	Registration	***Registration Desk**, Lobby Level*

PRE-CONFERENCE WORKSHOPS

08:30 – 16:30	Climate Change 101	***Frontenac Rm**, Convention Level*
	Indigenous Talking Circle	***Ballroom B**, Lobby Level*

EVENING ACTIVITIES

18:00 – 21:00	Opening Reception and Poster Session	***Penthouse** Level*
20:00 – 21:30	Indigenous Youth Caucus	***Richelieu Rm**, Convention Level*

PRE-CONFERENCE WORKSHOP | Climate Change 101

The primary focus for this workshop will be to increase awareness of available climate data, the uncertainty in that data, and to develop more robust analyses to forecast the effects of climate change on caribou. This full-day workshop will cover four main themes that will provide an overview of: 1) climate data and future climate scenarios available for ecological modelling; 2) forecasting future changes in sea ice and snow conditions; 3) forecasting future changes in fire regimes and vegetation; and 4) the different analytical approaches available for modelling wildlife responses to climate change. These themes will help provide ecologists with the necessary background to better understand the uncertainties, assumptions and limitations to climate change research to improve interpretation of modelled outputs.

The workshop will be co-led by a group of experts in the field of climate change research, including:

- **Greg Flato**, Research Scientist, Climate Change Research Division of Environment and Climate Change Canada, with expertise on climate data and climate projections;
- **Chris Derksen**, Research Scientist, Climate Change Research Division of Environment and Climate Change Canada, with expertise on quantifying observed historical changes to the cryosphere and developing climate models projections of a changing cryosphere;
- **Marc-André Parisien**, Research Scientist, Natural Resources Canada, Canadian Forest Service, Northern Forestry Centre, with expertise on fire research; and,
- **Mark Hebblewhite**, Professor in the Wildlife Biology Program of the Department of Ecosystem and Conservation Sciences, W. A. Franke College of Forestry and Conservation, University of Montana, with expertise in modelling wildlife responses to climate change.

PRE-CONFERENCE WORKSHOP | Indigenous Talking Circle

At the 13th North American Caribou Workshop in 2010, John Zoe emphasized the value of the Talking Circle for coming together, learning together, and thus enhancing our shared understanding of caribou and modelling an important collaborative process for the next generation. For the NACW 2018, Indigenous leaders will reconvene participants in a Talking Circle to reflect on the past decade and to share experiences and perspectives in ways that provide opportunities for, and promote the importance of, Indigenous leadership in conservation and management. This includes learning from and identifying intersections between Indigenous Knowledge and scientific approaches, encouraging more sharing of experiences with caribou, discussing how people and caribou relate, reflecting on the role of Indigenous youth as present and future caribou stewards, and building skills in evidence-based and culturally appropriate conservation efforts. The Talking Circle is a full-day event and represents a unique opportunity for Indigenous knowledge holders and other conference participants to discuss approaches taken across North America in "working together" for caribou.

The Indigenous Talking Circle will be facilitated by:

- **Walter Bezha**, Déljnę Got'jnę Government
- **Valérie Courtois**, Indigenous Leadership Initiative
- **John B. Zoe**, Tłı̨chǫ Government

EVENING ACTIVITY | Opening Reception and Poster Session

See next page for Poster Presentations List.

Join us on the Penthouse Level on Monday evening for stunning views of the city, stimulating discussions about caribou research and knowledge, an amazing drum and dance performance, and delicious food and drink. Posters will be displayed prominently and grouped by topic throughout the reception; attendees are encouraged to circulate among them all. Partway through the evening, Nunavut Sivuniksavut will perform Inuit drumming and dances in both the Pinnacle and the Panorama Room. Party-style refreshments and a drink ticket are included in your conference registration.

Nunavut Sivuniksavut (NS) is a unique eight-month college program based in Ottawa. NS is for Inuit youth who want to prepare for the educational, training, and career opportunities that are being created by the Nunavut Land Claims Agreement (NLCA) and the new Government of Nunavut. Since 2003, NS has been offering a second year of study for those students wanting to deepen their understanding of Inuit history and current issues, and/or prepare more specifically for college or university. Students also continue to develop their skills in Inuktitut, research and writing. Students take at least one Inuit-specific course each semester at NS; their remaining courses are delivered by Carleton University, Algonquin College, and/or the University of the Arctic. Students use NS as their home base, but otherwise manage their schedules like typical college/university students.

EVENING ACTIVITY | Indigenous Youth Caucus

Indigenous youth are well aware of the importance of caribou to their peoples, lands, and cultures, and also of the serious risks posed to caribou populations by climate change, land disturbance, and other pressures. Indigenous youth will host a daily discussion for youth participants to reflect on the day's events, share experience and knowledge from their lands and nations, and strategize on protecting the environment for future generations. These sessions are by youth and for youth, and will be a welcoming space where youth can speak freely with their peers about their issues and ideas. This is a valuable opportunity for youth participants to meet other young people, and to build working relationships that will continue beyond the life of the conference. This will also be used as a forum for the Youth Caucus to prepare a statement/presentation to the final plenary and a draft contributory text for the Indigenous Call to Action.

POSTER PRESENTATIONS

PINNACLE ROOM

Nutrition & Reproduction

- Causal links between vegetation and nutritional limitations for caribou during summer in montane and boreal ecosystems of northeastern British Columbia | Presenter: **Kristin Denryter**
- Indirect consequences of shrubification on summer forage of caribou
- Diet composition of the Atlantic-Gaspésie caribou: insights from stable isotope analyses | Presenter: **Evelyne Lemay**
- Nutritional condition indices for caribou: evaluating accuracy, precision and sensitivity | Presnter: **John Cook** on behalf of **Rachel Cook**
- Multi-regional comparisons among caribou populations reveal geographic patterns of nutritional condition and pregnancy in Ontario, British Columbia, and Northwest Territories | Presenter: **John Cook**

Demographic and Predator-Prey Models

- Environmental determinants of adult survival in migratory tundra caribou | Presenter: **Barbara Vuillaume**
- Demographic Response of Northern Mountain Caribou to Habitat Disturbance (Rangifer tarandus caribou) | Presenter: **Jared Gonet**
- A simple, empirically-linked demographic model to estimate likelihoods of recovering populations of boreal caribou (Rangifer tarandus caribou) | Presenter: **Eliot McIntire**
- Wolf recolonization leads to functional extirpation of caribou on Michipicoten and the Slate Islands, Ontario | Presenter: **Brent Patterson**

Structure of Caribou Populations

- Using genetics in conservation planning for Boreal Woodland Caribou (Rangifer tarandus caribou) | Presenter: **Pauline Priadka**
- Do biotic interactions inform the spatial distribution of coexisting ungulates in the Canadian Arctic Archipelago? | Presenter: **Deborah Jenkins**
- Multiple cycles of vicariance events, expansion, and admixture in western North America led to the evolution and diversification in caribou | Presenter: **Cornelya Klutsch**
- Evolutionary History of Ontario's Southern Boreal Caribou Caribou | Presenter: **Kirsten Solmundson**

PINNACLE ROOM

Space Use & Movements

- Biting flies alter the activity of caribou in the boreal forest forest | Presenter: **David Beresford**
- Natal habitat preference induction in caribou – Like mother, like child? | Presenter: **Benjamin Larue**
- Preliminary identification and evaluation of woodland caribou birth sites in northern Ontario | Presenter: **Phil Walker**
- Reindeer energetics, movement, and demography | Presenter: **Rebecca Viejou**
- Fine-scale habitat selection of female caribou in summer, using camera collars | Presenter: **Sophiane Béland**

Population Monitoring & Range Planning

- Implementation of a long-term boreal caribou monitoring program in Quebec : gaining better information for taking better actions | Presenter: **Claude Dussault**
- Past, present and future of migratory caribou herds in northern Québec | Presenter: **Joëlle Taillon**
- Developing a Framework for boreal caribou range planning in the NWT | Presenter: **James Hodson**

Community-Based Monitoring, Management, & Conservation

- Highlighting the diversity of Indigenous initiatives related to caribou management: building a national synthesis | Presenter: **Solange Nadeau**
- Caribou Co-management in the Kivalliq | Presenter: **Ezra Greene**
- A double observer method to model variation in sightability of caribou in calving ground surveys | Presenter: **David Lee**
- Working together to study population trends of the Torngat Mountains caribou herd (DU10) | Presenter: **Meredith Purcell**
- Caribou Conservation: Bridging Two Worlds | Presenter: **Stephanie Brown**
- Incorporating Inuit Qaujimajatuqangit (IQ) into Baffin Island Caribou Management | Presenter: **John Ringrose**
- The Keeyask Caribou Coordination Committee: Using traditional knowledge and science to understand project effects on caribou in northern Manitoba | Presenters: **Rachel Boone** and **Jimmy Lockhart**

Storytelling

- The importance of caribou to the outfitting community | Presenter: **Scott Ellis**

...continued POSTER PRESENTATIONS

PANORAMA ROOM

Decision Making in Caribou Conservation: Ideas & Opportunities

- A collaborative grassroots approach to securing positive Boreal Caribou outcomes, in Northwest Alberta | Presenter: **Lisa Wardley**
- Forest Landscape Restoration | Presenter: **Nicholas Mansuy**
- Where should we invest conservation resources to maximize the probability of long-term boreal caribou persistence?: An optimization approach | Presenter: **Amanda Martin**
- Should we give up isolated caribou populations at the southern limit of the species distribution? – The case study of Val-d'Or herd in Quebec | Presenter: **Serge Couturier**
- National Boreal Caribou Knowledge Consortium: collaborating to support boreal caribou conservation and recovery | Presenter: **Tatyana Flick**

Habitat Restoration & Management Interventions

- Technical considerations for a large predator exclosure as an innovative solution for boreal caribou recovery | Presenter: **John Nishi**
- Developing and Monitoring the Efficacy of Functional Restoration of Linear Features for Boreal Woodland Caribou Caribou | Presenter: **Noemie Jenni** on behalf of **Jonah Keim**
- Developing a Restoration Plan for BC's South Peace Northern Caribou (SPNC) | Presenter: **Scott Schilds**
- Assessment of Remote Sensing-Based Lichen Discriminators across Northern Canada | Presenter: **Blair Kennedy**
- Assessing the wolf numerical response to a moose reduction experiment in central British Columbia | Presenter: **Michael Klaczek**
- Initial predator-prey behavioural responses to silvicultural restoration of linear features in the Cold Lake area, Alberta, Canada | Presenter: **R. Scott McNay**
- Application of novel caribou transport techniques for successful long-distance translocation of woodland caribou | Presenter: **Owen Slater**
- Restoring Cladonia subgenus Cladina in disturbed environments | Presenter: **Sean Rapai**

Forecasting Future Landscapes

- Estimating forage lichen biomass recovery in forest stands of northwestern Canada: A collaboration | Presenters: **Ruth Gruel** and **Geneviève Degré-Timmons**
- Meeting forest age class targets for caribou under a changing climate | Presenter: **Daniel McKenney** on behalf of **John Pedlar**
- A population demography modeling tool to explore harvest management scenarios for the Fortymile caribou herd | Presenter: **Josie Hughes**
- Using lichen biomass to map suitable caribou foraging habitat in northeastern Alberta | Presenter: **Ashley Hillman**

PANORAMA ROOM

Impacts of Disturbance

- The density of anthropogenic features explains seasonal and behaviour-based functional responses in selection of linear features by a social predator | Presenter: **Karine Pigeon**
- The effects of forest fires on woodland caribou in the Sydney Range | Presenter: **Joseph Silva**
- Spatiotemporal response of mountain caribou to the intensity of backcountry skiing | Presenter: **Martin-Hugues St-Laurent** on behalf of **Frédéric Lesmerises**
- Potential Impacts of Sea Ice and Ship Traffic Changes on Caribou Migratory Routes Surrounding King William Island, Nunavut | Presenter: **Emmelie Paquette**
- Mobile Caribou Conservation Measures; an option to manage exploration-related disturbance to caribou | Presenter: **Kim Poole**
- The Influence of the Meadowbank Mine on Caribou Seasonal Habitat Use | Presenter: **Corey De La Mare** on behalf of **Jaewoo Kim**
- Habitat versus anthropogenic disturbance - relative influence on woodland caribou area use in the Boreal Shield of Saskatchewan | Presenter: **Michael Charlebois** on behalf of **Diress Tsegaye**
- Effects of Habitat Alteration on Caribou Terrestrial Lichens in Central British Columbia | Presenter: **Deborah Cichowski**
- Variation in consumption of caribou and moose by wolves evaluated against landscape disturbances: influence of linear features and forestry | Presenter: **Christa Dubesky**

Measuring the Anthropogenic Footprint

- Planning wind farms in Norway - the wild reindeer aspect | Presenter: **Frode Johansen**
- Mapping Forestry-Related Risk to Mountain Caribou in British Columbia | Presenter: **Mark Hebblewhite** on behalf of **Candace Batycki**
- Satellite observations for detection of dust from mining activity in a caribou habitat | Presenter: **H. Peter White**
- How far can barren ground caribou see mining operations in Canada's Arctic? | Presenter: **Wenjun Chen**

Storytelling

- In predator's clothing: The summer I dressed as a bear and spooked Newfoundland caribou | Presenter: **Kathy Unger**

Notes

Notes

Conference AGENDA

TUESDAY

TUESDAY, OCTOBER 30, 2018

REGISTRATION

07:30 – 20:30	Registration . . . . . ***Registration Desk**, Lobby Level*

OPENING and PLENARY SESSION

09:00 – 09:30	**Opening Prayer** | **Claudette Commanda** of the Kitigan Zibi Anishinabeg First Nation **Welcoming Remarks** | **Sean Fraser**, Parliamentary Secretary to the Minister of Environment and Climate Change **Daily Announcements** | NACW Organizing Committee ***Ballroom B+C**, Lobby Level*
09:30 – 10:00	**BREAK** . . . . . ***Ballroom Foyer**, Lobby Level*
10:00 – 12:00	Plenary Session | Armchair Panel . . . . . ***Ballroom B+C**, Lobby Level*
12:00 – 13:00	**LUNCH** . . . . . ***Ballroom Foyer**, Lobby Level & **Penthouse Foyer*** Lunchtime Discussion with **Beth McNeil**, Assistant Deputy Minister, Natural Resources Canada, 12:30-12:45 . . . . . ***Pinnacle**, Penthouse*

THEMED SESSIONS

13:00 – 14:45	Indigenous Leadership in Conservation . . . . . ***Ballroom B+C**, Lobby Level* Population Monitoring and Modelling I . . . . . ***Pinnacle**, Penthouse* Ecological Footprint of Disturbance . . . . . ***Panorama**, Penthouse*
14:45 – 15:15	**BREAK** . . . . . ***Ballroom Foyer**, Lobby Level & **Penthouse Foyer***
15:15 – 17:00	Habitat Restoration . . . . . ***Ballroom B+C**, Lobby Level* Population Monitoring and Modelling II . . . . . ***Pinnacle**, Penthouse* Indigenous Knowledge Informs Policies . . . . . ***Panorama**, Penthouse*

INDIGENOUS WALKS

17:30-19:00	Indigenous Walks. . . . . Registration Desk, Lobby Level

EVENING ACTIVITIES

18:30 – 20:30	Making Connections . . . . . ***Pinnacle** & **Panorama** Rooms, Penthouse*
20:00 – 21:00	Indigenous Youth Caucus. . . . . ***Ballroom B+C**, Lobby Level*

PLENARY SESSION | Armchair Panel

Panelists share their views about and experiences working together for caribou conservation and recovery in an informal armchair discussion.

Plenary Session Moderator

AMANDA SHEEDY
Co-Director, MetaLab Creations

A well-respected change agent and leader in the food movement, Amanda is recognized for her collaborative style and ability to work with a diversity of people, organizations and opinions to address complex problems. During her time as the Director of Engagement and Development at the national non-profit Food Secure Canada, she successfully established and led numerous projects, coalitions as well as a pan-Canadian engagement methodology. She recently co-founded MetaLab, where she supports organizations to work across different sectors and between governments and Indigenous organizations. Over the last 2 years, she has had the honour to support numerous Inuit organizations and others to elaborate policies, positions and plans on issues of food security, social policy, wildlife management and food sovereignty.

Armchair Panel Speakers

Note: Speakers are presented alphabetically by last name.

ADAMIE DELISLE-ALAKU
Executive Vice-President, Department of Environment, Makivik Corporation

Mr. Adamie Delisle-Alaku finished his education in his hometown of Salluit, Nunavik (Quebec). Adamie worked at the Raglan mine for 10 years for Kiewit Nuvumiut, initially as human resources coordinator and thereafter as a general open-pit foreman. Prior to being employed at Makivik Corporation, Adamie was a volunteer fireman, and was an active first responder in his home community.

Adamie joined Makivik Corporation in 2011 as Executive Assistant to then Vice President, Mr. Johnny Peters. He was elected as Executive Vice-President in 2014. He leads the department that looks after protecting Inuit harvesting rights, in addition to protecting the integrity and processes of the Land Claims Agreements.

In this position, he has developed a broad understanding of wildlife issues and the various challenges related to renewable resources facing Nunavik Inuit. He has shown great devotion in ensuring Nunavimmiut are heard and are well represented at the regional, national and international levels, including fora such as the Arctic Circle, Polar Bear Range State meetings, CITES and various conferences and lobbying efforts abroad. He is in charge of the state-of the-art Nunavik Research Centre in Kuujjuaq whose staff, amongst other priorities, monitor and collect land use & ecological data in the Nunavik region. Research is undertaken on the quality of country foods, environmental studies are conducted and management strategies are developed for various wildlife species. The facilities are equipped to conduct trace metal analysis, study of zoonoses and include both wet and dry labs, as well as cartographic and seabed mapping equipment.

... continued PLENARY SESSION | Armchair Panel

He is currently a member of the Hunting Fishing Trapping Coordinating Committee (HFTCC) where he has been active for the past seven years including Chairmanship during 2013 and 2017. He is equally co-chair of the Ungava Peninsula Caribou Aboriginal Roundtable (UPCART) since 2013.

He is currently a Board of Director to the Société du Plan Nord, the Co-operative Management Board to the Torngat Mountains National Park, and ArcticNet. Most recently, in July 2017, Mr. Delisle-Alaku was appointed for a four-year term as board member to Polar Knowledge Canada, where his experience regarding arctic research issues will be well served. In his elected capacity at Makivik, Adamie is committed to ensuring he represents the best interests of Inuit regarding cultural ties to the land and Nunavik's renewable resources. Mr. Delisle-Alaku is a former Director of: Air Inuit, First Air, Nunavik Creations, Halutik Enterprises, Nunavik Geomatics, Nunacell, and Kautaq Construction.

DAVE HERVIEUX

Regional Resource Manager – Peace Region, and Provincial Caribou Management Coordinator, Government of Alberta

Dave has been involved in caribou-related work since 1980. First with the Canadian Wildlife Service in the arctic and for the last 35 years with the Government of Alberta. As Alberta's Woodland Caribou Specialist, Dave has had a part in all woodland caribou conservation and management activities that have occurred in Alberta during the last decades. In addition Dave has had considerable involvement in many national scale processes related to woodland caribou.

NIALL O'DEA

Associate Assistant Deputy Minister, Canadian Wildlife Service, Environment and Climate Change Canada

Dr. Niall O'Dea was appointed Associate Assistant Deputy Minister for the Canadian Wildlife Service in March 2018. Before assuming this role, Dr. O'Dea was the Director General of Electricity Resources at Natural Resources Canada. In 2011, he joined Natural Resources Canada as Director of Climate Change Impacts and Adaptation. Niall joined the Government of Canada in 2006, working first at Environment Canada on policy, legislative and regulatory proposals for reducing industrial greenhouse gas emissions and subsequently at the Privy Council Office providing advice to the Prime Minister, Cabinet and the Clerk of the Privy Council on proposals and policy issues under the responsibility of the Minister of Fisheries and Oceans, the Minister of Natural Resources and the Minister of the Environment. Dr. O'Dea completed undergraduate degrees in biology and philosophy at Memorial University of Newfoundland, and a masters and doctorate at Oxford University as a Rhodes Scholar. His post-graduate work focused on understanding and managing the impacts of deforestation on cloud forests in the Ecuadorian Andes.

RACHEL PLOTKIN

Wildlife Advocate, David Suzuki Foundation

Rachel Plotkin left her position as the Director of the Forests and Biodiversity program at the Sierra Club of Canada where she had worked for six years to join the David Suzuki Foundation team in 2006.

Over her 18+ years work to protect wildlife and wildlife habitat, Rachel was involved in the development of the federal Species at Risk Act and Ontario's Endangered Species Act and has since played the role of a watchdog on implementation. Rachel was appointed as a member of Ontario's Species at Risk Program Advisory Committee and the federal Species at Risk Advisory Committee to the Minister when both committees were first struck. She was also appointed to the Advisory Group on the national Recovery Strategy for Boreal woodland caribou and participated in the 2008 workshop that informed the first Scientific Review for the Identification of critical Habitat for Boreal Woodland Caribou.

Most of Rachel's work is collaborative; she works with conservation colleagues, industry and Indigenous Peoples to advance wildlife recovery, including caribou recovery. For example, she recently worked with Doig River First Nation in British Columbia to produce a report that gathered traditional knowledge from elders to identify priority areas for habitat restoration. Rachel holds a Master's degree in Environmental Studies from York University and a teaching degree in Outdoor and Experiential Education from Queen's University. Her heart is in Gatineau park.

AMIT SAXENA
Senior Technical Lead for Wildlife, Biodiversity and Land, Devon Canada Corporation

Amit Saxena is currently the Senior Technical Lead for Wildlife, Biodiversity and Land with Devon Energy Corporation's Canadian Division (Devon Canada Corp.) Amit is a professional wildlife biologist with over 25 years of experience in wildlife research, species at risk recovery and planning, human-wildlife conflict resolution, environmental impact assessment, land use planning, environmental permitting and regulatory management, and environmental education. Amit might be considered a large carnivore expert by trade, having worked as a carnivore biologist for Parks Canada, the US Forest Service and the US Fish and Wildlife Service, where his focus was largely on wolves, bears and human-wildlife interactions in the early part of his career. During that time, Amit worked intensively on the reintroduction of gray wolves to Yellowstone and red wolves to the Carolinas, development of some of the first bear safety and awareness education programs, and was a lead researcher for the USFS feasibility assessment of woodland caribou reintroduction to Superior National Forest in Minnesota in the early 1990s. As a consulting ecologist and biophysical team lead, Amit has worked on and coordinated some of the largest and most complex environmental assessments in the world, mostly on energy, resource, pipeline and infrastructure projects in western and northern Canada. Since joining Devon Canada Corp., Amit has led the development of best-in-class BearSmart and other wildlife mitigation programs for energy sector activities, most recently in the oil sands region of Northeastern Alberta. Amit has represented both Devon and the energy sector as a whole on numerous industry associations and multi-stakeholder collaborations over the past many decades, including regional land use plans, biological monitoring programs, traditional use studies, and caribou range planning teams. Over the past 10 years, Amit has been a key contributor to many caribou-related initiatives led or conducted by the Canadian Association of Petroleum Producers (CAPP) and Canada's Oil Sands Innovation Alliance (COISIA). He is currently the energy sector representative on the federal Species At Risk Advisory Committee (SARAC), the Chair of COSIA's Caribou Working Group, and the Chair of the Regional Industry Caribou Collaboration (RICC), a group of energy and forestry companies collaborating on caribou recovery initiatives in the oil sands region of Alberta.

THEMED Sessions

TUESDAY, October 30 | 13:00 – 14:45

TUESDAY

BALLROOM B+C	PINNACLE ROOM	PANORAMA ROOM
Indigenous Leadership in Conservation	**Population Monitoring and Modelling I**	**Ecological Footprint of Disturbance**
The challenges and rewards with implementing a community-based caribou conservation plan | Presenter: **Walter Bezha** on behalf of **Sjoerd van der Wielen**	Conserving caribou through a multi-species approach to density estimation using camera traps and spatial count models | Presenter: **Joanna Burgar**	Noise measurement and propagation to help refine the zone of influence of mining activities on caribou | Presenter: **Sylvain Leblanc**
Trails of the Mountain Caribou: Renewing Indigenous Relationships in Conservation | Presenter: **Leon Andrew**	Temporal patterns in boreal caribou mortality: factors limiting caribou survival in an intact environment | Presenter: **Allicia Kelly**	Implementation of a terrestrial advisory group at the Agnico Eagle Meadowbank Mine, Nunavut | Presenter: **Ryan Vanengen**
34 years of caribou co-management: an Inuvialuit retrospective | Presenter: **Vernon Amos** on behalf of **Inuvialuit Game Council**	Potential for competition between eastern migratory caribou and muskoxen in Nunavut | Presenter: **Alexis Brodeur**	Death and disturbance? Predators and landscape features associated with central mountain caribou mortalities | Presenter: **Tracy McKay**
Co-management of Cape Bathurst, Bluenose-West, and Bluenose-East caribou herds: 17 communities, 2 territories and 6 land claim areas working together | Presenters: **Édouard Bélanger, Aimee Guile**, and **Laura Meinert**	Genetic influences on male and female variance in reproductive success and implications on the recovery of severely endangered mountain caribou | Presenter: **Samantha McFarlane**	Historical exposure to wildfires shapes the response of boreal caribou to timber harvesting: reliable cues and maladaptation | Presenter: **Martin-Hugues St-Laurent**
Cold Lake First Nations is Making Key Contributions to Boreal Woodland Caribou Range Planning in Alberta | Presenter: **Findlay MacDermid**	An integrated population model to assess population status and population augmentation scenarios | Presenter: **Anna Moeller**	Variation in habitat selection strategies of woodland caribou in burns | Presenter: **Kelsey Russell**
Fort Nelson First Nation's MAP: How UNDRIP and governments *CAN* work together to protect caribou. We hope. | Presenter: **Katherine Capot-Blanc**	Non-invasive monitoring of caribou: embracing new technologies | Presenter: **Micheline Manseau**	Losing sight of the forest for the caribou? Why we need to know more about species-habitat interactions when managing for woodland caribou | Presenter: **Philip McLoughlin**

THEMED Sessions

TUESDAY, October 30 | 15:15 – 17:00

BALLROOM B+C	PINNACLE ROOM	PANORAMA ROOM
Habitat Restoration	**Population Monitoring and Modelling II**	**Indigenous Knowledge Informs Policies**
Sharing the landscape: how the Regional Industry Caribou Collaboration are working together | Presenter: **Michael Cody**	Large-scale synchrony and climate drivers of barrenground caribou migration across North America | Presenter: **Eliezer Gurarie**	Porcupine Caribou Management Board's role in co-management | Presenter: **Joe Tetlichi**
Seismic line restoration influences large mammal line use in short-term: implications for caribou conservation in northern Alberta | Presenter: **Erin Tattersall**	Cape Churchill caribou seasonal habitat use and seasonal migrations within the Wapusk National Park MB | Presenter: **Cassidy Maidment** on behalf of **Derek Leask**	Taking care of caribou: weaving Indigenous Knowledge in the Bathurst Caribou Management Plan | Presenter: **Natasha Thorpe**
Building a Centre of Excellence in Restoration Practice | Presenter: **Katalijn MacAfee**	Analysis of environmental, temporal, and spatial factors affecting demography of the Bathurst caribou herd | Presenter: **John Boulanger**	Development of the Bathurst Caribou Range Plan | Presenter: **Dan Ohlson**
Working together to implement caribou habitat restoration: a case study | Presenter: **Paula Bentham**	Monitoring caribou - road interactions in Nahanni and Nááts'ihch'oh National Park Reserves using remote cameras | Presenter: **Sarah Arnold**	Sayisi Dene and Caribou - Working in Partnership to Conserve the Seal River Watershed - Winter Habitat of the Qaminuriak Caribou Herd | Presenter: **Ernie Bussidor**
Linear features and caribou declines: understanding the mechanisms and predicting restoration efficiency | Presenter: **Melanie Dickie**	Effects of capture and collaring on barren-ground caribou movement rates | Presenter: **Xavier Giroux-Bougard**	When the Caribou do Not Come: Indigenous Knowledge and Adaptive Management in the Western Arctic | Presenter: **Brenda Parlee**
Innovation, incentives, and a path to more efficient and effective restoration | Presenter: **Matthew Pyper**	Landscape/range level indicator for self-sustaining boreal caribou populations | Presenter: **Arthur Rodgers**	Honouring the spirit and intent of Land Claims co-management in the Canadian North | Presenter: **Paul Irngaut**

LUNCH | Lunchtime Discussion with Beth MacNeil, Assistant Deputy Minister, Natural Resources Canada, Canadian Forest Service

Please join ADM MacNeil in the Pinnacle Room (Penthouse) as she speaks to the conference theme of working together, highlighting Natural Resources Canada's commitment to working collaboratively with many partners (including provinces, territories, Indigenous peoples, industry, academia and NGOs) to conserve caribou and support communities.

EVENING ACTIVITY | Indigenous Walks

If you are interested in experiencing Ottawa from an Indigenous perspective, join one of the Indigenous Walks on Tuesday night! On this guided walking tour you will learn about Indigenous history and traditions in the context of Ottawa's landscape, architecture, art, and monuments. Participation is FREE, but spots are extremely limited (two groups of 30). Registration will be provided on a first-come, first-serve basis beginning at 08:30 on Tuesday at the Registration Desk.

Assemble at the Registration Desk by 17:30 to walk together to the tour start point.

EVENING ACTIVITY | Making Connections

Working together for caribou is not just about sharing knowledge, but also about making connections with others. Join us on Tuesday evening for a night of networking! All are welcome, and students and young professionals are particularly encouraged.

Chat with representatives of different caribou-related career paths, including academia, government (research as well as policy branches), the natural resources industy, ENGOs, and consulting firms. Light refreshments and non-alcoholic beverages will be served.

Photo courtesy of Great Canadian Wildlife Adventures

Notes

Conference AGENDA

WEDNESDAY, OCTOBER 31, 2018

WEDNESDAY

INVITED STORYTELLING and DAILY ANNOUNCEMENTS

09:00 – 10:00	***How Caribou Saved Me*** | David Serkoak
	Daily Announcements | NACW Organizing Committee ***Ballroom B+C**, Lobby Level*
10:00 – 10:30	**BREAK** ..... ***Ballroom Foyer**, Lobby Level & **Penthouse Foyer***

THEMED SESSIONS

10:30 – 12:00	**Modelling Tools to Support Decision-Making** ..... ***Ballroom B+C**, Lobby Level*
	Indigenous Knowledge Informs Management ..... ***Pinnacle**, Penthouse*
	Structure of Caribou Populations ..... ***Panorama**, Penthouse*
12:00 – 13:00	**LUNCH** ***Ballroom Foyer**, Lobby Level & **Penthouse Foyer***
13:00 – 14:45	**Decision-Making in Caribou Conservation:**
	Ideas and Opportunities ..... ***Ballroom B+C**, Lobby Level*
	Indigenous Values in Conservation ..... ***Pinnacle**, Penthouse*
	Caribou Ecology I ..... ***Panorama**, Penthouse*
14:45 – 15:15	**BREAK** ***Ballroom Foyer**, Lobby Level & **Penthouse Foyer***
15:15 – 17:00	**Community-Based Monitoring** ..... ***Ballroom B+C**, Lobby Level*
	Population Management Interventions ..... ***Pinnacle**, Penthouse*
	Caribou Ecology II ..... ***Panorama**, Penthouse*

EVENING ACTIVITY

17:30 – 22:30	**Conference Banquet** ..... ***Arctic Gallery**, 4th Floor, Canadian Museum of Nature*
	Caribou Across North America: Stories from the Land | Susan Morse

INVITED STORYTELLER | David Serkoak | *How Caribou Saved Me*

David Serkoak was born into a traditional Inuit camp on the northern shore of Neultin Lake, south west of Arviat, Nunavut. He lived through the many hardships suffered by his people, the Ahiarmiut, as they were moved from place to place by the Federal Government. Serkoak attended Territorial School in Rankin Inlet and Whale Cove in the 1960s. He moved with his family to Arviat and for a while he worked at promoting art made by local Inuit artists. Serkoak got interested in education when working part-time in the local school. Since 1978 he has taught in elementary school in Arviat, at Nunavut Arctic College in Iqaluit, and at Nunavut Sivuniksavut in Ottawa. Serkoak has also been Curator of the Arctic Exhibition at the British Museum. Serkoak developed Inuktitut teaching materials for every level at which he taught, and has shared his passion for drum making and drum dancing in his teaching and at various events throughout Nunavut, across Canada, and around the world.

WEDNESDAY, October 31 | 10:30 – 12:00

BALLROOM B+C	PINNACLE ROOM	PANORAMA ROOM
Modelling Tools to Support Decision-Making	**Indigenous Knowledge Informs Management**	**Structure of Caribou Populations**
Prioritizing restoration of fragmented boreal landscapes for caribou protection: a graph-theoretic approach | Presenter: **Denys Yemshanov**	Unique modelling approach engages local stakeholders in management of their herd | Presenter: **Christine Cuyler**	All caribou in Canada are currently at risk of extinction | Presenter: **Justina Ray**
Towards a long-term strategy for boreal caribou habitat stewardship: Quebec's approach | Presenter: **Frédéric Bujold**	Innu and Atiku (caribou): a community-driven cumulative impact assessment of caribou decline | Presenters: **Damian Castro et al**	Ecological genomics: a new interdisciplinary tool for the management and conservation of caribou in western North America | Presenter: **Maria Cavedon**
Cycle stratified harvest policies for a sub-population of barren-ground caribou | Presenter: **Eric Bongelli**	Integrating traditional Indigenous knowledge and involvement into resource management and Saskatchewan woodland caribou range planning | Presenter: **Michael McLaughlan**	A genomic refinement of A. W. F. Banfield's 1961 "A Revision of the Reindeer and Caribou, Genus Rangifer" for North American caribou | Presenter: **Paul Wilson**
Linking climate to vital rates for migratory tundra caribou: Carryover effects and regional patterns across North America | Presenter: **Don Russell**	Meaningful community participation in woodland caribou research and recovery in Northern Saskatchewan | Presenters: **Sarah Schmid** and **Robin McLeod**	CSI caribou: ecotype assignment in a wildlife forensics context | Presenter: **Vincent Bourret**
Web-based application for threatened woodland caribou population modelling | Presenter: **Mark Hebblewhite**	Discussion Period	An inter-jurisdictional scan of spatial structure of caribou populations | Presenter: **Steve Wilson**

THEMED Sessions

WEDNESDAY, October 31 | 13:00 – 14:45

BALLROOM B+C	PINNACLE ROOM	PANORAMA ROOM
Decision-Making: Ideas and Opportunities	**Indigenous Values in Conservation**	**Caribou Ecology I**
Where caribou is only a memory | Presenter: **Jeff Wells**	Tributaries of the land | Presenter: **Melissa Mollen Dupuis**	Moose interactions with natural and human-mediated disturbances: implications for quantifying habitat conditions within caribou range | Presenter: **Craig DeMars**
Extirpation despite regulation? How environmental assessment is failing caribou | Presenter: **Rosemary Collard**	On the naturalness of being unnatural: reestablishing the foundations of wildlife management | Presenter: **Leo Lepiano**	A simulation model to predict caribou abundance from movement patterns at landscape scale | Presenter: **Fabian Cid Yanez**
Cumulative Effects on Barren-ground Caribou – Overestimating the Effects and Ignoring the Evidence | Presenter: **Michael Setterington**	Inuit approaches to naming and distinguishing caribou: considering language, place, and homeland towards improved co-management | Presenter: **Gita Ljubicic**	Caribou on the menu: diet reconstruction of wolves and black bears across the ranges of migratory caribou in northern Québec-Labrador | Presenter: **Michaël Bonin**
New opportunities for leveraging boreal caribou conservation and other policy needs across Canada | Presenter: **Courtenay Lewis**	Coming together for caribou: Using community-led audio-visual methods to explore relationships among Inuit and caribou in Labrador | Presenter: **David Borish**	Are caribou on the menu for black bears? An analysis of predator-prey resource selection in Saskatchewan's Boreal Shield | Presenter: **Patricia Tomchuk**
Seeing the forest for the caribou: fostering new science to improve management in Canada's boreal forest | Presenter: **Darren Sleep**	Eh then' | Presenter: **Jean L'Hommecourt**	Classifying caribou migratory behaviour to identify and preserve intraspecies diversity | Presenter: **Jessica Theoret**
Conservation through co-occurrence: woodland caribou as a focal species for boreal biodiversity | Presenter: **Ronnie Drever** on behalf of **Chantal Hutchison**	Discussion period	The relative importance of human disturbances and environmental factors on migratory caribou survival | Presenter: **Sabrina Plante**

THEMED Sessions

WEDNESDAY, October 31 | 15:15 – 17:00

BALLROOM B+C	PINNACLE ROOM	PANORAMA ROOM
Community-Based Monitoring	**Population Management Interventions**	**Caribou Ecology II**
Summary of National Indigenous Guardians Network | Presenter: **Valerie Courtois**	Collaboration in action – averting extirpation of the Klinse-Za caribou herd and the hope for full recovery | Presenter: **Roland Willson**	A burning question: How woodland caribou use burned landscapes in Alberta? | Presenter: **Sean Konkolics**
Athabasca Denesuline Barrenground caribou community monitoring project | Presenter: **Tina Giroux**	Importance of Indigenous engagement for advancing the innovative concept of a large predator exclosure for caribou recovery | Presenters: **Mark Boulton** on behalf of **Lisa Schaldemose**	Resource selection by threatened woodland caribou in a high fire, low human disturbance system | Presenter: **Clara Superbie**
Barren-ground caribou traditional mapping and analysis | Presenter: **Angus Charlo** and **Pamela Wong**	Learning from the near extirpation of the Lake Superior caribou | Presenter: **Gordon Eason**	Examining the effects of disturbance on site fidelity behaviour at multiple scales by caribou (boreal population) in Ontario | Presenter: **Megan Hornseth**
Etthen Hat'ni - Monitoring the Bathurst caribou herd in their winter range | Presenter: **Herman Catholique** on behalf of **Joseph Catholique**	Exploring conservation breeding options for boreal caribou: an IUCN-endorsed multi-stakeholder workshop approach | Presenter: **Amit Saxena**	Analysis of calving locations highlights fidelity to core area for migratory caribou herd | Presenter: **Matthew Cameron**
Population management of Arctic tundra caribou based on Inuit Qaujimajatuqangit: an opportunity lost | Presenter: **Michael Ferguson**	Population response of Central Mountain caribou herds to wolf reduction in British Columbia | Presenter: **Dale Seip**	Quantifying snow characteristics of the winter range of the Central Arctic Herd in northern Alaska | Presenter: **Stine Højlund Pedersen**
Boots on the Ground: Indigenous Knowledge Bathurst caribou monitoring program | Presenter: **Tyanna Steinward**	Using adaptive management to save woodland caribou | Presenter: **Stan Boutin**	Lost in translation? Insights into caribou habitat selection from forest inventory data | Presenter: **Douglas MacNearney**

EVENING ACTIVITY | Conference Banquet

The conference banquet is always one of the highlights of NACW's evening programming. This year the banquet will be held at the Museum of Nature, a historic building of scientific and architectural interest. The banquet will feature a storytelling presentation by the incredible photographer, Susan Morse, and will also include access to the Museum's Arctic Gallery and Northern Voices Gallery.

