CARMA 8

Moving Forward: Knowledge to Action

CircumArctic Rangifer Monitoring and Assessment Network

December 4-6, 2012, Vancouver, BC, Canada

CARMA
CircumArctic Rangifer Monitoring & Assessment Network

CBMP

CAFF
Conservation of Arctic Flora and Fauna

IASC

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Some workshop presentations are available on the CARMA website

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CARMA 8 Summary – Don Russell

The CircumArctic Rangifer Monitoring and Assessment (CARMA) Network is an international, multidisciplinary group of individuals who are concerned about the health, in the face of global change, of the North's migratory tundra caribou and wild reindeer populations. Officially launched in 2004, CARMA has benefitted from funding through the International Polar Year in recent years. CARMA is a species network within the Circumpolar Biodiversity Monitoring Program (CBMP), the monitoring program of Arctic Council's Conservation of Flora and Fauna working group (CAFF). Annually the Network gathers around a theme that advances the capability of the Network to better monitor and assess the impacts of change on these *Rangifer* populations. With the end of IPY funding, CARMA has used the last year to take stock of its accomplishments and plan its future directions.

Since CARMA's inception, wild *Rangifer* herds across the circumpolar north have experienced overall declines, with some herds almost disappearing, others experiencing up to 80% declines and some, such as two herds on the Alaskan coastal plain, continuing to increase. The period, therefore, has been extremely challenging for co-management boards, management agencies, academic researchers attempting to account for the declines, and aboriginal leaders attempting to draw from past experiences to better understand what is happening.

CARMA 8 (meaning the 8th gathering of the Network since 2004) responded to the recommendations of its members to address four priorities: 1) managing and monitoring through abundance, 2) conservation of calving grounds, 3) cumulative impact assessment, and 4) development of a caribou health monitoring program. The format for the gathering was invited introductory talks on each of the priority issues followed by breakout groups that were assigned specific questions. Posters were

presented to the group and discussed at an evening session. The following provides a summary of the presentations and discussions on the four CARMA priorities.

Priority 1: Managing and monitoring through abundance

Introductory talks: Serge Couturier provided perspectives on how monitoring and management should change through the phases of a population cycle. Using a cycle "wheel" he provided data on the George River herd to illustrate changes in body condition, productivity and suggest changes in management as herds rise, peak and recover. Troy Hegel then offered an example using adult female survival of the power of sharing data to better understand how vital rates can change throughout the population cycle. His contention was that individually, using fate of collared cows, few jurisdictions have the sample size to understand how adult female survival shifts through the population cycle, particularly how we can predict when peaks and recovery should occur by monitoring survival rates. Greg Garner offered his experience in managing the recovery of the Forty Mile Caribou Herd in Alaska and Yukon. The Fort Mile herd is one of the few examples we have on how active management was responsible for the recovery of the herd from lows in the 1970s. This example can help other groups learn from Alaska and Yukon's experience.

Breakout groups addressed: a) how to set up a repository of lessons learned (follow-up on a recommendation from previous CARMA meetings); b) how priorities for management and monitoring should be adapted during phases of abundance; and c) how to resolve the practical issues around the recovery phase of abundance.

Priority 2: Conservation of calving grounds

Introductory talks: Anne Gunn outlined the state of knowledge of calving grounds of migratory tundra caribou. Benefitting from years of surveys, our knowledge of the stability of calving grounds is evolving. Some herds annually locate calving grounds in clusters responding to annual changes in environmental conditions. Some herds have shifted calving grounds directionally, responding to changes in population size. Some herds have shifted calving locations dramatically and thus exhibit cluster patterns in two locations. These patterns of change in calving grounds present a challenge to planners wishing to protect calving grounds. Monte Hummel provided an overview of the current status of calving ground conservation. He outlined an initiative by WWF. He proposed a matrix that includes the strongest protection for both habitat and caribou on the largest possible area, through to least protection for both habitat and caribou. He outlined the challenges of ensuring adequate protection.

Breakout groups addressed: a) monitoring and conserving calving grounds through the cycle of abundance; b) how "best practices" can reflect the diversity and state of information for calving ground conservation; and, c) how human activities can be compatible with conserving calving caribou and their habitat.

Priority 3: Cumulative impact assessment

Perspectives on current needs: Joe Tetlichi provided the perspective from a caribou co-management board. He discussed the need for and the steps taken to address the cumulative effects of development and climate change within the range of the Porcupine Caribou Herd in northern Yukon and northwest Alaska. The Porcupine Caribou Management Board faces potential development on the herd's calving ground as well as potential oil and gas activity on winter range in a region projected to have the most dramatic climate change this century. Boyan Tracz presented the agency perspective from a

collaborative program, the Cumulative Impact Monitoring Program (CIMP) that is responsible for facilitating governance and partnerships that would enhance the ability of government and co-management groups to manage cumulative effects on caribou herds in the Northwest Territories. He outlined accomplishments, current initiatives, data needs and challenges of the group. Mike Setterington outlined the needs and challenges of industry with respect to cumulative effects on caribou in the North. He outlined current projects across northern Canada where migratory tundra caribou were a significant component of the environmental impact assessment.

CARMA approaches: Don Russell provided an overview of cumulative effects with respect to caribou. He addressed a number of key questions: What are cumulative effects? How do cumulative effects assessments differ from other project effects? Why have assessments based on cumulative effects been a problem to implement? What are the elements of a cumulative effects assessment? How do we develop a CE mindset? Colin Daniel provided an overview of CARMA's tools for cumulative effects assessment. CARMA has been developing an energy-protein model that allows us to track the body condition of an individual caribou under natural environmental conditions and to track how changes in climate or impacts of human activity can alter fat and protein dynamics. CARMA is also in process of linking this individual-based model to a population-based model to allow CARMA to evaluate impacts at the population level.

Breakout groups addressed: a) best practices for monitoring cumulative effects; b) how we use thresholds and mitigation to manage cumulative effects; and, c) the obstacles, including governance, for implementing a practical approach to cumulative effects.

Priority 4: Development of a caribou health monitoring program

Introductory talks: Susan Kutz discussed long-term health monitoring as an essential component of a herd monitoring strategy and the adoption of a standardized approach (based on CARMA manuals) so we can learn from each other's monitoring results. Sylvia Checkly provided examples of successful health monitoring programs, particularly associated with the agricultural industry. She discussed lessons learned from these programs about what elements are required for a successful health monitoring program. Jacques Godfroid argued that jurisdictions should begin monitoring brucellosis globally. He highlighted the history of the disease and health issues. Christine Cuyler and Bob White used the experience in Greenland to illustrate how monitoring caribou health can link to vital rates and productivity of herds.

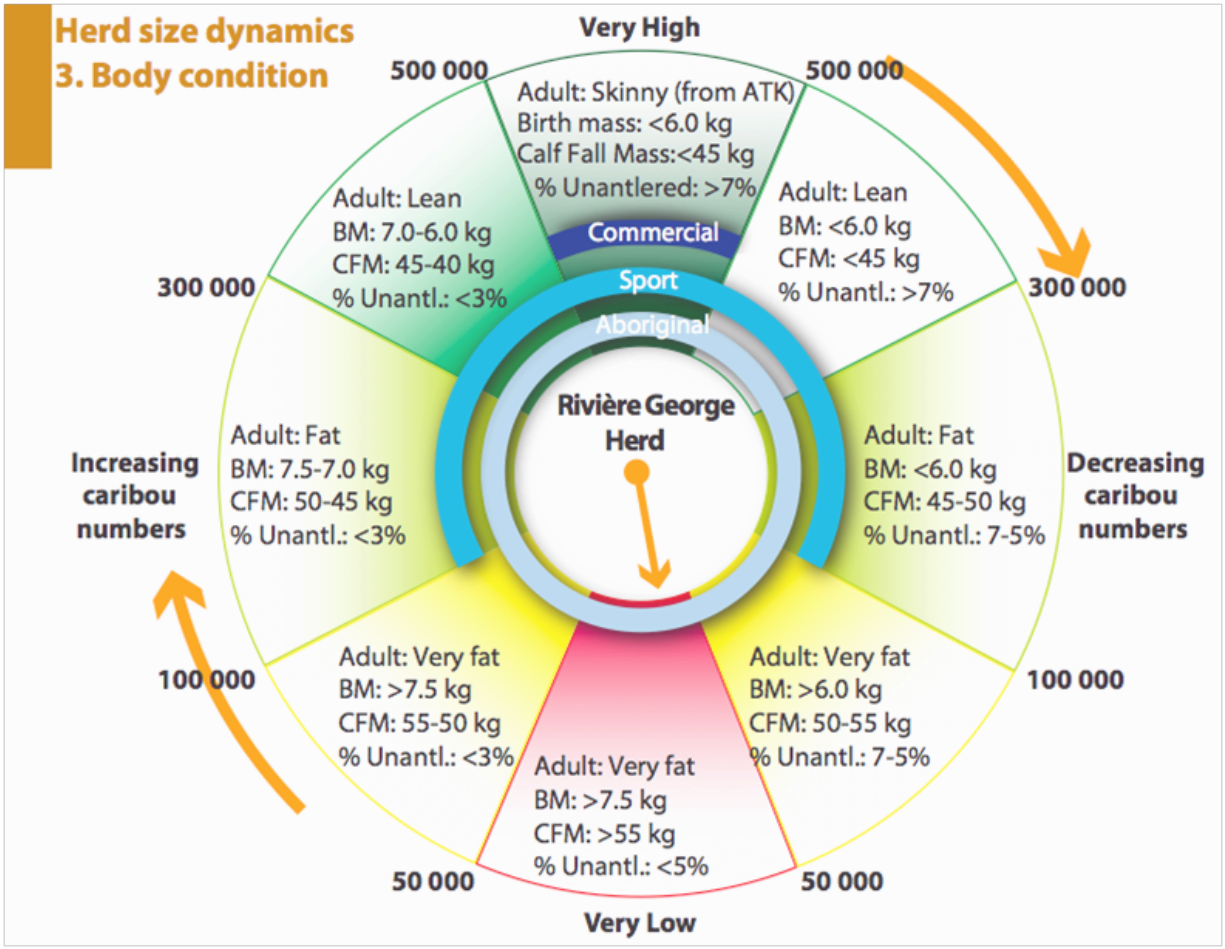
Breakout groups, instead of being randomly organized, this breakout group was organized by disciplines and answered the same question: *How do we integrate health into herd monitoring?*

Priority 1: Managing and monitoring through abundance

Introductory talks

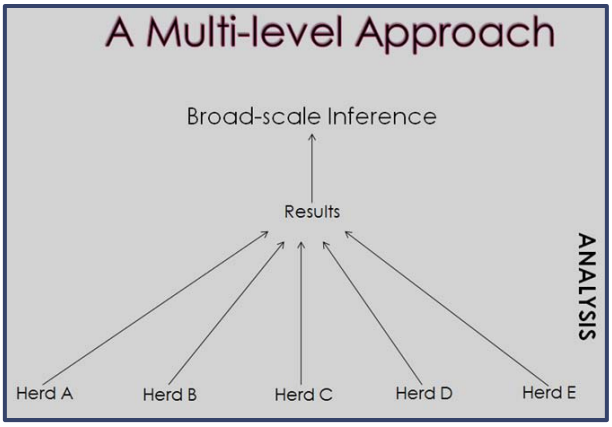
Phases of the cycle of abundance (how management and monitoring do and should change through abundance) – Serge Couturier

This presentation proposes a new multi-criteria management framework that could fit to abundance variations in caribou and reindeer. Although still a preliminary proposal, this framework can be adapted to different herds using herd specific biological data collected through scientific monitoring or Aboriginal Traditional Knowledge. A graphical model similar to a wheel (Fig. 1) has been developed to show how management actions or biological data vary during contrasting demographic conditions of the George River herd recorded over the last four decades.



An example of the multi-criteria management framework with the caribou wheel graphical model, showing how body condition indices vary according to differences in population size and trends as recorded since the 1970s in the Rivière-George Herd (George River Herd).

Monitoring: The power of sharing information – Troy Hegel

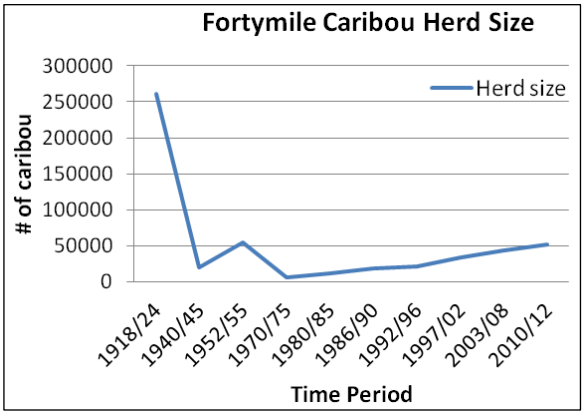


The sharing of information is important for the conservation and management of caribou. Sharing can take a number of forms. In this presentation I discuss an approach whereby data are shared and subsequently analyzed in one multi-level framework. Analyzing data in this manner may allow for greater inferences to be made regarding causal factors influencing important caribou vital rates such as adult female survival. Primary advantages from this approach are:

- Inference can be at a broad scale (e.g., species or sub-species) and at the individual herd level.
- Inferences are applicable beyond the herds used for the analysis.
- Information is "shared" across herds, while acknowledging that data from within a herd are more similar than other herds.
- Gain information from other herds' data (borrowing strength). Use information from all herds to draw inferences about an individual herd.
- Well suited for small samples sizes, sparse data, and unbalanced data (i.e., unequal data across herds).

History of Fortymile caribou management and research – Craig Gardner

Additional author: Rod Boertje



The Fortymile Herd is well known for its extreme decline in numbers and accompanying decline in range size. We identified the following three factors that contributed to the herd's decline: 1) reduced nutrition resulting from overabundance; 2) elevated wolf predation; and 3) excessive harvest. The Fortymile herd has experienced slow recovery in numbers and range use since 1973. Management programs enacted to encourage recovery included co-management teams to assist in development of management programs, including continuous conservative harvest (0.5%-2% annually) and various methods of wolf control. Still, wolf predation has remained the primary limiting factor during the herd's 39-year protracted recovery. The co-management team's initial vision of restoring the herd to its historic range was accepted by ideologically diverse groups across Alaska and continues to be the primary reason that Fortymile caribou management has broad public and political support despite intensive harvest and predator management decisions. We continue to monitor trends in herd size, range expansion, herd health, and nutritional status.