Your **name badge** will act as your ticket, so remember to bring/wear it!

Getting There | Regular shuttles will be provided to and from the banquet beginning at 5:45 p.m. Delegates will assemble in the hotel lobby to board the buses. To ensure that you arrive at the Museum of Nature in time for the storytelling presentation, we recommend arriving in the hotel lobby no later than 5:30 p.m.

Conference Banquet Storytelling Presentation | *Caribou Across North America: Stories from the Land* | Susan Morse

From the Atlantic Ocean to the Beaufort Sea, including arctic islands, mountains, boreal forests, open tundra and the coastal plain, Susan C. Morse has tracked, studied and photographed caribou and their remarkable diversity of habitats for 11 years. Sue's stories are illustrated with her own stunning photos that she has taken in warm seasons and cold throughout some of the most remote habitats in North America where Sue has patiently endeavored to get close to caribou. Her stories share a mix of humor, adventure and personal reflections – engaging us all to contemplate the fullest significance of caribou and the vast northern landscapes these animals embody. Her concluding lament is also hopeful that we could somehow "work together" and address the many serious threats that we and caribou face together.

Notes

Conference AGENDA

THURSDAY, NOVEMBER 1, 2018

INVITED STORYTELLING AND DAILY ANNOUNCEMENTS

09:00 – 10:00	***Innu legends pertaining to Atᵘk (caribou)*** | Anne-Marie André
	Daily Announcements | NACW Organizing Committee ***Ballroom B+C**, Lobby Level*
10:00 – 10:30	**BREAK** ***Ballroom Foyer**, Lobby Level & **Penthouse Foyer***

THEMED SESSIONS

10:30 – 12:00	**Forecasting Future Landscapes I** . . . . . ***Ballroom B+C**, Lobby Level*
	Innovative Mitigation Techniques . . . . . ***Pinnacle**, Penthouse*
	Indigenous Talking Circle Reconvenes . . . . . ***Panorama**, Penthouse*
12:00 – 13:00	**LUNCH** ***Ballroom Foyer**, Lobby Level & **Penthouse Foyer***
13:00 – 14:45	**Forecasting Future Landscapes II** . . . . . ***Ballroom B+C**, Lobby Level*
	Range Co-Management and Planning . . . . . ***Pinnacle**, Penthouse*
	Film ***Panorama**, Penthouse*
14:45 – 15:15	**BREAK** ***Ballroom Foyer**, Lobby Level & **Penthouse Foyer***

CLOSING EVENT AND FUTURE PLANNING

15:15 – 16:00	**Closing Event** . . . . . ***Ballroom B+C**, Lobby Level*
16:15 – 17:00	**NACW Business Meeting:**
	Should the NACW become an entity? . . . . . ***Richelieu Rm**, Convention Level*

EVENING ACTIVITY

18:30 – 20:00	**Public Programming** . . . . . ***Arctic Gallery**, 4th Floor, Canadian Museum of Nature*

THURSDAY

INVITED STORYTELLER | Anne-Marie André | *Innu legends pertaining to Atᵘk (caribou)*

A resident of Uashat and retired, Anne-Marie André taught the Innu language for almost 30 years, notably at the Kanatamat School in Schefferville. She has training in pedagogy from the University of Quebec in Chicoutimi and has a degree in linguistics. She has been a member of the Kaianuetm committee whose mission is to standardize the Innu language in order to facilitate its teaching in schools. Noting the lack of teaching material for Innu students, she wrote Mani Utipatshimissama, a children's book published in 1996 by the Montagnais Cultural and Educational Institute (ICEM), a recognized publisher.

THURSDAY, November 1 | 10:30 – 12:00

BALLROOM B+C	PINNACLE ROOM	PANORAMA ROOM
Indigenous Talking Circle Reconvenes	**Forecasting Future Landscapes I**	**Innovative Mitigation Techniques**
Discussion period	Assessing the importance of climate on the distribution of boreal caribou (Rangifer tarandus caribou) | Presenter: **Eric Neilson**	Zero Footprint Seismic: PinPoint eliminates seismic lines and dramatically reduces the exploration footprint | Presenter: **Jesse Tigner**
	Caribou monitoring and mitigation on Inuit Owned Lands at mining developments in the Kivalliq Region | Presenter: **Jeff Tulugak**	Caribou migration behaviour reveals potential resilience to climate change | Presenter: **Michel Laforge**
	Potential impacts of climate change on the habitat of boreal woodland caribou | Presenter: **Marc-André Parisien**	Terrestrial forage lichen response to harvesting and tree mortality caused by mountain pine beetle | Presenter: MPB) in west-central British Columbia | Presenter: **Michaela Waterhouse**
	A climate-sensitive simulation ensemble of future boreal caribou habitat in central Quebec, Canada | Presenter: **Yan Boulanger**	New operational approach to forest harvesting and road network deployment in woodland caribou habitat in Quebec | Presenter: **Jérôme Rioux**
	Regional-level cumulative effects assessment in Ontario's far north: scenario analysis of development and climate change impacts on caribou | Presenter: **Rob Rempel**	Wild forest reindeer returns to its historical range - reintroductions are conducted in nationwide cooperation project in Finland | Presenter: **Milla Niemi**

THEMED Sessions

THURSDAY, November 1 | 12:00 – 14:45

BALLROOM B+C	PINNACLE ROOM	PANORAMA ROOM
Film	**Forecasting Future Landscapes II**	**Range Co-Management and Planning**
Camera Trap | Contributed by: **Kelly Milner** We are bringing them back | Contributed by: **Roland Willson** **Discussion period**	How alternative spatial patterns of rehabilitation in the boreal forest impact caribou using a model of animal movement, perception and memory | Presenter: **Brianna Collis**	Deninu Kue First Nation Traditional Use Study - Boreal Caribou Habitat and Habitat Use | Presenter: **Marc d'Entremont**
	Evaluating potential implications of caribou-centric forestry plans on other species of conservation concern | Presenter: **Lionel Leston**	An indirect approach for integrating Indigenous Knowledge with caribou science | Presenter: **Christine Robichaud**
	Alberta's woodland caribou ranges: Building a shared understanding of the costs, benefits, and trade-offs of management strategies using spatiotemporal modelling | Presenter: **Joshua Killeen**	The wicked problem of caribou conservation: a tale of the Telkwa caribou herd | Presenter: **Laura Grant**
	Ontario woodland caribou range assessment based on spatially-explicit movement and population viability models | Presenter: **John Fryxell**	Co-management boards and barren-ground caribou conservation: a review of the Nunavut Wildlife Management Board actions and decisions aimed at conserving caribou and its habitat | Presenter: **Denis Ndeloh**
	Caribou Webtools: an interactive web-based GIS application for caribou recovery | Presenter: **Laura Finnegan**	Collaborative management of the Bathurst caribou herd 2009-2018 | Presenter: **Jan Adamczewski**
	Putting models in the hands of decision-makers: the Caribou Cumulative Effects modelling framework | Presenter: **Colin Daniel**	Effective integration and application of knowledge | Presenter: **Gord Vaadeland**

CLOSING EVENT | Closing Event

The conference closing will highlight the perspectives of the leaders of tomorrow in a facilitated group discussion that brings together Indigenous youth and young conservation professionals. Participants will close the 2018 NACW reflecting on the outcomes of the conference and what is needed as we move forward to work together for caribou conservation.

FUTURE PLANNING | NACW Business Meeting: Should the NACW become an entity?

Traditionally the NACW business meeting has focused on recruiting volunteers to host the next conference event. We are fortunate this year to already have a host for the 2020 workshop! The NACW is growing, and with over 500 delegates in attendance here in Ottawa, it is timely to discuss the idea of the NACW becoming a more formal entity that would provide a mechanism for record keeping and documenting conference outcomes as well as ease the transition as new volunteers take on the responsibility of organizing the next conference. If you have been involved in the organization of previous conferences and/or have interest discussing the future of the NACW, please join us for this informal discussion.

EVENING ACTIVITY | PUBLIC PROGRAMMING | When the caribou do not come: Understanding the human face of arctic ecosystem change

In the 1990s, headlines about declining barren ground caribou populations grabbed international attention. Were caribou the canary in the coal mine for climate change, or did declining numbers reflect overharvesting, failed attempts at scientific wildlife management or simply natural variability? Join us to hear more about this story at the Canadian Museum of Nature and learn from Indigenous elders from the Inuvialuit and Sahtú region - people for whom caribou stewardship has been a way of life for centuries.

Notes

THURSDAY

Notes

Conference AGENDA

FRIDAY, NOVEMBER 2, 2018

POST-CONFERENCE ACTIVITIES

09:00 – 17:00	Eastern Ontario Model Forest Tour	*Eastern Ontario Model Forest*
09:00 – 17:00	Field Trip to Kitigan Zibi	*Kitigan Zibi*
09:00 – 12:00	Collections Tour	*Canadian Museum of History*
09:00 – 12:00	Hike at Gatineau Park	*Gatineau Park*
09:00 – 12:00	Gatineau Satellite Station	*Gatineau Hills near Cantley, Quebec*

All trips will assemble in the hotel lobby beginning at 08:30.

PLEASE NOTE | If you are participating in one of the outdoor post-conference activities, come prepared for variable outdoor conditions with appropriate clothing and footwear. While temperatures vary in November, it is generally quite cool and rain is a possibility.

Eastern Ontario Model Forest Tour | Full-Day

A day long field trip highlighting urban forest management, sugar bush operations and recent forest management operations.

In recent years the City of Ottawa has been leading the way in managing the effects of Emerald Ash Borer, an invasive insect, on the urban ash population. The day will start with City of Ottawa forestry staff leading the group to two sites that demonstrate the impacts of this invasive species on their urban forests and the work they have undertaken to mitigate the effects and restore an urban forest environment.

The second stop will be at Wheeler's Pancake House, which will feature a traditional pancake lunch offered in the warm surroundings of a log building. The Wheeler family have been producing maple products since 1978 and have grown from a couple thousand to 20,000 taps. Following lunch, the tour participants will have the opportunity to tour the Maple Heritage Museum or Forest and Farm Museum, or take a walk on one of the forest hiking trails.

The last stop of the day will be a field visit in Lanark County Forest (4,583 hectares in size) that will highlight recent forest operations, such as tree marking and/or harvest activity. Lanark County Forest was one of the first community forests to become Forest Stewardship Council (FSC) certified under the Eastern Ontario Model Forest's Forest Certification Program. It is a landscape of contiguous Crown and privately owned properties and is managed sustainably to provide social, recreational, economic, scientific, cultural and spiritual benefits to the people of Lanark County.

Field Trip to Kitigan Zibi | Full-Day

Join us at the Kitigan Zibi, community of the Kitigan Zibi Anishinabeg First Nation, for a day filled with learning, discussion, and experience, begining with a scenic drive out to Kitigan Zibi, an hour and a half north of the National Capital Region adjacent to the town of Maniwaki, Quebec, on the shores of the Gatineau River. The day will include:

- Presentations and discussions that highlight Kitigan Zibi Anishinabeg's experience and lessons learned developing a Species at Risk Act (SARA) Section 11 Conservation Agreement, and species at risk projects they have carried out through the past 13 years.
- Invited speakers from three Algonquin First Nation communities north of Kitigan Zibi Anishinabeg talking about implementing measures to protect the Val-d'Or Boreal Caribou population.
- Indigenous dance or drumming performance.
- A traditional lunch.

Collections Tour at the Canadian Museum of History | Half-Day

A behind-the-scenes collections tour showcasing the human use of caribou from across the continent in both the recent and ancient past. The museum collections encompass the fields of history, archaeology, ethnology and cultural studies. The National Collection consists of more than four million artifacts, specimens, works of art, written documents, and sound and visual recordings.

Note: Participants will have free admission to the Canadian Museum of History after the tour. Please note that if you stay and explore the museum following the tour, you will be responsible for your own transportation when you depart.

Hike at Gatineau Park | Half-Day

A hike in the Capital's stunning conservation area, Gatineau Park, led by Les amis du parc de la Gatineau.

Gatineau Park lies in an area where the Canadian Shield meets the St. Lawrence Lowlands and where the Gatineau River meets the Ottawa River. The hike will commence at the Mackenzie King Estate, country estate of Canada's 10th prime minister, William Lyon Mackenzie King.

Participants will hike the Lauriault and Waterfall trails. While exploring this beautiful area they will discover the story of the local early settlers and learn about the natural world of Gatineau Park with an experienced guide.

Gatineau Satellite Station Tour | Half-Day

Have you ever wondered how satellite data is captured and processed into imagery that is used for everything from monitoring ice flows, measuring forest regrowth, determining deformation of the Earth's surface due to natural and human-made activities, to understanding changes in wildlife and human habitats? Wonder no more as you visit Natural Resources Canada's Gatineau Satellite Station in the beautiful Gatineau hills near Cantley, Quebec.

The Gatineau Satellite Station is a critical link in Canadian and global Earth observation activities. Our tour guides will provide you with an overview of operations, including a demonstration of the 13-metre antenna in action; of remote sensing science carried out at Natural Resources Canada; and of the power of satellite data in emergency management, measuring and mapping change over time, maritime navigation in northern waters and many, many other applications.

Notes

FRIDAY

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THEMED SESSIONS PRESENTATIONS

Tuesday, October 30, 2018 | 13:00 – 14:45
Indigenous Leadership in Conservation

Title *The challenges and rewards with implementing a community based caribou conservation plan*

Authors **Sjoerd W. van der Wielen,** Dél̨ı̨nę Got'ı̨nę Government
Jonas Modeste, Dél̨ı̨nę Renewable Resources Council

The Dene of Great Bear Lake, or Sahtúgot'ı̨nę as we call ourselves, have been hunting ʔekwę́ (barren-ground caribou) for thousands of years. This is a relationship that persists today and continues to inform contemporary Dene identity. The challenge is how to put this on paper. As Sahtúgot'ı̨nę increasingly face conservation concerns that could jeopardize these relationships, we have chosen a way forward that honours our cultural understandings of how to live with ʔekwę́, and relies on the teachings of our grandparents. With full support of our leadership, the people of Dél̨ı̨nę have developed and implemented our first ever community-based caribou conservation plan. We will talk about the implementation of this plan, the challenges and the rewards. It is our hope to inspire other communities to take the lead in caribou conservation, as it is mostly the communities who are impacted the most by caribou decline.

Title *Nío Nę P'ęné - Trails of the Mountain Caribou: Renewing Indigenous Relationships in Conservation*

Author **Leon Andrew,** Sahtú Renewable Resources Board

Located on the backbone of the Mackenzie Mountains straddling the Sahtú Region (Northwest Territories) and Ross River Dena traditional territory (Yukon), Nío Nę P'ęné encompasses all of nature – it's what holds everything together and attracts wildlife. The area has been a gathering place for people and caribou for thousands of years. The communities of Tuĺıt'a, Norman Wells, and Tu Łidlini (Ross River) have come together to develop a plan for maintaining the health of the caribou and the vitality of mountain Dene ways of life. The planning process is adapted from the Healthy Country Planning approach developed by Australian Indigenous communities, and is guided by Dene principles of bets'erı̨chá (respect) for the caribou, ʔełets'erı̨chá (respect) for each other, and ʔełexé ʔeghálats'eda (working together). Priority program areas include an Indigenous Guardian program, establishment of an Indigenous Protected Area, and "keep moving forward" - a strong evaluation component to support progress. This is a first initiative in developing a multi-community, cross-boundary community caribou conservation plan in the Sahtú region. Government, academic, and non-governmental organisations have played a strong supporting role. But most important to the success of the planning process has been the role of knowledge holders with experience and traditional knowledge of Nío Nę P'ęné, as well as youth who are preparing to take on guardian responsibilities through "boots on the ground" training with a strong focus on wellness and Dene way of life. Community engagement along with joint community leadership discussions have been our pathway to plan approval.

Title *34 years of caribou co-management: an Inuvialuit retrospective*

Authors **Vernon Amos**, Inuvialuit Game Council
Chanda Turner, Inuvialuit Game Council

Caribou are embedded within Inuvialuit culture and identity, providing a vital resource. The Inuvialuit have been managing caribou for thousands of years; the current co-management system is the most recent iteration of management systems. This presentation will begin by describing how Inuvialuit management has adapted over time as external influences have affected the herds and caribou management practices have changed.

There are a variety of management venues the Inuvialuit participate in to achieve effective and appropriate caribou management. The Inuvialuit, through the boards created under the Inuvialuit Final Agreement (IFA), work with community members, other boards, and government in order to achieve their management goals. It is this collaborative approach that has garnered success and helped build an inclusive co-management system. We will provide a high level overview of the different forums that the Inuvialuit participate and lead in for the co-management of caribou from the community to national level.

The co-management system is not without its difficulties. We will explore some of the key challenges that the Inuvialuit co-management system has faced in light of shifts in caribou populations, differences in management approaches, and tensions amongst management partners.

With over 34 years of co-management experience, the Inuvialuit have acquired a rich perspective on caribou management. The presentation will end with recommendations for effective caribou management that values traditional and local knowledge and knowledge holders in the process, while serving the conservation objectives of the IFA and caribou management.

Title *Co-Management of Cape Bathurst, Bluenose-West, and Bluenose-East Caribou Herds: 17 Communities, 2 Territories and 6 Land Claim Areas Working Together*

Authors **Édouard Bélanger**, Gwich'in Renewable Resources Board
Aimee Guile, Wek'èezhìı Renewable Resources Board
Laura Meinert, Wek'èezhìı Renewable Resources Board

Management and conservation of barren-ground caribou can be extensively challenging because caribou can cross multiple communities, land claims and territories. Communities in many areas of the NWT and Nunavut have long-considered themselves stewards of the caribou. Today, responsibilities for the management of wildlife stem from settled land claims. Modern treaties give Indigenous groups a significant say in land and resource management. They also clarify how parties will Work Together when making decisions related to resources. They rely on co-management – an approach in which Indigenous, territorial, federal, and public governments share Authorsity and decision-making in the management and stewardship of resources.

In 2014, members of the Advisory Committee for Cooperation on Wildlife Management (ACCWM) approved the Taking Care of Caribou: the Cape Bathurst, Bluenose-West, and Bluenose-East Barren-Ground Caribou Herds Management Plan. The Plan was developed through a collaborative management planning process that has involved 17 communities in six land claim areas, over the last ten years. The management goals are to maintain herds within the known natural range of variation, conserve and manage caribou habitat, and ensure that harvesting is respectful and sustainable.

The Gwich'in Renewable Resources Board and the Wek'èezhìı Renewable Resources Board are two wildlife management board partners to the ACCWM and to this management plan. Using examples

drawn from these two Boards, we show how Working Together can i) bring community, traditional and scientific knowledge together for efficient management decisions, and ii) lead to successful co-management from the community level up to the territorial level.

Title ***Cold Lake First Nations is Making Key Contributions to Boreal Woodland Caribou Range Planning in Alberta.***

Authors **Findlay MacDermid,** Cold Lake First Nations
Darren Frederick, Cold Lake First Nations
Nicole Nichols, Cold Lake First Nations
Sarah Chileen, Cold Lake First Nations

Woodland Caribou habitat in Alberta is a busy working landscape in which Cold Lake First Nations (CLFN) members practice their treaty rights. How can CLFN contribute to caribou recovery and habitat conservation? The Nation has been working collaboratively with Government, Industry, Academia and independent groups to develop practical solutions that deliver on CLFN priorities for caribou recovery. These include a Guardian Program, Monitoring, Wildlife Management, Traditional Knowledge Research, Landscape Restoration, and a proposal to conserve 25% of the Cold Lake Herd Range with two Indigenous Protected and Conserved Areas. The intent is to balance the need for management actions with the potential impact on treaty rights and access to the landscape for rights practice. The need for caribou range planning is driven by Federal Recovery targets that cannot account for the complexity of the landscape in CLFN's territory. Only by working together with all the stakeholders can CLFN achieve the goals of caribou recovery while protecting the places, spaces, and resources needed for rights practice to continue as the treaties promised.

Title ***Fort Nelson First Nation's MAP: How UNDRIP and governments *CAN* work together to protect caribou. We hope.***

Authors **Katherine Capot-Blanc,** Fort Nelson First Nation - Lands Manager
Rachel Holt, Veridian Ecological Consulting Ltd.
Susan Leech, The Firelight Group

Fort Nelson First Nation is custodian of 80% of BC's boreal caribou. The traditional seasonal round – people and animals living and moving over vast boreal landscapes — maintained both populations on the land since time immemorial. Canadian settler history abruptly ceased movement of First Nations peoples, with massive cultural and social impacts. Caribou now suffer the same fate: so called isolated herds are 'managed' as though they are rooted to a location. FNFN has written a Medzih (caribou) Action Plan that is largely novel for Canada. The MAP spatially identifies critical habitat (habitat that is in good condition and reflects lower probability of mortality for caribou), and demands strong and immediate protection for that habitat. It also identifies connectivity areas, and restoration priorities for immediate action. These strategies are in sharp contrast to the as yet unimplemented provincial Boreal Caribou Recovery Implementation Plans (BC RIP). FNFN are working together with the BC government to find practical ways to implement a real action plan. This work is ongoing – and key results will be presented to this conference. FNFN will candidly identify the successes, opportunities and barriers that have emerged from this process, including the benefits of collaborating with industry to make strong protected areas work. The new BC government has a stated goal to work with, rather than against First Nations to recover caribou. This talk will shed light on the success of collaboration attempts.

THEMED SESSIONS PRESENTATIONS

Tuesday, October 30, 2018 | 13:00 – 14:45
Population Monitoring and Modelling I

Title *Conserving caribou through a multi-species approach to density estimation using camera traps and spatial count models*

Authors **Joanna M Burgar,** University of British Columbia; University of Victoria
Erin Tattersall, University of British Columbia
Jason T Fisher, InnoTech Alberta, University of Victoria
Cole Burton, University of British Columbia

Caribou conservation is complex and multi-faceted. The ability to research the entire mammal community would greatly enhance our ability to forge more comprehensive and effective conservation decisions. Working closely with industry we deployed camera traps in a landscape undergoing seismic line restoration, adjacent to wolf control. Using two years of camera trap data and new statistical techniques —spatial count models, an extension of spatial-recapture models for unmarked populations— we concurrently estimated densities of boreal woodland caribou (Rangifer tarandus caribou), their predators (wolf Canis lupus; black bear, Ursus americanus; and coyote, Canis latrans) and alternative prey (moose, Alces alces; and white-tailed deer, Odocoileus virginianus) in the snow and snow-free seasons of each year. As predicted, caribou densities were extremely low, predator densities were intermediate (with black bear densities twice that of wolf and coyote) and alternative prey densities were high (with deer up to two orders of magnitude higher density than caribou). Working with the Alberta government is allowing us to improve caribou estimates by incorporating caribou telemetry data in the next round of modelling. Despite some imprecise estimates, there did not appear to be a decrease in wolf densities after the cull, but rather a decrease in wolf movement. Though wolf densities were higher than densities recommended for caribou conservation, we suggest that the markedly higher black bear, and similar coyote, densities may be of greater concern, especially if wolf control further releases these species. We recommend a broader focus on the interacting species within a community when conserving caribou.

Title *Temporal patterns in boreal caribou mortality: factors limiting caribou survival in an intact environment*

Authors **Allicia P Kelly,** Government of the Northwest Territories
Nicolas C Larter, Government of the Northwest Territories
Eliezer Gurarie, University of Maryland
Danny Allaire, Government of the Northwest Territories
Evelyn Merrill, University of Alberta
Andrew E Derocher, University of Alberta

Seasonal patterns of mortality are common in many ungulate populations. Reproductive or other life history stages influence susceptibility to predation, and seasonal movements, habitat use, and environmental conditions may directly or indirectly affect mortality risk. Our objective here was to identify temporal patterns in boreal caribou mortality to better understand factors affecting caribou survival in a relatively intact environment. Boreal caribou have been monitored in the southern Northwest Territories, with the cooperation and support of First Nation and government partners, since 2003. 439 caribou were monitored using radiocollars, and mortality sites were investigated when possible to determine cause of death (n=172 mortalities). We used generalized additive models (GAMs) to identify periods with higher and lower probability of mortality. The fitted values for the GAM show seasonal fluctuation of total mortality risk, with peaks during pre-calving (peak April 25) and mid-summer (peak July 26), and a smaller peak in late fall. A GAM of predation-only mortalities shows the same annual pattern, whereas a GAM of non-predation mortality events had a single peak period (peak July 6). We discuss factors associated with temporal changes in mortality risk, and propose further work to test hypotheses about factors limiting caribou survival. Insight into mortality risk can help managers prioritize the protection of habitats that provide higher nutritional resources or habitats that are characterized by lower mortality risk.

Title *Potential for competition between eastern migratory caribou and muskoxen in Nunavik*

Authors **Alexis Brodeur,** Caribou Ungava - Université Laval
Joëlle Taillon, Ministère des Forêts, de la Faune et des Parcs du Québec
Vincent Brodeur, Ministère des Forêts, de la Faune et des Parcs du Québec
Mathieu Leblond, Environment and Climate Change Canada
Steeve D. Côté, Caribou Ungava - Université Laval

Several caribou and reindeer (Rangifer tarandus) populations are declining across arctic and subarctic regions, in part due to climate change and anthropogenic disturbance. In northern Quebec, the Rivière-aux-Feuilles (RAF) herd has declined over 70% during the past 20 years. During the same time, muskox populations (Ovibos moschatus) have increased considerably since their introduction in northern Quebec in the 1960's. This led Indigenous people and scientists to question the potential role of muskox in caribou declines. Our project was thus developed in response to local concerns over the possible impacts of muskox on caribou populations in Nunavik. Our objectives were to assess the potential for competition between caribou and muskox, particularly in regards to space use, habitat selection and diet overlap. In 2017, 44 muskoxen were fitted with GPS collars in the range of the RAF herd, where more than 100 caribou were already equipped with telemetry collars as part of an ongoing long term study. Moreover, 190 fecal samples were collected and analysed using DNA metabarcoding. Preliminary results suggest that spatial overlap is highest during spring and winter along the coast of Hudson Bay. In winter, muskox were found at higher elevation and ruggedness than caribou. In spring, both species tended to select for lichen cover. Although there were important seasonal variations, Ericacae and Salicacea were the plant families most consumed by both species. We conclude that the two species may thus compete for habitat and diet composition.

Title *Genetic influences on male and female variance in reproductive success and implications on the recovery of severely endangered mountain caribou*

Authors **Samantha McFarlane,** Natural Resources Institute
Micheline Manseau, Environment and Climate Change Canada
Amy Flasko, Natural Resources Institute
Rebekah L Horn, Trent University
Neil Arnason, University of Manitoba
Lalenia Neufeld, Parks Canada
Mark Bradley, Parks Canada
Paul Wilson, Trent University

Small and declining large mammal populations are vulnerable to stochastic events and are at high risk of extinction. Population viability is also susceptible to the detrimental effects of low genetic diversity and inbreeding. Through a partnership between Parks Canada and academia, we monitored three endangered caribou populations using non-invasive genetic sampling over a 10-year period. We assessed demographic population changes by combining capture-recapture modeling, familial pedigree networks, individual fitness and inbreeding coefficients. Three Central Mountain caribou populations in Jasper National Park were systematically surveyed and fecal samples collected for DNA analyses. Population sizes and survival estimates for the Tonquin population declined during the study period. The estimated number of Tonquin females decreased from 41 in 2006 to only 14 in 2015. The Brazeau and Maligne populations, evaluated through minimum count surveys, also declined over the same period, from 22 and 11 individuals (11 and 5 females) in 2006, to 12 and 3 individuals (6 and 1 females) in 2015. Genetic diversity declined for all three populations during the study period, with

evidence of inbreeding avoidance among high-fitness individuals. Pedigree network results confirmed limited movement among populations. All population parameters point to a fast population decline, with the number of remaining females in each population below the quasi-extinction threshold. The varying reproductive fitness observed amongst males and females was significant and should be considered in future population augmentation or reintroduction efforts. Improved connectivity among the three populations and with neighbouring populations should also be considered to sustain or enhance genetic diversity.

Title ***An integrated population model to assess population status and population augmentation scenarios***

Authors **Anna K. Moeller,** University of Montana
Mark Hebblewhite, University of Montana
Paul M. Lukacs, University of Montana
J. Joshua Nowak, Speedgoat Wildlife Solutions
Lalenia Neufeld, Parks Canada
Jean-Francois Bisaillon, Parks Canada
Mark Bradley, Parks Canada
Micheline Manseau, Environment and Climate Change Canada
Paul Wilson, Trent University
Samantha McFarlane, University of Manitoba

Collaborating between population modelers, Parks Canada biologists, and geneticists, we developed an integrated population model (IPM) to produce a more complete picture of caribou demographic rates. Like many caribou populations across Canada, Southern Mountain woodland caribou in Banff and Jasper National Parks have seen drastic declines in numbers. One herd was extirpated in 2009, and three of the remaining four herds appear to be at or below the quasi-extinction threshold. Parks Canada adopted two independent monitoring methods for the remaining herds: conventional radio-telemetry demographic trend estimation and an innovative, non-invasive fecal DNA mark-recapture program. However, when monitoring small populations, sample sizes are frequently small, which reduces the precision of demographic rate estimates. Furthermore, estimating abundance, recruitment, and survival using independent monitoring methods can paint conflicting pictures of the population. For example, one dataset may show abundance increasing while other datasets show survival and recruitment decreasing. We developed a Bayesian IPM that estimates population trend by combining radio-telemetry-based survival of adult females, abundance and calf recruitment data from aerial surveys, and data from non-invasive DNA mark-recapture data. Furthermore, we disentangled apparent survival of juveniles and adults in the non-invasive DNA data. By providing a framework to let multiple sources of data work together, we produced a more precise and consistent analysis of the status of the population. This IPM allowed us to model the population's viability into the future and assess the impact of several population augmentation scenarios. The model has broad application to aid caribou recovery across Canada.

Title *Non-invasive monitoring of caribou: embracing new technologies*

Authors **Micheline Manseau,** Environment and Climate Change Canada
Paul Wilson, Trent University

It has been 15 years since we collected the first fecal sample from caribou and were able to successfully extract high quality and quantity DNA from this material for genetic profiling. Since then and in collaboration with provincial, territorial and federal governments, Indigenous organisations, wildlife management boards and industry, we have analysed more than 40,000 samples from across Canada. We have developed a suite of field, laboratory and analytical methods, and have shown how genetic and ecological data can be used to generate information needed for management. Project collaborators have been highly proactive in recognizing the potential of this research in supporting a single web-based national database and repository through significant investments in field collections and in the development of tools and protocols. As a result, the national database and repository has allowed for greater collaboration and synergies between individual projects and provided a framework for large-scale and long-term monitoring work to support regional, provincial/territorial and national conservation programs. In particular, the data has been critical in assessing short- and long-term changes in population distribution, movement and demographic parameters. Based on this experience, we propose to expand on this foundation and embrace new technologies such as next generation sequencing and deep learning to further develop population and landscape genomic methods for long-term monitoring of caribou.

Tuesday, October 30, 2018 | 13:00 – 14:45
Ecological Footprint of Disturbance

Title *Noise measurement and propagation to help refine the zone of influence of mining activities on caribou*

Authors
Sylvain G Leblanc, Canada Centre for Remote Sensing, Natural Resources Canada
Wenjun Chen, Canada Centre for Remote Sensing, Natural Resources Canada
H Peter White, Canada Centre for Remote Sensing, Natural Resources Canada
Bruno Croft, **Government of** Northwest Territories, Environment and Natural Resources
Jan Adamczewski, Government of Northwest Territories, Environment and Natural Resources
Andrea Patenaude, Government of Northwest Territories, Environment and Natural Resources
Karin Clark, Government of the Northwest Territories, Environment and Natural Resources
Jody S Pellissey Wek'èezhìi Renewable Resources Board
Laura Meinert, Wek'èezhìi Renewable Resources Board
Jessica Hum, Tłı̨chǫ Government
Anne Gunn, CircumArctic Rangifer Monitoring and Assessment Network
John Boulanger, Integrated Ecological Research Ltd

This study is part of the Northwest Territory Cumulative Impact Monitoring Program (CIMP), and includes scientists and students from Natural Resources Canada, and was a collaboration with the Ekati Diamond mine. Various techniques were used to explore factors affecting the zone of influence of mines on caribou in the Bathurst herd. During three visits at the Ekati Diamond Mine, about 300km northeast of Yellowknife (2015-2017), more than 75 noise spectra were measured with a specialised sound meter (Svantek 977). The noise sources measured were vehicles, airplanes, helicopters and blasts in open pit mines. Using sound propagation theory applied to the caribou hearing spectrum, then estimated the distance at which each sound/noise could be heard by caribou. Our results with simple sound propagation that do not consider environmental effect on the propagation will be presented. Those results indicate that in perfect propagation conditions, with no natural barriers, and no other sound, mining surface vehicles could not be noticed by caribou past 6km, helicopters in flight could potentially be heard as far as 15km, a blast could be heard up to 40km away, and that larger aircrafts have the potential to be heard more than 100 km away. We will also present initial results of our propose approach to more accurately estimate these distances using more sophisticated propagation models and experimental measurements that considerer topography, land cover and meteorological conditions.

Title *Implementation of a Terrestrial Advisory Group at the Agnico Eagle Meadowbank Mine, Nunavut.*

Authors
Ryan Vanengen, Agnico Eagle Mines - Nunavut
Jamie Quesnel, Agnico Eagle Mines

Adapting our design and mining activities to caribou movements is important for the protection of caribou herds interacting with our mining projects in Nunavut. Protection of the herd starts with the collection of Inuit Qaujimajatuqangit (IQ), use of data to inform mine design, reliable collection of observational data from environmental staff, onsite collaboration with Inuit stakeholders such as the Hunting and Trapping Organization (HTO) of Baker Lake and the Kivalliq Inuit Association, and responsiveness from mine management. Knowledge sharing, government collaboration and IQ through the establishment of the Terrestrial Advisory Group (TAG) further ensures the monitoring and mitigation efforts protect caribou herds. As a result, beginning in 2016, Agnico Eagle began hosting a series of stakeholder workshops to gather input on caribou monitoring and mine mitigation; recently this was formalized through the TAG, which consists of representatives from Agnico Eagle,

Government of Nunavut, Kivalliq Inuit Association and the Hunting and Trappers Organization of Baker Lake. Often consultation with industry and government are conducted separate from community engagement. The establishment and implementation of the TAG has removed these barriers and has provided a model of collaboration where government, industry, local hunters and trappers, hamlet representatives and other participants work together to leverage monitoring data, government agency input and experiences of traditional land users to inform current and future caribou protection measures.

Title ***Death and disturbance? Predators and landscape features associated with central mountain caribou mortalities***

Authors **Tracy McKay**, fRI Research Caribou Program
Bryan Macbeth, Government of British Columbia, Ministry of Forests, Lands, Natural Resource Operations and Rural Development
Barry Nobert, fRI Research Caribou Program
Karine Pigeon, fRI Research Caribou Program
Laura Finnegan, fRI Research Caribou Program

Increased mortality risk associated with landscape disturbance is linked to declines in central mountain caribou populations. In multi-predator systems, quantifying the role of different predator species in caribou mortalities and assessing how disturbance contributes to predation risk could help inform caribou habitat restoration.

We used field investigations of caribou mortalities and GPS collar data from two central mountain herds in Alberta and British Columbia to investigate predation-caused caribou mortalities, and to assess the influence of terrain and disturbance features on predation risk. We worked together with forestry companies, provincial governments, and wildlife veterinarians to develop mortality investigation protocols, visit mortality sites, and collect mortality and landscape disturbance datasets.

From mortality site investigations, we determined that cougars (17%), wolves (22%), and grizzly bears (33%) were responsible for predation-caused caribou mortalities, with multiple predators involved in 33% of mortalities. Terrain was the best predictor of mortality locations; mortalities generally occurred in valley bottoms and near streams. Linear features were the best predictors of habitat use during the 24-hours, 7-days, and 30-days prior to mortalities; caribou that died used areas with higher pipeline densities but lower road densities.

Our mortality site investigations provide new information regarding the caribou predator guild in our area, highlighting the importance of considering a multi-predator system in caribou predation risk. Our results support current efforts in western Canada to restore linear disturbances preferred by predators. Overall, results from this project provide governments and managers with better information for predator management and caribou habitat restoration.

Title ***Historical exposure to wildfires shapes the response of boreal caribou to timber harvesting: reliable cues and maladaptation***

Authors **Martin-Hugues St-Laurent,** Université du Québec à Rimouski
Alexandre Lafontaine, Université du Québec à Rimouski
Pierre Drapeau, Université du Québec à Montréal
Daniel Fortin, Université Laval
Sylvie Gauthier, Natural Resources Canada, Canadian Forest Service
Yan Boulanger, Natural Resources Canada, Canadian Forest Service

Studying wildlife responses to disturbances in the light of their evolutionary history may help explain their capacity to adapt to novel ecological conditions. In the North American boreal forest, wildfire has been the main disturbance driving ecosystem dynamics for thousands of years, but the widespread decline of boreal caribou has been associated with the rapid expansion of timber harvesting. Although caribou may not be adapted to this new disturbance, cutovers share many similarities with wildfires (large landscapes of whole stand removal associated with an increased predation risk). We hypothesized that caribou with more evolutionary experience of wildfires should better perceive the cues associated with disturbances and adjust their behaviour towards cutovers accordingly. Using GPS data from 233 females of 8 herds across boreal forest in Québec, we assessed how historical exposure to wildfires could explain caribou behavioural response towards burns and cutovers. Our results indicate that caribou from regions with high historical burn rates displayed a consistent avoidance of recent burns, a behaviour translated to a similar avoidance of recent cutovers. Inversely, caribou with less evolutionary experience of wildfires were more likely to select recently disturbed habitats. In the context that timber harvesting and its associated road network has been linked to increased mortality in caribou populations, we discuss how this naive habitat use of cutovers can be exacerbated by historical disturbance regimes and become maladaptive for this endangered species. Our results will contribute to adjust management actions to the different anthropogenic and natural disturbance regimes across the species' range.