Breakout groups

1A. How to create a repository of lessons learned – methods, contributors, format, access, updates?

Leaders: Michael Svoboda & Jonathan Launspach

i. Lessons learned characteristics

Both synthesis and data should be considered.

Stories have lots of lessons learned. How do we capture these lessons learned that already exist in the form of stories, as well as future lessons learned? Potentially, this could be accomplished through a review of existing information – this is a large task. Another questions to consider is, how do we share knowledge from Traditional Knowledge of the past and make it relevant in the current context?

Some more thinking around defining and framing what constitutes a lesson learned is needed. The geographic relevance of lessons learned is an important dimension. What works in one place may not be applicable to another. However, sharing the story may still be beneficial.

An important point is that it is not just outcomes that are associated with projects, but that the project and outcomes are associated with people. Contributors should be reachable. It is important to have that human contact, face-to-face, or by phone. This makes a difference.

Full disclosure is important. Researchers often report project-relevant findings. They may consider also profiling results that others may find useful.

In terms of approach, consider include 'asking' not just telling. An example is the fast food chain McDonald's food question campaign. People asked questions and received expert responses via audio/ video and or text. Response was good. Consider a button/forum for questions on the CARMA website.

ii. Comprehensive repository

Create a searchable database that:

- looks at both knowledge and the sub-components of the lessons learned;
- focus on priorities for lessons learned (include: Traditional Knowledge, community engagement, ways to monitor abundance);
- captures lessons learned and makes them accessible;
- avoids a data dump that bogs down the ability to get the information one seeks;

The repository should remain part of CARMA's business. The principle of contributing to CARMA knowledge/lessons learned repository is "open access". The group identified a need to tweak the CARMA website to make it more user friendly. Keep it very simple and intuitive. The lessons learned 'category' should be flagged by the initial individuals and contributors, ideally using a template that links lessons to CARMA priorities/relevant categories (e.g. management relevance, abundance, communities etc.), aiming to minimize the burden to the CARMA core or to a third party and to increase success, comprehensiveness and accuracy.

iii. Audience

It is important to target key audiences for lessons learned/knowledge. Content and approach need to be appropriate for audience 'consumption'. Target audiences:

- Communities: current 'way' is for key individuals go to meetings and come back and report (which can be a challenge). Opportunities for using new technology (e.g. social media/ Facebook). This may provide new communication paths.
- Management Boards
- Governments

Consider increasing the range of communication tools used (for example, as used in Voices of the Caribou project). Podcasts, audio/video. This better serves some audiences.

iv. CARMA's role

- Profiling key contacts/contributors is an important service for CARMA to offer.
- Metadata repository – agreed that this is a correct role
    - Interoperability with other systems is important (want to avoid duplication – one place shared for all to use)
- Data – this remained a question
- Website /conduit
- Repository

1B. How should management and monitoring priorities change during phases of abundance and what are the practical problems in implementing those practices?

Leaders: Vincent Brodeur & Julien Mainguy

First, there is a need to implement baseline monitoring and management practices, regardless of the population status and trend, to allow demographic modelling in the long term.

i. Management

A co-management team should be composed of the users of the resource, managers and scientists, with the possibility for each party to give their opinion/input on all aspects of herd management. Communication is crucial for the integration of both local and scientific knowledge to increase the likelihood of success of a co-management plan. Co-management should be established with the primary objective of achieving "buy in" by all stakeholders.

Monitoring the harvest is of importance for management purposes. Harvest monitoring can also be used to further study body condition, health and range use. Managers should take into account the selective pressure of hunters, i.e. the preference for healthy individuals. Thus, harvesting can often be considered as an additive source of mortality.

ii. Monitoring

A strategic sampling plan should be implemented according to local and regional realities to better assess the demographic status of a given herd.

Relying only on census data may slow down the decision process for the management of a herd because of the long interval between surveys. This is problematic, especially when a herd is declining (e.g., the George River herd). Since certainty is difficult to achieve, a multi-criteria approach using several

biological indicators is desirable to obtain the best possible picture of the status of a herd (stable, increasing, or declining).

Modelling the population trend based on a few reliable indicators provides relevant input in the management of a herd. Consistency in the monitoring effort through time allows improving the predictive capacity and accuracy of population models.

Main biological indicators of interest for the monitoring of herd status and trend are:

- survival (adult, calf)
- recruitment
- body condition/health

Assessment of range quality, especially summer range is also of importance.

Satellite telemetry (collars) is a valuable monitoring tool to obtain information about both survival and range use, and thus provide biological input in the modelling.

iii. Practical problems

The budget available may restrict both the monitoring and management of the herd, as collecting biological data and forming committees are generally expensive.

Ethical problems may be raised when the population reaches low levels as the capture and study of caribou/reindeer can create additional (detrimental) impacts on the herd, thus limiting our ability to monitor some aspect of the herd when it faces difficult times.

Occasionally conflicting views/comprehension of the status/trend of a given herd arise according to the local knowledge vs. scientific knowledge when communication is lacking or incomplete.

iv. Conclusions, the role of CARMA

The CARMA Network should provide, as a platform, input on modelling strategies, methods and clear definitions of the parameters of interest. CARMA should also act as a network for data sharing among herds and provide guidelines for community-based monitoring.

1C. Practical problems of recovery and how to resolve them?

Leaders: Jodi Snortland & Archana Bali

i. Responding to recovery

Two-fold process:

1. Improve ability to assert CAUSES of DECLINE [We need a good handle on the causes of decline. Or do we? Since causes of decline and recovery may not be necessarily symmetrical]
2. Improve ability to DETECT RECOVERY

Solutions:

1. Improve monitoring in Decline and Recovery phases for asserting causes of decline and onset of recovery – Need for creative ways and innovative measures. [However, note that the drivers of decline and indicators of recovery need not be the same and/or correlated]
    a. Identify KEY INDICATORS for each phase.

   b. Population monitoring is as important as habitat monitoring – to keep model results and reality in check with each other.
   c. Effective harvest monitoring.
   d. Use forecast models creatively to predict decline and recovery via environmental and habitat changes [e.g. CARMA MERRA dataset, Vladimir's models etc.]
2. Improve ability to obtain and disseminate the information in a timely manner to appropriate agencies, stake-holders, co-management groups [mainly the harvesters]

ii. Maintaining habitat availability proactively

Incorporate in land-use planning the need for keeping the ranges available for future use for recovering herds.

iii. Managing people's EXPECTATIONS

Very crucial practical problem!