Title ***Variation in habitat selection strategies of woodland caribou in burns***

Authors **Kelsey L. M. Russell,** University of Northern British Columbia
Chris J Johnson, University of Northern British Columbia
Troy Hegel, Alberta Environment and Parks

Caribou (Rangifer tarandus caribou) may avoid winter habitat for up to 60 years post-fire due to the time required for terrestrial forage lichens to recover. Nonetheless, some caribou occupy burns despite the apparent disadvantages to foraging and movement. Working across the range of the Klaza caribou herd in west-central Yukon, we used locations from GPS-collared caribou to develop resource selection functions and quantified habitat selection strategies of caribou during early and late winter relative to topography, density of terrestrial lichen, and fire history. We examined variation in selection among individual caribou and with the population, isolated locations that occurred in or adjacent to burns, and identified important factors for explaining the relative use of burned habitat. At the population scale, Klaza caribou avoided burned habitats during winter in most years. In some season-years, more individual caribou selected for burned habitat; however, this selection was weak compared to individuals who avoided burns. Caribou used burns selectively during early winter and focused their use at edges and in proximity to areas of high lichen density. During late winter, when snow was deeper, denser, and crustier, caribou encountered and used burns randomly. The relationship between caribou and burns is complicated and requires careful consideration in the context of cumulative landscape change. Although challenging, managers must translate knowledge into action by recognising variability in caribou behaviour while developing tractable land-use strategies that represent requirements of the population. As a starting point, differences between pooled (i.e., population-level) and individual habitat selection should be assessed.

Title *Losing sight of the forest for the caribou? Why we need to know more about species-habitat interactions when managing for woodland caribou*

Authors
Philip D. McLoughlin, University of Saskatchewan
Charlotte E. Regan, University of Saskatchewan
Clara D Superbie, University of Saskatchewan
Patricia D Tomchuk, University of Saskatchewan
Ruth D Greuel ,University of Saskatchewan
Sarah J. Hart, Washington State University
Jill F. Johnstone, University of Saskatchewan

Habitat-mediated apparent competition describes anthropogenic and natural disturbances (in the context of caribou conservation) that increase the abundance of ungulates like moose or deer to promote predator (primarily wolf) numbers, with negative impacts on caribou. The concept is now widely assumed to be the key mechanism limiting boreal and mountain caribou populations in Canada. However, predator-prey guilds are not the same from west to east nor latitudinally across ecozones even within a province; neither are the types nor amounts of industrial activities and successional trajectories. E.g., in the Saskatchewan Boreal Shield despite high levels of natural disturbance (55% burned in the last 40 years) more than 90% of jack pine stands (preferred habitat for caribou; 57.6% of the region) self-replace and show very high resilience. Deer are absent, moose numbers are low as are densities of wolves, and we believe that this decoupling of the disturbance-predation argument is why caribou in the region are doing well. Managing for disturbance and lower moose numbers in situations like this—likely applicable in other regions of the shield—may not only be costly but ineffective in making things more secure for caribou, but also pit managing for caribou against the very real needs of country-food security in northern communities. To avoid managing for the wrong thing in the wrong place based on the wrong hypothesis, research that fills the gaps in our understanding of caribou-predator-alternate prey-habitat relationships where we know the least may prove to be the most valuable going forward.

Tuesday, October 30, 2018 | 15:15 – 17:00
Population Monitoring and Modelling II

Title *Large-Scale Synchrony and Climate Drivers of Barrenground Caribou Migration across North America*

Authors **Eliezer Gurarie**, Department of Biology, University of Maryland
Mark Hebblewhite, University of Montana
Natalie Boelman, Lamont-Doherty Earth Observatory, Columbia University
Sarah Davidson, Department of Civil, Environmental and Geodetic Engineering, The Ohio State University
Allicia Kelly, Department of Environment and Natural Resources, Government Northwest Territories
Michael Suitor, Department of Environment, Yukon Government
Kyle Joly, National Park Service

The Arctic has been warming and getting wetter even as many caribou populations have declined, but links between climate and populations are tenuous. Perhaps the most variable weather occurs in spring, during the migration to calving grounds. Understanding the relationship between weather and migration phenology may be essential to understanding mechanisms that link climate to populations.

As part of a large-scale, collaborative effort across US and Canadian agencies, we aggregated GPS movement data collected over 20 years from over 1000 caribou across 5 major herds. We developed a model to estimate the timing and duration of spring migrations that is robust to variability in sampling, number of collars, and individual behavior. Among other patterns, we discovered a striking range-wide synchrony in migration timing (cross-correlation 0.59, p-value < 0.0001): i.e. an early year of spring migration on the Bering Sea almost certainly corresponds to an early year as far away as Nunavut.

We explored an array of climate and weather indicators that might explain the variation in spring migration timing across populations. While spring conditions were almost completely uncorrelated with timing, climate indicators from the previous summer and fall were much more significant predictors. The results suggest that migrations are driven in large part by physical condition and rut timing of caribou from the preceding summer and fall. Our results lay the groundwork for understanding caribou population dynamics in a way that incorporates the lagged effects of an increasingly variable Arctic environment.

Title *Cape Churchill Caribou Seasonal Habitat use and Seasonal Migrations within the Wapusk National Park MB*

Authors **Derek Leask**, University of Manitoba
Ryan K Brook, University of Saskatchewan
Rick Baydack, University of Manitoba

The Cape Churchill population is situated in the northern extent of Manitoba to include the Wapusk National Park and the Churchill Wildlife Management Area.

Very little is known about the Cape Churchill Caribou movements and seasonal core use areas but are traditionally known to calve on the coast of the Hudson Bay within the Wapusk National Park along Cape Churchill, deriving the name of the range.

GPS telemetry data of 30 unique individuals from 2010 to 2016 will be utilized for the analysis of this project, and by using Brownian Bridge Movement Models (BBMM) the spring and fall migration movement corridors will be identified. Parturition sites will also be identified using daily movement rates of the collared female caribou from 2010 to 2016.

In addition, resource selection function (RSF) using logistical regression and k-fold cross validation the habitat selection of the collared female caribou will be identified and extrapolated across the extent of the study.

Using this approach will be compared to traditional knowledge (TK) knowledge gathered from community engagement meetings conducted within areas where locals rely on the caribou for sustenance, in conjunction with information collected by Brook et al, 2011.

With the spatial approach and the TK knowledge-based data, the bringing together of western science and traditional knowledge to better understand the movements and habitat use of the Cape Churchill caribou to assist regulators to make landscape decisions.

Title ***Analysis of environmental, temporal, and spatial factors affecting demography of the Bathurst caribou herd***

Authors **John Boulanger,** Integrated Ecological Research
Jan Adamczewski, Department of Environment and Natural Resources, Government of Northwest Territories
Judy Williams, Department of Environment and Natural Resources, Government of Northwest Territories

One of the main conservation concerns for the Bathurst caribou herd in the Northwest Territories (NT) between 2012 and 2015 has been recent low survival and productivity rates that challenge the recovery of this herd. Fundamental to the co-management process is understanding the factors limiting the herd; co-management partners have expressed interest in any factors contributing to decline and potentially hindering recovery. This model utilized data from collared caribou, composition surveys, and calving grounds surveys in addition to remote sensing-based weather covariates to explore the relationship between environment covariates and herd demography. In addition, the locations of Bathurst collared cow mortalities were compared to locations of live collared caribou to assess temporal and spatial trends in survival rates. Analysis of the environmental covariates revealed correlations between many of the variables as well as directional trends in many of them. Strongest linkages between demographic parameters and environmental covariates occurred for female pregnancy rate and adult female survival with weaker linkages for calf survival. Analyses identified different factors influencing pregnancy rates and calf survival which are both contained within calf-cow ratios. Spatial survival analysis revealed that mortality hotspots have shifted from a more dispersed pattern in 1996-2009 to primarily summer range areas in 2010-2016, with lower mortality on winter ranges and the lowest mortality on the calving grounds. Our analysis illustrates the complexities in understanding factors influencing herd demography and demonstrates how modelling methods can be used to confront these complexities.

Title ***Monitoring caribou - road interactions in Nahanni and Nááts'ihch'oh National Park Reserves using remote cameras***

Authors **Sarah Arnold,** Parks Canada
Audrey Steedman, Parks Canada
Faye D'Eon-Eggertson, Parks Canada

Working collaboratively between and within jurisdictions is key for land managers of wide-ranging Northern Mountain caribou herds. Together Nahanni and Nááts'įhch'oh National Park Reserves protect much of the range of the South Nahanni herd. Parks Canada has consequently implemented

a pilot project using 61 remote cameras across 9 transects to understand caribou use of the area traversed by the Howards Pass Access Road (HPAR), using lessons learned from the Mountain Parks in Alberta and BC. Initial data demonstrate that remote cameras can characterize caribou activity over space and time (5 years) in the HPAR area. As a monitoring program, this design has sufficient power to detect reasonably small changes in caribou activity in the road area. In combination with aerial surveys, genetic typing using fecal DNA, and satellite collaring, Parks Canada's caribou monitoring in Nahanni and Nááts'įhch'oh National Park Reserves can contribute critical information towards the regional effort to understand and protect caribou in the Dehcho and Sahtu regions (NWT) and the Yukon.

Title ***Effects of capture and collaring on barren-ground caribou movement rates***

Authors **Xavier Giroux-Bougard,** Department of Natural Resource Sciences, McGill University
Judy Williams, Wildlife Division, Department of Environment and Natural Resources, Government of the Northwest Territories
Brett T. Elkin Wildlife Division, Department of Environment and Natural Resources, Government of the Northwest Territories
Murray M Humphries, Department of Natural Resource Sciences, McGill University
Jeffrey C. Cardille, Department of Natural Resource Sciences, McGill University
JanZ. Adamczewski, Wildlife Division, Department of Environment and Natural Resources, Government of the Northwest Territories

The use of GPS telemetry has significantly contributed to our understanding of caribou movement behaviour and range use, and is essential to monitoring and management of barren-ground caribou herds. However, deploying GPS collars requires capture and immobilization, which can adversely affect certain individuals. Impacts that only become evident post-capture are especially hard to detect and describe because close monitoring is often impossible in remote areas. For example, capture myopathy, characterized by damaged muscle tissues caused by stress, can occur anytime in the 30 days after capture. In subjects that may appear otherwise healthy upon release, elevated cortisol and creatine phosphokinase levels in blood samples collected during immobilization can provide useful indicators of muscle stress that can develop into capture myopathy.

While the capture of caribou is governed by a strict set of best practices aimed at reducing risks, researchers continuously strive to minimize potential impacts on subjects and maximize the quality of data collected through collaring programs. Working together to combine the expertise of wildlife managers and veterinarians from the Government of the Northwest Territories (NWT) and academic researchers from McGill University, we studied the effects of capturing and collaring on caribou. Specifically, we collected indicators of stress during nearly 400 captures spanning five years and several barren-ground caribou herds of the NWT and Nunavut, and related these to subsequent impacts on post-capture movement rates recorded by GPS collars. We present our findings along with suggestions on best practices for use of location data collected in the days following capture.

Title *Landscape/Range Level Indicator(s) for Self-Sustaining Boreal Caribou Populations*

Authors
Arthur R. Rodgers, Ontario Ministry of Natural Resources & Forestry
Jennifer Shuter, Ontario Ministry of Natural Resources & Forestry
Jennifer A. Rodgers, Ontario Ministry of Natural Resources & Forestry
Robert S. Rempel, Ontario Ministry of Natural Resources & Forestry
Kevin Green, Ontario Ministry of Natural Resources & Forestry
Dennis Brannen, Manitoba Sustainable Development
Daniel Fortin, Centre d'étude de la forêt, Département de Biologie, Université Laval, Québec
Phil McLoughlin, Department of Biology, University of Saskatchewan

Based on a 2011 meta-analysis of disturbance-recruitment data from 24 ranges, Environment Canada recommends a minimum threshold of 65% undisturbed habitat to provide a 60% probability of caribou persistence over a 20-year period. Since then, new ranges have been delineated and new demographic data have been collected in Ontario. We added these new data to the EC analyses and found almost half of Ontario ranges (mostly in the Far North) were outside the 90% PI of the original relationship. We attributed the poor fit of these new data to quality of disturbance data used in the original analysis and differences in disturbance regimes between northern caribou ranges, dominated by natural disturbance, and more southerly ranges, dominated by anthropogenic disturbance. Subsequently, we undertook a reanalysis of disturbance-vital rate relationships in Ontario following the EC methodology but incorporating Ontario-specific disturbance data. Initially, we assessed the quality of demographic data required for these analyses and found that a minimum of 50 cow/calf observations are required for reliable recruitment estimates. For reliable survival estimates, 35 collared individuals are needed from medium-to-large sized populations (i.e., >100 individuals) or 20-30 collared individuals from small populations (i.e., 25-50 individuals). Achieving these standards necessitates combining some Ontario ranges, leaving 10 ranges for recruitment and 5 ranges for survival estimates. To increase the number of ranges considered and expand the scope of our findings, we are working with Saskatchewan, Manitoba and Quebec to undertake a reanalysis of disturbance-vital rate relationships that will be applicable to the Boreal Shield.

Tuesday, October 30, 2018 | 15:15 – 17:00
Habitat Restoration

Title ***Sharing the landscape: How the Regional Industry Caribou Collaboration are working together***

Authors **Michael Cody,** Cenovus
Margaret Donnelly, Alberta-Pacific Forest Industries
Melanie Dickie, Alberta Biodiversity Monitoring Institute
Amit Saxena, Devon

Woodland caribou inhabit landscapes with a variety of natural and human-made disturbances which are linked to widespread declines across much of their range. Historically, each stakeholder managed their own resource development areas separately. However, responding to caribou decline requires a response to cumulative impacts and management at larger scales, including across stakeholder boundaries. The Regional Industry Caribou Collaboration (RICC) is a group of energy and forestry companies that recognize this need, and as such we lead research and habitat restoration programs aimed at informing and contributing to caribou recovery in northeastern Alberta. We will provide an update on our collaborative habitat restoration progress, learnings and current goals in the face of changing management levers and our plans for the future. To date, RICC members collaborated on restoration of over 1000 km of seismic lines and in 2018 plans are underway for two additional large-scale projects. Through engaged collaboration among members, we demonstrate the economies of scale and effectiveness that are essential for caribou recovery. In addition, knowledge sharing and coordination with other stakeholders and academia provides a net benefit to caribou as well as each participant.

Title ***Seismic line restoration influences large mammal line use in short-term: implications for caribou conservation in northern Alberta***

Authors **Erin Tattersall,** University of British Columbia
Joanna Burgar, University of British Columbia
Jason T Fisher, Innotech Alberta
Cole Burton, University of British Columbia

Boreal woodland caribou declines in northeastern Alberta are a consequence of the boreal mammal community responding to anthropogenic disturbances. Seismic lines cut for oil exploration contribute to increased habitat suitability for generalists such as white-tailed deer, thus enhancing apparent competition with caribou, while also fragmenting caribou habitat and facilitating predator movement across the landscape. Seismic line restoration shows promise as a method of caribou conservation; however, the impact of current initiatives has not yet been assessed. In partnership with one caribou habitat restoration initiative, we used camera traps to monitor large mammal seismic line use following restorative treatments within the East Side Athabasca River caribou range. We focused on five target species: caribou, caribou competitors (white-tailed deer and moose), and caribou predators (wolves and black bears). Three years after restoration, large mammal species already show differential responses to seismic lines according to treatment. White-tailed deer use restored seismic lines much less frequently than unrestored lines, while wolves strongly prefer the most open unrestored lines but do not decrease use of actively restored lines. Although caribou use restored lines more frequently than unrestored lines, the effect is small within the few years post-restoration. This multi-species monitoring approach to caribou conservation emphasizes how a network of biotic interactions work together to influence caribou's fate on the working boreal landscape. By incorporating long-term wildlife monitoring into existing restoration initiatives, science, government and industry can create comprehensive solutions to the root issues for caribou conservation.

Title *Building a Centre of Excellence in Restoration Practice*

Authors **Katalijn MacAfee**, Natural Resources Canada, Canadian Forest Service
Michael Cody, Cenovus Energy
Matthew Pyper, Fuse Consulting

Among the major gaps faced by resource sectors operating within woodland caribou habitat is the need to build capacity in response to requirements for forest restoration.

Silviculture techniques have proven to be successful in the restoration and return to forest cover to anthropogenic disturbances. For caribou, restoration of linear and polygonal features will decrease fragmentation of the landscape and help establish the large areas of intactness needed by caribou.

To date, even basic silvicultural knowledge has been restricted to a subset of forest professionals, but there remains a void among reclamation planners, consultants and contractors working outside of the forest industry.

To meet this challenge, Natural Resources Canada (NRCan) collaborated with Canada's Oil Sands Innovation Alliance (COSIA), Fuse Consulting, FPInnovations, InnoTech Alberta and NAIT BRI, to develop a Silviculture Toolkit. The Toolkit provides end-users such as reclamation workers and planners, consultants and operators, with practical knowledge and information based on decades worth of experience from the forest sector; the information is geared towards oil and gas settings. The toolkit consists of guidebooks, factsheets, videos and a decision-making matrix.

Building on this project, NRCan, COSIA, Fuse and NAIT are collaborating again to share restoration best practices through demonstration and monitoring sites, virtual field tours and a knowledge portal - in essence creating a Centre of Excellence in Restoration Practice. These efforts address the critical need for a knowledge network related to woodland caribou habitat restoration, in order to meet current and future forest management challenges, including provision of important caribou habitat.

Title *Working Together to Implement Caribou Habitat Restoration: A Case Study*

Authors **Paula Bentham,** Golder Associates
Katherine Capot-Blanc, Fort Nelson First Nation
Caitlin Parker, Golder Associates
Steve Wilson, EcoLogic Research
Shauna Huculak, Golder Associates
Megan Watters, Forests, Lands, Natural Resource Operations & Rural Development, Government of British Columbia

The BC Parker Caribou Range Pilot Habitat Restoration Program Plan is the first plan to propose application of habitat restoration techniques over an entire boreal caribou range in Canada. A multi-year program plan is complete with a disturbance inventory and restoration plan covering four restoration zones. During an 8 week field program in the winter of 2017, implementation of the Program Plan within Zone 1 was completed. With the support of Fort Nelson First Nation's environmental technicians, a FNFN owned contractor company, and local service providers; restoration treatments including treefelling and mounding/seedling planting were applied to 61 km's of historical disturbances within the Parker boreal caribou range. We will provide the key outcomes of the implementation program including local capacity building and learning opportunities, year 1 post treatment monitoring results, as well as highlight the high desire of Aboriginal communities for early and ongoing engagement and collaboration within larger landscapes on where and how to focus habitat restoration programs. This project is informing restoration and mitigation policies and practices in British Columbia to maximize restoration effectiveness benefits for caribou.

Title *Linear features and caribou declines: Understanding the mechanisms and predicting restoration efficacy*

Authors **Melanie Dickie,** Alberta Biodiversity Monitoring Institute
Rob Serrouya, Alberta Biodiversity Monitoring Institute
Craig DeMars, Alberta Biodiversity Monitoring Institute
Meike Wittmann, Universität Bielefeld
Stan Boutin, University of Alberta

Linear features (LFs) can alter predator-prey dynamics in 3 ways: 1) By allowing incursions of predators into habitat that was previously a refuge; 2) by increasing movement rate and thus foraging efficiency of predators; and 3) by creating forage for alternate prey due to the removal of the forest canopy. Each of these mechanisms is thought to contribute to the decline of woodland caribou. Empirical support for these mechanisms varies, and it is important to quantify these if recovery actions are to be successful. Additionally, the effect of climate change in facilitating the expansion of alternate prey (particularly white-tailed deer) may dwarf effects from all 3 of these mechanisms and would present an alternate hypothesis to the federal boreal caribou recovery strategy. We explore the degree in which each of these mechanisms has been supported and how we plan to work with industry, academia and government to fill gaps in our current understanding. We present an experimental design using camera traps and radio telemetry to contrast the effects of all these mechanisms and use simulations to understand the possible implications of LF restoration to caribou populations. Unless the relative magnitude of linear features compared to climate are quantified, recovery actions cannot be expected to succeed.

Title *Innovation, incentives, and a path to more efficient and effective restoration*

Author **Matthew Pyper**, Fuse Consulting Ltd.

Restoration of linear features has been acknowledged as a critical component of woodland caribou conservation for over 20 years, and recent on-the-ground efforts within Alberta have begun to shed light on the potential approaches and costs for this work. By working together, governments, industry, Indigenous communities, and local stakeholders have helped to advance restoration as a viable tool in the caribou conservation toolbox. However, restoration is not cheap, and current cost estimates for the restoration of linear features, such as seismic lines, are approximately $8,000 to $12,000 per kilometre.

To ensure that habitat restoration remains a viable long-term solution within woodland caribou ranges there is a need to explore opportunities to reduce restoration costs while maintaining the ecological effectiveness of restoration techniques.

One core way this can be achieved is through new scientific innovations and the effective synthesis and application of new scientific knowledge. A second way is through equipment innovations that can apply treatments effectively but at significantly lower costs. While the application of new knowledge can arguably be solved through better communication, education, and sharing of information, new equipment innovations may require a different approach. I suggest that economic incentives could be a critical tool to help stimulate entrepreneurs to make investments in new equipment and new technologies for both the deployment and monitoring of restoration treatments.

In this presentation, I will showcase examples of recent innovations and demonstrate how incentives could help stimulate new equipment development to help achieve linear restoration goals at lower costs.

THEMED SESSIONS PRESENTATIONS

Tuesday, October 30, 2018 | 15:15 – 17:00
Indigenous Knowledge Informs Policies

Title *Porcupine Caribou Management Board's role in co-management*

Author **Joe Tetlichi,** Porcupine Caribou Management Board

Joe Tetlichi will briefly speak about the Porcupine Caribou Management Board's (PCMB) role in co-management and collaboration between traditional users of the herd and government. He will outline the significant achievements and milestones in the Board's history including the Harvest Management Plan, the Implementation Plan, and most recently a Native User Agreement. The presentation will then focus on PCMB's input to the COSEWIC and SARA processes for barren-ground caribou and the Board's role regarding the current conservation concern in the herd's calving grounds located within the Arctic National Wildlife Refuge. Joe will highlight the need for Canadian management bodies and organizations to work together to foster international cooperation regarding managing the impact of development in the calving grounds of the Porcupine Caribou herd.

Title *Taking Care of Caribou: Weaving Traditional Knowledge in the Bathurst Caribou Management Plan*

Authors **Natasha Thorpe**, Thorpe Consulting Services Ltd.
Tina Giroux, Athabasca Denesuline Né Né Land Corporation
Karin Clark, Environment and Natural Resources, Government of the Northwest Territories
Dan Ohlson, Compass Resource Management Ltd.
John Nishi, EcoBorealis Consulting Inc.
Bathurst Caribou Working Group

Indigenous peoples and scientists are working together to respect and weave together multiple understandings of the Bathurst barrenground caribou and their habitat. Researchers affirm what communities report: fewer caribou than seen in living memory, caribou in poor health, and a strained relationship between people and caribou. In 2014, these concerns along with recommendations from recent environmental assessments led the Government of the Northwest Territories to advance the Bathurst Caribou Range Plan (BCRP). The BCRP process was built around a collaborative working group from Nunavut, Northwest Territories and northern Saskatchewan which considered ecological, cultural and socio-economic values across the Bathurst range as a basis for management recommendations.

We present two land management recommendations from the BCRP based on scientific understandings and traditional knowledge. First, the importance of key caribou crossings articulated by community members and coupled with supporting spatial data from TK databases resulted in a recommendation to protect these sites where caribou are funneled between large lakes on narrow "bridges" of land and swim or wade across rivers or lakes at water crossing locations on the summer and fall range. Second, the BCRP defines a "center of habitation" based on the current core use area according to data from satellite collared caribou from 2015-2017 coupled with traditional knowledge of important migratory, geographic, and habitat features. Because of the important role of the core use area in sustaining herds throughout cycles of low and high numbers, the BCRP recommends mitigating land use activities more stringently in this centre of habitation

Title *Development of the Bathurst Caribou Range Plan*

Authors **Dan Ohlson**, Compass Resource Management
John Nishi, EcoBorealis Consulting
Natasha Thorpe, Thorpe Consulting Services
Karin Clarke, Government of Northwest Territories

The Bathurst herd is a population of migratory barren-ground caribou whose range extends across Nunavut, the eastern NWT and northern Saskatchewan. In response to concerns about significant population declines and the cumulative effects of mineral development and other land use activities on the Bathurst range observed by biologists and community members alike, the Government of NWT coordinated a range planning process to provide guidance on ways to manage and reduce disturbance to caribou and caribou habitat (i.e., cumulative land disturbance thresholds, habitat conservation, mobile conservation measures, etc.).

We provide an overview of the reflexive, iterative and balance-seeking process that underpinned the development of the Bathurst Caribou Range Plan. The range planning process brought together a Working Group with representatives from Aboriginal governments and organizations, industry, federal and territorial governments, and non-governmental organizations. The heart of the planning process revolved around Working Group workshops where participants engaged in open, frank and often difficult conversations about the socio-cultural, environmental and economic implications of various range-scale management actions.

Facilitated by an interdisciplinary team of professionals, the process involved both technical tasks (e.g., defining future land development scenarios, modeling the potential response of caribou to these scenarios) and engagement activities (e.g., Traditional Knowledge (TK) workshops, community visits). The Working Group integrated traditional, local and scientific knowledge as a basis for the plan.

The result is a Range Plan that seeks the balance among competing interests and includes recommendations that are intended to guide land use planners, resource management Authorities, development proponents and communities alike.

Title *Sayisi Dene and Caribou - Working in Partnership to Conserve the Seal River Watershed - Winter Habitat of the Qaminuriak Caribou Herd*

Authors **Ernie Bussidor,** Sayisi Dene First Nation
Ron Thiessen, Canadian Parks and Wilderness Society - Manitoba chapter

My presentation will be conducted orally and accompanied by an illustrative map.

The Sayisi Dene First Nation (SDFN) have a historic relationship with barrenland caribou. Our food, our clothing, our tools, our shelters and all aspects of life revolved around caribou for thousands of years. Within recent memory, we were falsely accused of slaughtering too many caribou so the government moved us away from our homeland, which almost destroyed our people. We have since relocated to our traditional lands at Tadoule Lake and learned the hard way to be conservative when it comes to harvesting caribou. There has been many challenges.

SDFN is at the forefront in the efforts to create a safe haven for the Qaminuriak caribou in their winter range – the Seal River Watershed.

The SDFN, with the assistance of ILI (Indigenous Leadership Initiative) and CPAWS (Canadian Parks & Wilderness Society) are in the process of communicating with regional First Nations, to discuss ways to create an Indigenous Protected and Conserved Area, to be managed collectively, and with support of Canadian governments. I am spearheading this on behalf of SDFN as the Facilitator. We have conducted a successful initial meeting with regional First Nations.

The purpose is to protect this pristine wilderness area from industrial development, promote economic prosperity through ecotourism, showcase the diverse cultures, and protect and cooperatively manage caribou. The youth of our community are in full support as they will be the ones to be trained as Guardians of the lands, waters, and caribou.

Title ***When the Caribou do Not Come: Indigenous Knowledge and Adaptive Management in the Western Arctic***

Authors **Brenda Parlee,** University of Alberta
Frank Pokiak, Inuvialuit Game Council
Anne Marie Jackson, Fort Good Hope
Laura Jane Michel, Lutsel Ke Dene First Nation

The oral presentation is based around a book project involving elders, indigenous leaders and scholars involved in research and management of barren ground caribou. A range of social science and Indigenous knowledge dimensions of the recent declines in caribou in the Northwest Territories are highlighted. What can we learn from history? What are the strengths and capacities in communities for coping with caribou popolation change? Can we get beyond 'harvest management'? What are the big picture food security and livelihood implications? Whose voices are not at the boardroom table? A key goal of the presentations will be the honoring of traditional knowledge system (knowledge, practices, institutions) and their importance to adaptive management.

Title ***Honouring the spirit and intent of Land Claims Co-Management in the Canadian North.***

Authors **Paul Irngaut,** Nunavut Tunngavik Incorporated
Bert Dean, Nunavut Tunngavik Incorporated
David Lee, Nunavut Tunngavik Incorporated
Cheryl Wray, Nunavut Tunngavik Incorporated

Harvesting wildlife remains critical to the Inuit of Nunavut for both subsistence and cultural reasons. Caribou is an important component of Inuit diet as well as other terrestrial and marine wildlife. Sustaining the capacity to harvest wildlife is vital for maintaining and strengthening Inuit economic, social and cultural well-being. The Nunavut Agreement states that there is a need for an effective system of wildlife management that complements Inuit harvesting rights and priorities, and recognizes Inuit systems of wildlife management that contribute to the conservation of wildlife and protection of wildlife habitat. This presentation highlights the importance of the inclusion of Inuit Qaujimajatuqangit (IQ) in the co-management decision making processes in order to achieve this objective. IQ represents the past, present, and future knowledge, experience, and values of Nunavut Inuit society. Nunavut Tunngavik Inc., (NTI), as the representative aboriginal organization that represents the Inuit of Nunavut is responsible for the implementation of the Nunavut Agreement. NTI continues to promote the inclusion of IQ in wildlife management decision processes.

THEMED SESSIONS PRESENTATIONS

Wednesday, October 31, 2018 | 10:30 – 12:00
Modelling Tools to Support Decision-Making

Title *Prioritizing restoration of fragmented boreal landscapes for caribou protection: a graph-theoretic approach*

Authors **Denys Yemshanov,** Natural Resources Canada, Canadian Forest Service, Great Lakes Forestry Centre
Robert Haight, USDA Forest Service, Northern Research Station
Marc-André Parisien, Natural Resources Canada, Canadian Forest Service, Northern Forestry Centre
Frank H Koch, USDA Forest Service, Southern Research Station
Tom Swystun, Natural Resources Canada, Canadian Forest Service, Great Lakes Forestry Centre
Quinn Barber, Natural Resources Canada, Canadian Forest Service, Northern Forestry Centre
Cole Burton, University of British Columbia
Ning Liu, Natural Resources Canada, Canadian Forest Service, Great Lakes Forestry Centre
Salimur Choudhury, Lakehead University
Nicolas Mansuy, Natural Resources Canada, Canadian Forest Service, Northern Forestry Centre

Exploration of non-renewable natural resources in boreal regions of western Canada involves the creation of seismic lines to access resource deposits, which create linear disturbances in forests. Seismic lines have caused habitat fragmentation and increased predator access, leading to a subsequent decline of some wildlife populations, particularly the woodland caribou, Rangifer tarandus caribou. Decision-makers strive to develop conservation strategies that can sustain these struggling caribou populations while keeping project costs within a defined budget. We present an economic optimization model with the objective of determining optimal landscape restoration strategies that maximize the area of connected accessible habitat for a caribou population in a fragmented landscape. We used our model to find optimal seismic line restoration strategies in the Cold Lake Area of Alberta, Canada, a 6726-km2 expanse of boreal forest that represents prime caribou habitat. We formulate two mixed integer programming models that depict the landscape as a network of interconnected habitat patches and emphasize the population's local or long-distance access to habitat. Optimal restoration involves a mix of two strategies: the first establishes short-distance connections between forest patches with large areas of intact habitat and the second establishes corridors between areas with known species locations and large amounts of suitable habitat. Our approach reveals the trade-offs between these strategies and other competing objectives (such as mining or industrial forest harvesting) and finds the optimal restoration solutions under a limited budget. The approach is generalizable and applicable to other regions where caribou is sensitive to changes in landscape-level connectivity.

Title *Towards a long-term strategy for boreal caribou habitat stewardship: Quebec's approach*

Authors **Frédéric Bujold,** Ministère des Forêts, de la Faune et des Parcs du Québec
Andrée-Anne Déry, Ministère des Forêts, de la Faune et des Parcs du Québec
Jérôme Rioux, Ministère des Forêts, de la Faune et des Parcs du Québec

The Quebec Government announced its Boreal Caribou Habitat Stewardship Plan in April 2016. In doing so, Quebec plans to implement a weighted approach in which the protection effort will be focused on the key elements of caribou habitat, in places where chances of success are the greatest. In keeping with the Action Plan, Québec will be adopting a long-term strategy for boreal caribou habitat stewardship.

To achieve this, Quebec is carrying out a socio-economic analysis of various scenarios of caribou

habitat management and has developed a landscape diagnosis, based on caribou habitat quality, caribou presence, protected areas, human activities and forest productivity.

This iterative approach lead to the identification of immense landscapes suitable for caribou, in which appropriate management methods could be deployed to promote self-sufficiency. In addition, habitat restauration trials are conducted in highly disturbed landscape where remaining caribou populations subsist. Direct actions such as forest road dismantling and reforestation are being tested. Finally, the implementation of large protected areas and an adaptation of the northern boundary for timber allocations will ensure that large landscapes remain free of industrial activities.

The Québec Government sees to a continuous contribution from partners and stakeholders, including First Nations. The Partners' Panel as well as the Québec-First Nations Panel meet regularly to discuss the strategy and any arising concerns. The Quebec Boreal Caribou Recovery Team and researchers are also consulted as the strategy progresses.

A long-term population monitoring framework will assess the effectiveness of the strategy and will contribute to its future refinement.

Title *Cycle stratified harvest policies for a sub-population of barren-ground caribou*

Authors **Eric Bongelli,** Lakehead University
Mitch Taylor, Lakehead University
Mitch Campbell, Government of Nunavut
Martha Dowsley, Lakehead University

Migratory barren-ground caribou (Rangifer tarandus groenlandicus) are a cyclic species that is highly valued by northern residents, and represent a keystone species for North America's vast barren-lands. Developing a sustainable harvest regime for a subpopulation of barren-land caribou is currently difficult due to challenges in accommodating for natural population cycles. Barren-ground caribou subpopulations are large and typically cover multiple jurisdictions, making rapid unilateral management decisions inefficient and often impractical. To address this problem, I have developed a cyclic individual based life-table caribou harvest model to examine the user-benefits of cycle stratified harvest policies. The model (program CARIBOU 1.0) allows for the development of harvest regimes that are specific to various stages of the cycles, which when taken together are sustainable on a cycle basis.

Program CARIBOU's primary purpose is support harvest co-management decisions. In line with the conference theme of "Working Together" program CARIBOU 1.0 could be employed to explore sustainable harvest options collectively and identify policies for any subpopulation of barren-ground caribou that best satisfies the needs and preferences of hunters and also meets the conservation mandates of the various responsible agencies.

Various researchers and Traditional Ecological Knowledge (TEK) agree that barren-ground caribou subpopulations experience regular cyclic fluctuations in population abundance. In addition to the development of program CARIBOU 1.0, I have conducted a cycle analysis of 11 barren-ground caribou subpopulations identifying the cycle length, and amplitude values associated with each subpopulation cycle, and explored other range specific attributes that may be driving the population cycles.

Title *Linking climate to vital rates for migratory tundra caribou: Carryover effects and regional patterns across North America*

Authors **Don Russell,** CircumArctic Rangifer Monitoring and Assessment Network
Anne Gunn, CircumArctic Rangifer Monitoring and Assessment Network

Using CARMA's MERRA climate database, we analyzed herd-specific climate variables with available vital rate data for seven migratory tundra herds from the Western Arctic Herd in Alaska to the George River herd in Ungava. Where sample sizes permitted, we produced two-variable models for all vital data variables that were available. In cases where vital rate data trended over time, we detrended both vital rate and climate data to better represent cause and effect relationships. To explore carry-over effects we also created 2-and 3-year running average climate variable to relate to vital rates. Our results indicate that climate variables that entered the model differ among herds and between vital rates although both regional patterns and length of average length of vital rate carryover effects were evident. In general spring climate variables were only entered the models in the western herds; fall variables decreased in importance going from west to east; summer and winter variables increased in importance going from west to east. Of note was that peak winter snow depth never entered any of our models. Further the average carry-over effect from adult cow mortality was 2.3 years, while at the other end of the scale, carry-over effect for fall calf:cow ratios was only 0.8 years. These findings highlight the need to treat climate change on a herd specific basis. For example summer drought conditions do not affect all herds in the same way. Further our results provide some insights into how to allocate monitoring priorities to better track herd productivity.

Title *Web-based Application for Threatened Woodland Caribou (Rangifer tarandus caribou) Population Modeling*

Authors **Mark Hebblewhite,** University of Montana
Daniel R. Eacker, Alaska Department of Fish and Game
Robin Steenweg, Alberta Environment and Parks
Mike Russell, Alberta Environment and Parks
Amy Flasko, Alberta Environment and Parks
Dave Hervieux, Alberta Environment and Parks
Eric Palm, University of Montana

Woodland caribou are threatened in Canada, with population and distribution declines evident in most regions of the country. The Federal Species at Risk Act requires effective protection caribou critical habitat, and enables actions to increase caribou survival. which requires effective monitoring of caribou population trends. Due to their low densities, however, caribou populations are nearly impossible to count using traditional aerial survey methods. Demographic-based monitoring approaches can be used to estimate population trends based on population modeling of vital rates from marked animals. Caribou monitoring programs have used a well-known simple population model (the Recruitment-Mortality (R/M) equation) to estimate population trends, but face challenges in managing large data streams and providing transparency. Here, we present a stand-alone statistical software application using open-source software to permit efficient, transparent, and replicable demographic estimation for woodland caribou populations. We developed an easy-to-use, interactive web-based application for the R/M model that uses a flexible Bayesian estimation approach, as well in output features. We illustrate the web-application to the A la Pêche Southern Mountain (Central Designatable Unit) woodland caribou population in west-central Alberta. Our estimates of population demographics are consistent with previous research on this population and highlight the utility of the application in assessing caribou population responses to species recovery actions. We provide example data, computer code, the web-based application package, and a user manual to guide installation and use. We expect our software will contribute to efficient monitoring of woodland caribou, and help in the assessment of recovery actions for this species.

THEMED SESSIONS PRESENTATIONS

Wednesday, October 31, 2018 | 10:30 – 12:00
Indigenous Knowledge Informs Management

Title *Unique modelling approach engages local stakeholders in management of their herd*

Authors **Christine Cuyler,** Greenland Institute of Natural Resources
Colin J. Daniel, Apex Modelling Systems
Martin Enghoff, Nordic Agency for Development and Ecology
Nuka Møller-Lund, Greenland Ministry of Fisheries Hunting and Agriculture
Nette Levermann, Greenland Ministry of Fisheries Hunting and Agriculture
Per N. Hansen, Government of Greenland Fisheries License Control (GLFK)
Ditlev Damhus, Nordic Agency for Development and Ecology
Finn Danielsen, Nordic Agency for Development and Ecology

Integrating information derived from different knowledge systems to provide the basis for management decisions is challenging. To participate in decision-making, indigenous peoples' well-founded expert knowledge needs to be in a format where it can be incorporated and used by communities. We instigated a unique process whereby community-executed population modeling was combined with knowledge gathered from community-based field surveys to predict future abundance and herd composition. This new approach was applied in the Arsuk hamlet community and their small (ca. 1000) muskox population located in the Ivittuut region of southwest Greenland. Local-stakeholders identified sustainable harvest scenarios and examined if these were achievable. The result was informed community decisions regarding harvest management and the immediate implementation of community recommendations by government wildlife management. This community-informed population modelling empowered the local community in natural resource governance and helped integration of knowledge systems. Our new process of working together provides a blueprint for other Greenland populations of muskoxen and caribou.