1. Challenge of STOCHASTICITY – how to manage people's expectations in case of declines caused by factors outside of management considerations and planning [e.g. Mount Pinatubo eruption, climatic events] → To some extent, we can make use of forecast models, existing knowledge of habitat and herd status to prepare for uncertainty. Therefore create and expand information baselines.
2. Use KEY INDICATORS to "proactively" manage habitat/ harvest/ predators.
3. Harvest monitoring is very important in pre-decline and post-recovery phases.
4. Need to keep stakeholders informed of conditions, even in case of uncertainty → so that there are no shocking surprises leading to crises.
5. Learning from other's experiences and sharing of knowledge is vital → Create a common, shared knowledge pool, through workshops, websites.
6. Political engagement → for taking knowledge to action. Top-Down vs. Bottom-Up political interventions: In case of Canadian experience – bottom-up approach more powerful in getting political attention (co-management); in Russian experience – in dire straits, top-down enforcement is easier to achieve desired outcomes for managing harvesters' expectations.

iv. Managing during recovery (and decline phase) for herds across borders

(e.g. Porcupine Caribou Herd case) – jurisdictional differences across States and First Nations, multiple levels of decision-making and enforcement make it complex.

Solution: Need to harmonize management process and agreements across jurisdictions [international borders, provincial governments, First Nations] → Co-management!!

v. Co-Management → Is as much of a problem as a solution.

Why does co-management not work always?

Issues

1. Issues of trust-building. Complex and long processes of consultation within co-management slows down the action-taking.
2. Government regulations can act as impediments for agencies to respond effectively to co-management needs OR creative solutions that might emerge through co-management processes.

Solutions

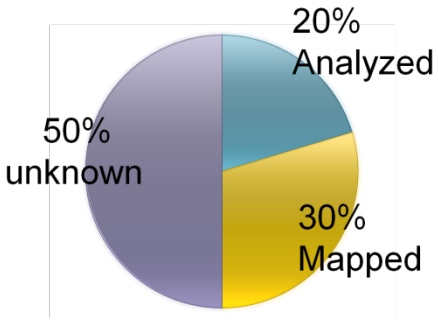
1. Bring RIGHT stakeholders, ALL potential stakeholders on board,
2. Facilitate co-management process very effectively (e.g. the Fortymile herd case) and create a shared VISION for different stakeholders to work together.
3. Encourage local involvement, include TEK,
4. Identify and empower local leadership
5. Issues of trust-building can be addressed through improving communication – delivery of correct and relevant information in the right format to all parties at all times. Also inform about 'lack of information' if applicable. QUALITY CONTROL of information.

Priority 2: Conservation of calving grounds

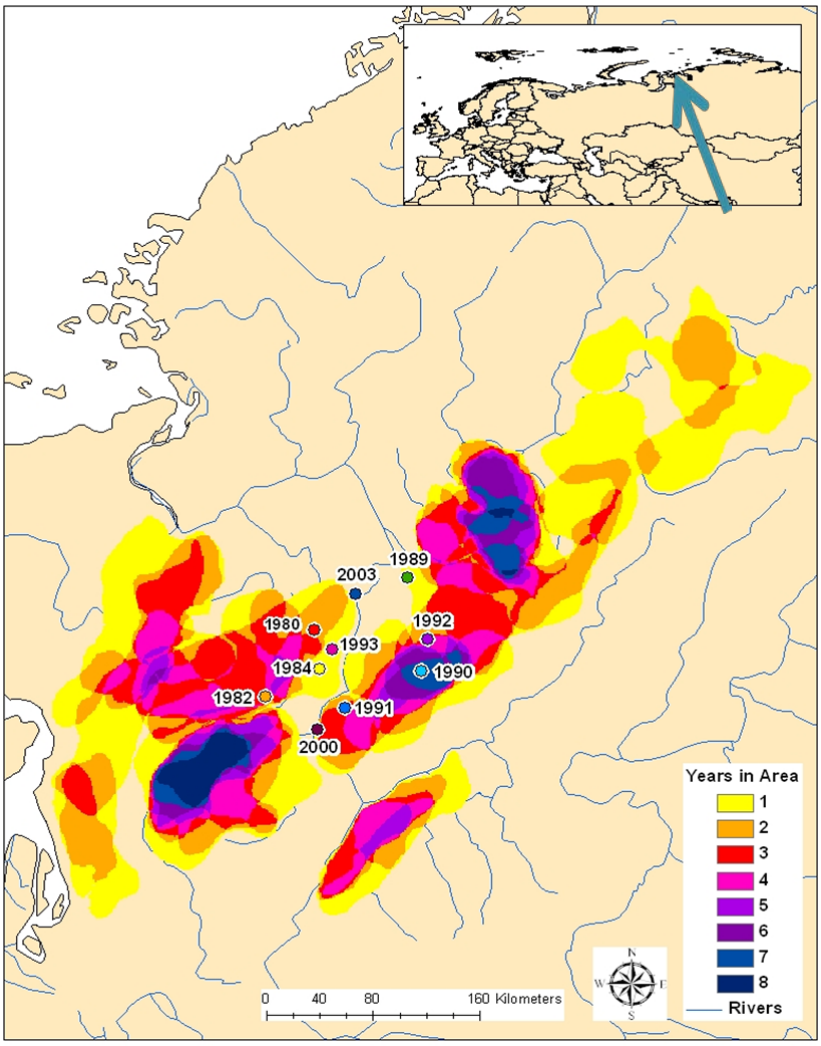
Introductory talks

Current state of knowledge of calving grounds and migratory tundra caribou – Anne Gunn

We summarize the present state of knowledge of calving grounds. Provisionally, we have identified four calving grounds in Alaska; 12 to 20 in Canada; 10 in Greenland; 2 in Iceland and 17 calving grounds in Russia. For almost half the calving grounds, there is little information beyond a name and a location. So far most information is for relatively few herds, which tend to be the larger herds. For some herds the annual overlap of calving grounds is non-directional and the calving grounds do not appear to shift over decades. For a lower proportion of herds, there are periods when annual calving grounds are clustered, interspersed with years when the overlap is directional and the calving ground shifts. For the Bathurst, George River and Leaf herds, this pattern appears to be related to changes in abundance – shifts occur during peaks and declines. For the Porcupine herd, the annual shifts are both clustered and directional and appear to coincide with snow melt and plant green up. In relation to conservation, measures will have to be adaptable and variable to accommodate the calving strategies of different herds at different times in their abundance cycles.



Information on calving grounds

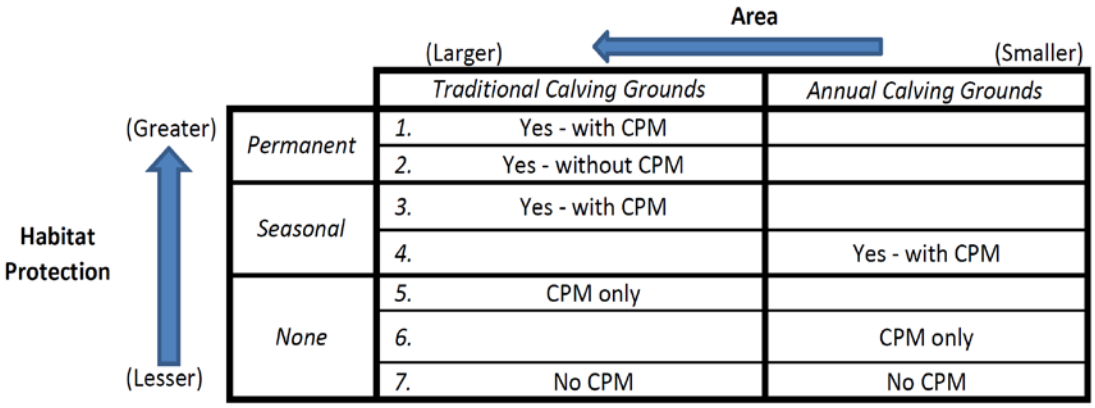


Taimyr herd: map shows eight years of overlapping with the centroids, suggesting non-directional shifts, at least between 1982 and 2003. Meerdink, S. and Petrov, A. 2012. Taimyr wild reindeer spatial fidelity and calving grounds dynamics in a changing climate. ARCSES working paper 001-2012. University of Northern Iowa, IA

Current status of calving ground conservation – Monte Hummel

This presentation explores the options for protecting caribou traditional calving grounds and/or annual calving areas and caribou when they are in either. It proposes a matrix that includes the strongest protection for both habitat and caribou on the largest possible area, through to least protection for both habitat and caribou. Both seasonal and permanent protections are considered. The matrix also factors in the use of Caribou Protection Measures. It is argued that our choices on the matrix are largely driven by the economic value jurisdictions place on caribou, especially in relation to the value placed on industrial resource development such as mining, road building, and oil and gas. High valuing of caribou

results in maximum protection of calving areas. Low valuing results in little or no protection. There are a range of unproven options in the middle that reflect an attempt to "balance" the two. Although the issue can be complex, it is difficult to understand how we will conserve caribou for the long term if these critical habitats, and caribou when they are in them, are not adequately protected.



		Traditional Calving Grounds	Annual Calving Grounds
Permanent	1.	Yes - with CPM	
	2.	Yes - without CPM	
Seasonal	3.	Yes - with CPM	
	4.		Yes - with CPM
None	5.	CPM only	
	6.		CPM only
	7.	No CPM	No CPM

Caribou calving area management options. (CPM=Caribou Protection Measures)

Breakout groups

2A. How should calving grounds be monitored and conserved through the cycle of abundance?

Leaders: John Nishi & Jillian Steele

i. Objectives of monitoring calving grounds

- to conserve them
- to ensure successful calving for now and the future
- produce a predictive model or framework
- estimating abundance
- protection for development / disturbance

ii. Benefit of an adaptable definition of calving ground

(e.g. if the annual ground is outside of the tradition, when does it become part of the traditional area)

- Protection of indicators of caribou ***calving success*** versus calving ground
  - What do the caribou need? This will tell us how we need to structure our monitoring
- Need to fill in gaps in the data regarding use of the regions. What makes animals move and where we are in the cycle of abundance?
- Having mobile protection measures ensures that you don't focus on the environment, which could be very different from what caribou need for success.

iii. Hierarchies of strategies

- A strategic/adaptive approach lets us focus on preserving structures that caribou require
- Maintenance > reproduction > disturbance/predation

But, animal movements throughout the year may mean that monitoring of calving only might limit our understanding of the actual impacts/pressures on herds

iv. Realities of the situation

Get with the political realities that we can't protect the whole range. Is it defensible to protect the traditional range, to predict the future range? If we don't do the monitoring then we can't do the conservation.

v. Outcomes

Outcomes should be focused on current calving grounds and indicators of success of calving. Monitoring needs to be realistic. Need to keep in mind what resources we have to monitor and to manage human resources.

2B. How should "best practices" reflect the diversity and state of information for calving ground conservation?

Leaders: Andrey Petrov & Lori White

The key to applying best practices is a full understanding the habitat and the impacts of development on habitat. If we don't know much about the calving ground then we need to err on the side of caution. However the group stressed that there are no best practices in the absence of knowledge.

Part of that understanding is a better grasp of how caribou are using their calving grounds – i.e. the relative trade-off between predator avoidance and gaining optimal nutrition. This may be different for each herd. For example, the Bathurst Herd may use their calving ground to avoid predators, whereas the Porcupine Herd may rely on forage and predator avoidance may be secondary.

Another aspect of monitoring calving grounds is to understand changes that have occurred compared to baseline conditions. For example, the Taimyr herd calving is very late because the amount of growing degree days on the calving grounds is very low until late June. However, on the Taimyr range the climate has been warming in June, leading to questions about the impact on calving time and health of the calves.

Another consideration is: if protection is an option, how do you map the calving ground to protect, and what if the calving grounds shift as animals move? Also, protection may only cover the period that caribou occupy the site (May to end of June, or example, for the Qamanirjuaq herd). Habitat is not necessarily protected in other seasons. Also as a herd expands its calving grounds also expand and there may be a directional shift. For example, the calving grounds of the Leaf River herd were protected early on, then the herd expanded, the calving ground expanded and shifted. Now only a small part of the calving ground is protected. There seems to be an association between calving grounds and mineralization, thus lots of conflicts with potential mines.

There needs to be a better process to define the use of calving grounds and to accommodate potential shifts in use, as well as a more streamlined process to make, implement and monitor protection measures. For example are calving grounds defined by the nutrition of the calf (i.e. where the cows and calves are from birth to when the calf is able to forage on its own, about 3 weeks after birth)? How many years of overlapping calving grounds should we use to represent calving grounds for protection purposes (i.e. differentiate annual from total calving grounds)? Also need to consider the historic pattern: whether it is a cluster, directional shift, or linear shift.

We need to develop a better conceptual model for how different herds use their calving grounds. For example, for predator avoidance, nutrition, and avoiding parasites. The conceptual model should help us dictate what monitoring needs to be done, how to assess the relative importance of these factors, and how to design protection measures that reflect these strategies.

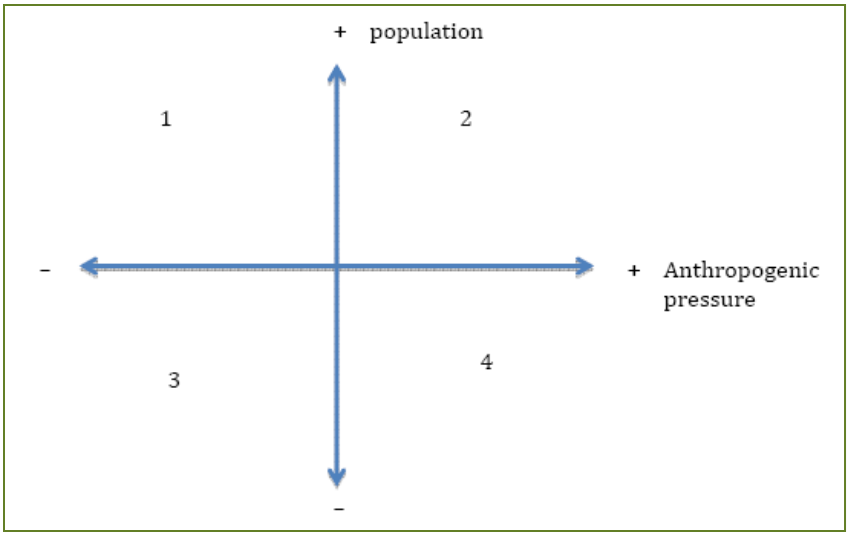
Best practices in management

The emphasis for management actions should be flexibility (always be ready to intervene), so that actions reflect the condition of the females and the annual location of the calving grounds. Therefore permanent protection measures, if not in the most appropriate place, will not work. Thus there needs to be an active satellite collaring program to monitor caribou approaching the calving grounds. Also need to incorporate local knowledge in decisions.