Title *Innu and Atiku (Caribou): A Community-driven Cumulative Impact Assessment of Caribou decline*

Authors **Damian Castro,** Memorial University of Newfoundland
Carolina M Tytelman, Memorial University of Newfoundland
Mario Blaser, Memorial University of Newfouandland

In this presentation we like to show the experience on a caribou assessment where scientists and Labrador Innu community members work together to understand Labrador's caribou decline. Scientists assessments have focused on finding the decline's causes, including the impact of the human and environmental factors. However, this problem has not been addressed considering the point of view of the Labrador Innu. Through a series of interactions (such as workshops and interviews) we identified an appropriate methodological approach for how the assessment could be done in a way that would incorporate the perspectives of the communities. The foundation of Innu perspective is that Atiku (Innu-aimun for caribou) are (non-human) people. As such, they are powerful, strong and have feelings. They think, make decisions, and want to be admired and respected just like human people do. They also have a 'boss' or spirit-master who leads them. The spirit-master of atiku made an agreement with the Innu at the beginning of time: atiku would give themselves to the Innu so that the Innu can live. In turn, the Innu show respect in various prescribed ways to atiku and their boss so that the souls of hunted atiku are reborn and the relation of gift giving between atiku and the Innu can continue down the generations. From this perspective, the Labrador's caribou decline can be understood as the decline of a relationship between persons (human and non-human) rather than simple as the decline of the abundance of a natural resource.

Title ***Integrating traditional Indigenous knowledge and involvement into resource management and Saskatchewan woodland caribou range planning.***

Authors **Michael S McLaughlan**, Saskatchewan Ministry of Environment - Fish, Wildlife & Lands Branch
Tim Trottier, Saskatchewan Ministry of Environment - Fish, Wildlife & Lands Branch

Effectively integrating traditional Indigenous knowledge and involvement into resource management and woodland caribou range planning is unfamiliar territory for most coordinating agencies. The Saskatchewan Ministry of Environment will identify some lessons learned by providing context and a historic overview of the topic by:

1) Recognizing the important historic role that Indigenous knowledge has played in civilization and Canadian exploration,
2) Contrasting and comparing the characteristics of Indigenous knowledge with Western science,
3) Highlighting the benefits of introducing traditional ecological knowledge into resource management,
4) Illustrating some legal foundations and agreements for incorporating Indigenous knowledge at international, national, and provincial levels,
5) Recognizing the current barriers that are restricting the documentation and integration of Indigenous knowledge into resource management,
6) Sharing some methods of qualitative data gathering and a process to integrate Indigenous knowledge with Western science,
7) Providing a series of recommendations to assist in the incorporation of Indigenous knowledge into resource management, and
8) Sharing the approach used in the development of Saskatchewan's woodland caribou range plans.

Title ***Meaningful Community Participation in Woodland Caribou Research and Recovery in Northern Saskatchewan***

Authors **Sarah Schmid,** General Manager, Prince Albert Model Forest
Robin McLeod, Prince Albert Grand Council

Efforts to incorporate traditional ecological knowledge (TEK) into land-based activities and planning processes are a necessary step to promote reconciliation and achieve meaningful working partnerships. Two organizations, the Prince Albert Grand Council (PAGC) and the Prince Albert Model Forest (PAMF), have been working together to enhance participation of Indigenous communities in Saskatchewan's Woodland Caribou Range Planning. Communities have identified TEK as a both a research method and a means of including them in the range planning process. Through interviews, mapping exercises, youth outreach programs and community driven initiatives, project participants will adhere to cultural protocols when collecting and documenting TEK, which can then be incorporated into range plans. Thus far, the partnering organizations have hired and trained local Indigenous people to lead work within their communities, including efforts to collect TEK and conduct fieldwork. The project has already collected TEK from various communities in the SK1 and SK2 regions, delivered youth initiatives in two communities and enhanced of awareness of range planning throughout the area. It TEK is a form of data that can be used to complement or challenge scientific information. By working together, the PAMF and PAGC will ensure that TEK is incorporated into all levels of caribou recovery and management in Saskatchewan.

Wednesday, October 31, 2018 | 10:30 – 12:00
Structure of Caribou Populations

Title *All caribou in canada are currently at risk of extinction*

Authors **Justina Ray,** Wildlife Conservation Society Canada
Graham Forbes, University of New Brunswick
Chris Johnson, University of Northern British Columbia
Anne Gunn, independent consultant

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) reviewed the status of all caribou in Canada in 2014-2017 and found all to be at some risk of extinction. The tremendous variation displayed by caribou over their broad distribution in arctic, boreal, and mountain habitats has been recognized through a national framework of 12 Designatable Units, defined by COSEWIC as spatially, ecologically or genetically discrete and evolutionarily significant units that are irreplaceable components of biodiversity. Six of 11 DUs qualify as Endangered at present, exceeding quantitative thresholds for population decline over the last three generations. Four DUs -- Barren-ground, Eastern Migratory, Torngats, and Central Mountain – were assessed for the first time, all qualifying as Threatened or Endangered. Of the seven DUs that were last evaluated in 2002-2004, the status of only one (Peary) has improved, moving from Endangered to Threatened. Otherwise, three remained unchanged and three had deteriorated. Listing under the federal Species At Risk Act to reflect these changes lags much further behind assessment, and we explore some consequences of these delays. Habitat protection, however, will rely primarily on deliberate actions taken by the provinces and territories.

Title *Ecological genomics: a new interdisciplinary tool for the management and conservation of caribou in western North America*

Authors **Maria Cavedon,** University of Calgary
Bridgett vonHoldt, Princeton University
Stefano Mariani, University of Salford
Troy Hegel, Yukon Department of Environment
Dave Hervieux, Alberta Environment and Sustainable Resource Development
Marco Musiani, University of Calgary

Caribou are a globally declining species and, in North America, there is an urgent need to set a clear path for their recovery and protection. A fundamental step toward caribou management and conservation in Canada has been the delineation of 12 Designatable Units (a concept similar to U.S.' Distinct Population Segments); however genomic analyses were demanded by the Committee on the Status of Endangered Wildlife Species in Canada to fill knowledge gaps. We applied an ecological genomic approach to caribou populations throughout western North America and detected signatures of selection on alleles associated with environmental variables along a North-South gradient. Our population structure analysis supported DUs designation with some exceptions, indicating the robust basis of DUs' classification scheme, but also highlighted the possibility for refinement. Our interdisciplinary study relies on collaborations with different government agencies, universities, foundations, and first nations. We aim to build a strong bond with all partners that will allow us to work together now and in the future towards a better management and conservation of caribou. Overall, our study provides a model approach that will be useful for the management and conservation of caribou and for threatened terrestrial species in general.

Title *A Genomic Refinement of A.W.F. Banfield's 1961 "A Revision of the Reindeer and Caribou, Genus Rangifer" for North American caribou*

Authors **Paul Wilson,** Trent University
Micheline Manseau, Landscape Science and Technology Division, Science and Technology Branch, Environment and Climate Change Canada
Rebekha Horn, Trent University

Banfield's characterization of Rangifer evolution is an invaluable resource for understanding and conserving an iconic species. We completed the whole-genome sequencing of representative caribou subspecies and ecotypes, coupled with a comprehensive mitochondrial DNA survey, to compare to Banfield's work of more than 50-years ago. There was striking concordance in the two evolutionary reconstructions. Demographic reconstruction indicated a major expansion of caribou during the glacial interstitial stage of a largely ice-free North America 120 kya with subsequent differential population trajectories of emerging subspecies. Timing of subspecies divergence was concordant with barren-ground, woodland, and diversification of Arctic Peary and Greenland. Some revisions were notable between the original Banfield and genomic reconstructions. Mountain caribou have a more complex history beyond ecotypic characterization within the woodland subspecies, with lineages related to barren-ground caribou of Beringian origin, and this relationship was further observed with Grant's caribou. Convergence of ecotypes was observed in a Beringian derived lineage evolving a boreal ecotype independent of woodland caribou where it is currently placed. Genomic characterization detected admixture among lineages, and while Banfield described intergradation among caribou forms, introgression among lineages is consistent with the recent findings of many mammalian species in that introgression is a more important evolutionary driver than previously thought. Overall, the similarity of Banfield's revision from 1961 captured the main patterns of caribou evolution; however, our genomic revision will provide a more accurate characterization of introgression and the complexity ecotypic divergence relevant to delineating conservation units under Canada's Species-at-Risk Act (SARA).

Title *CSI Caribou: Ecotype assignment in a wildlife forensics context*

Authors **Vincent Bourret,** Gouvernement du Québec - Laboratoire d'expertise biolégale
Joëlle Taillon, Gouvernement du Québec - Service de la gestion des espèces et des habitats terrestres
Éric Normandeau, Université Laval - Institut de biologie intégrative et des systèmes
Louis Bernatchez, Université Laval - Institut de biologie intégrative et des systèmes
Vicky Albert, Gouvernement du Québec - Laboratoire d'expertise biolégale

Legal protection of caribou ecotypes differs among Canadian provinces and territories and even within regions. In Québec, three ecotypes of caribou are present while only migratory caribou is still legally harvested. In this context, Québec's wildlife protection agency is faced with an issue regarding the accuracy of assignment by ecotypes of caribou being illegally harvested on its territory. We therefore aimed to develop a tool that could help determine a caribou ecotype based on its genetic profile. We focused on a genomic approach involving the identification of new genetic markers using next-generation sequencing. This method allows to detect and analyze thousands of genetic markers called SNP who should provide enough assignment power to distinguish caribou ecotypes. We thus analysed 378 caribou samples collected over the entire species' distribution in Québec and Labrador, and equally distributed among the five genetic groupings previously identified via STR markers. Approximately 2.5 million of 100pb reads were obtained and analyzed per samples. Using a bioinformatics workflow, we were able to discover and simultaneously genotype over 8 000 SNPs. These markers showed increased resolution of population genetic structure which significantly raised

the confidence in caribou ecotype assignment (boreal, migratory or montane (Gaspésie)). Overall, this new method will better support investigations lead by the Québec's wildlife officers and court expert testimonies. Furthermore, it represents a significant milestone in the field of wildlife forensics by paving the way to the legal use of genomic approaches in protecting vulnerable or threatened species from illicit exploitation.

Title *An Inter-jurisdictional Scan of Spatial Structure of Caribou Populations*

Authors
Steve Wilson, EcoLogic Research
Glenn Sutherland, Wildlife Infometrics Inc.
Nic Larter, Department of Environment and Natural Resources, Government of the Northwest Territories
Allicia Kelly, Department of Environment and Natural Resources, Government of the Northwest Territories
Ashley McLaren, Ontario Ministry of Natural Resources and Forestry
James Hodson, Department of Environment and Natural Resources, Government of the Northwest Territories
Troy Hegel, Alberta Environment and Parks
Robin Steenweg, Alberta Environment and Parks
Dave Hervieux, Alberta Environment and Parks
Tom Nudds, Department of Integrative Biology, University of Guelph

Three jurisdictions collaborated to study spatial structure of trans-boundary local population units (LPUs) of boreal woodland caribou as delineated in the federal recovery strategy. Population viability analyses central to contemporary integrated risk assessments (IRAs) of LPUs implicitly assume geographic closure. However, several LPUs in northwest Canada are, in part, delineated geopolitically. We pooled >1.2M locations from >1.2K GPS/VHF-collared caribou and developed a transparent, repeatable Bayesian cluster analysis that generated different candidate LPUs. Spatial relationships among caribou were represented by a "social graph" that characterized the degree of mutual information shared by all pairs of collared caribou. We resolved 10 candidate LPUs, of which 2 appeared to be artifacts in under-sampled areas; 5 were delineated LPUs that were conserved (Snake-Sahtaneh, Prophet, Parker, Chinchaga and Red Earth); and 1, at >136K km2, subsumed 6 delineated LPUs spanning AB, BC and NT. These results (1) are consistent with independent genetic and Indigenous knowledge about spatial structure of caribou populations in the region generally and suggest less geographic closure of delineated LPUs than assumed by the IRA; (2) underscore the need for inter-jurisdictional collaboration to manage trans-boundary LPUs to achieve recovery goals; (3) help to inform land-use scenario analyses and management plans, which in turn should lead to recovery planning better assured to reduce risks to caribou; and (4) will be discussed in relation to challenges and opportunities related to conservation and recovery of trans-boundary boreal caribou local populations.

THEMED SESSIONS PRESENTATIONS

Wednesday, October 31, 2018 | 13:00 – 14:45
Decision-Making: Ideas and Opportunities

Title *Where caribou is only a memory*

Author **Jeff Wells,** International Boreal Conservation Campaign

Woodland caribou were long a part of the natural legacy of parts of the U.S. and Maritime Canada. Despite caribou being gone from many of these areas for a century or more, a memory of their presence lingers like an elusive spirit. The name "caribou" is still found on maps where there are no longer any left--as the name of towns, mountains, lakes, rivers and bogs. In Maine, where I am from, the last wild caribou was seen in the state about the time my grandparents were born but we have a small northern city called "Caribou" and many other remnants of their time here. Now, only stories remain in places like Maine—stories that recount the last small herds of caribou that were seen (and hunted) in the last decades before they disappeared forever. The story of what it is like to have lost a precious part of one's natural heritage but to still be able to see its reflection in the mirror of history is a precautionary tale to consider as the world considers the fate of caribou throughout their range.

Title *Extirpation despite regulation? How environmental assessment is failing caribou*

Authors **Rosemary Collard,** Simon Fraser University
Jessica Dempsey, University of British Columbia

Many caribou populations are in decline despite dozens of provincial and federal legislative instruments designed to protect them and their habitat. How can this be? Our broader research project sets out to answer this question through qualitative, social scientific investigation of political economic institutions and their role in caribou decline. In this paper, we examine one state institution: environmental assessment (EA). A systematic search of all Canadian and British Columbian EAs from the 1990s to today yields 79 EAs for projects deemed to have significant adverse effects for caribou. All projects but one were approved despite these effects. Based on a close, inductive reading of all documentation pertaining to these EAs, we find most are approved based on promised mitigation measures; yet, the effectiveness of mitigation is largely unknown. Additionally, several projects' approval rests in part on the claim (often contested by First Nations) that caribou in the region are already gone or their habitat is already degraded; this poses a significant barrier to caribou recovery and to fulfilling Canada's duty to protect Indigenous rights. Finally, a select few projects are approved even though mitigation measures are insufficient, because of perceived public interest in the project. By combining qualitative, social scientific approaches with existing scientific research, our study illustrates specific points where the most rigorous and scientifically-based regulatory apparatus is failing caribou and many First Nations. Our findings are relevant for governments reforming EA and seeking to understand and intervene in caribou declines, which we suggest are politically-economically driven.

Title *Cumulative Effects on Barren-ground Caribou – Overestimating the Effects and Ignoring the Evidence*

Author **Michael Setterington,** EDI Environmental Dynamics Inc.

There are many questions and concerns about cumulative effects on barren-ground caribou. Despite having a number of cumulative effects assessments completed that consider barren-ground caribou herds, there are continued calls for a comprehensive cumulative effects assessment (e.g., Festa-Bianchet et al. 2011). Cumulative effects assessments triggered by mining projects included consideration of mining and overall disturbance effects on a number of barren-ground herds. These assessments, prepared by various impact assessment specialists and ungulate biologists, were critically reviewed at technical and public forums through impact review board processes and defended in public hearings. The results repeatedly show that we have yet to realize cumulative effects as a result of exploration or mining disturbances on caribou under past, present, and likely future scenarios. Regardless of documented and peer-reviewed evidence, land-use and impact assessment concerns continue to focus on the impending doom that industry will bring upon arctic caribou populations. Why? Mortality

risk assessments indicate pre-existing cumulative effects that are occurring regardless of the presence of mines and exploration. Energetics effects are masked by natural high variation, and it is clear that caribou would have to experience disturbances at levels of orders of magnitude greater than what they experience now before disturbance effects are realized. Even considering the precautionary principle and conservation first, the collective science and traditional knowledge analyses must be sufficient by now for us to make reasonable effects predictions and informed decisions. How can the northern mining industry and biologists work together to determine the risks and arrive at solutions?

Title *New Opportunities for Leveraging Boreal Caribou Conservation And Other Policy Needs Across Canada*

Authors **Courtenay Lewis,** Natural Resources Defense Council
Anthony Swift, Natural Resources Defense Council

In Canada, federal and provincial tools to protect critical boreal woodland caribou habitat under the Species at Risk Act (SARA) are in need of urgent implementation. Moreover, protections under SARA could be made even more effective if paired with Indigenous-led conservation efforts, and federal and provincial policies around climate change mitigation. This presentation would rely on qualitative and quantitative data including NRDC estimates of the climate change implications of widespread logging in Canada's boreal forest that both threatens this forest's ability to store carbon and boreal caribou critical habitat. Collaborative approaches between Indigenous Peoples, federal and provincial policymakers, scientists, non-governmental organizations and companies can help ensure a coherent approach to conservation of boreal woodland caribou that delivers benefits across multiple critical objectives, including working to meet Canada's obligations under the UN Declaration on the Rights of Indigenous Peoples, the Convention on Biological Diversity (including the Aichi Targets) and greenhouse gas reduction commitments under the UNFCCC. Indigenous-led land management, climate regulations, and funding related to ecosystem services are examples of important initiatives that can also protect caribou and conservation values. This consideration of overlapping conservation priorities and policies highlights the conference's key theme of "working together," and exemplifies the presentation theme of "finding innovative solutions."

Title *Seeing the forest for the caribou: fostering new science to improve management in Canada's boreal forest*

Author **Darren Sleep,** Sustainable Forestry Initiative

The decline of woodland caribou has generated significant concern, research and focus. However, such single-species focus could be to the detriment of sustainably managing the broader landscape and biodiversity. Working together with academics, research institutes, and the forest product sector, the Sustainable Forestry Initiative (SFI) has been working to develop new approaches to caribou management that are sensitive to the needs of the broader landscape, and to the goals of managing for biodiversity in general. SFI's Conservation Grant and Conservation Impact programs have targeted projects related specifically to woodland caribou research. Moreover, by fostering the funding of innovative research by SFI program participants, SFI has helped develop new and deeper understandings of both fundamental caribou ecology, and more broadly applied management practices for the species, all while keeping in mind the need to consider both other species at risk and biodiversity in general. Key to these initiatives is the co-creation of new knowledge from all stakeholders. With specific examples of highlights from recent work, this presentation will outline how SFI works to help develop and foster new caribou knowledge and apply that knowledge to forest management standards in Canada. This collaborative, innovative and iterative approach will lead to improved management of biodiversity going forward and will help sustain the values desired from the boreal landscape.

Title *Conservation through co-occurrence: Woodland caribou as a focal species for boreal biodiversity*

Authors
Chantal Hutchison, McGill University
C. Ronnie Drever, The Nature Conservancy
Chantal Lana Hutchison, McGill University
Mark C Drever, Environment and Climate Change Canada, Canadian Wildlife Service
Daniel Fortin, Université Laval
Cheryl Ann Johnson, Environment and Climate Change Canada, Science and Technology Branch
Yolanda F Wiersma, Memorial University

Working together as a collaboration among NGOs, academic and government scientists allowed us to tackle research questions regarding boreal caribou that have an applied focus while advancing conservation science underpinning policy. Our goal was to better understand how conservation of woodland caribou, an at-risk species for which large undisturbed areas are often proposed to maintain viable populations, can conserve boreal diversity. We estimate the value of woodland caribou for conservation of mammalian and avian diversity (n=434) in the boreal region of Canada by (i) evaluating co-occurrence of native taxa with caribou distribution for boreal mammals (n=102), birds (n=332), at-risk mammals (n=9) and at-risk birds (n=28); and (ii) conducting systematic conservation planning to identify minimum representative reserve networks, comprised of planning units deemed large enough (10,000 km2) for caribou persistence, both at the extent of woodland caribou range and the entire boreal region. While woodland caribou overlap with the range of 90% of boreal birds and mammals, area-efficient networks representative of diversity are focused on areas south of caribou range or southern herd ranges, due to the latitudinal gradient in species richness across the boreal, although this situation differs markedly if anthropogenic footprint on the landscape is considered. Efforts to sustain the boreal population of woodland caribou offer considerable opportunities to conserve diversity of co-occurring mammals and birds, especially in southern herd ranges. Our work demonstrates that decision makers need to consider a range of patterns, not only the overall richness gradient, for strategic and effective representation of boreal taxa.

THEMED SESSIONS PRESENTATIONS

Wednesday, October 31, 2018 | 13:00 – 14:45
Indigenous Values in Conservation

Title *Tributaries of the land*

Author **Melissa Mollen Dupuis,** David Suzuki Foundation

Language and stories hold power and responsabilites. By sharing our knowledge we are also empowering others to be capable of acting and sharing the shared gift that lands and territories offer it's childern. But in language there is also confusion, between nations one word can hold many meanings and one meaning may need many words.

When we talk about "Our" territories, in the settlers languages it may imply a right of possession to the land, but in many indigenous languages "Our" indicates and relates to our relation to that land, the same way you would talk of your mother or claim relation to another person. It also have the implication of showing responsability that is owned to that land. Making us tributaries of the land

Not as tribute owned to a king or lord, but as loving children to it's parent.

In regard of the future we now have a responsablity not only not to loose this concept in language, but also to hold it's other children to the same role of loving the mother that is the land and make them tributaries of the territories by sharing this knowledge and responsability.

Title *On the naturalness of being unnatural: reestablishing the foundations of wildlife managment*

Author **Leo Lepiano,** Michipicoten First Nation

In the fall and winter of 2017-2018, a small group of concerned citizens including wildlife aficionados, biologists, and the managerial and political branches of Michipicoten First Nation, succeeded in a series of requests toward eleventh-hour translocations to conserve the last caribou of the Lake Superior Range. Extirpation was imminent because wolves were predating remaining caribou (<20) on two islands that were the anchor populations of the entire range. The group asking for urgent conservation actions faced a surprising amount of opposition by the Ministry of Natural Resources and Forestry. Ministry staff repeatedly claimed that because the imminent crisis was part of a "natural process," we should "allow nature to take its course". While this approach was in conflict with the Federal Woodland Caribou Recovery Plan, the Provincial Caribou Conservation Plan, the Federal Species at Risk Act, and the Provincial Endangered Species Act, it was presented as being in accord with Ontario's Provincial Parks and Conservation Reserves Act, since the caribou of concern were located in provincial parks. In this paper we attempt to understand both the apparent contradiction in the Ministry's mandate, and why the language of "allowing nature to take its course" proved so captivating even to those within the Species Conservation Branch. We do this by carrying out a philosophical investigation into the concepts of 'nature' and 'natural' as they relate to ecology and wildlife management, out of which emerges a new mode of thinking about wildlife management that emphasizes the necessity of working together.

Title *Inuit approaches to naming and distinguishing caribou: Considering language, place, and homeland toward improved co-management*

Authors **Gita Ljubicic,** Carleton University
Simon Okpakok, Independent Interpreter/Translator
Sean Robertson, University of Alberta
Rebecca Mearns, Carleton University

Qikiqtaq (King William Island), in the Kitikmeot region of Nunavut, has been largely overlooked in caribou research to date. However, for community members of Uqsuqtuuq (Gjoa Haven, on Qikiqtaq), documenting and sharing Inuit knowledge of caribou was identified as a local priority. From 2011 to 2016 we worked with Uqsuqtuurmiut (people of Uqsuqtuuq) to document and share their knowledge of caribou and the connections to community well-being. An important part of this process was

to understand Inuktitut terminology and local approaches to naming and distinguishing caribou. Uqsuqtuurmiut do not generally distinguish caribou (tuktuit in Inuktitut) according to herds, in the way that biologists or wildlife managers do. Locally there are four main ways that caribou are differentiated: iluiliup tuktuit (inland caribou), kingailaup tuktuit (island caribou), qungniit (reindeer), and a mixture of iluiliup tuktuit and kingailaup tuktuit. From our work in Uqsqutuuq, as well as reviewing research from other Kitikmeot and Kivalliq communities, we emphasize how Inuit-caribou connections are articulated and enacted through language, place, and homeland. Key considerations that emerged include: i) accounting for dialectical differences; ii) understanding relative geographic references; and iii) recognizing historical and contemporary influences of traditional homelands and societies on terminology used. Through careful consideration of Inuit approaches to naming and distinguishing caribou in research and management contexts, we feel there is potential to: enhance communications and mutual understanding; support more inclusive and meaningful incorporation of Inuit knowledge in co-management; and refine approaches to caribou herd and habitat monitoring.

Title ***Coming together for caribou: Using community-led audio-visual methods to explore relationships among Inuit and caribou in Labrador.***

Authors
David Borish, University of Guelph
Ashlee Cunsolo, Labrador Institute of Memorial University
Inez Shiwak, Rigolet Inuit Community Government
Charlie Flowers, University of Guelph
Michele Wood, Nunatsiavut Government
Jim Goudie, Nunatsiavut Government
Amy Hudson, NunatuKavut Community Council
George Russell, NunatuKavut Community Council
Aaron Dale, Torngat Secretariat
Jamie Snook, Torngat Secretariat
Sherilee Harper, University of Alberta

Inuit in Labrador, Canada have shared an enduring relationship with caribou in the region for millennia. This relationship has changed in recent years as caribou herds have experienced population declines. Compounding this, the Provincial Government issued a total hunting ban on caribou in 2013.

Through community-led and participatory audio-visual methods, this research works in partnership with the regions of Nunatsiavut and NunatuKavut to explore the ways in which changing caribou populations and hunting bans impact Inuit well-being. A combination of qualitative and visual research methods – including participatory video, PhotoVoice, focus groups, and community engagement events – will be used to explore how changing caribou populations and a hunting ban in Labrador have impacted Inuit communities, lives, and wellbeing. Through this process, this research will focus on highlighting the significance of caribou for Inuit well-being; examine how changes in caribou management and populations have disrupted this historic relationship; and demonstrate the ways in which participatory audio-visual methods can co-produce knowledge and share Inuit knowledge, wisdom, and sciences.

Through the production of community-based, research-oriented, participatory documentary film, photography, and art-making, this project brings together two diverse Inuit regions for caribou, for culture, and for conservation, and represents an exciting partnership among Labrador Inuit to 'work together' on telling the story of people and caribou through diverse, yet unified, voices. This presentation will share preliminary findings and filmings, and discuss the potential value and ability of visual research methods to both celebrate and enhance relationships between and among Inuit and caribou

Wednesday, October 31, 2018 | 13:00 – 14:45
Caribou Ecology I

Title *Moose interactions with natural and human-mediated disturbances: implications for quantifying habitat conditions within caribou range*

Authors **Craig DeMars,** Caribou Monitoring Unit, Alberta Biodiversity Monitoring Institute
Rob Serrouya, Caribou Monitoring Unit, Alberta Biodiversity Monitoring Institute
Matt Mumma, University of Northern British Columbia
Mike Gillingham, University of Northern British Columbia
Stan Boutin, University of Alberta

Boreal woodland caribou are federally listed as Threatened due to population declines throughout their distribution. The main proximate cause of decline is increasing predation, which ultimately has been linked to landscape disturbance and climate change. Increasing predation from disturbance is thought to occur because it increases the extent of early seral habitat, resulting in population increases of other ungulate species (e.g. moose), which subsequently leads to population increases of predators that opportunistically prey on caribou. Because of this hypothesized effect, management has been guided by disturbance thresholds within caribou range. These thresholds take into account both human-mediated and natural disturbances. A key assumption in this framework is that all disturbances create favourable conditions for other ungulate species. This assumption, however, may not hold and instead ungulate response may be influenced by disturbance type, age, intensity and/or the land cover type in which the disturbance occurs. Here, we evaluated moose response to cutblocks and burned areas of varying ages using data from 102 radio-collared moose located within or adjacent to boreal caribou ranges in Alberta and British Columbia. Surprisingly, while moose showed moderate use of cutblocks, they showed low use of burns, regardless of time since fire. To determine if these fine-scale responses scale up to population changes, we present results linking disturbance to moose densities. By refining our understanding of how disturbance affects caribou populations, these results will inform assessments of caribou habitat quality, which in turn should guide the collaborative management actions required for mitigating disturbances within caribou range.

Title *A simulation model to predict caribou abundance from movement patterns at landscape scale*

Authors **Fabian Cid Yanez,** University of British Columbia
Lael Parrott, University of British Columbia
Daniel Fortin, Université Laval

Population abundance and movement trajectories are ecosystem signatures of multiple behavioural processes and environmental variables acting at the individual and group levels. Reverse engineering these signatures help us understand species population dynamics and ecosystem states. In turn, this knowledge can inform ecologists and decision makers to improve conservation and stewardship strategies at the corresponding decision level. This paper presents an agent-based simulation model (ABSM) that simulates individual animal behaviour to track abundance patterns in space and time. The simulator incorporates landscape, movement, predation and population dynamics modelling in real landscapes to follow the abundance of a focal species local population. To validate the ABSM we present results describing the spatial interactions between Boreal caribou (Rangifer tarandus c.), moose (Alces americanus) and wolves (Canis lupus). Simulation results reflect movement, space-use and abundance patterns at the landscape scale. Projected abundance fit observed data and provides additional information compared to existing population projection tools. The simulator can be used to test the impact of land-use changes on the predator-prey dynamics and its impact on wildlife conservation.

Title *Caribou on the menu: diet reconstruction of wolves and black bears across the ranges of migratory caribou in northern Québec-Labrador*

Authors **Michaël Bonin,** Laval University, Caribou Ungava, CEN
Christian Dussault, Ministère des Forêts, de la Faune et des Parcs du Québec
Joëlle Taillon, Ministère des Forêts, de la Faune et des Parcs du Québec
John Pisapio, Government of Newfoundland and Labrador, Department of Fisheries and Land Resources, Wildlife Division
Nicolas Lecomte, Université de Moncton
Steeve D. Côté, Laval University

Assessing predator diet is crucial to the understanding of predator impacts on the population dynamics of their prey. Migratory caribou herds in Québec-Labrador have been declining for the last decades, yet little is known about the contribution of caribou into the diet of it's main predators, wolf and black bear. While diet reconstruction based on the identification of prey remains in feces is mainstream, the short temporal window of this approach and its digestive bias against soft prey items have fostered the utilisation of complementary methods such as stable isotopes analysis and metabarcoding. In collaboration with Inuit and Cree hunters of Eeyou Istchee, Nunavik and Nunatsiavut we gathered various tissues samples of wolves and black bears and used them to estimate the diet of each predator species. With our three diet reconstruction approaches, we consistently found that caribou is the main prey in wolves' diet all year round, even if some wolves appear to specialize on other prey like muskoxen. Contribution of caribou to black bear diet was influenced by local prey availability and season with a higher occurrence of caribou within the spring diet of bears compared to fall, potentially highlighting that some bears predated on caribou calves within their first weeks of life. The complementary use of 3 approaches of diet reconstruction has allowed a robust description of predator diet. These informations constitute a first step toward elucidating the role of predators within the tundra food web and quantifying their impacts on migratory caribou populations.

Title *Are caribou on the menu for black bears? An analysis of predator-prey resource selection in Saskatchewan's Boreal Shield*

Authors **Patricia Tomchuk,** University of Saskatchewan
Philip D McLoughlin, University of Saskatchewan

Resource selection is the behavioural process by which individuals use a non-random set of available habitat features or resources. Studies of resource selection are designed to answer fundamental ecological and management questions as they reveal priorities in resources needed for survival, reproduction, and conservation. The decline of boreal woodland caribou in Canada has been driven largely by anthropogenic impacts. In Saskatchewan's Boreal Shield, woodland caribou exist in conditions with relatively low anthropogenic impacts, high fire, and few invasive species. Consequently, this population may differ in predator-prey interactions from more human-impacted areas. Wolves are key predators of adult caribou, but black bears may be effective predators of caribou calves. I used resource selection functions (RSFs) to model habitat selection of collared black bears, wolves, and caribou in Saskatchewan's Boreal Shield. From these data, I tested the predator facilitation hypothesis in relation to caribou. If predator facilitation plays a role in caribou habitat selection during the calving season, then selection patterns of black bears and caribou should show greater overlap as caribou choose calving sites away from wolves. The results suggest potential for baiting of black bears to function as diversionary feeding during the spring calving season. This study provides a baseline of data to which black bear-caribou-wolf interactions in more disturbed areas can be compared. Overall, these results are intended to inform collaborative management decisions regarding caribou, black bears, and wolves and uncover important factors relevant to the conservation of woodland caribou in Saskatchewan and Canada.

Title *Classifying caribou migratory behaviour to identify and preserve intraspecies biodiversity*

Authors **Jessica Theoret**, University of Calgary
Maria Cavedon, University of Calgary
Bridgett vonHoldt, Princeton University
Troy Hegel, Government of Yukon
Robin Steenweg, Government of Alberta
Helen Schwantje, Government of British Columbia
Jan Adamczewski, Government of Northwest Territories
Marco Musiani, University of Calgary

Preserving intraspecies biodiversity, a fundamental conservation goal, strengthens species adaptability. Conservation biology literature suggests focusing on the concordance of ecological traits with genetic traits potentially of adaptive value, as extinction of locally adapted populations can concurrently result in the permanent loss of those adaptations.

Caribou are declining, with some populations having gone extinct. Caribou migratory or sedentary behaviours are considered adaptive behaviours relative to local ecological conditions. These behaviours impact survival and may be influenced by genetic predispositions. As populations decline and are lost, gene to environment associations within migratory and sedentary populations may therefor be at risk of extinction.

As part of a multidisciplinary approach, my research contributes to addressing an important research question: is the presence of migratory behaviour associated to (a)genomic differences, (b)environmental factors, or (c)genomic differences when controlling for environmental factors? Through collaborations with officials and indigenous groups from British Columbia, Northwest Territories and Yukon, genetic and GPS telemetry data were obtained for 143 barren-ground and woodland caribou from 18 herds across western Canada. Utilizing a Net Squared Displacement (NSD) approach, individuals were classified as migratory or non-migratory based on movement behaviours. From these results, correlations of migratory behaviour with genomic traits and with environmental conditions will be evaluated.

This research contributes to the growing field of ecological genomics and aids in defining its applicability for management strategies within species. Specifying migration behaviours within populations, the focus of my research, may itself result in more specialized conservation and management strategies and ultimately support preserving intraspecies biodiversity.

Title *The relative importance of human disturbances and environmental factors on migratory caribou survival*

Authors **Sabrina Plante,** Caribou Ungava, Université Laval
Christian Dussault, Ministère des Forêts, de la Faune et des Parcs
Julien H. Richard, Université Laval
Steeve D. Côté, Université Laval

Predation, food limitation and climate are known to contribute to caribou population decline. Recently, human disturbances have also been suggested to contribute to population decline, but their relative role on survival and population dynamics remains to be investigated. Here, we evaluated the relative role of human disturbances on short-term survival of caribou from the Rivière-aux-Feuilles (RFH) and Rivière-George (RGH) herds, in northern Quebec and Labrador, Canada. We compared individual habitat selection (habitat suitability), proximity to disturbances, predation risk by wolves and climate conditions encountered by individuals on the day they died to those encountered by individuals that survived during the same day. In some seasons, we found that caribou were more

likely to die near villages and roads, especially when they were selecting for highly suitable habitat. At the opposite caribou far from disturbances increased their chance of survival by selecting highly suitable habitat. Predation risk had a strong negative impact on short-term survival, but only in the RFH during the spring migration. Climate also impacted short-term survival, mainly on the RGH during the spring and fall migration, when temperatures may affect snow and ice conditions and increase costs of movements for caribou. Our results suggest that climate, predation and individual variation in habitat selection can impact short-term survival of caribou, but human disturbances also need to be considered to explain survival in these herds. We discuss these findings in the perspective that limiting factors may also have different cumulative effects on the long-term survival of caribou.

Wednesday, October 31, 2018 | 15:15 – 17:00
Community-Based Monitoring

Title *Summary of National Indigenous Guardians Network*

Author **Valérie Courtois**, Indigenous Leadership Initiative

Indigenous Nations across Canada have been stewards and Guardians of their respective territories since time immemorial. It is a sacred cultural responsibility to care for the lands, waters and the species that inhabit them. Indigenous Nations reasserting their Authorsity and jurisdiction over these lands and waters presents an opportunity to formalize and express this responsibility through initiatives like Guardians. This concept is not new – many Nations have been building their own systems of Guardianship, some for decades. The Indigenous Leadership Initiative (ILI) recognized that the time was opportune to extend the reach and impact of Indigenous Guardians and over the past four years has been at the forefront of advocating sustained support and national recognition of their importance. These efforts included hosting a Gathering in October 2016 of 200 Indigenous Guardians, where a vision for a National Indigenous Guardians Network (the "Network") was expressed. Aspiring to catalyze, promote, support, connect and expand Indigenous Guardians initiatives across Canada, this vision empowers Indigenous Nations, governments, and our communities to honour and fulfil our cultural responsibilities to our homelands and to enable a true Nation-to-Nation partnership with the Government of Canada on responsible territorial land and marine stewardship. It also included a workshop in May of 2018. Persuaded by the power of this vision, the Government of Canada's Budget 2017 committed $25 million over five years, starting in 2017–18, to support a pilot Indigenous Guardians initiative to recognize Indigenous leadership in responsible environmental stewardship, sustainable development, and the management of natural resources in Indigenous territories. The Indigenous Leadership Initiative was asked by the Minister of Environment and Climate Change Canada to play a leadership role in developing the pilot. The ILI is committed to ensuring that the design of the Network and the associated pilot is developed and implemented in the spirit of a Nation-to-Nation relationship between the Indigenous Nations in Canada and the Government of Canada.

Title *Athabasca Denesuline Barrenground Caribou Community Monitoring Project*

Authors **Tina Giroux,** Athabasca Denesuline Né Né Land Corporation
Ronald A Robillard, Denesuline Ne Ne Land Corporation

The Athabasca Denesuline culture, way-of-life, and health are intrinsically linked to barrenground caribou populations. For this reason, the Athabasca Denesuline Barrenground Caribou Monitoring Project was established in 2009 by Hatchet Lake, Fond du Lac and Black Lake Denesuline First Nations. Using Elders guidance as a foundation, the projects aim was to: build relationships, increase education and awareness, share information, collect and use TEK in caribou management, increase capacity for biological monitoring and collect harvest data. Successes of the project include the development of a methodology for collecting caribou harvest data, annual Elder-Youth Caribou Culture camps, 10 Traditional Protocols for Hunting Caribou, and a new Harvesting Protocol between the Athabasca and Manitoba Denesuline. Indigenous community involvement, through community-based monitoring programs, is the most effective way to ensure meaningful management of caribou populations, the lifeblood of the north.