There is a need to cooperate and learn from others' experiences. Need a mechanism to share information, especially on how to interact with industry. We need strategies for population highs and population lows. Also need to understand how different activity and infrastructure affect calving caribou and, in the absence of information, err on the side of caution.

Monitoring	Nutrition quantity & quality	Predator avoidance	Climate	Stability	Pathogen avoidance	Impacts
Management 1						
Management 2						
Management 3						
Management 4						
Conservation 1						
Conservation 2						
Conservation 3						
Conservation 4						

Calving ground "best practices" matrix. Because all calving grounds are not created equal, the matrix represents a conceptual model of what management (1,2,3,4) and conservation actions (1,2,34) would be appropriate for calving grounds with a mix of 1) relative importance of use of calving grounds (predator avoidance, etc), 2) climate change trends, 3) relative "stability", and 4) development pressures etc).



The group viewed calving ground strategy as a 2-dimensional state between caribou population highs and lows and high and low development pressures. The best strategy is to implement development protection measures when the population is high and pressure is low – most can be achieved.

2C. How can human activities be compatible with conserving calving caribou and their calving ground habitat?

Leaders: Justina Ray & Shannon Stoytn

i. Is human activity compatible with conserving calving caribou and their calving ground habitat?

Human activity can have different levels of impact. Impact can range from little to greater impact (e.g. x-country skiing vs. heavy industry). Heavy industry would have the greatest impact and would be of greatest concern to calving grounds (e.g. all-season roads, mines, permanent structures and pipelines). From this point on our discussion focused on industrial development on calving grounds.

Level of risk

Risks to caribou persistence can vary depending on where and when development occurs (e.g. calving ground high risk, and winter range low risk). Risk is thought to be too high and with too much uncertainty for development in calving grounds. Society decides on the level of risk. The precautionary approach should be followed when there is uncertainty.

Role of science

Need evidence to defend protection. In many decision-making processes, the burden of proof falls on science to demonstrate harm, rather than on proponents to demonstrate there will be no harm. Biologists need to be objective and to base advice and decisions on best available information (caution against advocating a position with no or little evidence to back it.) Traditional Ecological Knowledge can be useful, especially when the science is not sufficient.

Evidence of impact of industrial activity on calving grounds

It is difficult to prove, based on currently available information, how much industrial activity can take place on calving grounds without adverse impact to the caribou herd. There is no scientific proof that industrial activity of any kind on calving area will negatively affect caribou. A large amount of data are required to establish proof. One case study (Central Arctic herd) is commonly held up as example of development proceeding in calving areas without impact because the population has been growing, not declining: but there are nuances to this conclusion.

What do we measure to determine impact (at the population level or individual level)? Development mimics changing to sub-optimal calving grounds (e.g. poorer female nutrition, increased predation, lower survival). Options to move calving grounds need to be available in case this becomes necessary. Clearly, shifting of calving areas happens even under natural conditions. There are some examples of longitudinal studies (Porcupine, Central Arctic herd, Pen Islands) that could be used to come up with "lessons learned".

Pressure to develop

In many cases there is pressure to find ways to have both caribou and industrial development in calving grounds, especially if large areas are identified as calving grounds. We need bottom-line statements if development is truly not compatible in calving habitat.

ii. How can human activity be compatible with conserving calving caribou and their calving ground habitat?

Protection of calving grounds

Flexibility may be required to account for large-scale and directional shifts in calving areas and different time frames (e.g. annual, five-year or additional calving areas). Protection of calving grounds may be difficult to implement and enforce. Different zones of protection are suggested. Permanent protection is valued in consultations with First Nations in the North (e.g. sacred areas). Long-term protection is required for calving areas due to the large, long-term population cycles of caribou.

Mitigation of development on calving grounds

There is concern about the approach of mitigation – it can open doors for more development (be seen as a "slippery slope"). One example of mitigation provided was crossings constructed in Russia that allowed successful movement to calving grounds across a pipeline, although this mitigation didn't continue into the subsequent developments.

Indicators can be used to track the impact of changing calving grounds. Can use these indicators as proxies for impact of industrial development. Early calf survival, nutrition and body condition are important indicators.

An important consideration is the degree of resilience of caribou to development. Some aspects to consider:

- Predictability of the activity can influence the degree of impact from development.
- Availability of alternate calving areas for caribou to move to if current calving area is disturbed may increase resilience (e.g. Central Arctic herd).
- Lack of barriers to caribou movement (e.g. pipeline crossings) enhances resilience.
- Effects of development may be different depending on the phase the herd is in (e.g. growing or declining).

Sharing knowledge and mitigation options is important. We need to clarify what knowledge is available from science and TEK that can be applied to mitigation options. Another aspect is learning about the abilities of industry to mitigate or alter their activities. Need more sharing and communication of information.

Priority 3: Cumulative impact assessment

Introductory talks: current needs

Co-management groups – Joe Tetlichi

This presentation discussed the needs and the steps taken to address cumulative effects of development and climate change within the range of the Porcupine Caribou Herd in northern Yukon and northwest Alaska. From the perspective of a co-management board (the Porcupine Caribou Management Board), better understanding of the combined impacts of the Dempster Highway, seismic lines on the Eagle Plains, potential oil development on the herd's calving grounds, and changing climate will help the board provide informed recommendations in order to conserve this international herd.

Agencies – Boyan Tracz

The Cumulative Impact Monitoring Program (CIMP) began in 1999 to address the fact that the monitoring of cumulative impacts is a constitutional obligation contained in the Sahtu, Gwich'in and Tlicho comprehensive land claim agreement and a statutory requirement of Part 6 of the Mackenzie Valley Resource Management Act. CIMP's vision is "to watch and understand the land and to use it respectfully forever". In fulfilling its mandate, CIMP:

- Facilitates governance and partnerships
- Facilitates the collection, analysis and synthesis of information
- Develops and maintains an information management system
- Reports and communicates

Industry – Mike Setterington

This presentation highlighted the experience, perspectives and challenges of addressing cumulative effects from an industry viewpoint. A number of industrial projects where caribou were a major concern from an impact assessment standpoint were highlighted.