Title *Barren-ground Caribou Traditional Mapping and Analysis*

Authors **Fred Sangris,** Yellowknives Dene First Nation
Pamela Wong, Trailmark Systems

For more than 40 years, the Yellowknives Dene First Nation (YKDFN) has recorded traditional knowledge (TK) onto maps through community-based projects. Unfortunately, most of this material has been difficult to access, being stored away in unfiled paper formats within the Lands Department or offsite with restricted access. These projects include important information on barren-ground caribou and could inform efforts to protect this culturally and economically important species. Our caribou traditional mapping project developed a web-based information management system that made past and current TK of caribou available to YKDFN Lands and Environment. This allowed YKDFN community members, researchers, regulators and decision-makers to work together to improve understanding and monitoring of caribou. Using workshops, interviews, and interactive mapping to document TK, we collected information on movement, migration, and population changes and observations YKDFN use to monitor the herd. We also developed a mobile, on-the-land caribou survey that synched to our TK information management system. Common caribou TK themes included migration patterns, herd composition, and health, as well as interactions with habitat, climate, and humans. Using maps, photos, and PowerPoint slides, we will share some this information and YKDFN knowledge of and past experiences with caribou and how that has changed over time. We will also share YKDFN's more recent experiences with research and monitoring. We hope these methods can promote projects that involve community members and inform other caribou monitoring and conservation initiatives.

Title *Etthen Hat'ni - Monitoring the Bathurst caribou herd in their winter range*

Authors **Joseph Catholique,** Lutsel K'e Dene First Nation
Lauren King, Lutsel K'e Dene First Nation

My name is Joseph Catholique. I am a member of the Lutsel K'e Dene First Nation. I was raised on the land and I am a hunter, father, grandfather, brother, and uncle. I live in Lutsel K'e, Northwest Territories. In winter 2017, myself and three other Dene Rangers for the Lutsel K'e Dene First Nation spent a month living on the barren-lands to observe and document the Bathurst caribou herd's interaction with the land, winter road, other animals, and mines during the winter. This was the first year of a three-year pilot community-led program to monitor the Bathurst caribou herd in their winter range. I will share with you what I observed during this trip and my understanding of the changes the herd has undergone over the last 40 years.

Title *Population Management of Arctic Tundra Caribou based on Inuit Qaujimajatuqangit: An Opportunity Lost*

Authors **Michael Ferguson,** Qikiqtaaluk Wildlife Board
James Qillaq, Qikiqtaaluk Wildlife Board
Jason Mikki, Nunavut Inuit Wildlife Secretariat

Inuit describe the population dynamics of caribou on Baffin Island as being cyclical, lasting the lifetime of an elder. During this cycle, caribou ecology, distribution and abundance changes predictably according to Inuit Qaujimajatuqangit (IQ). In the 1980s and 1990s, Inuit described caribou population changes, both observed and predicted, across southern Baffin Island, enabling development of an IQ-based conceptual model for future management. During that period, all predictions by Inuit elders were verified through scientific research to the extent possible. These included but are not limited to: shifts in winter ranges, depletion of winter forage, poor physical condition and recruitment, and changes

in calving but not post-calving areas. During workshops in the early 2000s, three major phases of the population cycle were identified, each requiring different management strategies. At that time, Inuit elders indicated that the caribou were at or near the peak in their long-term cycle, and also predicted that the next phase of the population cycle was imminent, a major long-term decline due to cumulative forage depletion on most winter ranges. Several multi-scale predictive indicators for the next 15-year decline phase were provided, and mitigative management actions were recommended based on IQ. These IQ-based management actions for 2006-2020 were not implemented, but government biologists did confirm that a major decline was underway by at least 2014. Currently, the Qikiqtaaluk Wildlife Board has to allocate an annual harvest of 250 male caribou among 10 communities, but IQ does not support the harvesting of only one sex of caribou.

Title ***Boots on the Ground: Traditional Knowledge Bathurst Caribou Monitoring Program***

Author **Tyanna Steinwand,** Tłı̨chǫ Government

The 'Boots on the Ground' traditional knowledge caribou monitoring program ran its third year this past summer. The program involves researchers, field guides, hunters and Elders from both Tłı̨chǫ and Inuit culture who take part in a 6 week field program on the tundra observing the Bathurst caribou herd on and near Contwoyto Lake which lies in both the Northwest Territories and Nunavut. Observations on caribou health, population, predation and habitat are recorded and later shared in an annual report. The report also holds stories of the past heard from the people who use the land. Several organizations work together on this project which is headed by the Tlicho Government. The Government of Northwest Territories's Department of Environment and Natural Resources, the Wek'èezhii Renewable Resources Board and Dominion Diamond Ekati Corporation are also partners to this research. By staying small scale (teams of 7 people max) the research teams are better able to travel and use the land as indigenous people have done in the past to observe caribou in their natural habitat without disturbance to the animals. Due to the population decline of the caribou, in recent years indigenous hunters have been restricted from hunting the Bathurst herd. This program aims to discover the realities of a caribou's life on the tundra and report back to the right parties.

THEMED SESSIONS PRESENTATIONS

Wednesday, October 31, 2018 | 15:15 – 17:00
Population Management Interventions

Title *Collaboration in action – averting extirpation of the Klinse-Za caribou herd and the hope for full recovery*

Authors **Roland Willson,** West Moberly First Nations
R. Scott McNay, Wildlife Infometrics Inc.
Ray Proulx, Teck Coal Ltd.

With three examples of functionally extirpated caribou herds in British Columbia (BC), translating knowledge into effective recovery actions would seem to be paramount and urgent. In 2013, after two decades of steep decline in the size of the Klinse-Za caribou herd in northern BC, two First Nations communities collaborated with Industry to identify and implement positive recovery actions for the herd. Selected on the basis of both aboriginal and technical information, the recovery actions (predator management using traditional measures, maternity penning including supplemental feeding, and habitat restoration) were initially enabled by a broad spectrum of Industrial partners. Both provincial- and federal-level governments have now joined in the collaborative recovery effort with the ambitious goal to create one of the first fully recovered caribou herds in British Columbia. The two First Nations communities have formalized their agreement to work together by forming a not-for-profit society focused on recovery of caribou populations within the territory of Treaty No. 8. The working collaboration in northern BC has led to a cascade of positive outcomes including: conservation of caribou and restoration of caribou habitat, protection of treaty rights and livelihoods, and increased capacity and education within the First Nations communities.

Title *Importance of Indigenous engagement for advancing the innovative concept of a large predator exclosure for caribou recovery*

Authors **Lisa Schaldemose,** Schaldemose & Associates Inc.
Scott Grindal, ConocoPhillips Canada
John Nichi, EcoBorealis Consulting Inc.
Rochelle Harding, REDES Inc

A suite of complementary recovery actions that include habitat restoration and population management levers are likely required to recover and ensure self-sustaining woodland caribou populations in northeast Alberta. Large predator exclosures could contribute towards innovative solutions for caribou conservation through the establishment of a small breeding subpopulation of boreal caribou within a predator-free fenced area in natural habitat. The main purpose of an exclosure would be to improve caribou survival and productivity inside a fenced area and to regularly translocate caribou born within the exclosure to reinforce extant local population(s). Throughout 2016 and 2017, the energy sector (through COSIA; Canadian Oil Sands Innovation Alliance) engaged with local Indigenous communities to inform the concept development of a possible predator exclosure. This presentation specifically describes the collaborative approach that industry has taken to work closely with Indigenous communities early on to integrate traditional, cultural and land use knowledge and expertise alongside conventional western science. In addition to informing the development of the concept, participating Indigenous communities co-Authorsed a report of recommendations for the project proponent to facilitate implementation. We contend that working closely with Indigenous communities whose traditional territories would accommodate the project, has produced a more robust and readily acceptable caribou recovery option.

Title *Learning from the near extirpation of the Lake Superior caribou*

Authors **Gordon Eason,** Independent
Leo Lepiano, Michipicoten First Nation
Brian McLaren, Lakehead University
Christian Schroeder, Independent
Serge Couturier, Independent

In the winter of 2014, wolves reached the Slate Islands and Michipicoten Island in Lake Superior. These islands were the anchors of the Lake Superior caribou population. By 2017 the caribou on the Slate Islands were functionally extirpated by predation, and the caribou on Michipicoten Island were on a trajectory to be completely extirpated in 2018. A few caribou were still thought to be present in a small section of the mainland north shore of Lake Superior in 2016, but none were confirmed. Research studies and monitoring were undertaken on the Lake Superior caribou, but not immediate conservation actions. When it became clear that the Lake Superior caribou population was likely to be extirpated, only pressure from the Michipicoten First Nation, the Municipality of Wawa, local citizens, and the general public resulted in the rescue of a few caribou. Two translocations were conducted: nine caribou were moved from Michipicoten Island back to the Slate Islands to restart that population; and six caribou were moved to Caribou Island to establish a backup population. The translocations were a combined effort of the Provincial Government, the First Nation, local citizens, and two private organizations. Institutional reasons that led to the near extirpation of the Lake Superior caribou are examined, as are the reasons that led to the population rescue. Institutional changes to caribou conservation for the Lake Superior population are recommended to prevent future extirpation. These changes may have broader use for other caribou populations and other species.

Title *Exploring conservation breeding options for boreal caribou: an IUCN-endorsed multi-stakeholder workshop approach*

Authors **Amit Saxena,** Devon Energy Corp.
John Ewen, University College London
Axel Mohrenschlager, Calgary Zoological Society

In the face of declining population trends in western Canada, there is an urgent need to consider interventionist approaches to assist caribou population recovery until landscapes are returned to conditions more suitable for caribou through habitat restoration. In this context, population-based management tools potentially play an important role in population recovery, but there are many options available and factors to consider. To this end, the IUCN facilitated a multi-stakeholder workshop on conservation breeding options for boreal caribou. The workshop was attended by a diverse group of stakeholders, including governments, industry, academia, ENGOs, Indigenous peoples, zoos, and independent consultants. Two IUCN facilitators led participants through a collaborative structured decision-making process that IUCN Species Survival Commission's Reintroduction Specialist Group experts have successfully applied to other species conservation issues around the world. Population-based management tools considered in this workshop included maternal penning, captive breeding and release, wild-to-wild translocation, and predator exclosure fencing. Over the course of three days, workshop participants (first individually and then in stakeholder groups) defined and weighted their own values and objectives, expected outcomes and alternative strategies. At the workshop's conclusion, sets of limitations and benefits of each tool were identified, and predator exclosure fencing was deemed to best meet most stakeholders' objectives. The results of this workshop will provide guidance to regulatory agencies in determining which strategies to advance depending on the objectives they value most. This presentation will provide insight into the diverse set of objectives valued by different stakeholders interested in boreal caribou recovery in western Canada.

Title ***Populaton Response of Central Mountain Caribou Herds to Wolf Reduction in British Columbia.***

Author **Dale Seip**, British Columbia Ministry of Environment

Central Mountain caribou herds in British Columbia exhibited major population declines over the past 20 years, and wolf predation was a major cause of the decline. Although wolf predation is the proximate cause of the caribou decline, the ultimate cause is believed tp be habitat changes which have altered the natural predator-prey system. In an effort to prevent the imminent extirpation of these herds, the province of B.C. initiated a wolf reduction program in 2015 that included aerial shooting and First Nations trapping. The wolf reduction program has been associated with a reduction in the adult mortality rate, increased calf recruitment and increasing caribou numbers. In comparison, a no wolf control comparison area has continued to have very high adult mortality and low calf recruitment resulting in ongoing population decline. These preliminary results indicate that wolf control can effectively increase the survival and population growth of Threatened caribou herds and prevent extirpation.

Wolf numbers almost completely recover each year which means that a similar large number of wolves need to be removed each winter to maintain the effectiveness of the program. Consequently, wolf control will need to be ongoing until habitat recovers to a condition that allows caribou to co-exist with unmanaged wolf populations. The province is involved in a variety of Recovery Planning initiatives with the Government of Canada, First Nations, and NGO's to develop habitat management plans to reduce or eliminate the need for wolf control in the future.

Title ***Using adaptive management to save woodland caribou***

Authors **Stan Boutin,** University of Alberta
Robert Serrouya, Caribou Monitoring Unit
Dale R Seip, BC Ministry of Environment
Dave Hervieux, Alberta Environment and Parks
Bruce N McLellan, BC Ministry of Forests, Lands, and Natural Resource Operations
R. Scott McNay, Wildlife Infometrics Inc
Mark Hebblewhite, University of Montana
Douglas C Heard, Tithonus Wildlife Research
Robin Steenweg, Alberta Environment and Parks
Michael Gillingham, University of Northern British Columbia

Adaptive management is frequently promoted as a means of learning how to sustainably manage complex ecosystems. Outcomes, however, are rarely reported, particularly in the context of recovering species at risk. Here, we synthesize adaptive management approaches for recovering woodland caribou, a species that is naturally rare yet covers 3 million km2. The abundant natural resources across their range make woodland caribou recovery one of the greatest conservation challenges in North America. The resulting continental scale of disturbance means that the classic paradigm of a protected area network combined with ecosystem restoration will likely fail unless population management is also implemented as an emergency measure to avoid extirpation. We report on 18 populations in western Canada where 12 were subjected to population-based management actions (hereafter, 'Treatments' in an adaptive management context) and 6 were reference areas. Treatments were caribou translocations, reductions of overabundant prey and native predators, and creating safe havens for caribou from predators. Eight of 12 treated populations showed increases to population growth rates (λ) after treatments began, ranging from λ = + 0.06 to 0.28. Increases to λ were great enough such that 6 of the 8 populations achieved stable or increasing population growth. Combinations

of treatments that affected multiple vital rates produced the highest population growth, yet the level of ecosystem disturbance did not influence population response. By coordinating treatments among scientists, governments, academics and First Nations, socioeconomic inertia was overcome at large spatial scales to credibly inform how to recover this iconic species.

Wednesday, October 31, 2018 | 15:15 – 17:00
Caribou Ecology II

Title *A burning question: How woodland caribou use burned landscapes in Alberta?*

Authors **Sean Konkolics,** University of Alberta
Stan Boutin, University of Alberta
Rob Serrouya, Alberta Biodiverisity Monitoring Institute, Caribou Monitoring Unit

The Canadian Federal Recovery Strategy classifies areas burned by wildfire in the last 40 years as disturbed habitat for woodland caribou. This delineation of fire disturbance has major economic and social implications for a variety of stakeholder groups including indigenous peoples, resource extraction, forestry, and biologists across Canada. Yet, detailed research about the relationship between post-fire forest regeneration and caribou habitat selection is lacking. In a major collaboration with University of Alberta, Regional Industry Caribou Collaboration, ABMI's Caribou Monitoring Unit, and the Alberta Government we have developed multi-scale habitat selection and movement models for six Alberta populations to detail how burned areas and fire skips are selected by caribou. Previously, studies used coarse mapping techniques that are unable to account for unburned residual patches, which could provide viable habitat for caribou. This analysis is comprehensive in scope and technique, utilizing Resource and Step Selection Functions while creatively mapping fires with the Normalized Burn Ratio and Google Earth Engine. Preliminary results suggest that caribou avoid burned landscapes at the home-range scale but display selection for unburned residual patches when inside the boundaries of a fire. Only through the partnership of multiple groups was this research possible, with government collected GPS data, support from industry and design through academia. Understanding the relationship between caribou and burned landscapes is imperative to successfully conserving critical habitat with limited conservation dollars and this information will allow for effective land management with flexibility and transparency among stakeholder groups.

Title *Resource selection by threatened woodland caribou in a high fire, low human disturbance system.*

Authors **Clara Superbie,** University of Saskatchewan
Kathrine Stewart, University of Saskathewan
Philip D McLoughlin, University of Saskatchewan

Conserving species at risk requires a deep understanding of resource selection, as such processes shape the distribution of animals through space and time. Resource selection functions (RSFs) have been used for many years as a means to both quantify how animals select their habitat and predict species' probability of occurrence in a given landscape. In this study, we built RSFs modelling seasonal habitat selection at different spatial scales of boreal woodland caribou in Saskatchewan's Boreal Shield. In comparison to caribou management units occurring in areas where human activities prevail, the Saskatchewan's boreal population has been understudied while existing in a unique, naturally regulated environment characterized by low anthropogenic pressure and extremely high rates of wildfire. Consequently, this population is ideal to improve our knowledge about caribou-habitat interactions in an environment close to the one they historically evolved in while estimating how natural disturbances affect them. Our results suggest that caribou globally select for mature coniferous forest stands where predation pressure is minimized and wetlands offering highly nutritive food. Regarding how disturbances affect resource selection by caribou, we show that RSF results are strongly dependent on spatial scales. As wide-ranging species are more feasibly managed at broad spatio-temporal scales, we also map the probability of occurrence of woodland caribou through the boreal shield of Saskatchewan. The results from this study are intended to help managers identifying critical habitat of boreal caribou in Saskatchewan as defined as the minimum habitat area containing the biophysical attributes required for the population to be self-sustaining.

Title *Examining the effects of disturbance on site fidelity behaviour at multiple scales by caribou (boreal population) in Ontario.*

Authors **Megan Hornseth,** Borealis Ecology
Rob Rempel, Ontario Ministry of Natural Resources and Forestry
Darren Elder, Ministry of Natural Resources and Forestry
Justina Ray, Wildlife Conservation Society Canada
Cheryl Chetkiewicz, Wildlife Conservation Society Canada

Site fidelity, the tendency of animals to remain in or return to a particular space, is a central behaviour for measuring the effects of anthropogenic and natural disturbances on animal movement. Boreal caribou, a species at risk in Ontario, display site fidelity during the nursery season which may increase calf survival. However, site fidelity during the winter season may also increase predation risk, especially where linear features facilitate predator movements. Changes in the amount and types of disturbance within a caribou range may prevent caribou from returning to nursery sites or restrict movement away from areas with increased predation risk. We examined six caribou ranges in northern Ontario that differed in amount (8% to 45%) and type (natural vs. anthropogenic) of disturbance within each range. Using data from 150 caribou fitted with GPS collars between 2009 and 2015, we examined site fidelity within individual home ranges and core areas (95% and 50% utilization distributions, respectively) during the nursery and winter seasons from consecutive years. We assessed caribou sensitivity to disturbance by examining changes in home ranges and core areas across a gradient of disturbance. Our spatially explicit models enable managers, industry, and conservation scientists to work together to identify and manage areas for either protection or development, as well as areas that need active restoration efforts to improve critical habitat as required by federal and provincial legislation and policies. Our models will inform land use planning and impact assessment across Ontario's near and far north under different climate change scenarios.

Title *Analysis of calving locations highlights fidelity to core area for migratory caribou herd.*

Authors **Matthew Cameron,** University of Alaska Fairbanks & National Park Service
Kyle Joly, National Park Service
Greg A Breed, Institute of Arctic Biology, University of Alaska Fairbanks
Christa P Mulder, Institute of Arctic Biology, University of Alaska Fairbanks
Knut Kielland, Institute of Arctic Biology, University of Alaska Fairbanks

Management of one of Alaska's largest migratory barren-ground caribou (Rangifer tarandus) herds, the Western Arctic Herd, is a collaborative effort across multiple agencies and incorporates stakeholders of the herd through the Western Arctic Herd Working Group. A goal of the Working Group is to ensure conservation of the herd now and into the future. One unique aspect of migratory caribou ecology is the strong fidelity to calving grounds in the spring by pregnant females. Understanding the spatial extent, variation, and ecological attributes of the calving area is an important aspect for conservation of migratory caribou herds. We identified parturition events using a movement-based approach for females from 2010 – 2017. We then assessed variability by delineating annual calving areas based on parturition sites and tested for spatial overlap at 1 – 7 year intervals. To understand the selection process for calving grounds at a landscape scale, we performed a resource selection analysis and compared parturition locations to available points across the herd's range. We included physiographic factors and annually varying indicators of phenology. Our results highlight that while there has been significant annual variation in the spatial distribution of calving females in the Western Arctic Herd, the herd has a core calving area that has been consistently used, and which overlaps with estimates of calving areas from studies 5 decades prior. We discuss what ecological factors distinguish the calving area and relate these findings to conservation objectives for the herd.

Title *Quantifying snow characteristics of the winter range of the Central Arctic Herd in northern Alaska*

Authors **Stine Højlund Pedersen**, Department of Biological Sciences, University of Alaska Anchorage
Glen E. Liston, Cooperative Institute for Research in the Atmosphere, Colorado State University
Kelly Elder, US Forest Service, Rocky Mountain Research Station
Adele Reinking, Cooperative Institute for Research in the Atmosphere, Colorado State University
Jeffrey Welker, Department of Biological Sciences, University of Alaska Anchorage

Caribou winter foraging and movement can be affected by snowpack characteristics that are the result of a complex combination of storm type, wind speed and direction, topography, elevation, vegetation, and proximity to mountainous terrain and the Arctic Ocean. Snow is redistributed across the tundra and mountains by strong winds that lead to uneven snow depths, variable physical properties at fine and course scales, and snow cover patches that differ in their longevity each spring. Of particular importance to caribou in Alaska and across northern Canada are snow properties such as hardness and depth that may affect caribou's access to forage and their energy budget as they migrate and seek forage. In addition, the spatial and temporal variation in snow distribution may affect route choice through multiple possible migration corridors from the tundra to wintering habitats in the mountains and foothills in fall, and the reverse in spring.

In spring 2018 we conducted a six-week snow machine and aircraft-supported survey of snow properties across the home range of the Central Arctic Caribou Herd (CACH) from the coastal plain of northern Alaska, across the northern foothills of the Brooks Range, and into the valleys and forests of the central and southern Brooks Range. Our team of snow scientists and ecologists will use these data to model snowpack properties using SnowModel and combine them with recent caribou location data to understand how within- and between-year variations in snow properties and distributions may influence CACH migration, feeding ecology, and seasonal energy budgets.

Title *Lost in translation? Insights into caribou habitat selection from forest inventory data*

Authors **Douglas MacNearney,** FRI Research
Tyler D Rudolph, Ministère des Forêts, de la Faune et des Parcs du Québec, Direction de la gestion de la faune
Laura Finnegan, FRI Research

The gap between research and its implementation is an impediment to conservation of the environment, and translating science into actionable management and policy requires effective communication and collaboration between scientists, practitioners, and policy makers. Ecologists routinely rely on spatial data to describe wildlife distributions, however habitat definitions vary by species, and data sources often differ from those used by land managers. Finding commonalities in the language and data used to plan for both industrial activities and wildlife conservation may help address the research-implementation gap for threatened species such as woodland caribou (Rangifer tarandus caribou). We built resource selection functions (RSFs) for caribou using Alberta Vegetation Index (AVI) habitat data, which is employed by the Alberta forest industry for landbase planning. Our goal was to decrease the research-implementation gap by providing the forest industry with tools to facilitate planning for caribou conservation within their jurisdiction. In contrast to previous studies that highlighted shortcomings in AVI data for predicting wildlife habitat use, we found that RSF models

that combined AVI data with complementary covariates validated well and were accurate to describe caribou habitat use. We suggest that by using a data source familiar to the end users, ecologists can work together with land managers to bridge the research-implementation gap without compromising the quality of ecological modeling, thereby increasing the effectiveness of conservation and landscape management for caribou.

Thursday, November 1, 2018 | 10:30 – 12:00
Forecasting Future Landscapes

Title *Assessing the importance of climate on the distribution of boreal caribou (Rangifer tarandus caribou)*

Authors
Eric W Neilson, Natural Resources Canada, Canadian Forest Service
Justin Beckers, Natural Resources Canada, Canadian Forest Service
Claudia Castillo Ayala, Natural Resources Canada, Canadian Forest Service
Nicolas Mansuy, Natural Resources Canada, Canadian Forest Service
David Price, Natural Resources Canada, Canadian Forest Service
Marc-André Parisien, Natural Resources Canada, Canadian Forest Service

Boreal woodland caribou (Rangifer tarandus caribou, Designatable Unit 6, boreal caribou) are listed as Threatened in Canada. Working together with Environment and Climate Change Canada, NRCan-Canadian Forest Service is developing habitat models to reduce uncertainty around the distribution of boreal caribou at broad scales under future climate conditions. Climate may affect the distribution of boreal caribou via habitat productivity, winter severity, and the distribution of boreal caribou's competitors and predators. We used principal component analysis (PCA) to summarize a series of standard climate variables across Canada's boreal region into homogenous domains then defined the climate space of boreal caribou. We examined which climate domains boreal caribou occupied then modeled boreal caribou distribution as a function of each climate PCA axis, controlling for habitat, fire, and human disturbance. Boreal caribou occupy a relatively limited but common set of climate domains featuring mid-range temperatures and low precipitation relative to the boreal region. After controlling for habitat and human disturbance, we found that climate was an important predictor of the boreal caribou distribution at broad scales, comparable to the importance of the presence of peat and broadleaf forest. We discuss the implications of climate's effect on the distribution of boreal caribou and the conservation actions needed for various climate change scenarios.

Title *Caribou migration behaviour reveals potential resilience to climate change*

Authors
Michel Laforge, Memorial University of Newfoundland
Quinn Webber, Memorial University of Newfoundland
Eric Vander Wal, Memorial University of Newfoundland

Dealing with the consequences of a continually changing environment is one of the main challenges facing migratory animals. The green-wave hypothesis suggests that migratory herbivores such as caribou should time their migration such that they are able to exploit highly nutritious, newly emergent vegetation that matures along a latitudinal or elevational gradient. For this strategy to be successful, individuals should have evolved the capacity to adjust when they migrate as a function of the timing of spring plant growth along their migratory route. Climate change may be disrupting this ability if individuals are not adapted to migrating in earlier summers impacted by a warming climate. Working together with government, we tested whether caribou are able to adjust the timing of their migration to changes in the timing of spring "green-up", and whether this resulted in caribou being better able to select for areas with more nutritious vegetation. We found that caribou are highly plastic in the timing of their spring migration as a function of green-up date, and that this plasticity translated to better overall selection of nutritious vegetation. Furthermore, we found no evidence that climate change is directly affecting the ability of caribou to adjust their behaviour to optimally exploit spring resources. While our results provide cautious optimism about the persistence of caribou in the face of a changing climate, we stress that caribou researchers must continue to work together to determine the fate of caribou in increasingly unpredictable environments.

Title *Potential impacts of climate change on the habitat of boreal woodland caribou*

Authors **Marc-André Parisien,** Natural Resources Canada, Canadian Forest Service
Quinn E. Barber, Natural Resources Canada, Canadian Forest Service
Ellen Whitman, University of Alberta
Diana Stralberg, University of Alberta
Chris J. Johnson, University of Northern British Columbia
Martin-Hugues St-Laurent Université du Québec à Rimouski
Evan R. DeLancey, Alberta Biodiversity Monitoring Institute
David T. Price, Natural Resources Canada, Canadian Forest Service
Dominique Arseneault, Université du Québec à Rimouski
Xianli Wang, Natural Resources Canada, Canadian Forest Service
Mike D. Flannigan, University of Alberta

Boreal woodland caribou (Rangifer tarandus caribou) are currently listed as "Threatened" in Canada, with populations in the province of Alberta expected to decline as much as 50 percent over the next 8-15 years. We assessed the future of caribou habitat across a region of northeast Alberta using a model of habitat quality and projections of future climate from three general circulation models. We used mapped climatic and topo-edaphic properties to project future upland vegetation cover and a fire simulation model to project the frequency and extent of wildfires. Based on those projections, we quantified the future habitat of caribou according to estimates of nutritional resources and predation risk derived from vegetation cover type and stand age. Grassland vegetation covered up to half of the study area by the 2080s, expanding from less than 1% in the present, and contributing to a significant contraction in mixedwood and coniferous forests. This change in vegetation would increase the risk of predation and disease, as habitat becomes more suitable for white-tailed deer (Odocoileus virginianus) and, consequently, gray wolves (Canis lupus). Frequent fires drove rapid vegetation change, but vegetation, in turn, only modestly increased landscape fire likelihood, thus not further compromising key peatland habitat. Our findings suggest that the long-term persistence of caribou in boreal forests will be threatened by predicted changes in vegetation community and increasing predation risk. This study brings together researchers from several disciplines (wildlife biology, vegetation modeling, fire ecology, climatology) to help "bracket" the future uncertainty in caribou habitat suitability.

Title *A climate-sensitive simulation ensemble of future boreal caribou habitat in central Quebec, Canada*

Authors **Yan Boulanger,** Natural Resources Canada, Canadian Forest Service
Dominic Cyr, Environment and Climate Change Canada
Martin-Hugues Saint-Laurent, Université du Québec à Rimouski
Anthony R Taylor, Natural Resources Canada, Canadian Forest Service
David T Price, Natural Resources Canada, Canadian Forest Service
Francis Manka, Natural Resources Canada, Canadian Forest Service

The boreal caribou is sensitive to natural landscape disturbances such as fire, but also to anthropogenic disruptions. The effects of human disruption of the boreal caribou are both direct and indirect, and they operate at multiple spatial and temporal scales, as it is generally the case for such far-ranging species. Among the direct impacts of harvesting on boreal caribou at fine scales is the increased rate at which late seral coniferous forests, its preferred habitat, are converted into early seral forests. In the southern boreal forest, projected climate changes could interact with human disruptions to further reduce these forest covers by increasing the disturbance rates and trigger decline in conifer tree species. We project future woodland caribou habitat in the Lac St-Jean area, Quebec, over a spatiotemporal horizon relevant to strategic planning (100 yrs, 10Mha) by coupling a woodland caribou

resource selection function with climate sensitive simulation ensemble of forest cover. Average habitat quality is projected to steadily decline in the upcoming decades in the study area, unless harvesting levels drop substantially and fire activity does not increase. Business-as-usual clearcutting rates would cause swift decline in habitat quality, regardless of the climate forcing scenario. However, climate change will exacerbate the decline in caribou habitat quality, mainly through the associated increase in fire activity. Lowering clearcutting rates could partially mitigate climate-induced decline of caribou habitat.

Title *Regional-level cumulative effects assessment in Ontario's far north: scenario analysis of development and climate change effects on caribou*

Authors
Robert S Rempel, Ontario Ministry of Natural Resources and Forestry
Rob Mackereth, Ontario Ministry of Natural Resources and Forestry
Art Rodgers, Ontario Ministry of Natural Resources and Forestry
Matt Carlson, ALCES Landscape and Land-use Ltd
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Claire Farrell, Ontario Ministry of Natural Resources and Forestry
Peter Hinz, Ontario Ministry of Northern Development and Mines

The risk to woodland caribou conservation resulting from resource development in Ontario is complex, as multiple factors can affect long-term population sustainability. Development threats are best evaluated using a cumulative effects assessment (CEA) approach, treating threat factors as a system of interacting effects. In this project scientists, specialists, and planners from MNRF and MNDM worked collaboratively with the ALCES group to explore alternative futures (scenarios) by simulating and assessing cumulative effects of infrastructure development and resource extraction on caribou. We used a set of natural reference (natural disturbance plus climate change) and development scenarios (2 levels of development) to assess outcomes based on "natural change only" versus "natural change plus development activity". We developed a near-term (20 year) tactical level CEA of currently proposed community access roads, and a longer-term (50 year), more strategic-level assessment of accelerated development activity once some initial roads and other infrastructure have been implemented. Strategic level assessment adds industrial access and various exploration and mineral extraction activities associated with the Ring of Fire. We used a spatially dynamic model of caribou populations to assess the cumulative effects of climate (causing change to prey abundance), natural disturbance (causing change to forest age structure), infrastructure development (causing change to linear feature density) and forest harvest (causing change to both linear features and age structure). We found that local scale assessment was insufficient for assessing threats to caribou, and more informative assessments were at regional scales that considered climate change and natural disturbance effects in addition to development.

THEMED SESSIONS PRESENTATIONS

Thursday, November 1, 2018 | 10:30 – 12:00
Innovative Mitigation Techniques

Title *Zero Footprint Seismic: PinPoint eliminates seismic lines and dramatically reduces the exploration footprint.*

Authors **Jesse Tigner**, Explor
Allan Châtenay, Explor
Christine Daly, Suncor
Gary Bunio, Suncor

Oil and gas exploration and production (E&P) creates an extensive surface disturbance in boreal ecosystems that undesirably impacts boreal woodland caribou (caribou). Despite continued development of best practices, seismic lines remain a pervasive management challenge for caribou. Seismic lines can directly disturb 15% of the land base, can indirectly increase caribou predation rates, and can create habitat for alternative prey which, in turn, increases predator populations. Significant effort to mitigate those impacts include reclaiming conventional legacy lines to restore habitat functionality and preparing low-impact seismic (LIS) lines to prevent initial impacts, however, the efficacy of both approaches is variable. Even where those mitigations have been applied extensively, caribou populations continue to decline at least in part due to seismic lines.

Previous mitigation efforts have focused on how to tweak seismic lines to make them less impactful. By incorporating principles from mathematics, physics, and operations management, as well as from ecology, we show how a multidisciplinary approach can redefine seismic data acquisition potentially rendering seismic lines obsolete.

Here we provide a high-level overview of PinPoint, a new method that eliminates the need for mechanized equipment or construction of seismic lines to achieve an innovative potential solution for a pervasive caribou conservation challenge. Through case studies from the Athabasca Oilsands, Alberta, we discuss field operations and compare resulting seismic data quality and environmental performance between PinPoint and conventional LIS acquisition. We demonstrate how PinPoint delivers modern geophysical needs and a potential solution for an entrenched problem in caribou conservation across E&P landscapes.

Title *Caribou monitoring and mitigation on Inuit Owned Lands at mining developments in the Kivalliq Region*

Authors **Jeff Tulugak,** Kivalliq Inuit Association
Jeff Hart, Kivalliq Inuit Association
Luis Manzo, Kivalliq Inuit Association
Nunavut Tunngavik Inc
Kivalliq Wildlife Board
Kangiqlinik Hunters and Trappers Organization
Baker Lake Hunters and Trappers Organization
Kim Poole, Aurora Wildlife Research
Anne Gunn, CARMA

Two mines are on the ranges of migratory barren-ground caribou on Inuit Owned Lands in the Kivalliq Region, Nunavut, lands which are managed by the Kivalliq Inuit Association (KivIA). Agnico Eagle Mines (AEM) owns both projects, which are connected by all-weather service roads to the communities of Baker Lake (Meadowbank mine) and Rankin Inlet (Meliadine mine). AEM has developed caribou monitoring and mitigation to minimize sensory disturbance and impacts to migration. Large numbers of migratory caribou were recently exposed to both mines. For the Meliadine mine, this was unexpected as the Environmental Assessment concluded that the probability of large migrations was rare. Implementation of monitoring and mitigation has improved in recent years, and is a collaborative effort among AEM, KivIA, Government of Nunavut (GN), Kivalliq Wildlife Board and the

respective Hunters and Trappers Organizations (HTO) in each community. This presentation describes monitoring and mitigation activities used to manage the migration of caribou across the Meadowbank road in fall 2017, and through the Meliadine mine and road in early summer 2018. Satellite collar data provided by the GN provided an early warning of impending migration through the sites. Mine environmental staff in collaboration with KivIA land use inspectors, GN conservation officers, and the local HTOs monitored caribou numbers approaching the road, triggering increasing intensity of mitigation based on group size and distance to development. In both cases the roads were closed to traffic to facilitate migration. Through working together disturbance to migrating caribou has been reduced in the Kivalliq Region.

Title *Terrestrial forage lichen response to harvesting and tree mortality caused by mountain pine beetle (MPB) in west-central British Columbia*

Authors **Michaela J. Waterhouse,** British Columbia Ministry of Forests, Lands, Natural Resource Operations and Rural Development
Carolyn Shores, British Columbia Ministry of Forests, Lands, Natural Resource Operations and Rural Development
Amanda F. L. Nemec, International Statistics and Research Corporation

In northern caribou (designatable unit 7) habitat in west-central B.C., we tested the response of terrestrial forage lichens to silvicultural systems (1994 – 2017) and to the partial death of lodgepole pine forests by MPB. We applied group selection (GS) and irregular group shelterwood (IGS), which maintains forage lichens throughout space and time by creating a mosaic of gaps and forest, and clearcutting, which removes lichen for extended periods. Three types of studies were undertaken: pilot, replicated experiment, and adaptive management. Various prescriptions were tested: GS (33% area cut in 0.02 ha or 0.15 ha gaps), IGS (50% area cut in 0.07 ha or 0.15 ha gaps), clearcut, and uncut forest. We repeatedly measured 1,700 plots (2 m^2) set out on grids of at least 30 plots per treatment unit. Project collaborators include inter-disciplinary provincial and university researchers plus forest industry partners. Key findings include: (i) after eight years, lichens recovered to pre-treatment levels for GS with 0.02 ha gaps, with a 14-year recovery time for IGS with 0.07 gaps; (ii) in uncut forests and GS with 0.02 gaps, MPB damage caused lichen cover to decline between 2004 and 2008 (to 14-20% of the pre-MPB level) with recovery by 2013 in areas where Cladonia lichens are dominant, and delayed recovery where Cladina lichens dominate; and (iii) recovery in clearcuts was slower and more variable. Although GS and IGS systems maintain habitat and enhance recovery, they need to be applied to large blocks and access management is required to reduce disturbance.

Title *New operational approach to forest harvesting and road network deployment in woodland caribou habitat in Quebec*

Authors **Jérôme Rioux,** Ministère des Forêts, de la Faune et des Parcs du Québec
Frédéric Bujold, Ministère des Forêts, de la Faune et des Parcs du Québec

In the managed forest of Quebec, the permanent unpaved road network is the main disturbance factor of the woodland caribou habitat. To answer this challenge, Quebec plans to apply innovative adjustments to forest operations in order to facilitate road dismantling and therefore to reduce long term disturbances in the caribou habitat. In 2017, the Government of Quebec conducted a pilot project in collaboration with the forest industry, FPInnovations, and regional and First Nations communities. Tests were carried out to dismantle existing forest roads in the Quebec North Shore region. Costs were evaluated and operational challenges were identified. Furthermore, trials of a new operational approach to harvesting and deploying the road network have been conducted in two regions since the summer of 2018. Increased harvesting levels in clearcut agglomerations, reduced road network and

the use of removable watercourse crossing structures are being tested. Results confirm that the cost of dismantling existing forest roads is high in Quebec. However, adequate forest operations planning can fully absorb the costs of dismantling future roads. With this project, the province of Quebec has an excellent toolbox to start the implementation of its long-term Strategy for the woodland caribou habitat management.

Title ***Wild forest reindeer returns to its historical range - reintroductions are conducted in nationwide cooperation project in Finland***

Authors **Milla K. Niemi**, Metsähallitus Parks & Wildlife Finland
Sakari Mykrä, Metsähallitus Parks & Wildlife Finland

The Finnish wild forest reindeer (WFR) Rangifer tarandus fennicus once occurred throughout Finland and in certain western parts of Russia. Nowadays, the total world population is only approximately 4000 individuals living in these two countries, and the overall trend has been negative. Combining the knowledge and expertise of various stakeholders and conducting concrete conservation actions will be essential to conserving the subspecies in the long term.

In 2016, Finland and the EU began a seven-year LIFE-project, which tackles WFR conservation from various angles. Altogether ten partners are involved in the project, with the main aim of reintroducing the subspecies to two National parks within its historical range. Target areas were selected after landscape and social impact analyses conducted by WFR researchers, and the reintroduction will be carried out through captive breeding and soft releases managed by the Parks & Wildlife Finland.

First founder animals (13 individuals) originating from both partner zoos and the wild were moved into enclosures during autumn 2017, and the first calves were born in May 2018. Further founders will be introduced in upcoming years, and the offspring will be released directly from the enclosures at the age of 16–20 months in 2019–2021.

The short-term objectives are to have approximately 30–40 WFR living near both enclosures after the captive breeding and releases between 2017 and 2021, and that both of these populations are steadily growing. The long-term aim is to improve WFR conservation status by increasing the population size and extending its distribution.

Title *Camera Trap*

Authors **Kelly Milner,** Shot in the Dark Productions
Marty O'Brien, Midnight Light Media

In this half-hour documentary, aspiring wildlife photographer Peter Mather puts everything on the line to capture one image that will tell the story of the Porcupine caribou herd and their great land migration.

Title *We are bringing them back*

Authors **Roland Willson,** West Moberly First Nations
Dre Anderson, Saulteau First Nations

A short film was made with the aim to increase awareness of both the plight of woodland caribou and the unique and unprecedented efforts undertaken by First Nations to recover local populations back to self-sustaining and huntable levels. The film is focused on the Klinse-Za caribou herd in northern British Columbia and seeks to reveal the ways in which First Nations are linked to this iconic species. Members of Saulteau First Nations and West Moberly First Nations are interviewed for their personal perspectives and the recovery actions undertaken by the Nations are described.

Thursday, November 1, 2018 | 13:00 – 14:45
Forecasting Future Landscapes II

Title *How alternative spatial patterns of rehabilitation in the boreal forest impact caribou using a model of animal movement, perception and memory*

Authors **Brianna E. Collis**, University of Guelph
Robert C Corry, University of Guelph
John M. Fryxell, University of Guelph

The boreal ecotype of woodland caribou, Rangifer tarandus caribou, is a threatened species in Canada. Their decline is complex, but cumulative effects of anthropogenic activity in the boreal region seem to be contributing to this decline, including habitat alteration from activities related to settlement, mining and forestry.

Habitat rehabilitation has been identified as a key component for species recovery, and could complement science-informed landscape planning where anthropogenic landscape activities consider caribou needs. This study investigates how spatial design of landscape rehabilitation and caribou habitat at the regional scale compares to a business-as-usual projection of landscape patterns using designed alternative landscapes for northern Ontario. These landscapes are compared with an empirically parameterized individual-based model to identify how various spatial configurations of landscape change impact boreal woodland caribou, their primary predator and alternate prey.

Through its multidisciplinary approach and inclusion of many land-uses, this landscape design is informed by science and is truly nested within a 'working together' framework. The design process also poses new questions for science. This research asks, i) what might the landscape pattern be in the future based on continuation of current land-use trends? ii) What could the pattern be with alternative practices? And iii) What are the impacts for boreal woodland caribou? Results have implications for species conservation, landscape planning, boreal land-use practices, spatial ecology, and applied landscape ecology's role in the recovery of imperilled species. Findings may be instructive to other landscape scales, as well as other species.

Title *Evaluating potential implications of caribou-centric forestry plans on other species of conservation concern*

Authors **Lionel Leston,** Department of Biological Sciences, University of Alberta
Erin Bayne, Department of Biological Sciences, University of Alberta
Elston Dzus, Alberta-Pacific Forest Industries Inc. (Al-Pac)
Dave Cheyne, Alberta-Pacific Forest Industries Inc. (Al-Pac)

We sought to understand if other species of conservation concern incidentally benefit, or are negatively affected, by long-term habitat management for woodland caribou. Deferring timber harvest from large portions of designated caribou range could shift harvest pressure to forest stands preferred as habitat by other species of concern (e.g., boreal forest birds). After engaging interested and affected parties (ENGO's, Indigenous peoples, other forestry operators), Alberta-Pacific Forest Industries Inc. used the software Patchworks to develop forest harvest plans with and without additional caribou habitat management measures for its 6.3 million-hectare Forest Management Agreement (FMA) area. Patchworks combines knowledge of forest growth and economics to predict and minimize harvest costs associated with different harvest plans, changes in forest age-structure over time, and optimize timber and pulpwood harvested and caribou habitat managed. Outputs from Patchworks include forest stand attributes (tree species / stand age) at different points in time. We used models developed by the Boreal Avian Modelling Project to predict changes in abundance of several bird species over 50 years within FMA Area. We found that similar changes in several bird species over 50 years (some increasing, some decreasing) occurred whether or not harvest planning emphasized management for woodland caribou habitat. We concluded that emphasizing habitat management for caribou should not detract from conservation efforts for boreal birds. This is one of the first studies to evaluate the

response of a suite of boreal bird species (some of conservation concern) to different forest harvest scenarios with and without additional caribou habitat management.

Title *Alberta's woodland caribou ranges: Building a shared understanding of the costs, benefits, and trade-offs of management strategies using spatiotemporal modeling*

Authors **Joshua Killeen**, FORCORP Solutions
Bob Christian, FORCORP Solutions

Woodland caribou ranges in Alberta are large, complex landscapes with a wide variety of land users. The need to return disturbed landscapes to undisturbed habitat to achieve self-sustaining caribou herds is well understood, while the options for and impacts of achieving undisturbed habitat are less clear. The relative impacts of alternative management strategies on both caribou and land users are complex and often poorly understood. We are providing analysis for collaborative multi-stakeholder groups working in all 15 provincially managed caribou ranges in Alberta, using a spatially and temporally explicit modeling environment. This model is used for testing management and restoration strategies, such as alternative well spacing layouts for energy development and aggregation of forest harvesting to reduce fragmentation and road networks. The results of these analyses facilitate dialogue between the diverse groups involved in caribou range planning by providing an assessment of impacts on habitat targets and associated costs and benefits for other land users.

We use a customized Patchworks forest management planning model to track the state and type of caribou habitat through time as forests grow or become disturbed. Future disturbances are predicted based on assumptions developed in collaboration with land users. 'Scenarios' are developed to inform recommendations to government and to industry for caribou range planning. Effective collaboration is built on shared understanding of the issues at hand and this work helps to provide clarity in terms of the potential improvements for caribou habitat under different management scenarios, and the potential trade-offs involved for other land users.

Title *Ontario woodland caribou range assessment based on spatially-explicit movement and population viability models*

Authors **John Fryxell,** University of Guelph
Tal Avgar, Utah State University
Boyan Liu, University of Guelph
Art Rodgers, Ontario Ministry of Natural Resources and Forestry

Movement, energy acquisition, predation risk, and demographic response by woodland caribou were estimated across an anthropogenic disturbance gradient. Caribou movements showed a positive response to food abundance but a negative response to predation risk and preferred moose habitat. A spatially-explicit PVA suggests that anthropogenic disturbance can appreciably increase the risk of caribou declines due to increased predation risk and to a lesser extent resource limitation. This outcome is echoed by estimates of asymptotic lambda estimated from Lefkovitch matrices for caribou sub-populations at the extreme ends of the disturbance gradient. The spatially-explicit PVA was extended to ranges of 12 different caribou herds in Ontario to project their long-term viability. Those projections highlight the impact of regional variation in moose and wolf abundance as well as annual primary productivity, precipitation, and forest fragmentation on population viability.

Title *Caribou Webtools: an interactive web-based GIS application for caribou recovery*

Authors **Laura Finnegan,** fRI Research
Barry R Nobert, fRI Research
Dan Wismer, fRI Research
Tracy McKay, fRI Research
Karine Pigeon, fRI Research
Doug MacNearney, Environment and Climate Change Canada

Spatially-explicit habitat models, such as Resource Selection Functions (RSFs), use static spatial data, and can therefore become obsolete because of ongoing landscape disturbances or restoration activities. With the goal of improving the efficacy of landscape planning decisions for caribou recovery, we worked in partnership with industry to meet two objectives: 1) assess habitat selection by caribou when resting/foraging versus when travelling, and 2) integrate those behaviour-based spatially-explicit habitat models into an interactive web-based application that can be updated to account for landscape changes. Using GPS collar data from 115 female caribou acquired from two central mountain caribou herds in west-central Alberta, we partitioned GPS collar locations into resting/foraging and travelling behaviour based on movement speed and directionality. By modelling these two behaviours, we found that while resting/foraging, caribou selected higher elevations, alpine herb habitat, and areas with low densities of anthropogenic disturbance. While traveling, caribou avoided lakes and rivers, rugged terrain, dense forest cover, and areas near roads or with high road density. We used these habitat models, together with previously published predator habitat models as the basis for 'Caribou Webtools' – a Shiny web-based application. Caribou Webtools provides an up-to-date spatial prediction of caribou and predator habitat that allows land-use planners to predict how caribou and predator habitat will change under different management scenarios. Scenarios include adding and restoring anthropogenic and natural features on the landscape. Caribou Webtools supports the conference theme of "working together" by providing industry with user-friendly tools for caribou recovery planning.

Title *Putting models in the hands of decision-makers: the Caribou Cumulative Effects modelling framework*

Authors **Colin Daniel,** Apex Resource Management Solutions
Leonardo Frid, Apex Resource Management Solutions
Don Russell, Shadow Lake Environmental
Anne Gunn, Consultant

A wide range of quantitative models have been developed over the past several decades to inform the management of barren-ground caribou herds. Delivering the results of these models in a way that can support decisions regarding the management of these herds has proven challenging, particularly when complex dynamics, such as the cumulative effects of multiple stressors, require linking multiple models. Here we present the Caribou Cumulative Effects framework, a novel software environment for developing and delivering the results of multiple, linked quantitative models to stakeholders and decision makers. Within the context of developing a new range plan for the Bathurst barren-ground caribou herd – a herd that has declined from a peak of 450,000 animals to approximately 20,000 today – we demonstrate the approach by linking together models of habitat, animal movement, energetics and population dynamics in order to project the potential future cumulative effects of harvest, industrial development and climate change on the herd. A key feature of this new framework is the user-friendly way in which it delivers models to stakeholders, including the framing of uncertainties, allowing non-technical users to work together with scientists in order to cooperatively develop and explore alternative "what-if" scenarios regarding future development.

THEMED SESSIONS PRESENTATIONS

Thursday, November 1, 2018 | 13:00 – 14:45
Range Co-Management and Planning

Title *Deninu Kue First Nation Traditional Use Study - Boreal Caribou Habitat and Habitat Use*

Authors **Marc d'Entremont,** LGL Limited Environmental Research Associates
Rosy Bjornson, Deninu Kue First Nation

The Deninu Kue First Nation of Fort Resolution, NWT has hunted boreal caribou for generations. To assist with recovery planning, this project was initiated to incorporate traditional knowledge and scientific information in the identification of critical habitat for boreal caribou in the South Slave region of the NWT. This project followed a knowledge-based habitat suitability mapping approach. A Geographic Information Systems model was used to relate traditional knowledge and boreal caribou location data to environmental data, which included land cover mapping from satellite data, linear disturbances, such as roads and seismic lines and recent and historic forest fires. Habitat suitability models for the winter period and the calving period were created based on land cover mapping conducted for the Earth Observation for Sustainable Development of Forests project. Habitat suitability was based on the vegetation characteristics of each cover type and the specific ecology and habitat requirements of boreal caribou obtained through traditional knowledge and scientific literature. Traditional knowledge was collected during individual interviews, a boreal caribou workshop and from participants in the field surveys. Results of the model showed that wetland herb and shrub communities made up the majority of suitable calving habitat in the region, whereas, treed wetlands and open coniferous forest provided suitable winter habitat. Recommended actions by the Deninu Kue First Nation to improve the status of boreal caribou in the region included: 1) improvements to fire management; 2) a restricted or complete harvest ban, and 3) increased community monitoring efforts.

Title *An Indirect Approach for Integrating Indigenous Traditional Knowledge with Caribou Science*

Authors **Daniel Coulton,** Golder Associates Ltd.
John Virgl, Golder Associates Ltd.
Kim Dawe, Quest University Canada
Amanda Karras, Golder Associates Ltd.

Indigenous peoples have been observing and interacting with caribou since time immemorial. The knowledge that has been acquired and passed down over this time has resulted in a deep understanding of the animal and its habitat. Alternatively, scientific data to inform caribou ecology has been collected over decades by scientists and wildlife managers. Integrating Traditional Knowledge with scientific information in ways that are acceptable to both Indigenous groups and the scientific community has challenges, but working together towards this goal should benefit caribou conservation. While science and Indigenous Traditional Knowledge apply different methods, there are commonalities. For example, habitat selection has been shared in Indigenous studies on caribou and is also a fundamental concept in science-based wildlife management and conservation. We reviewed Indigenous studies to identify knowledge about Bathurst caribou habitat relationships shared by communities. We also developed a resource selection model using collar data from adult females of the Bathurst herd from 1996 to 2014, and indirectly applied habitat relationships shared by Indigenous Traditional Knowledge. Our results show that the patterns of habitat preference quantitatively derived from a resource selection function model are in agreement with knowledge of ecological relationships shared by Indigenous peoples interacting with the Bathurst herd. Indigenous knowledge about relationships between caribou and their environment can be applied to science and can lead to stronger connections and results, with potential to provide new and different insights into caribou management that has been typically based on science alone.

Title *The wicked problem of caribou conservation; a tale of the Telkwa caribou herd*

Authors **Laura Grant**, University of Northern British Columbia; Ministry of Forests, Lands, Natural Resource Operations, and Rural Development
Chris Johnson, University of Northern British Columbia
Conrad Thiessen, Ministry of Forests, Lands, Natural Resource Operations, and Rural Development

Management actions necessary for the persistence of caribou populations have socio-economic and cultural impacts, making caribou conservation a wicked problem. The Telkwa caribou herd in west-central British Columbia, Canada exemplifies these challenges, having suffered extensive landscape-scale change and drastic declines over the past 4 decades. A number of management levers, including translocation, have occurred over time and have involved extensive collaboration with First Nations, stakeholders, and the public. Yet, the herd has continued to decline and is now numbered at approximately 22 individuals. A long-term dataset of caribou locations (1991-2015) was used to investigate the influence of human disturbances – including forestry, roads, and recreation – on survival (N = 224) and habitat selection (N = 76) in three herds, including the Telkwa caribou. Results suggested that the decline of this herd was largely driven by a shift in predator-prey dynamics following forest harvest and was potentially exacerbated by the cumulative effects of disturbance in the Telkwa Range. We relate threats identified by this research to population trends and the collaboration and management that has occurred in the Telkwa Range. This work provides insight into the successes and failures of various management approaches, the trade-offs that are necessary to conserve caribou, and the impacts that these trade-offs have on socio-economic and cultural values.

Title *Co-management boards and barren-ground caribou conservation: A review of the Nunavut Wildlife Management Board actions and decisions aimed at conserving caribou and its habitat.*

Authors **Denis E Ndeloh,** Nunavut Wildlife Management Board
Kyle Ritchie, Nunavut Wildlife Management Board
Jordan Hoffman, Nunavut Wildlife Management Board
Amber Giles, Nunavut Wildlife Management Board
Jason Akearok, Nunavut Wildlife Management Board

Most caribou herds across Canada are now in decline and some have reached critically low populations levels. The Bathurst caribou herd in Canada's central Arctic, for example, is reported to have plummeted from a peak of roughly 450,000 in the mid-1980s to a low of about 20,000 in 2015 — a drop of 96 percent. While science and Inuit Qaujimajatuqangit indicate that most caribou herds undergo a 40-70-year natural population cycle, the current decline is troubling because of the unprecedented threats from global warming and increased industrial development. Of the thirteen barren-ground caribou (Rangifer tarandus groenlandicus) herds that occur in the Canadian arctic, the range of ten herds occur fully or partially in Nunavut. Caribou are essential to Inuit culture and economies and have been so for thousands of years. Like other wildlife species in Nunavut, the conservation management of barren-ground caribou is enshrined in Article 5 of the Nunavut Agreement. Under this Article, the Nunavut Wildlife Management Board (NWMB) is responsible for decisions on caribou harvest limitations as well as approving management plans for caribou, in collaboration with its co-management partners and subject to the Authorsity of the relevant Minister. Here, we conduct a ten-year review of the management actions carried out by the NWMB to protect barren-ground caribou and its habitat in Nunavut while respecting Inuit harvesting rights. These actions include NWMB decisions on harvest restrictions, approval of management plans, public hearings, workshops, contributions to land use planning and funding for Inuit Qaujimajatuqangit and scientific research.

Title *Collaborative management of the Bathurst caribou herd 2009-2018*

Authors **Jan Adamczewski,** Government of Northwest Territories, Environment and Natural Resources
John Boulanger, Integrated Ecological Research
Karin Clark, Government of Northwest Territories, Environment and Natural Resources
Dean Cluff, Government of Northwest Territories, Environment and Natural Resources
Bruno Croft, Government of Northwest Territories, Environment and Natural Resources
Jessica Hum, Tłı̨chǫ Government
Lisa-Marie Leclerc, Government of Nunavut, Department of Environment
John Nishi, EcoBorealis Consulting
Jody Pellissey, Wek'èezhìı Renewable Resources Board
Heather Sayine-Crawford, Government of Northwest Territories, Environment and Natural Resources
Sean Richardson, Tłı̨chǫ Government

The Bathurst barren-ground caribou herd in northern Canada was estimated in 1986 at about 470,000 but by 2015 had declined to about 20,000. Barren-ground caribou populations in the Northwest Territories (NT) and Nunavut (NU) were assessed as Threatened federally by COSEWIC in 2016 and in the NT by the Conference of Management Authorsities in 2018. Like other tundra migratory populations, the Bathurst herd has long been of enormous significance to Indigenous cultures in northern Canada. Because of the herd's large decline, management has focused on providing the herd the opportunity to recover through actions on harvest, land use and predators. Harvest was reduced about 95% in 2010 in the NT, then closed in 2015. Harvest was limited to 30 bulls in NU in 2016. A range plan to limit development on the herd's annual range is being developed using a multi-partner process, and environmental assessments have closely examined proposals for new developments that might affect the herd. A feasibility assessment of wolf reduction options on the Bathurst range was carried out 2016-2017. An overall management plan for the herd from 2004 is currently being updated through an inclusive co-management process. Decisions about Bathurst caribou management have been made through collaborative processes, with responsibility shared among management boards, Indigenous governments, and the territorial and federal governments. The Wek'èezhìı Renewable Resources Board created through the Tłı̨chǫ Agreement (2005), the Nunavut Wildlife Management Board, along with the Tłı̨chǫ Government and other Indigenous organizations, have played key roles in Bathurst caribou management 2009-present.

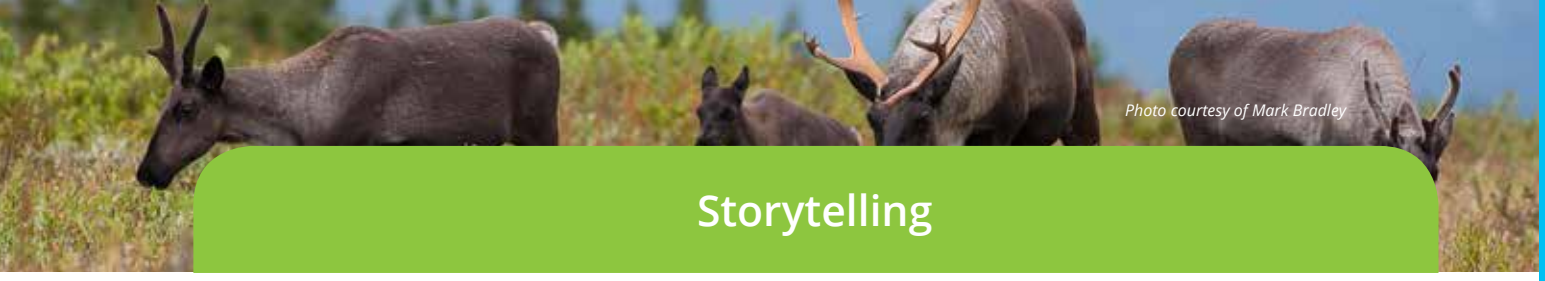
Title *Effective Integration and Application of Knowledge*

Authors **Gord Vaadeland,** Canadian Parks and Wilderness Society- Saskatchewan Chapter
Sarah Schmid, Canadian Parks and Wilderness Society- Saskatchewan Chapter

The practical application of knowledge to inform landscape-based processes is essential to ensure the health of our natural ecosystems and to secure a sustainable future for all Canadians. Knowledge can be collected and applied through various methods, such as quantitative data and research, community involvement, direct participation, and traditional knowledge. In Saskatchewan, Canadian Parks and Wilderness Society (CPAWS) is working collaboratively with all levels of government, local communities, other ENGO's, and Indigenous peoples to use knowledge to help inform three landscape-based processes: forest and caribou management, and the creation of protected areas. Through active participation on Public Advisory Groups for Forest Management Plans and on the Provincial Caribou Recovery management team, CPAWS has been able to contribute vital knowledge into those plans. In addition, CPAWS has been working directly with the company Weyerhauser to refine their caribou management zones, by conducting on the ground monitoring for caribou. Finally,

CPAWS has been working with Cumberland House, Peter Ballantyne, Ducks Unlimited, Weyerhauser and the government to identify a large protected area in the Suggi Lowlands/Mossy River Watershed. By working together, using the collected and documented quantitative data, as well as local and traditional knowledge, CPAWS has been able to take that knowledge and apply it into a proposal to designate the Saskatchewan River Delta a protected area. Through working with a diverse set of stakeholders and taking knowledge back to the land, responsible land use can be promoted and can be sustainable for nature, communities and the economy.

POSTER PRESENTATIONS



Storytelling

Title *The importance of caribou to the outfitting community*

Author **Scott Ellis,** Guide Outfitters Association of British Columbia

My Power Point/video presentation is called "the importance of caribou to the outfitting community." It hopes to share some insights on how the hunting industry can Work Together to save caribou.

Wildlife is a valuable resource; it must be seen as such and managed accordingly. We must take a proactive, aggressive action to ensure we have abundant wildlife populations for all to enjoy, both today and in the future.

We believe we need to focus our resources on the factors we can make a meaningful impact. There are things that we can control (logging, access, habitat protection, predator density and hunting) and things we cannot (climate change, wildfire and disease).

What we appreciate, appreciates. We must apply a value to wildlife. Hunting is one activity that puts a value on wildlife but this value needs to be elevated so caribou are considered when land use decisions are being made.

Outfitters believe in sustainable use, the North American Model for Wildlife Conservation, and science-based decision. When there is no huntable surplus, there is no hunt. Many species have benefited under this management philosophy.

There are over 2,000 hunting and fishing outfitting businesses throughout Canada. The industry employs more than 20,000 people, mainly in rural and remote areas, and has an economic impact of nearly one billion dollars annually. Outfitter care about the health of our caribou populations.

Title *In predator's clothing: The summer I dressed as a bear and spooked Newfoundland caribou*

Author **Kathy Unger,** Canadian Parks and Wilderness Society

This is the quick and dirty story of my Masters research on the behaviour of Newfoundland woodland caribou. Summer is an extremely important period for caribou. This is the time food is most easily accessible, fat stores are replenished after a long winter of scarce food and mothers fervently nurse their young to become strong runners. There is no time to waste, because as we all know, summer and all the good things that come with it only last a short time. On the island of Newfoundland, there are no wolves to disturb the summer grazing caribou – there haven't been any since the 1920's. However, there are still black bears, lynx and eagles around, and since the 1980s there are also coyote. For my research, I wanted to know whether caribou would choose to expend their valuable energy differently when faced with different top NL predators. Would the more wolf-like coyote be the more threatening predator, or the more familiar black bear? This is what I dressed up in black and tan outfits one summer to find out.

POSTER PRESENTATIONS

Nutrition & Reproduction

Title *Causal links between vegetation and nutritional limitations for caribou during summer in montane and boreal ecosystems of northeastern British Columbia*

Authors **Kristin A Denryter,** University of Northern British Columbia and University of Wyoming
Rachel C Cook, National Council for Air and Stream Improvement
John G Cook, National Council for Air and Stream Improvement
Katherine L Parker, University of Northern British Columbia

Relatively low nutritional condition of woodland caribou (Rangifer tarandus caribou) in several areas of northern British Columbia (BC) suggests that available nutritional resources are inadequate to support lactation and replenishment of body fat. Using tame caribou, we evaluated nutritional value of montane and boreal plant communities in northeastern BC during summer and identified attributes of plant communities that may contribute to poor nutritional condition of wild caribou. We found: (1) levels of digestible energy and digestible protein in diets selected by caribou were generally high (averaging 12 kJ/g and 5%, respectively), but rates of forage intake were below levels needed to satisfy nutritional requirements; (2) diets dominated by selected deciduous shrubs (e.g., Salix, Betula papyrifera) satisfied or exceeded nutritional requirements of caribou, whereas diets dominated by selected lichens (e.g., Cladina, Cladonia) failed to satisfy nutritional requirements; (3) caribou generally satisfied requirements in willow alpine and early-seral forest communities (especially white and Engelmann spruce forests), but failed to satisfy nutritional requirements in plant communities with <500 kg/ha of accepted biomass (e.g., dry alpine, mid- to late-seral boreal communities (especially forested and open peatlands and swamps)). The ability of caribou to satisfy nutritional requirements during summer was largely a function of the abundance of accepted vascular plants, not lichens. Our novel findings suggest that vegetation types with high nutritional value during summer may not fit paradigms of optimal winter habitat. These findings may be informative to industry, government, First Nations, and other stakeholders working together to conserve and restore habitats for caribou.

Title *Indirect consequences of shrubification on summer forage of caribou*

Authors **Evelyne Lemay,** Laval University
Jean-Pierre Tremblay, Laval University
Steeve D. Côté, Laval University

A striking consequence of climate change is the densification of the shrub layer in subarctic regions. These shrubs could be seen as an increased amount of available forage for arctic ungulates such as caribou, but we don't know how the quality of the resource will change. By acting as a snow barrier, erected shrubs can increase snow cover during winter, which insulates the soil upper layer and increases nutrients availability by promoting microbial activity. However, in the snow-free period, shrubs could limit the amount of light reaching the ground, resulting in reduced soil temperature and increased soil moisture, thus affecting both shrubs and surrounding plants. Our objective is to determine the effects of increased snow cover and light attenuation by shrubs on the availability of digestible protein for caribou across summer. In 2015, we implemented an experiment simulating conditions induced by increased shrub cover using snow barriers and shading tarps at Deception Bay, Nunavik, within the summer range of the Rivière-aux-Feuilles caribou herd. We estimated plant biomass using point intercepts and localized Normalized Difference Vegetation Index (NDVI) sensors. We harvested plants foliar tissues from July to mid-August and conducted analyses of their chemical composition (nitrogen, carbon, fibres, phenols) and digestibility. Our results will help understanding indirect effects of climate change on caribou habitat and improve management and conservation actions. This work is part of a large scale cooperative research program (Caribou Ungava) involving regional administration, provincial and regional government, industrial, and academic partners.

POSTER PRESENTATIONS

Title *Diet composition of the Atlantic-Gaspésie caribou: insights from stable isotope analyses*

Authors **Ève Rioux,** Université du Québec à Rimouski
Martin-Hugues St-Laurent, Université du Québec à Rimouski
Fanie Pelletier, Université de Sherbrooke

Foraging is a key behaviour in ecology as it can affect individual growth, reproduction and survival. Stable isotope ratios have become a key tool to study the foraging ecology of wild species, providing information on trophic relationships and diet composition. The objective of our study was to assess diet composition of the endangered Atlantic-Gaspésie caribou (Rangifer tarandus caribou) population using stable isotope analyses, contrasting differences between sexes, seasons and regions. Carbon (δ13C) and nitrogen (δ15N) stable isotope signatures were obtained for hair, plasma and clotted cell samples from nearly half of the population (44 out of 75 animals). Bayesian mixing models were applied to assess the diet composition of caribou and to estimate variation in diet composition. Caribou selected ferns, lycopods and aquatic plants in summer and selected mosses, ericaceous shrubs, fungi and deciduous trees in autumn. Lichens were less consumed in winter than expected based on the literature. Caribou consume mostly mosses in winter but also use others plants including graminoids, ericaceous shrubs, deciduous and evergreen trees. δ13C signatures differed between the three subranges frequented by caribou (Logan, Albert and McGerrigle, from west to east) suggesting different carbon sources and resources consumption patterns. Males had higher δ15N signatures than females indicating males held a higher trophic position. This enrichment can also indicate different food resources consumption between sexes. Our study provided a more detailed depiction of the Atlantic-Gaspésie caribou diet, supplying fundamental information to understand the ecology of this isolated herd and to contribute efficiently to its recovery.

Title *Nutritional condition indices for caribou: evaluating accuracy, precision and sensitivity.*

Authors **Rachel C. Cook,** National Council for Air and Stream Improvement
John A. Crouse, Kenai Moose Research Center, Alaska Department of Fish and Game
John G. Cook, National Council for Air and Stream Improvement
Thomas R. Stephenson, Sierra Nevada Bighorn Sheep Recovery Program, California Department of Fish and Wildlife

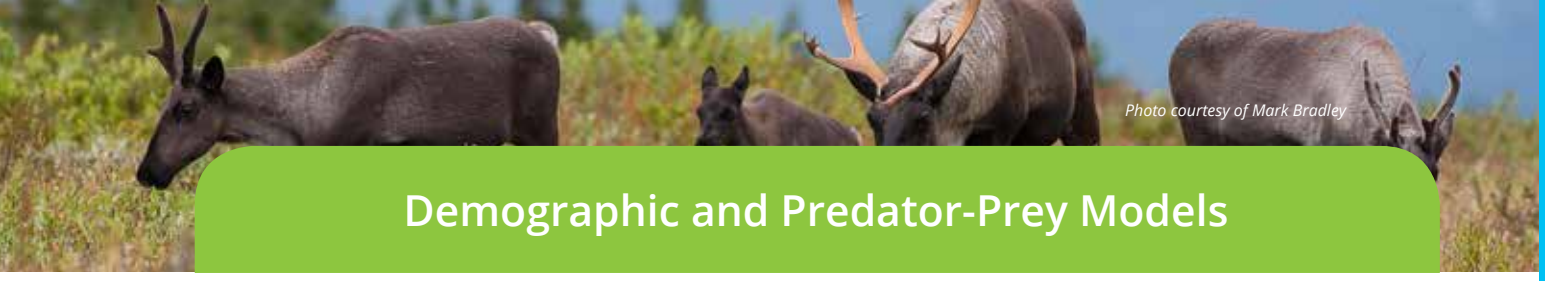
Measuring nutritional resources for ungulates is inordinately difficult. Alternatively, nutritional condition data, if collected using robust indices, can be an intermediate measure linking habitats and populations. As such, body composition studies are critical for assessing the accuracy of condition indices. We examined >40 indices of nutritional condition for caribou (Rangifer tarandus) using 29 females captured from 3 populations in Alaska ranging in condition from 2.3 – 11.2% body fat and 6 captive females from Alaska and British Columbia ranging in condition from 8.1 – 26.0% body fat. Estimates of body components were regressed against each condition index. Generally, indices with linear or slightly curvilinear relations to body fat and those based on multiple fat depots were the most accurate in predicting body fat and were the most useful over the full range of nutritional condition. A LIVINDEX (a combination of subcutaneous fat thickness measured using ultrasound and a condition score), CONINDEX (a combination of kidney and marrow fat), and a subset of the Kistner score (pericardium and kidneys only) had the strongest relationships with body fat ($r^2 > 0.86$) and were also useful over the entire range of nutritional condition. Because none of these indices had been validated previously in caribou, our results may benefit widespread collaborative data collections like those done for CARMA. Geographically widespread nutritional condition data may enhance the ability of industry, government, First Nations, and other stakeholders to collaboratively target specific caribou populations that may benefit from management designed to bolster nutritional resources for caribou.

Title ***Multi-regional comparisons among caribou populations reveal geographic patterns of nutritional condition and pregnancy in Ontario, British Columbia, and Northwest Territories***

Authors
John G. Cook, National Council for Air and Stream Improvement, Forestry and Range Sciences Lab
Rachel C. Cook, National Council for Air and Stream Improvement, Forestry and Range Sciences Lab
Glen S. Brown, Ontario Ministry of Natural Resources and Forestry
Brad A. Culling, Diversified Environmental Services
Diane E. Culling, Diversified Environmental Services
Allicia P. Kelly, Government of the Northwest Territories, Department of Environment and Natural Resources
Megan E. Watters, British Columbia Ministry of Forests, Lands, and Natural Resource Operations
Dale R. Seip, British Columbia Ministry of Environment
Nicholas C. Larter, Government of the Northwest Territories, Department of Environment and Natural Resources
Ashley McLaren, Ontario Ministry of Natural Resources and Forestry
Krista L. Sittler, Wildlife Infometrics

Dynamics of ungulate populations not only reflect mortality rates and the proximate factors that drive mortality, but also those factors (e.g., nutrition, energy expenditure) that affect animal performance (e.g., health, nutritional condition, and reproduction). Nutritional condition integrates among nutritional inputs and expenditures and thus provides a useful metric to identify populations with inadequate nutritional environments, yet studies of nutritional condition are rare for woodland caribou. Working with multiple private and governmental organizations since 2009, we estimated nutritional condition, using ultrasound and body condition scoring techniques, and pregnancy of ~750 adult female woodland caribou in 19 populations to identify geographic variation in NT, BC, and ON. Our data indicate a 2-fold range in body fat among populations (from 5% to 10%), with the lowest body fat levels in four mountain populations in northeastern BC, moderate levels in boreal forests of BC and much of Ontario, and highest levels in southern NT. Pregnancy rates generally covaried with body fat estimates. Thus, our data suggest considerable geographic variation of energetic/nutritional influences on long-term sustainability of populations. To offset the high costs of caribou capture to sample nutritional condition, capture operations conducted for other purposes by multiple agencies to obtain condition data potentially provide a solution. However, multi-regional sampling intended to provide geographically robust and accurate estimates of nutritional condition for woodland caribou across Canada requires consistent, validated measurement techniques, elimination of observer bias, and, often, modification of standard capture protocols to accommodate objectives of nutritional condition evaluations.

POSTER PRESENTATIONS



Demographic and Predator-Prey Models

Title *Environmental determinants of adult survival in migratory tundra caribou.*

Authors **Barbara Vuillaume**, University Laval, Caribou Ungava, Center for Northern Studies
Marco Festa-Bianchet, University of Sherbrooke, Caribou Ungava, Center for Northern Studies
Steeve D Côté, University Laval, Caribou Ungava, Center for Northern Studies

We investigated adult survival in relation to environmental and demographic parameters for two declining migratory caribou herds: the Rivière-aux-Feuilles Herd (RFH) and the Rivière-George Herd (RGH) of northern Quebec and Labrador. We analyzed data from more than 800 adult caribou marked with satellite collars since 2000. We used known-fate models to quantify adult survival rate, considering multiple environmental variables to assess the possible impacts of climate, vegetation quality and availability, predation and hunting.

Annual adult survival was highly variable for both herds, revealing that adult female survival for the RFH was insufficient to explain the decline and that no population growth was possible for the RGH considering low adult female survival. Male survival was always on average 14% lower than female survival regardless of the temporal scale. Three critical biological seasons were shared by adult caribou from both sex and herds: summer, fall migration and winter. We identified direct and carry-over effects of climate and resources on annual and seasonal survival, and observed different effects for the two herds.

The pressure of current environmental disturbances justifies the need of wildlife conservation for both habitat and population, in order to maintain natural resources. As migratory caribou are a key economic, ecologic and social element of the North, Inuit and Cree communities are concerned about its future. In may 2017 COSEWIC assessed migratory caribou in eastern Canada as endangered. Our results will serve as guidelines to improve the collective effort of efficient management of these populations and their habitats.

Title *Demographic Response of Northern Mountain Caribou to Habitat Disturbance (Rangifer tarandus caribou)*

Authors **Jared Gonet**, University of Alberta
Fiona Schmiegelow, University of Alberta
Troy Hegel, Alberta Environment and Parks

Description: This project is developing regionally-appropriate models of Northern Mountain Caribou (NMC)response to habitat disturbances and other population drivers. The mechanisms by which anthropogenic habitat alteration, natural disturbance (mainly fire), climate, and hunting/trapping affect recruitment are being explored. The two major objectives are: 1) to characterize range conditions over time on northern mountain caribou ranges including: anthropogenic and natural disturbances, harvest pressure, and climate; 2) to link range conditions to demographic response of northern mountain caribou.

Methods: We have applied boosted regression tree analysis to explore potentially influential variables. Resultant important variables are then evaluated through regression analysis to determine their effects on caribou recruitment.

Results: Preliminary results suggest the strongest influences on NMC recruitment in the Yukon are moose harvest, natural disturbance and climate (pacific decadal oscillations).

How this work connects to the conference theme: Long-term data collection supported by government facilitates analysis of patterns in caribou response over meaningful time frames. Input from local experts results in stronger hypotheses and interpretation of results. The end goal of this project is to support locally appropriate, evidence-based management decisions for NMC.

POSTER PRESENTATIONS

Title ***A simple, empirically-linked demographic model to estimate likelihoods of recovering populations of boreal caribou (Rangifer tarandus caribou)***

Authors **Eliot McIntire**, Natural Resources Canada
Glenn Sutherland, Wildlife Infometrics
Cheryl A Johnson, Environment and Climate Change Canada
Fiona Schmiegelow, University of Alberta
Matthieu Leblond, Environment and Climate Change Canada
Robert Jagodzinski, Environment and Climate Change Canada

Boreal caribou (Rangifer tarandus caribou) populations continue to exhibit widespread declines in both population size and in distribution across Canada, particularly in western Canada. Because of the importance of population trends in defining responses to these declines by both federal and provincial jurisdictions and by industry, tools to support demographic projections for boreal caribou contribute to the assessment of population self-sustainability and in habitat management planning in several ways

Here we describe a re-implementation (in R and the SpaDES package) of and update to the original population model developed for Environment and Climate Change Canada in 2011 (Environment and Climate Change Canada 2011). Together with a database of demographic data for individual boreal caribou local population units (LPUs) compiled by Environment and Climate Change Canada (ECCC), the re-implemented model was developed, tested, and a sensitivity analysis was conducted.