Challenges facing the environmental assessment of industrial projects:

- How to quantify cumulative effects
- Incorporating climate change interactions

- Decision-making under uncertainty
- Regulators' capacity and experience
- Incomplete land-use planning
- Information gaps and regulators' conservative inclination

Project	Location	Caribou Issue
Mary River Iron Mine	Baffin Island, eastern Nunavut	North Baffin: Low in 70 year cycle; railway effects on movement
Kiggavik Uranium Mine	Baker Lake, central Nunavut	Multiple herds: New road access through summer habitat, increased harvest pressure
Izok Corridor Zinc Mine	Western mainland Nunavut	Bathurst: Road at edge of traditional calving ground Dolphin Union: Road in winter range
Casino Copper/Zinc	Central Yukon	Klaza caribou: road access through winter range
Various Oil and Gas and Mining	NE British Columbia	Multiple herds: core winter ranges

Examples: Industrial projects and caribou

Introductory talks: CARMA approaches

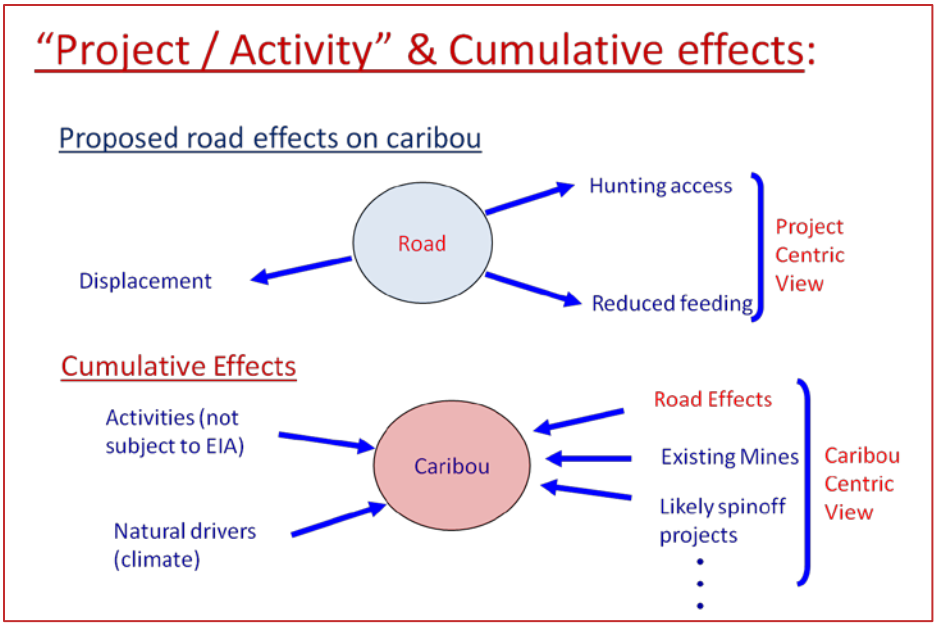
Cumulative effects on migratory tundra caribou: towards a CE mindset – Don Russell

Additional authors: Anne Gunn and Lorne Greig

This presentation addressed five key questions and points:

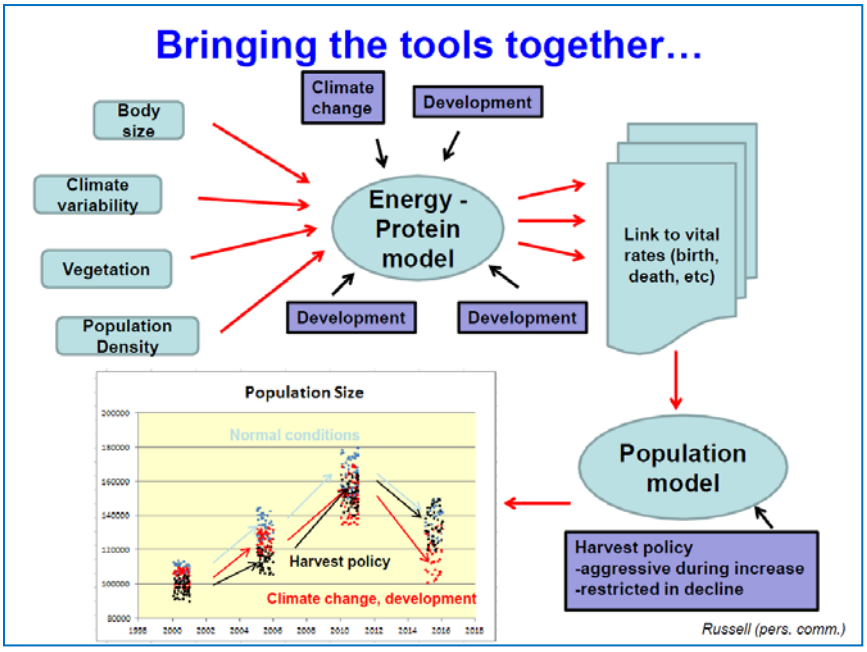
1. What are cumulative effects?
2. How do CE assessments differ from other (project) effects?
3. Why have assessments based on CE been a problem to implement?
4. Elements of a CE assessment
5. Developing a CE Mindset

Actions to develop a CE Mindset: (1) bring environmental data together; (2) use data to better understand caribou; (3) identify stressors and types of impacts; (4) assess impacts; (5) manage human activity and caribou to mitigate impacts; (6) monitor management actions and mitigation and adjust; (7) all CE stakeholders cooperate in actions #1-6.



CARMA tools for cumulative effects: current state, limitations and future availability – Colin Daniel

This presentation provided the rationale for using models as tools to assess cumulative impacts of development and climate change on caribou. There is a need to not only assess, through field surveys, direct impacts on individual activity, movement and diet, but then to use the tools to quantify impacts on body condition, vital rates, and, ultimately, population productivity.



Breakout groups

3A. What are the best practices for monitoring cumulative effects?

Leaders: Christina Semeniuk & Leonardo Frid

i. Objectives of cumulative effects (CE) monitoring

- Understand all variables to reduce stressors on herd.
- Manage for sustainability within a management framework with already well-defined goals and objectives

ii. Best practices

Begin with a conceptual diagram that delineates the interactions and synergies. The focus is on the sustainability of valued ecosystem components (VEC), not on the project. Start with a cumulative effects assessment (CEA) and work towards an environmental impact assessment (EIA).

- Core hypotheses
- Key VECs
- Key stressors

Define the spatial/temporal scope. Defining a study area is challenging. There are challenges, for example, with the COSEWIC "designation unit" definition (considering subpopulations/management units). Temporal scope: past, present and future. Past dynamics are important. Develop hypotheses of future impacts to have more directed monitoring focus, and to reduce uncertainties.

Best practices need to consider natural disturbances (fire, insect harassment). Legal definitions of cumulative effects tend to focus only on anthropogenic disturbances.

Consider incorporating thresholds as part of the CE monitoring output. Tiered thresholds suggested (green, yellow, red). "Buyer Beware".

Some points to consider:

- Management is for sustainability of VEC's in the context of land-use planning.
- Each component of the CE Model (body condition, spatial distribution, population) is actually a monitoring component.
- Monitoring is not the mitigation. It can inform mitigation strategies.
- Define what you can control – which are actionable stressors?