Overall, the model appears to generate projections with a reasonable correspondence to empirical data. In addition, assessment of the relative influence of, and interactions between all projected demographic parameters found that both adult survival and calf recruitment were found to highly influential considering all response variables, and together were by far the most important of the input demographic variables.

Our results show probabilities of long-term population persistence so to inform the on-going meta-analysis of the effects that different types of habitat disturbance may have on boreal caribou demography. We also show initial integration with other habitat projection models (also in SpaDES) and initial results about sensitivity of demographic parameters to dynamic habitat.

Title ***Wolf recolonization leads to functional extirpation of caribou on Michipicoten and the Slate Islands, Ontario***

Authors **Brent R Patterson,** Ontario Ministry of Natural Resources & Forestry, Wildlife Research & Monitoring Section
Arthur R Rodgers, Ontario Ministry of Natural Resources & Forestry, Centre for Northern Forest Ecosystem Research
Jen Shuter, Ontario Ministry of Natural Resources & Forestry, Centre for Northern Forest Ecosystem Research
Steve Kingston, Ontario Parks
Evan McCaul, Ontario Parks
Ashley E McLaren, Ontario Ministry of Natural Resources & Forestry, Wildlife Research & Monitoring Section
David Keiter, University of Nebraska
John F Benson, University of Nebraska

Predation can shape the structure and function of ecosystems. Nonetheless, debate persists regarding whether the abundance of ungulate populations is regulated by top down or bottom up forces. Anthropogenic landscape disturbance exacerbates predation on woodland caribou, often leading to serious conservation concern. Until recently caribou remained abundant on the relatively undisturbed 184 km2 Michipicoten Island, and the 36 km2 Slate Islands archipelago, in Lake Superior, Ontario. Both systems were naturally recolonized by wolves via ice bridges in winter 2014. Our objective was to contrast the impacts of wolves on caribou in these two systems. Given its more abundant alternate prey population (beaver) and the less complex habitat structure (e.g. reduced opportunity for caribou to escape wolves by swimming), we predicted that predation would more seriously limit caribou abundance on Michipicoten. We estimated caribou and wolf numbers via aerial surveys, camera trapping, and DNA mark-recapture. There were likely 50-100 and ≥450 caribou on the Slate and Michipicoten Islands, respectively, at the time of wolf colonization. Caribou subsequently declined rapidly in both systems. We documented no wolf reproduction on the Slate Islands and wolves were extirpated there by June 2017 at which time there were only a few caribou remaining. On Michipicoten, wolves produced pups every summer following colonization and by winter 2018 wolf numbers had at least quadrupled and caribou approached extirpation. Wolves continue to persist on Michipicoten owing to the high beaver population. These data highlight the importance of alternate prey in influencing predation on caribou.

POSTER PRESENTATIONS

Structure of Caribou Populations

Title *Using genetics in conservation planning for Boreal Woodland Caribou (Rangifer tarandus caribou)*

Authors **Pauline Priadka,** University of Manitoba
Micheline Manseau, Environment and Climate Change Canada
Paul J Wilson, Trent University

A genetic approach to characterize population structure is essential to wildlife conservation planning in allowing for hierarchical spatial patterns of genetic variation to be detected among individuals or groups. Through collaboration between governments, scientists and stakeholders, large scale sampling and sample processing can take place to allow for comprehensive genetic analysis at the landscape scale. This is particularly important for Species at Risk that have smaller population sizes and require that genetic connectivity be maintained or restored over time. A genetic approach was taken to characterize population structure of the nationally threatened Boreal Woodland Caribou (Rangifer tarandus caribou) in the province of Saskatchewan, including neighboring ranges in western Manitoba and eastern Alberta. Scientists from the University of Manitoba, Parks Canada and Trent University worked together with provincial governments, Manitoba Hydro, Sask Power and the forestry sector to organize non-invasive fecal pellet collections across the study area. DNA was extracted and processed from fecal pellets at Trent University. Three spatial patterns of genetic variation were detected in the study area by Moran's eigenvector maps using the program MEMGENE, which allowed for higher-order structure to be identified and to determine sources of regional spatial genetic patterns. This approach was useful for understanding dispersal behavior that shapes population structure across the landscape, and to allow for conservation planning beyond the delineation of discrete population boundaries.

Title *Do biotic interactions inform the spatial distribution of coexisting ungulates in the Canadian Arctic Archipelago?*

Authors **Deborah A. Jenkins,** Environmental & Life Sciences Graduate Program, Trent University
Glenn Yannic, Univ. Grenoble Alpes, Univ. Savoie Mont Blanc, CNRS, LECA (Laboratoire d'Ecologie Alpine)
Nicolas Lecomte, University of Moncton
James A. Schaefer, Trent University

The longstanding quest to understand species' geographic and ecological distributions has become urgent with global declines in wildlife and their habitat. In response, modelling the distribution of species has emerged as a fundamental conservation tool. Yet predictions from these models, under current or future conditions, are often based on environmental variables alone (e.g. temperature, precipitation); they overlook fundamental biotic interactions (e.g. competition, predation) that can shape a species range. Here we work together—researchers representing four institutions from two continents—in applying niche theory and a multi-species/multi-scale approach. We are developing species distribution models, exploring niche dimensions, and testing for geographic predictions of competitive interactions (such as competitive exclusion and release). We focus on two iconic species of the Canadian Arctic Archipelago, caribou and muskoxen. Specifically, we are using maximum entropy models (Maxent) to couple extensive observations of animals and their sign from systematic and random winter surveys (across a vast area of almost 800,000 km2: 2000-2008) with a suite of land cover, topographic, and climate variables putatively related to the distribution of each species. To evaluate caribou-muskoxen interactions, we are comparing the large-scale fundamental niche of each species to their realized niches on islands, where they occur singularly or in sympatry. Our research highlights how both biotic and abiotic features can shape a species range and ultimately influence conservation planning.

POSTER PRESENTATIONS

Title *Multiple cycles of vicariance events, expansion, and admixture in western North America led to the evolution and diversification in caribou*

Authors
Cornelya Klutsch, Trent University
Micheline Manseau, Environment and Climate Change Canada
Jean Polfus, Trent University
Audrey Steedman, Parks Canada
Dave Hervieux, Government of Alberta
Allicia Kelly, Government of the Northwest Territories
Nic Larter, Government of the Northwest Territories
Mary Gamberg, Consultant
Paul Wilson, Trent University

Diversification of high-altitude wildlife species was partially generated by glacial cycles due to recurrent range contraction, population isolation and divergence, expansion from glacial refugia and admixture of refugial populations. Two major refugia, north and south of the Cordilleran and Laurentide Ice Sheets, existed during glacial periods in western North America but additional cryptic refugia have been proposed in the region. Caribou (Rangifer tarandus) display morphological and behavioural adaptations to different environments but it is unclear how these evolved. Here, we used two genetic markers and Approximate Bayesian Computation to test different evolutionary scenarios to improve our understanding of diversification and the impact of past glaciations in this species. Our results clearly rejected a model of a uniform Beringian refugium and recolonization after the Last Glacial Maximum (LGM). Instead, ancient divergence of Alaskan and barren-ground caribou indicated substructure within Beringia. The mountain ecotypes originated from separate refugia, suggesting independent evolution of similar adaptations. Caribou in central and northern British Columbia diverged from populations further inland long before the LGM. Finally, ancient admixture of refugial populations gave rise to boreal caribou in the Northwest Territories indicating that introgression was not limited to post- LGM. Our results suggest that the climatic oscillations significantly diversified contemporary caribou populations and contribute to a growing body of evidence suggesting that multiple and partially cryptic refugia shaped ancient diverse evolutionary histories in western North America.

Title *Evolutionary History of Ontario's Southern Boreal Caribou*

Authors
Kirsten Solmundson, Trent University
Jeff Bowman, Ontario Ministry of Natural Resources and Forestry
Rebekah Horn, Trent University
Micheline Manseau, Environment and Climate Change Canada
Paul Wilson, Trent University

Boreal caribou (Rangifer tarandus caribou) have experienced population declines and range retractions throughout large parts of the boreal zone, resulting in the designation of "Threatened" under the Species-at-Risk Act. Despite this range retraction, several southern populations have persisted on a few Lake Superior Islands and along the coastal mainland, disjunct from the continuous caribou range of Ontario. The history and distribution of these remnant populations offer the potential for


Photo courtesy of Mark Bradley

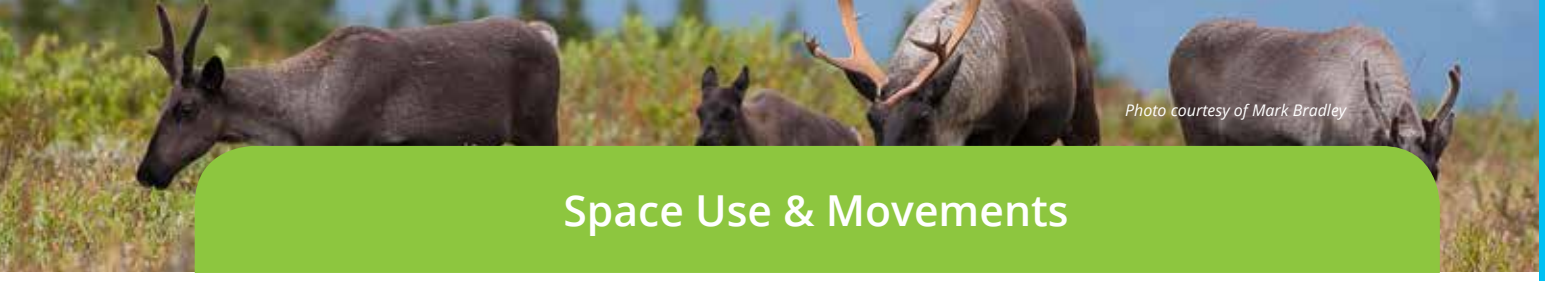
distinct differences that may be significant for caribou conservation in Ontario. In recent years, these populations have faced severe population declines, generating conservation concern among various organizations and stakeholders, who have worked together to conserve the disjunct Lake Superior caribou populations. During winter 2018, two translocation projects were undertaken; an assumption of these efforts is that Lake Superior caribou have unique genetic material that warrants conservation, but this assumption has not been tested as no study of adaptive genes has been undertaken. We tested the distinctiveness of these populations by sequencing and analysing high-quality genomes (40x coverage) from several caribou populations. We are using the program NGSAdmix and ABBA BABA statistics to reveal population structure and investigate historic admixture. Our results will place these caribou populations into an evolutionary context with surrounding populations in Ontario and Manitoba. Identifying the evolutionary significance of these populations is a key first step in identifying appropriate conservation priorities and actions.

Title ***Biting flies alter the activity of caribou in the boreal forest***

Authors **David V. Beresford,** Trent University
Marco Raponi, Trent University
James A. Schaefer, Trent University
Ian D. Thompson, Natural Resources Canada, Canadian Forest Service
Philip A. Wiebe, Natural Resources Canada, Canadian Forest Service
Arthur R. Rodgers, Ontario Ministry of Natural Resources and Forestry
John M. Fryxell, University of Guelph

Habitat loss is the major agent of decline of forest-dwelling caribou, but it is unknown how biting insects, a potentially important component of boreal forest habitat, influence the activity of this threatened species. During summers of 2011 and 2012 in northern Ontario, we collaborated across disciplines and jurisdictions—academics with federal and provincial government scientists, students with mentors, caribou ecologists with entomologists—to quantify the relative abundance of black flies, mosquitoes, and tabanids in stands of different ages and relate their abundance to caribou activity. We counted insects in young (25–35 yrs since forest harvesting), intermediate (36–69 yrs), and old (≥70 yrs) stands using sweep nets and counts on human subjects. We related the daily variation in abundance of these insect families, along with daily maximum temperature, to the activity of female caribou, determined by accelerometers in GPS collars. We found higher insect abundance in young versus old stands. During the first 5 minutes in a forest stand, the rate of accumulation of mosquitoes and black flies on human subjects increased, but at a decelerating rate, whereas tabanid abundance declined over time. On days when tabanids were more numerous, female caribou were less active, possibly a response to reduce exposure and harassment. To a lesser extent, mosquitoes and black flies also tended to elicit lower activity of caribou. Our study reveals that biting flies can alter the behaviour of female caribou in the boreal forest. Loss of old stands may accentuate the potential for insect harassment.

POSTER PRESENTATIONS



Space Use & Movements

Title *Natal habitat preference induction in caribou – Like mother, like child?*

Authors **Benjamin Larue,** Université de Sherbrooke
Mathieu Leblond, Environment and Climate Change Canada
Steeve D Côté, Université Laval
Christian Dussault, Ministère des Forêts, de la Faune et des Parcs du Québec
Martin-Hugues St-Laurent, Université du Québec à Rimouski

Caribou habitat selection has received considerable attention during the last decades, yet the underlying forces shaping individual differences in selection are poorly documented. Some of these differences could be explained by the early experience of calves in their natal habitat. By selecting habitat attributes like those encountered in early life, individuals could improve resource acquisition, survival, and ultimately fitness. This behaviour, known as natal habitat preference induction (NHPI), could occur in caribou because calves generally stay with their mother for an extended period. To assess NHPI in caribou, we undertook a collaborative research project gathering researchers from academia as well as provincial and federal governments. We combined our expertise to assess NHPI in the boreal caribou population of Charlevoix using three complementary approaches: 1) population-based resource selection functions (RSFs), 2) individual-based RSFs, and 3) behavioural repeatability. All approaches compared the behaviour of calves in their natal range to their behaviour as independent subadults during the snow-covered (Dec – Apr) and snow-free (May – Nov) seasons. Using RSFs, we found that the magnitude of selection between calf and subadult stages differed for most habitat covariates, yet the signs of statistically significant effects (selection vs. avoidance) were generally the same. We also found that habitat selection was repeatable across life stages during the snow-free season, and that selection for natural and anthropogenic disturbances was repeatable year-round. This study highlights the potential role of natal habitat preference induction in shaping individual differences in caribou habitat selection and implications for caribou management and conservation.

Title *Preliminary identification and evaluation of woodland caribou birth sites in northern Ontario*

Authors **Phil Walker,** University of Alberta
Evelyn Merrill, Univeristy of Alberta
Art Rodgers, Ontario Ministry of Natural Resources and Forestry
Ian Thompson, Natural Resources Canada - Canadian Forest Service
John Cook, National Council for Air and Stream Improvement
Rachel Cook, National Council for Air and Stream Improvement

While studies within Ontario have examined annual resource selection of adult caribou, knowledge concerning the factors influencing selection of parturition sites is limited. We used a statistical approach based on movements of female caribou with GPS/video-collars (n= 19) to predict parturition events within three distinct regions in northern Ontario. We tested the accuracy of the predicted dates using footage from camera collars of parturient GPS-collared caribou. Parturition dates were correctly identified to the day for 53% (n=10) of the caribou and was within 1.1 + 1.2 days across all caribou that gave birth. We applied the model to 96 GPS-collared caribou with unknown parturition events that were monitored from 2010 to 2014. We evaluated the effects of female age, region, and previous fall and winter weather on birth date. We defined calving areas based on displacement movement post parturition and compared characteristics of these areas (i.e., forest types, road densities, and previously derived wolf density layers) among Pickle Lake (n=36), Nakina (n= 48), and Cochrane (n=31), ON. We derived individual resource selection functions for caribou and evaluated how the strength of selection for these 3 variables changed with their availability across areas in a functional response framework. Preliminary results of this study will be used to guide a larger effort to develop tools for evaluating the influences of forest management on nutritional resources within caribou calving areas.

POSTER PRESENTATIONS

Title *Reindeer energetic, movement, and demography*

Author **Rebecca Viejou,** University of Guelph

We are starting the analysis phase of a project investigating the connection between space use and demography through energetic mechanisms. The study is being applied to wild and semi-domestic Norwegian reindeer, a system where space use patterns are dependent on human land use. By combining data from vegetation surveys across three wild and three semi-domestic herds with remotely sensed information, the first goal of the project is to project available forage for reindeer across the landscape. Using the forage availability estimates, we will assess the local effect of infrastructure on reindeer foraging behaviour using animal-borne video collars. We will combine this with larger scale hidden Markov models of animal movement to predict the energetic budgets and feeding rates of about 200 GPS collared individuals. We will test the assumption that extensive and migratory movements of reindeer increase their access to energy using a hierarchical HMM model that distinguishes migratory and home-ranging behaviour. Finally, we will test for an association between human disturbance and carrying capacity at the range scale. This project is being conducted as a collaboration between Canadian and Norwegian scientists in academia and government, as well as cooperation with Sami herders.

Title *Fine-scale habitat selection of female caribou in summer, using camera collars.*

Authors **Sophiane Béland,** Caribou Ungava - Université Laval
Martin Bernier, Department of Physics, Engineering Physics, and Optics - Université Laval
Steeve D. Côté, Caribou Ungava - Université Laval

Migratory caribou (Rangifer tarandus) is a socioeconomically and culturally important species for Quebec, and its populations are experiencing a sharp decline. Although these caribou herds have been studied for several years, our knowledge of the amount of habitat that must be protected to ensure the persistence of these populations is limited. In this context, the study of habitat selection is a useful tool. It is known that female caribou are directly dependent on the availability of summer habitat resources given the very high costs associated with lactation, but also the need to accumulate reserves for other seasons, when resources are less abundant. However, we do not know how these females select the resources and the different habitats at a fine spatial scale. This is what will be determined in this project with the objective of evaluating the summer habitat selection of female caribou in the Rivière-aux-Feuilles herd at a fine spatial scale. Specifically, we will focus on habitat selection at the feeding sites. We will also evaluate the effects of environmental variables such as temperature and wind, as well as the effects of insect harassment, on female habitat selection. To do this, we will use camera collars that capture the images in front of the animal equipped with such a collar. This project will provide us with information on the selection of summer habitat by female caribou at a fine spatial scale, which will contribute to the collective management and conservation of the migratory caribou and its habitats.

Population Monitoring & Range Planning

Title *Implementation of a long-term boreal caribou monitoring program in Quebec : gaining better information for taking better actions*

Authors
Antoine St-Louis, Ministère des Forêts, de la Faune et des Parcs
Claude Dussault, Ministère des Forêts, de la Faune et des Parcs
Stéphane Déry, Ministère des Forêts, de la Faune et des Parcs
Christian Dussault, Ministère des Forêts, de la Faune et des Parcs
Sandra Heppell, Ministère des Forêts, de la Faune et des Parcs
Caroline Hins, Ministère des Forêts, de la Faune et des Parcs
Mathieu Morin, Ministère des Forêts, de la Faune et des Parcs
Guillaume Szor, Ministère des Forêts, de la Faune et des Parcs
Joëlle Taillon, Ministère des Forêts, de la Faune et des Parcs
Caroline Trudeau, Ministère des Forêts, de la Faune et des Parcs
Vincent Brodeur, Ministère des Forêts, de la Faune et des Parcs

In order to base its management decisions on the best available scientific information, the Government of Quebec initiated an extensive boreal caribou monitoring program during the Fall 2017. This program is part of the ongoing development of a long-term caribou habitat management strategy in Quebec, with two principal aims: 1) foster our knowledge on boreal caribou population size, trends and delineation, and 2) assess the efficiency of habitat management measures that will be implemented through the Strategy. The first stage of the monitoring program will take place until 2020 and is targeted toward the deployment of GPS radio-collars and aerial surveys. To date, 162 collars were fitted on both female and male boreal caribou throughout its whole distribution range in the Province. This monitoring program will help guide management and conservation actions over both short and long-term period. It is also developed as part of a general collaborative process between the Government, First Nations and academic scientists in order to address the future of this emblematic species of the boreal ecosystem.

Title *Past, present and future of migratory caribou herds in northern Québec.*

Authors
Joëlle Taillon, Ministère des Forêts, de la Faune et des Parcs, Gouvernement du Québec
Vincent Brodeur, Ministère des Forêts, de la Faune et des Parcs, Gouvernement du Québec
Marie-Claude Richer, Ministère des Forêts, de la Faune et des Parcs, Gouvernement du Québec
Stéphane Rivard, Ministère des Forêts, de la Faune et des Parcs, Gouvernement du Québec

The dynamics of migratory caribou herds in northern Québec has greatly evolved since the 1950's. The rivière George herd was once one of the largest migratory caribou population with over 800 000 caribou, but is now below 9 000. The rivière aux Feuilles herd is currently estimated at about 209 000 caribou, but was three times larger at the beginning of the 2000's. Since 1978, the Québec Government has maintained a monitoring program to better understand and predict changes in migratory caribou herd size. This program has allowed to collect biodemographic data on a regular basis such as calf birth mass, fall recruitment rate, gestation rate, population composition and adult survival rate. In addition, the satellite telemetry program, initiated in 1986, allows to describe the annual and seasonal space use by the two herds. Based on these data, we have investigated several research questions in partnership with the Caribou Ungava research program (http://www.caribou-ungava.ulaval.ca/). In addition, we are working actively with aboriginal nations, outfitters and sport hunters, and the Newfoundland and Labrador Government in order to maintain and improve the

long-term monitoring of the herds, and, more critically, to identify management and conservation actions needed to maintain the rivière George and the rivière aux Feuilles herds in Northern Québec and Labrador. This presentation offers an overview of the herds' monitoring and presents the current day management challenges.

Title ***Developing a Framework for boreal caribou range planning in the NWT***

Authors **James Hodson,** Government of the Northwest Territories, Department of Environment and Natural Resources
Joanna Wilson, Government of the Northwest Territories, Department of Environment and Natural Resources
Philip Halteman, Compass Resource Management
Lee Failing, Compass Resource Management

The NT1 boreal caribou range is one of Canada's largest continuous ranges, spanning four settled indigenous land claim regions, two regions with ongoing land claims, and extending into the Yukon Territory. The large geographic extent and uneven distribution of disturbance within the range make range planning challenging. Responsibility for management of boreal caribou and their habitat in the NWT is shared amongst the Government of the Northwest Territories (GNWT), Indigenous Governments and Organizations, and federal government. GNWT is proposing to develop 5 regional range plans within the NWT. To ensure consistency and coordination amongst regional plans, territorial, Indigenous and federal governments and other stakeholders will need to work together on a common approach to range planning. A Framework to guide the development of regional range plans has been drafted which outlines regional thresholds for habitat disturbance based on fire history, a tiered approach to managing disturbance based on regional status relative to thresholds and relative habitat importance for boreal caribou, and research and monitoring needed to evaluate how well range plans are working. GNWT is engaging with two working groups consisting of Indigenous Governments and Organizations, federal government departments, regulatory and land use planning boards, and industry and environmental organizations to review and provide input on the Framework. This poster provides an overview of the main elements of the Framework and some of the key feedback and recommendations from working group members that will eventually shape the final Framework and subsequent regional range plans.

Community-Based Monitoring, Management, & Conservation

Title ***Highlighting the diversity of Indigenous initiatives related to caribou management: building a national synthesis***

Author **Solange Nadeau,** Natural Resources Canada, Canadian Forest Service

Over the years, many First Nations, indigenous organizations and communities have launched or taken part into initiatives related to caribou and management of its habitat. Depending on the local context, those initiatives aimed at: documenting indigenous knowledge related to caribou; developing management structure, plans and strategies, testing practices designed to support caribou populations or monitor caribou and its habitat. There seems to be an untapped richness in those initiatives as they are documented mainly on an individual basis. By reviewing documents on indigenous initiatives related to caribou, conducted in Canada, and publicly available, we seek to develop a comprehensive synthesis of those initiatives. The synthesis would present reflections on the lessons learned in different contexts, and on how to improve the integration of indigenous worldviews, values and knowledge in caribou management. The project is in an early stage of development; so far, about 40 initiatives have been documented via reports and scientific papers. The poster will start sketching a global picture from the identified initiatives, and propose an approach to further advance and validate the synthesis. The poster session will serve to engage the conversation with the conference's attendees regarding their interest for the synthesis, and tap their knowledge to find out more about indigenous initiatives related to caribou management.

Title ***Caribou Co-management in the Kivalliq***

Authors **Qovik Netser**, Kivalliq Wildlife Board | presenter
Ezra Greene, University of British Columbia | presenter

Inuit have long hunted caribou in the Kivalliq region of Nunavut, and Inuit culture, knowledge and sustenance is intricately interconnected to the animals. Ensuring the long-term sustainability of caribou populations and protecting the right to hunt now and long into the future is of vital importance to Inuit and the Kivalliq Wildlife Board (KWB).

KWB is an Inuit regional wildlife organization made up of members from the seven Hunters and Trappers Organizations (HTOs) in the Kivalliq. KWB works on and helps coordinate wildlife co-management in the Kivalliq, including management related to caribou.

Our poster will highlight recent and ongoing caribou co-management initiatives in the Kivalliq, including: working together with Nunavut Tunngavik Inc. (NTI) and the Government of Nunavut's Department of Environment on caribou population and seasonal movement research; working with co-management partners to protect caribou during major migrations, especially close to roads and near communities; and, proposals to limit sports-hunting of Kivalliq caribou herds.

The poster will also draw attention to emerging matters in the Kivalliq, including: how to better oversee commercial and social media sales of caribou in Nunavut; the need for land use planning and how to balance wildlife conservation concerns and increasing industrial development into the future; and, how to encourage and strengthen Inuit hunting expertise values to ensure safe and responsible hunting.

KWB wishes for Inuit to always have their close connection to caribou in the Kivalliq, and this poster will highlight working together towards making this happen.

POSTER PRESENTATIONS

Title *A double observer method to model variation in sightability of caribou in calving ground surveys*

Authors **David S Lee,** Nunavut Tunngavik Inc.
John Boulanger, Integrated Ecological Research
Mitch Campbell, Government of Nunavut

The principal objective of our research was to develop a robust method to minimize the effect of heterogeneity in sighting probabilities in aerial surveys of barren-ground caribou (Rangifer tarandus groenlandicus) used in generating population estimates. We have applied this method to numerous surveys in Nunavut, Canada. Issues of sightability of wildlife in aerial surveys have been recognized in the field and literature for many years. In general, not all animals are seen during aerial transect surveys, which may result in a negative bias of estimates. A number of methods are available to correct for sightability such as distance sampling, double observer sampling, or combinations of both. Of the methods available, double observer methods that utilize two observers per side of the plane to estimate sightability were most applicable. Further, a single dependent observer method first suggested by Cook and Jacobsen (1979) was utilized because it allows observers to communicate about observations. In northern studies, there is an expectation for an effective role for Inuit in all aspects of wildlife management, including research. This method fits into a co-management framework where community members participate as observers. Results of one study demonstrated that sightability of caribou varies by observer, snow cover, terrain features, and the relative rate of observation occurrence. Therefore, it is likely that raw counts of caribou will underestimate the true number of caribou on transect. However, results also demonstrated that, in general, sighting probabilities are usually reasonably high, and the use of double observers can substantially reduce sightability bias.

Title *Working together to study population trends of the Torngat Mountains caribou herd (DU10).*

Authors **Meredith Purcell**, Torngat Wildlife, Plants & Fisheries Secretariat
Serge Couturier, Biologist Consultant
Aaron Dale, Torngat Wildlife, Plants & Fisheries Secretariat
Jamie Snook, Torngat Wildlife, Plants & Fisheries Secretariat

Due to an annual range that spans over Nunavik, Nunatsiavut, and Nunavut, the Torngat Mountains caribou herd is of interest for two provinces, six governments, two parks and two Co-Management Boards. Out of necessity and this shared interest, an informal Torngat Caribou Technical Committee was created (Government of Quebec, Government of Newfoundland & Labrador, Nunatsiavut Government, Makivik Corporation, Kativik Regional Government, Parks Canada, and Torngat Wildlife and Plants Co-Management Board). The shared goal of the Torngat Committee is to deliver a coordinated effort to generate information about the herd, with the hopes that this information and the ties built through working together will contribute to management discussions that are ongoing in various forums.

During Inuit community consultations, the need for aerial population surveys was expressed. To add to the scientific knowledge (SK) of the Torngat herd, helicopter transect surveys were performed. The herd size was estimated at 930 caribou (CI: 645-1,369) in March 2014 using Distance Sampling. Another similar aerial population survey put the population size at 1,326 caribou (CI: 912-1,986) in 2017. Recruitment was high, with calves accounting for 17.2% and 23.1% in 2014 and 2017 respectively.

Inuit knowledge (IK) identified a decreasing herd trend before 2013, and conveyed that overhunting is a concern while other potential threats included predators, development, noise, recreation, and environmental changes (Wilson et al. 2014). Even though SK indicated that the Torngat herd might have increased between 2014 and 2017, it is still a small population which needs careful attention from managers and users.

Title ***Caribou Conservation: Bridging Two Worlds***

Authors **Stephanie Brown**, Aseniwuche Winewak Nation
Chantelle Bambrick, Foothills Landscape Management Forum

The Aseniwuche Winewak Nation (AWN) in Grande Cache, Alberta initiated the Caribou Patrol Program in 2012, with assistance from the Foothills Landscape Management Forum (FLMF). AWN formed a dynamic partnership with the Government of Canada, Government of Alberta, FLMF and fRI Research in this collaborative project that contributes to recovery efforts for threatened woodland caribou and advocates for this iconic at-risk species.

follow the advice of their Elders who said, "We must speak for those that have no voice". Caribou Patrollers are community members who work in two worlds; the traditional Indigenous world, using knowledge passed down through generations to observe animal behavior, and the modern world, using cutting-edge technology to create electronic records and populate GIS databases.

Patrolling and Outreach complement each other. Caribou Patrol crews safely divert caribou from roadways and the patrollers' presence reminds us of the uncertain future of caribou. Social media is the catalyst of making the plight of caribou personal for everyone. School presentations have inspired a new generation of environmentally-conscious individuals and presentations to industry and the general public encourage people to have a compassionate understanding of the importance of species protection and preservation. The rapid encroachment of development and urbanization is creating pressures on the environment unknown to previous generations. It is critical that people from all walks of life work together to create and implement solutions to maintain a healthy landscape that is inclusive of all values.

Title ***Incorporating Inuit Qaujimajatuqangit (IQ) into Baffin Island Caribou Management***

Authors **John Ringrose,** Government of Nunavut, Department of Environment

The Government of Nunavut (GN) led a series of projects from 2014-2017, collaborating with multiple co-management partners, to assess the Baffin Island Caribou population. A major component of these studies was the incorporation of Inuit traditional knowledge. The Barren-ground caribou (DU3) population on Baffin Island experienced a significant decline during the 1990's. Suspected declines were identified by research conducted in 2012 and Inuit Qaujimajatuqangit (IQ) from Baffin Island communities. Due to the remoteness and size of Baffin Island, limited robust demographic research had been conducted. In 2014, the GN and multiple co-management partners conducted an aerial abundance survey covering the majority of Baffin Island (approximately 570,000km2). IQ was incorporated into the survey design and local community members participated in the survey implementation. Results from this survey indicated the population on Baffin and ancillary islands was 4,652 caribou (3,462-6,250, 95% CI), a substantial decline from previous estimates of 120-340,000 caribou. An 8-month moratorium on hunting was enacted on Baffin Island to allow time to assess the survey results and discuss management options. In 2015, a Total Allowable Harvest (TAH) of 250 male caribou was supported for the population, including mandatory reporting. In order to determine potential effects of a sex-specific harvest regime, seasonal composition surveys were conducted from 2015-2018. The composition surveys assessed calf survival and recruitment, population demographics, and population trajectory. The 4-year monitoring effort exemplifies the substantial efforts of multiple co-management partners in working together to assess, manage, and monitor the Barren-ground caribou population on Baffin Island, Nunavut.

POSTER PRESENTATIONS

Title ***The Keeyask Caribou Coordination Committee: Using traditional knowledge and science to understand project effects on caribou in northern Manitoba***

Authors **Rachel Boone**, Manitoba Hydro
Jimmy Lockhart, Fox Lake Cree Nation

The Keeyask Caribou Coordination Committee is a collaborative effort of the Keeyask Hydropower Limited Partnership – which includes Manitoba Hydro and four partner First Nations: Tataskweyak Cree Nation, War Lake First Nation, York Factory First Nation and Fox Lake Cree Nation. The Committee is a venue to share caribou monitoring results from the Keeyask Generation Project - currently under construction on the Nelson River, learn about other caribou monitoring and research in the region, and communicate with provincial wildlife managers and others involved in caribou stewardship in northern Manitoba.

Both traditional knowledge and technical science monitoring programs are being used by the Partnership to verify predictions made in the Project's Environmental Impact Statement and to assess the effectiveness of Project mitigation measures. Each of the four partner First Nations is leading their own Aboriginal Traditional Knowledge monitoring programs consistent with their own priorities and vision. Through the Keeyask Caribou Coordination Committee, Manitoba Hydro and the four partner First Nations are working together to share knowledge and understandings of Project effects on caribou, and find ways to bring this information together in a meaningful way.

Photo courtesy of Mark Bradley

Decision Making in Caribou Conservation: Ideas & Opportunities

Title *A collaborative grassroots approach to securing positive Boreal Caribou outcomes, in Northwest Alberta*

Authors **Lisa Wardley,** Alberta Northwest Species at Risk Committee
Crystal McAteer, Town of High Level
Hayley Ann Gavin, Town of High Level

Northwest Species at Risk Committee (a collaboration of 6 northwestern municipalities) have joined forces with researchers and experts at Alberta Biodiversity Monitoring Institute and Calgary Zoo to conduct vegetation inventories, habitat disturbance ground-truthing and Boreal Caribou breeding-translocation pilot projects, in Northwest Alberta. The natural environment of Northwest Alberta is among one of the least studied regions of Alberta and Canada. Existing available data for the region is of low quality and is vastly out-dated - this makes planning for the recovery of five Boreal Caribou herds very difficult. Large conservation areas with no management strategies have been proposed as a tool to recover the northwest caribou; the region has been home to Canada's largest national park, and Alberta's largest provincial park for several years, yet the caribou are still declining. The Federal government is looking for positive outcomes for caribou, and tangible actions towards progress. Our proactive approach involves the collaboration of northern elected leaders; subject matter experts; field researchers; trappers; Indigenous Peoples and individuals. These partnerships are enabling: the collection of new current data; caribou translocation activities; the deployment of electronic observational devices; and input from diverse stakeholder groups, towards positive outcomes for caribou. We hope that our collaborative approach and the methods used, will inspire other local groups to proactively get involved in complex pilot projects for the benefit of their communities and wildlife. Provincial, Territorial and Federal governments alone, cannot recover the caribou; providing respectful, collaborative support form the local level is essential for successful caribou recovery.

Title *Forest Landscape Restoration*

Authors **Nicolas Mansuy,** Natural Resources Canada, Canadian Forest Service
Denys Yemshanov, Natural Resources Canada, Canadian Forest Service

Caribou recovery requires unprecedented commitment and cooperation among the different land users. Forest Landscape Restoration (FLR) is defined as the long-term process to regain ecological functionality and enhance human well-being in deforested or degraded landscapes. FLR offers an opportunity to restore caribou habitat into functional and working landscape that deliver co-benefits to multiple people. FLR does not mean returning land to its original state or simply planting trees. FLR builds from the concept of working landscapes where industrial activities support diverse values, multiple land uses as well as socio-economic aspects of the landscape; all of which rely upon collaboration and coordination by stakeholders. The benefits of FLR are multiple and complementary: mitigation of cumulative effects and loss of biodiversity, contribution to carbon sequestration, valuation of ecosystem goods and services to meet the changing needs of society, and improved land management and governance. The objectives of FLR are aligned with national priorities and supports Canada in its caribou recovery efforts. In this context, we present the challenges and opportunities to implement FLR practices using the Cold Lake caribou range in Alberta as an example. We also describe tools and guidelines available to move from target to implementation on the ground. This includes the identification of key phases and interventions in implementing FLR activities. As an example, we also highlight preliminary results showing how improving landscape connectivity could support caribou habitat restoration as well as facilitate quantification of socio-economic trade-offs for resources activities.

POSTER PRESENTATIONS

Title ***Where should we invest conservation resources to maximize the probability of long-term boreal caribou persistence?: An optimization approach.***

Authors **Amanda E Martin,** Environment and Climate Change Canada
Patrick J Kirby, Environment and Climate Change Canada

Where should we invest conservation resources to maximize the probability of long-term boreal caribou persistence? From a conservation perspective, the best answer is "everywhere". However, this does not account for the fact that resources (e.g. time, money) are often limited, and thus immediate action everywhere may not be feasible. When resources are limited optimal resource allocation approaches can be used to find the best conservation outcome given the available resources. Here we develop a national-scale, spatially-explicit framework to prioritize areas for conservation action via mixed integer linear programming. This framework considers the threats to caribou, socioeconomic factors that could influence the probability of conservation action/success, and cultural significance of caribou to Indigenous peoples. We then use this framework to prioritize among 392, 10,000 km2 planning units that span the caribou range under different constraints on the area that can be targeted for conservation (5–95% of the range). Not surprisingly, the ability to reach our conservation objective, i.e. the measured conservation value of the total range, declined with increasing resource limitation. However, our prioritization approach substantially increased the achievable conservation value relative to selection of priority areas at random or using a ranking scheme, more than doubling the achievable value in some cases. This suggests that our prioritization framework could be a useful tool for conservation decision-making, providing a transparent and replicable way to maximize the ability to reach—or get as close as possible to—a conservation objective that benefits both boreal caribou and Canadians when resources are limited.

Title ***Should we give up isolated caribou populations at the southern limit of the species distribution? – The case study of Val-d'Or herd in Quebec.***

Authors **Serge Couturier**, Wildlife Biologist Consultant
Marcel Paré, Wildlife Biologist Consultant

Increased anthropogenic disturbance is changing the boreal forest. This northward disturbance gradient is parallel to the boreal caribou range contraction reported in all Canadian provinces where populations became gradually isolated at the southern limit of the species distribution. As this northward disturbance pattern will likely continue, the question could be asked: Should we give up isolated caribou populations at the southern limit of the species distribution? To answer this question, the case study of the isolated Val-d'Or caribou population in Quebec is analyzed.

Like most isolated populations in the southern portion of the Canadian distribution, the Val-d'Or herd survives in highly disturbed habitat (76% disturbed habitat). The continuous caribou distribution is now located at about 200 km north of Val-d'Or herd. From about 75 caribou in the 1950s, population size declined and was last estimated at 18 caribou in 2016. It was proposed that the province should give up the Val-d'Or herd because of its disturbed range and instead should focus conservation efforts on the continuous range. This is dangerous circular reasoning. Because the province Authorsized most of the disturbances in the boreal caribou range, it is inappropriate for the government to abandon these small isolated populations because their ranges are too disturbed.

Provincial and federal governments must work together with First Nation, NGOs and industry toward conservation of the Val-d'Or caribou population. These isolated populations are valuable because accepting their local extirpation is simply accepting that boreal caribou will continue to decline in Canada.


Photo courtesy of Mark Bradley

Title ***National Boreal Caribou Knowledge Consortium: collaborating to support boreal caribou conservation and recovery***

Authors **Tatyana Flick,** Environment and Climate Change Canada
Margaret Sawatzky, Environment and Climate Change Canada
Matthew Boeckner, Environment and Climate Change Canada

It is agreed that most boreal caribou populations across Canada are declining and that the primary cause is anthropogenic disturbance of boreal habitat. Effectiveness of conservation and restoration efforts would benefit greatly from bringing together boreal caribou experts, decision makers, and knowledge keepers to share information and collaboratively identify priority work. Established as per the 2018 Federal Action Plan for the Woodland Caribou, the National Boreal Caribou Knowledge Consortium (NBCKC) will serve as a forum for sharing knowledge and pooling capacity between government, Indigenous organizations, ENGOs, academia, and industry. This diverse group will work together to share lessons learned, track the state of knowledge, and address knowledge gaps, thereby informing decision-making related to boreal caribou conservation. The June 2018 NBCKC launch highlighted: (i) how best to focus work towards conservation outcomes; (ii) data sharing considerations and sensitivities, (iii) quantification of multi-species or ecosystem services outcomes associated with caribou conservation; (iv) consideration of dietary, financial, social, and spiritual importance of caribou to Indigenous peoples when conducting cost-benefit analyses, and (v) co-applying Indigenous knowledge and western science in support of boreal caribou. Moving forward, the NBCKC will advance monitoring and habitat restoration work, collaborate with Indigenous partners on a path forward for involving a balanced representation of Inuit, Métis, and First Nations knowledge holders, of both genders, and continue developing a platform, where appropriate, for sharing data and knowledge. At NACW 2018, the NBCKC seeks to share information about the consortium, and gain additional perspectives from other conference attendees.

POSTER PRESENTATIONS

Habitat Restoration & Management Interventions

Title ***Technical considerations for a large predator exclosure as an innovative solution for boreal caribou recovery***

Authors **John Nishi,** EcoBorealis Consulting Inc.
Rochelle Harding, REDES Inc.
Lisa Schaldemose, Schaldemose & Associates Inc.
Scott Grindal, ConocoPhillips Canada

A suite of complementary recovery actions that include habitat restoration and population management levers are likely required to recover and ensure self-sustaining woodland caribou populations in northeast Alberta. Large predator exclosures may contribute towards innovative solutions for caribou conservation through the establishment of a small breeding subpopulation of boreal caribou within a predator-free fenced area in natural habitat. The main purpose of an exclosure would be to improve caribou survival and productivity inside the fenced area and to regularly translocate caribou born within the exclosure to reinforce extant local population(s). A focus of our recent work on advancing the exclosure concept has been to develop management planning guides with recommended content and procedures to support implementation. In this presentation, we describe a proposed scope and scale of an exclosure, and summarize key technical planning considerations which include site selection, fence and facility design, caribou husbandry, genetic conservation, and predator and wildlife management within an exclosure.

Title ***Developing and Monitoring the Efficacy of Functional Restoration of Linear Features for Boreal Woodland Caribou***

Authors **Jonah Keim,** Trove Predictive Data Science
Philip D. DeWitt, Science and Research Branch, Ontario Ministry of Natural Resources & Forestry
Steven F. Wilson, Matrix Solutions Inc.
Noemie Jenni, Matrix Solutions Inc.
Subhash R. Lele, Department of Mathematical and Statistical Sciences, University of Alberta

Oil and gas seismic lines, pipelines, forestry roads and other linear developments have encroached into boreal caribou ranges, require decades to recover, and have increased the efficiency of predators and their ability to encounter caribou. Blocking linear developments with logs has been shown to reduce predator efficiency, but it remains unknown if such mitigations can disrupt the functional response between caribou and predators at scales relevant to caribou demography. We conducted collaborative research with the British Columbia Oil and Gas Research and Innovation Society to evaluate the efficacy of a large-scale habitat restoration program to mitigate the functional response of humans, predators and prey within a caribou range. We randomly deployed 100 motion sensing cameras on linear developments and undisturbed sites across an entire caribou range. We continuously monitored human wolf, bear, caribou, moose, white-tailed deer, moose, and elk habitat use for 2.5 years – before and after a wide-scale habitat restoration program was deployed across nearly 20% of the range. We sampled vegetation and conducted a timed-walk to quantify travel resistance at each camera monitoring station before and after restoration. We reveal the spatiotemporal response of caribou and interacting predator and prey species to one another, linear developments, restoration, recreational snowmobiling, vegetation, snow, time of year, and travel resistance. We share our learnings applicable to managing and monitoring large-mammal communities and the restoration of boreal caribou ranges.

POSTER PRESENTATIONS

Title *Developing a Restoration Plan for BC's South Peace Northern Caribou*

Authors **Scott Schilds,** BC Ministry of Forests, Lands, Natural Resource Operations, and Rural Development (BC MFLNRORD)
Hillary Morgan, BC Ministry of Forests, Lands, Natural Resource Operations, and Rural Development (BC MFLNRORD)
Paula Bentham, Golder Associates
Tanya Seebacher, Golder Associates

The South Peace Northern Caribou (SPNC) consists of six Central Mountain caribou herds (Moberly, Scott, Burnt Pine, Kennedy Siding, Quintette, and Narraway) and one Northern Mountain herd (Graham) located within Northeast BC. Monitoring of these herds over the past 20 years has shown significant population decline, with all seven herds currently below federal and provincial population objectives. The loss and fragmentation of high value caribou habitat resulting from anthropogenic disturbances, and the subsequent increase in wolf predation, has been identified as the main limiting factor to these populations. To address the decline, BC's caribou recovery program calls for habitat restoration and protection, in addition to a suite of other measures. In order to identify potential habitat restoration areas, the BC Government contracted Golder Associates to create the Preliminary Tactical Restoration Plan for the South Peace Northern Caribou Ranges. The Tactical Plan creates an inventory of linear disturbances on the landscape across all seven herd ranges (3,282,558 ha), and uses available information such as biogeoclimactic classifications, natural disturbances, caribou occurrence data, elevation, habitat protection measures, current and future development, and tenure information to identify 12,251 km of linear features that are candidates for restoration. Restoration polygons were then determined to identify clustered areas where restoration would provide the greatest benefit to caribou based on available information. Our poster presentation proposes to review the methodology used to develop the Tactical Plan across the SPNC ranges, and to discuss the next steps of collaboratively integrating local and traditional knowledge into the prioritization process.

Title *Assessment of Remote Sensing-Based Lichen Discriminators across Northern Canada*

Authors **Blair Kennedy,** Environment and Climate Change Canada, Landscape Science and Technology Division
Darren Pouliot, Environment and Climate Change Canada, Landscape Science and Technology Division
Micheline Manseau, Environment and Climate Change Canada, Landscape Science and Technology Division
Robert Fraser, Natural Resources Canada, Optical Methods and Applications
Jason Duffe, Environment and Climate Change Canada, Landscape Science and Technology Division
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Terrestrial lichens are an important food source for caribou (Rangifer tarandus) influencing their movement, distribution and population change over time. Mapping the spatial distribution and cover of terrestrial lichens with remote sensing can serve as an important approach for monitoring critical changes in caribou habitat (e.g. impact of forest fire) and understanding the factors explaining differences in lichen abundance amongst different regions of northern Canada. Previous remote sensing-based efforts to map (and retrieve) lichen distribution and abundance have relied upon limited in situ field data restricted to particular regions/locales and thus are not indicative of the potential for pan-Arctic mapping and monitoring. In this study, we assessed the efficacy of various empirically-based


Photo courtesy of Mark Bradley

modelling approaches for mapping and retrieving lichen distribution and abundance (i.e. percent cover) across a diverse set of field sites situated in the Canadian Arctic and sub-Arctic using moderate-resolution optical satellite data (i.e. Landsat TM). By working together with various groups and organizations, a Canada-wide field-based dataset representative of various northern ecosystems was assembled for model calibration and validation. We also investigated regional differences in accuracy in an attempt to characterize uncertainty associated with lichen retrievals using a combination of machine learning and resampling methods.

Title ***Assessing the wolf numerical response to a moose reduction experiment in central British Columbia***

Authors **Michael Klaczek,** Government of British Columbia
Doug Heard, Tithonus Wildlife Research

Caribou recovery plans are based on the rationale that to increase caribou numbers, wolf numbers need to be reduced either directly or indirectly through a reduction in their main prey base. Moose are the predominant ungulate in the Parsnip drainage of central British Columbia, and are the primary prey of wolves. Between 2006 and 2016 moose hunting permits were doubled to reduce moose numbers, so that wolf density and ultimately predation on caribou would decline. Moose numbers declined from 3000 to 1000 but wolf numbers showed no trend, remaining at about 40 individuals within 5 packs (about 9 wolves/1000km2). All published wolf numerical response [WNR] curves predict that wolf numbers should have declined. When we fit a type II WNR curve to data from wolf-moose systems (excluding Isle Royale), the Parsnip data lay on the flat part of the curve suggesting that moose numbers were not reduced to the point where wolf numbers would be expected to decline. These findings suggest that general ungulate-biomass models used to predict wolf density by combining prey types may not be appropriate for wolf-moose systems. In the Parsnip, moose densities would need to decline below 400 moose (<200 moose/1000km2) to achieve a wolf density expected to promote caribou recovery (3-5 wolves/1000km2). Hunters play an important role, however, there are challenges with hunter crowding, declining hunter success, and many do not want to lose future opportunities to hunt moose. We highlight next steps to test primary prey management as an intermediate-term approach for caribou recovery.

Title ***Initial predator-prey behavioural responses to silvicultural restoration of linear features in the Cold Lake area, Alberta, Canada***

Authors **R. Scott McNay,** Wildlife Infometrics Inc.
Glenn Sutherland, Wildlife Infometrics Inc.
Geoff Sherman, Woodlands North Inc.
Melanie Dickie, Alberta Biodiversity Monitoring Institute
Michael Cody, Cenovus Energy Inc.

Anthropogenic LFs are commonly thought to have fundamentally altered the relation between wolves and woodland caribou for example, and restoration of LFs is therefore promoted as a measure to help conserve caribou populations. In an industry-led, landscape-level restoration experiment - the LiDea Forest Habitat Restoration Project – an innovative collaboration involving multiple oil and gas companies, academic researchers and First Nations, we assessed whether silvicultural methods of restoring LF could potentially benefit caribou. We investigated the use of restored LFs by two predators (wolves, black bears) and two ungulate prey species (moose and boreal caribou) by comparing differences among species in their use of natural LFs and their use of anthropogenic LFs that were either treated or not. Moose and bears tended to prefer to use natural linear features but use of those features by wolves was equivocal. We found evidence that treatments to restore anthropogenic LFs led to a reduction in preference for those features by wolves. Bears were equivocal in their use of

anthropogenic LFs and to restoration of those features. Moose tended to avoid anthropogenic LFs and use of anthropogenic LFs by caribou could not be fully assessed. All four species traveled slower when they used restored LFs. These results will help identify efficient approaches to mitigate those effects. Longer-term, improving our understanding of both the the amount of time post-restoration, and the extent that is required to return predator-prey systems to pre-disturbance conditions will be crucial to design of effective action plans incorporating large-scale restoration activities.

Title ***Application of novel caribou transport techniques for successful long-distance translocation of woodland caribou.***

Authors **Owen M Slater,** University of Calgary; Canadian Wildlife Health Cooperative (CWHC)
John Cook, National Council on Air and Stream Improvement
Rachel Cook, National Council for Air and Stream Improvement

Translocation of woodland caribou via long-distance transport is challenging and can result in significant injuries or mortality during or post-transport. Working together, novel caribou transport methods were used for two groups of woodland caribou trailored over 2300km from British Columbia to Ontario (N=14) or Alaska (N=11) in April 2017. The day prior to transport animals were sedated with medetomidine (0.19 +/- 0.04 mg/kg) via intramuscular (IM) remote drug delivery, weighed if a recent weight had not been obtained within 30 days, tranquilized with zuclopenthixol acetate (1mg/kg IM), followed by reversal of medetomidine with atipamezole at 5 times the medetomidine dose. The following morning animals were hazed into a trailor and housed in groups of 3-6 animals depending on the size of the internal compartment, except for the adult bull that was housed individually. All animals were remotely monitoring via infrared video cameras with wireless transmission to a split-screen monitor in either the chase or transport vehicle. Two animals developed extrapyramidal side effects to the zuclopenthixol within 24 hours of injection that consisted of abnormal behaviours and muscle movements, which was effectively treated with midazolam (0.2mg/kg, IM). Animals remained calm during transport and remote video monitoring facilitated smoother transport, real-time monitoring and identification of issues and timely treatment if required. No significant injuries or mortalities occurred during or > 45 days post-transport. The use of these techniques facilitated successful transport of caribou over long-distances and can be considered for transport of other caribou during conservation translocations or research projects.

Title ***Restoring Cladonia subgenus Cladina in disturbed environments***

Authors **Sean Rapai,** University of Guelph / Chu Cho Environmental
Richard T. McMullin, Canadian Museum of Nature
Duncan McColl, British Columbia Ministry of Forests Lands and Natural Resource Operations and Rural Development
Robert Hanner, University of Guelph
Steven Newmaster, University of Guelph

The development of habitat restoration techniques for restoring critical woodland caribou (Rangifer tarandus caribou) winter habitat will play an role in meeting the management thresholds in woodland caribou recovery plans. The goal is to restore disturbed environments within critical winter habitat for the declining woodland caribou. Woodland caribou are diet specialists, utilizing lichen-rich habitat for forage during winter months. Cladonia sub-genus Cladina is the most frequently eaten species during this time. To better understand how to rehabilitate winter habitat for caribou in disturbed environments, we have established three experimental field trials to evaluate lichen transplant success. These field trials evaluate the impact of different substrates, amendments, and lichen abundance on lichen transplant establishment success. During this presentation, we will share the year 2 and year 3 results from our lichen transplant studies from the Detour Gold mine in northeastern Ontario and the Mesilinka wild fire in north central British Columbia.

Forecasting Future Landscapes

Title *Estimating forage lichen biomass recovery in forest stands of northwestern Canada: A collaboration*

Authors
Ruth Greuel, University of Saskatchewan
Geneviève Degré-Timmons, Wilfrid Laurier University
Steven Cumming, Université Laval
Nicola Day, Wilfrid Laurier University
Sarah Hart, Washington State University
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Jennifer Baltzer, Wilfrid Laurier University
Jill Johnstone, University of Saskatchewan

The availability of forage lichens is a key component of habitat quality for boreal caribou (Rangifer tarandus caribou). Many lichen species take decades to recover substantial cover and depth after severe disturbance e.g. by wildfire. To better understand changes in caribou habitat after fire, we gathered detailed vegetation data for 414 sites within Saskatchewan's Boreal Shield (n = 221) and the Northwest Territories' Taiga Plains (n = 193). Both ecozones experience frequent, large lightning-caused fires, but have a limited human footprint. We used destructive samples (n = 233) to develop allometric equations predicting lichen biomass from field measures of cover or volume (area depth) for several species of Cladonia forage lichens. We then applied the equations to data from all sites and evaluated how stand-level biomass of forage lichens (kg/ha) varied among stand types, ecozones and stand age using nonlinear mixed effects models. Equations incorporating a measure of lichen height performed better when predicting biomass, particularly in older stands. Lichen biomass increased with stand age and was higher in the Boreal Shield than in the Taiga Plains. Building allometric equations using an extensive, statistically representative network of sites across ecozones gave us confidence in predicting lichen abundance across a greater geographic region than is typical in a single study. We demonstrate a generalized approach to assessing dynamics of lichen availability while controlling for variation in climate and landform. This will contribute to forecasts of caribou habitat quality with the expected increases in fire activity following on climate warming.

Title *Meeting forest age class targets for caribou under a changing climate.*

Authors
John H. Pedlar, Great Lakes Forestry Centre, CFS-NRCAN
Daniel W. McKenney, Great Lakes Forestry Centre, CFS-NRCAN
Lisa Venier, Great Lakes Forestry Centre, CFS-NRCAN

We simulated wildfire across boreal caribou ranges under both 'climate change' and 'no climate change' scenarios. The simulations made use of national forest attribute grids, disturbance layers, and published projections of annual area burned (AAB) for homogenous fire regime (HFR) zones across the boreal region. Model outputs tracked the amount of forest habitat in each of six, 20-year age classes for each caribou range. Availability of caribou habitat (defined as forest > 40 years) was projected to sharply decline over the course of the current century for caribou ranges in dry, fire prone regions of the country, while ranges in moist, eastern boreal regions showed little change. These findings suggest that, with a changing climate, caribou habitat targets may be challenging to maintain in certain regions – even in the absence of forest harvesting activities. Future plans for this work will be discussed, including the incorporation of harvesting and socioeconomic considerations. On the theme of 'Working Together', this study involved a sharing of data and ideas between the Canadian

Forest Service (CFS), Environment and Climate Change Canada (ECCC), and the Ontario Ministry of Natural Resources and Forests (OMNRF). Furthermore, we hope it will contribute to ongoing efforts by the natural resource management community in Canada to develop effective caribou conservation plans and policies.

Title *A population demography modeling tool to explore harvest management scenarios for the Fortymile caribou herd*

Authors **Josie Hughes,** Environment and Climate Change Canada
Leonardo Frid, Apex Resource Management Solutions Ltd.
Mike Suitor, Environment Yukon
Troy Hegel, Environment and Parks Alberta

We present a case study application of DG-Sim, a demographic simulation modeling tool that allows caribou managers to explore alternative harvest scenarios while explicitly accounting for uncertainties. The goal is to allow stakeholders to consider the risks and trade-offs associated with different harvest levels, and to identify uncertainties with a large influence on the projected population trajectory. The Fortymile caribou herd (FMCH) ranges across east-central Alaska, USA, and as far as the west-central Yukon, Canada. This herd has a history of rapid decline from approximately 50,000 to 6,000 individuals between 1963 and 1973, followed by a subsequent recovery to approximately 71,000 individuals in the most recent 2017 photo census. Given recent population increases, there is pressure from some stakeholders to increase harvest rates, while others argue for caution. We analyzed available fecundity and survival data using Bayesian generalized linear mixed models, accounting for trends, inter-annual variability, and correlations in parturition rate among age classes. We sampled DG-Sim model parameters from the Bayesian posterior probability distributions to project population trajectories retrospectively and prospectively. DG-Sim is designed to facilitate the exploration and summary of many alternative harvest scenarios. Population projections from these scenarios can be used to inform discussions of FCMH harvest policy among stakeholders.

Title *Using lichen biomass to map suitable caribou foraging habitat in northeastern Alberta*

Authors **Ashley Hillman,** University of Alberta
Scott Nielsen, University of Alberta

Understanding the relationship between lichen cover and biomass for common reindeer lichen species in northeastern Alberta is important for accurately mapping available lichen forage for boreal woodland caribou. To establish the relationship between lichen cover and associated biomass in important caribou habitat, we surveyed reindeer lichen populations in peatlands and upland jack pine stands in caribou ranges in northeastern Alberta. Upland pine stands were stratified into 10 to 20 years post-fire, 21 to 40 years post-fire, and mature forest to observe the effect of time since fire on lichen biomass recovery. Percent cover of lichen was estimated in the field, and a subsample of lichen was harvested, dried, and weighed to determine biomass. Analysis is ongoing, with preliminary results suggesting a linear relationship between percent cover and biomass. Once this relationship is established, estimates from the field will be applied at the landscape scale using remote sensing techniques. Spectral data from satellite imagery will be used to predict percent cover of terrestrial reindeer lichens in our study areas. The percent cover to biomass relationships determined for reindeer lichen species in our study area can be used to predict landscape-scale biomass of forage lichens within caribou ranges. By implementing these techniques, areas of high forage availability can be mapped throughout caribou ranges in northern Alberta. Our work will provide a resource for governments, communities, and industry to guide resource development, the management of protected areas, and policy development throughout boreal caribou habitat.

Impacts of Disturbance

Title *The density of anthropogenic features explains seasonal and behaviour-based functional responses in selection of linear features by a social predator*

Authors
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Mark Hebblewhite, University of Montana
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Anthropogenic linear features facilitate access and travel efficiency for predators, and can influence predator distribution and encounter rates with prey. We used GPS collar data from eight wolf packs and characteristics of seismic lines to investigate whether (1) ease-of-travel or (2) access to areas presumed to be preferred by ungulate prey best explained seasonal selection patterns of wolves near seismic lines, and whether the density of anthropogenic features led to functional responses in habitat selection. At a broad scale, wolves showed evidence of habitat-driven functional responses by exhibiting greater selection for areas near low-vegetation height seismic lines in areas with low densities of anthropogenic features. At a localized scale, the same relationship was evident for wolves in the less-industrialized foothills landscape, but not in the more-industrialized boreal landscape. Our results support behaviour in line with search for primary prey during summer and fall, and ease-of-travel during spring, while patterns of selection during winter aligned best with ease-of-travel for the less-industrialized foothills landscape, and with search for primary prey in the more-industrialized boreal landscape. These results highlight that time-sensitive restoration actions on anthropogenic features can affect the probability of overlap between predators and threatened prey within different landscapes. Working together, our results can help managers prioritize actions aimed towards the recovery of threatened species such as caribou, and with the goal of effective restoration in mind, we propose the need for management actions that consider the potential ripple effects of specific human activity (restoration or continued industrial activity) on predator-prey dynamics.

Title *The effects of forest fires on woodland caribou in the Sydney Range.*

Authors
Joseph Silva, University of Alberta, Department of Biological Sciences
Brian McLaren, Faculty of Natural Resources Management, Lakehead University
Christine Hague, Ontario Parks, Red Lake Cluster
Tomislav Sapic, Faculty of Natural Resources Management, Lakehead University

The woodland caribou population on the Sydney Range in northwestern Ontario has been assessed as not self-sustaining due to its small size and extensive anthropogenic and natural disturbances on the range.In 2016, the Red 003 Fire burned most of the northwestern area of the Sydney Range, which contained the best caribou habitat, and the result could be further decline in the Sydney caribou population.

A Resource Selection Function using telemetry data was constructed for a period prior to the Red 003 Fire and showed the importance of the area now burned as winter habitat for the Sydney caribou. The Resource Selection Function also showed how previously burned areas were used and avoided in different seasons. Post-fire habitat analysis using Landsat imagery indicated that 33% of the land area within the perimeter of the burn is residual habitat and potentially useful for caribou. Due to the large size of the Red 003 burn and its central location in the occupied portion of the Sydney Range, continued use of post-fire residuals is expected. In addition, caribou may begin to reoccupy regenerating burns, as lichen biomass and other habitat characteristics become more suitable.

This project was conducted as an undergraduate thesis in partnership with Lakehead University and Woodland Caribou Provincial Park. It is an example of academia and government working together to effectively share information and conduct research that benefits both organizations.

Title *Spatiotemporal response of mountain caribou to the intensity of backcountry skiing*

Authors **Frédéric Lesmerises,** Université du Québec à Rimouski
Florent Déry, Université du Québec à Rimouski
Chris J. Johnson, University of Northern British Columbia
Martin-Hugues St-Laurent, Université du Québec à Rimouski

Nature-based activities promote human-fauna encounters, which may be detrimental to wildlife. Animals may redistribute themselves across the landscape if human presence and activity is perceived as a type of predation risk. The response of animals to low intensity or ephemeral human activities, such as backcountry skiing and hiking is not well studied. Yet, these activities are increasing in popularity, especially in the east of North America. This is the case in the Gaspésie National Park where skiers are pushing for the opening of new ski areas within habitat of the endangered Atlantic-Gaspésie caribou population. To assess the impact of backcountry skiing, we used GPS telemetry to monitor 20 caribou frequenting a ski area partially included in the park. More than 14% of caribou locations were within the ski area when skiers were absent. Use of that area by caribou decreased to 2.1% when there were a relatively large number of skiers (9-12 skiers). A resource selection function suggested that caribou avoided the ski area, and the disturbance response was modulated by the number of skiers. In the presence of skiers, caribou were displaced to lower elevation habitats where predation from coyotes is potentially higher. Our results revealed a relatively strong disturbance response and corresponding loss of a large area of functional habitat as a result of backcountry skiing. Park managers, with the help of field observations of skiers and patrollers, should adjust the opening of ski areas according to the presence of caribou.

Title *Potential Impacts of Sea Ice and Ship Traffic Changes on Caribou Migratory Routes Surrounding King William Island, Nunavut*

Authors **Emmelie Paquette**, Carleton University
Gita Ljubicic, Carleton University
Cheryl Johnson, Environment and Climate Change Canada
Jackie Dawson, University of Ottawa

Caribou (Rangifer tarandus, tuktuit in Inuktitut) use the sea ice for seasonal migrations among islands of the Canadian Arctic Archipelago, and between the islands and the mainland. Sea ice is a critical part of caribou habitat and supports their ecological persistence. Research on caribou movement across sea ice is limited, especially in the Northwest Passage surrounding King William Island (KWI), Nunavut.

Climate change models predict a lengthening summer open water season, which is expected to increase the frequency and magnitude of Arctic shipping. Such changes could impact caribou negatively, as well as curtail hunting success and travel safety for nearby communities. Caribou continue to be very important for Inuit communities, with subsistence hunting contributing to economic, cultural, physical and emotional well-being.

This research is a part of an ongoing collaboration with the Inuit community of Gjoa Haven, on KWI. We explore community concerns surrounding changes in sea ice conditions and ship traffic, in relation to caribou crossings to/from KWI previously mapped by Elders and hunters in Gjoa Haven. We will characterize changes in break-up/freeze-up timing between 1983-2017 in the area using Canadian Ice Service regional ice charts. Changes in shipping traffic will also be examined.


Photo courtesy of Mark Bradley

Preliminary results will be discussed in community workshops in the fall of 2018, to learn about the interplay between ship transit, sea ice, caribou, and local travel and hunting. The work highlights how multidisciplinary, collaborative research and Inuit knowledge are integral in improving caribou research and our understanding of the socio-ecological impacts of climate change.

Title *Mobile Caribou Conservation Measures; an option to manage exploration-related disturbance to caribou*

Authors **Kim Poole,** Aurora Wildlife Research
Anne Gunn, Independent consultant

For land and wildlife managers, understanding the likelihood of caribou encountering and responding to industrial activities is necessary to effectively reduce sensory disturbance to caribou without unnecessarily limiting economic development. To create incentives for applying adaptive mitigation, we needed a framework that was appropriate at a local scale. In collaboration with the Kivalliq Inuit Association, we developed Mobile Caribou Conservation Measures (Mobile Measures) as a flexible tool to minimize and avoid effects on caribou when exposed to human disturbance wherever the caribou and in any season. Mobile Measure can be implemented in concert with Protected Areas, and are designed to address exploration activities covered under Land Use Permits, such as exploration or drill camps. Mobile Measures link monitoring with site-specific mitigation, and are based on thresholds (numbers and proximity of caribou to development coupled with seasonal sensitivity and movement rates) for enhanced monitoring and tiered mitigation. The monitoring component is flexible and can accommodate innovative technologies including drones or ground-based surveillance. The approach relies on monitoring of development site specific zones to give early warning to mitigation to avoid and minimize interaction between caribou and development. The mitigation is scaled to thresholds for caribou exposure. Mobile Measures offer considerable benefits to land users and land managers through their flexibility and through adding predictable rules for land use operations.

Title *The Influence of the Meadowbank Mine on Caribou Seasonal Habitat Use*

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The Meadowbank Mine was developed in 2007 and is connected to the community of Baker Lake, Nunavut by a 100 km all-weather access road (AWAR). Barren-ground caribou from the Lorillard and Wager Bay herds have seasonal ranges that overlap these two developments during spring, fall and winter. The herds are important to the culture and food security of Inuit in the region. In support of an assessment for a proposed expansion to the Mine, an independent study was completed to evaluate if caribou use and amount time spent in areas adjacent to the Mine and AWAR during pre- and post-development periods supported an avoidance (zone of influence) hypothesis. The study objectives and design integrated recommendations from the Government of Nunavut (GN) and Kivalliq Inuit Association (KIA), and collared caribou data collected by the GN. Linear regression analyses detected no avoidance of development by caribou during post-development in either spring or fall but showed avoidance during winter. However, the conclusions were constrained by the limited number of collared animals in the study area during the post-development winter period. Importantly, the

Mine and AWAR are located outside of core use areas for either herd so any reduction in the use of quality habitat may affect only a small proportion of each population. Currently, there is no empirical link between caribou avoidance of development and demography. Future collaboration is expected with the KIA and GN to increase confidence in assessment predictions, and provide feedback for the adaptive management and conservation of caribou.

Title *Habitat versus anthropogenic disturbance - relative influence on woodland caribou area use in the Boreal Shield of Saskatchewan*

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The 2012 Canadian Federal Recovery Strategy for woodland caribou states that habitat alteration has led to local population declines. The disturbance regimes in northern Saskatchewan differ substantially from those in other caribou ranges across the country, as they are characterized by high fire/low anthropogenic disturbance. We investigated the relative influence of anthropogenic disturbance and habitat types on woodland caribou in two areas (Key and Cree). In the Key area there are more sources of anthropogenic disturbance while in the Cree area there is a lesser amount of anthropogenic disturbance. We used three years of GPS data from 56 female woodland caribou (133 caribou years). We found negative effects assocaited with roads and an active mine/milling in the Key area and a settlement in Cree area during all seasons. We found either a minor effect or attraction/no effects for the minor linear infrastructures in both areas. Caribou generally avoided areas close to roads during all seasons, but when using these areas they selected for mature forests or bogs-fens, including post-fire residual patches. Resource extraction related access/development infrastructure had a greater negative influence on caribou area use than habitat differences. Within 10 km, the avoidance zone for each type of infrastructure varied depending on the habitat and season. Importantly, caribou did not completely avoid areas within 500 m of infrastructure, and in some instances, we found attraction effects. These findings may challenge the government's recovery plan as it relates to buffering of various types of anthropogenic disturbance types and habitat type importance.

Title *Effects of Habitat Alteration on Caribou Terrestrial Lichens in Central British Columbia*

Authors
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The recent mountain pine beetle (Dendroctonus ponderosae; MPB) epidemic and associated increased forest harvesting pressures on caribou (Rangifer tarandus) winter ranges in central British Columbia have led to concerns about habitat supply and caribou population dynamics. In this study, we assessed response of caribou terrestrial lichens in central British Columbia to nine forest harvesting treatments and one prescribed burn 8-14 years following treatment, and to MPB attack, using previously established permanently-marked plots. Information from this project will assist wildlife managers in assessing the effects of habitat alteration due to MPB, forest harvesting, and fire on habitat supply of caribou in central British Columbia. Permanently-marked plots were established from 2001 to 2009, prior to disturbance, and revisited 1-2 years following disturbance, and then again in 2016 or 2017. Data collected included stand structure, regeneration, coarse woody


Photo courtesy of Mark Bradley

debris, and abundance of terrestrial lichens and other competing vegetation. Response of caribou terrestrial lichens to forest harvesting treatments varied depending on ecological site characteristics. Terrestrial lichen abundance decreased following MPB attack and we found a significant negative relationship between level of MPB attack and relative change in total caribou terrestrial lichen abundance. Caribou terrestrial lichens had not yet started to re-colonize the prescribed burn eight years following treatment. This study was conducted with participation from Tsay Keh Dene Nation, Habitat Conservation Trust Foundation, Fish and Wildlife Compensation Project, and BC Ministry of Forests, Lands, Natural Resource Development and Rural Development.

Title ***Variation in consumption of caribou and moose by wolves evaluated against landscape disturbances: influence of linear features and forestry.***

Author **Christa Dubesky**, University of Calgary, Veterinary Medicine Graduate Studies, Ecosystem and Public Healh

Anthropogenic disturbance by means of linear features and forestry can be of detriment for some species and of benefit for others. With greater anthropogenic disturbance occurring in the boreal forest regions of Canada where endangered boreal caribou (Rangifer tarandus) inhabit; linear features (e.g., seismic lines, roads) are a mechanism by which more encounters and potential predation by wolves (Canis lupis) can occur causing numbers to decline. Wolves benefit by utilizing these features as an efficient means of traveling through a specific area, facilitating predation and searching efficiency. Within the boreal forest of Canada, forestry also disturbs habitat for caribou yet can be beneficial for moose (Alces alces). Linkage strength measures of distance between consumer to resource from the hair samples of 140 wolves, 300 caribou and 123 moose were taken from stable isotope analysis values. In West-Central Alberta and Northern Manitoba, samples were collected within 12 caribou ranges and were used a proxy for consumption. The distance from individual wolf to each caribou and wolf to moose in the range were calculated. These values indicating consumption were evaluated to the amount and/or type of linear feature and forestry disturbance in each range. Variations in the findings in linkage strength between individual implying higher consumption by wolves to the degree and type of disturbance are reported. Current mitigating strategies for low caribou numbers is reducing predator numbers; suggestion of alternate ways of working together with industry and government to prevent wolf predation through landscape disturbance remediation is discussed.

POSTER PRESENTATIONS

Measuring the Anthropogenic Footprint

Title *Planning wind farms in Norway - the wild reindeer aspect*

Authors **Frode Johansen,** Norwegian Water Resources and Energy Directorate
Jan Henning L'Abée-Lund, Norwegian Water Resources and Energy Directorate

The Norwegian Water Resources and Energy Directorate (NVE) is the licensing Authorsity for power plants and all high voltage electricity installations in Norway. In 2016, the Ministry of Petroleum and Energy instructed NVE to create a management tool called "National framework for wind power". The objective was to make sure that future wind farms are localized in suitable areas. The method was to create a knowledge base about effects of wind power plants on all topics, and based on this, making a map showing in which areas future wind power plants should be concentrated in Norway. As a part of the national framework, NVE ordered a report about wild reindeer from the Norwegian Environment agency summarizing conclusions from research on effects of wind power plants on wild reindeer. Since the southern part of Norway is the last area in Europe with wild reindeer, NVE decided to have a precautionary approach, and have suggested that the most important wild reindeer habitat including nearby boarder areas should not be included in the areas with possible concentrations of wind farms. Thus, these areas have now been removed from the map, and are no longer considered suitable for development of wind power plants. This project shows how different Authorsities can work together to make a management plan for wind power in wild reindeer habitat

Title *Mapping Forestry-Related Risk to Mountain Caribou in British Columbia*

Authors **Candace Batycki**, Yellowstone to Yukon Conservation Initiative
Gregory Kehm, Kehm Associates
Tim Burkhart, Yellowstone to Yukon
Gwen Bridge, Yellowstone to Yukon

Loss of forest habitat is the primary driver of mountain caribou decline. Historic forestry activities have converted mountain caribou range – mostly old-growth forest habitats -- into a mosaic of younger forests. This has led to increased proximity of elk, deer, moose to mountain caribou, and the concomitant proximity of the predators that follow these ungulates. Mountain caribou are now suffering unsustainable predation levels, and almost all herds are in decline.

Despite the loss of mature and old forests having created the current imbalance, the British Columbia (B.C.) government's current mountain caribou recovery program permits logging in mountain caribou critical habitat while recovery planning proceeds, a process that could take until 2020.

Yellowstone to Yukon wished to understand the extent of planned logging in mountain caribou habitat, in order to support discussions with First Nations, the B.C. and Canadian governments, scientists, community organizations, the timber industry, and other stakeholders. Since this information was not available from the BC government, we collected it directly from forest companies. This required working together with those companies, and with community organizations and consultants who had previously sourced this data.

We mapped logging plans within the critical habitat boundaries identified in Recovery Strategy for the Woodland Caribou, Southern Mountain population in Canada (Environment and Climate Change Canada, 2014). The first phase focused on the Central Group Herds in the Peace region; the second phase on the North Columbia region.

The resultant maps and information tables are informing discussions with community organizations, scientists, First Nations, Environment and Climate Change Canada, and B.C.

POSTER PRESENTATIONS

Title *Satellite observations for detection of dust from mining activity in a caribou habitat*

Author **H. Peter White,** Canada Centre for Remote Sensing, Natural Resources Canada

Diamond mining via open pit mining has been ongoing within the Tłı̨cho region of the Northwest Territories for several decades, which includes the habitat range of the Bathurst Caribou Herd. This has led to the importance of quantitative characterization of the Zone Of Influence (ZOI), where resource development activities may be influencing the natural behaviour of the caribou herd in the tundra environment. As part of better defining and understanding the ZOI in this region, an initiative to evaluate the potential of detecting and mapping mine waste rock dust in the surrounding environment is explored. This dust has been shown to coat foliage near roads, influencing the acidity levels of the surficial soil layer and impacting the foliage distribution. To this end, field spectrometry was acquired at various distances from road ways. Satellite imagery from the Proba-1 CHRIS hyperspectral sensor and the multi-spectral Sentinel-2a system were also acquired of the region. This presentation will present the initial spectral analysis pursued to evaluate the potential to remotely spectrally detect waste rock dust material used in road construction in the surrounding tundra vegetation.

Title *How far can barren ground caribou see mining operations in Canada's Arctic?*

Authors **Wenjun Chen**, Natural Resources Canada
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Jessica Hum, Department of Culture and Lands Protection, Tłı̨chǫ Government
Anne Gunn, CircumArctic Rangifer Monitoring and Assessment Network
John Boulanger, Integrated Ecological Research

The Zone of Influence (ZOI) refers to the distance at which caribou change their behaviour due to the influence of industrial developments. A better understanding of the mechanisms of the ZOI is needed for improving the environmental assessment and for effectively implementing mitigation plans. Observations by researchers and community members suggest there are several environmental changes caused by mining activities might disturb caribou's sensors and thus contribute to the ZOI. These sensors include the mining operations they can see, the noise from mining operations they can hear, the dust on forage near a haul road they can taste, and the high concentration of fine particulates in the air can they smell. As a part of the Northwest Territories Cumulative Impact Monitoring Program (NWT CIMP), we investigated these sensory disturbances around the Ekati Diamond Mine in the Bathurst caribou summer range, using field survey and satellite remote sensing during the summers of 2015, 2016, and 2017. In this presentation, we focus on the question related to visual disturbance. We used two independent methods for quantifying visual disturbance. The first method is physical determination using topography information, atmospheric visibility, and the threshold of the minimum size of an object at a distance eyes can see. The second method used visual observations recorded at various distances from a mining operation (e.g., a haul truck, a light truck, a dust plume, camp buildings, and waste rock piles). Results for specific locations as well as for a given average distance will be presented.

Photo courtesy of Mark Bradley

POSTER PRESENTATIONS

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