Poor practice issues:

- Company goes it alone without communicating with anyone. Process should be open and collaborative.
- "Cumulative effects" is often the last chapter in the EIA and often only a few pages long – receiving minimal treatment.
- When looking at natural drivers of variability, the baseline is often narrow, based on limited data. The concept of a range of natural variability is often not considered in EIA. It becomes difficult to "pin" a statistical effect with shifting baselines.
- No post-project monitoring. There is no regulatory framework for this.

iii. Deliverables of CE, within a properly defined management framework:

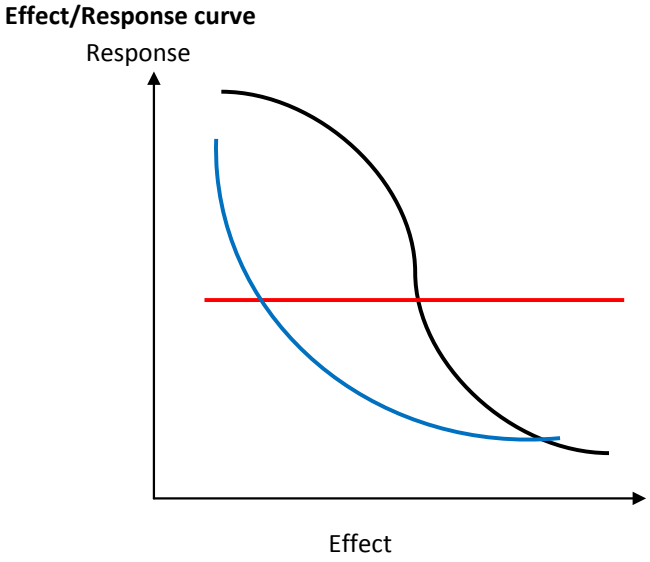
- Monitoring for activities
- Accuracy of predictions
- Success of mitigations

3.B. How do we use thresholds and mitigation to manage cumulative effects?

Leaders: Chris Johnson & Katrine Raundrup

i. Definition of threshold (which includes biological and social thresholds): Point of change after which there are (positive or negative) effects on the herd/population. Examples of effects: habitat loss; harvesting resulting in animal loss; health (body condition, number and types of pathogens, pregnancy rates/breeding pauses.)

- Consider the response as a probability of some change.
- Some consider thresholds as similar to zones of influence.



ii. Questions and points around certainty

- Are there precise break-points?
- Can thresholds fluctuate?
- Thresholds are complex - use land-use scenarios to qualitatively compare effects
- Need to know the response function to be certain about outcome
- Need to know mechanistic relationships between effect and response
- If uncertain, consider the threshold as a range, not a point (a "confidence interval")
- Consider the costs of adjusting thresholds down or up

iii. Applying the threshold concept

- A key question is the applicability among herds. Do thresholds generalize or are they specific to each herd?
- Given the uncertainty, use thresholds as part of an adaptive management experiment.
- Consider socio-ecological thresholds, for example, based on meeting needs: "there are enough caribou"

iv. Concluding thoughts

- Thresholds are a necessity
- Don't consider them as truth
- Accept uncertainty
- What are the alternatives if we do not have thresholds?

3.C. What are the obstacles, including governance, for implementing a practical approach to cumulative effects?

Leaders: Joan Eamer & Christine Cuyler

i. Obstacles related to governance

It is difficult to assess cumulative effects on a regional basis in a multi-jurisdictional setting when approaches and legal requirements do not mesh (for example, across the NWT and Nunavut). The solution is to work towards regional (or population-based) assessments that are not dependent on the jurisdictions. Talking is not enough, though, where the rules are different – still need to address working across the region under the same set of rules for an effective assessment.

Governance structures are often the problem. The example of the Fortymile Herd was discussed. Industry was brought to the table and the participants showed that a collaborative approach works. This is, however, fundamentally at odds with how government often works, which tends to be through linear hierarchies of power. Thus one can end up with people sitting at the 'table' but unable (not empowered) to make the final decisions. The top-down approach doesn't provide the framework that works.

Potential solutions:

- Strengthen the co-management teams so that they can act as a body to implement the necessary changes independent of government;
- Ensure that people at the table have decision-making authority. The group agreed, from their experiences in various Canadian jurisdictions, that it is not like this now – often people are acting as representatives for various parties at the table, but can make no decisions.

Another obstacle is that legislation is shaped to solve specific problems, but then things becomes entrenched and this does not permit proactive management.

Impact assessments usually come late in the process, after the development has been given the 'go-ahead'. Impact assessments are also often disregarded, for example, in land-use planning. This leads to loss of options.

The group discussed putting the focus on the regional level and setting guides and limits. For example, a herd-based management body could set a limit on the number of active mines in the range of a herd.

As the discussion to this point had been mainly about Canadian governance issues, the group turned to lessons about governance-related obstacles to addressing cumulative effects based on other countries' experiences.

Russia – Many levels of governance, including associations of indigenous peoples; lack of involvement at the local and regional level in decision-making means that cumulative effects approaches cannot be taken.

In the Taimyr, decision-making could be improved with an association of local communities with a mandate to make decisions for reindeer resources in Tamiyr within the federal framework. This is a theoretical concept and hopefully next this association of communities could be adopted and implemented. At the moment, managers do not know how many reindeer are taken by each community. Dealers buy the reindeer hunted by the communities. An association of communities could control the harvest and sale. This is a co-management solution. There are also options to cooperate with the mining industry who provide local funding.

Russia Chukchi region – the reindeer are regulated by federal legislation. Regional legislation is being developed but co-management is not being considered. The communities are not economically viable; the indigenous residents receive no benefits from resource extraction and do not have a direct voice in decision-making. Local knowledge can contribute: for example, it is important to make use of local knowledge to understand how wild reindeer affect domestic reindeer.

Alaska – One problem (as in other regions) is that when looking into the future it is difficult or impossible to forecast what to predict. The development strategies are not open with information and it is difficult to know anything until it is a done deal, making it hard to be proactive. Another issue is considering where the burden of proof falls. For marine projects, where marine indigenous user groups have had a strong voice, they have been successful in shifting the balance of proof from the users to the project proponents.

Greenland – does not have jurisdictional problems. Also, there has been no industrial development. This will change.

Moving from project-by-project to a more proactive, regional CE assessment approach:

An adversarial situation arises when a single project assessment is being conducted at the same time as a regional assessment. Potential solutions:

- Have provisions for land use. Involve industry at an earlier level and not just regarding their own project.
- Do something to avoid the adversarial approach and develop a collaborative approach instead. Governance generally encourages or imposes adversarial rules and procedures (seem inflexible) that make the whole situation difficult to move forward within.

ii. Obstacles related to insufficient tools or resources for cumulative effects assessment (and CARMA's role)

- The difficult transition of taking data to knowledge, teasing out what that data means. Making applications from the data one has.

- Having the right kind and right amount of data to make logical inferences. A lot of data was missing 20 years ago and still is missing. To help address this, CARMA could put a 'knowledge gaps' folder on the website so that up-and-coming graduate students might get interested and begin working on these issues.
- Need to have vegetation experts involved in CARMA. Need vegetation/range data that are linked to herd productivity.
- To focus on a **caribou centric perspective** (e.g., to prevent road use or land use at times caribou cows need protection), need information on small impacts, e.g. behavioural reactions of caribou to the various impacts and how to minimize those effects.
- Data on the actual developments are piecemeal. At the moment efforts to deal with problems are piecemeal.
- People need to know that 'they' can 'do it'. CARMA doesn't need to put together the data. CARMA's role is to be a repository for information and could put the links of how-to-do-it on the web and let others do the work. E.g., CARMA started with a habitat manual and then dropped this. It might still mbe something that could be done if the need is identified and someone takes the lead.
- The group discussed if, as another approach (in addition to modelling) there something about land use that could be put together based on knowledge of the aboriginal communities, e.g., their practical observations of what could be allowed. This might be a way to get to a simple set of rules for what is OK or not OK on the land.

Priority 4: Caribou Health Monitoring Program

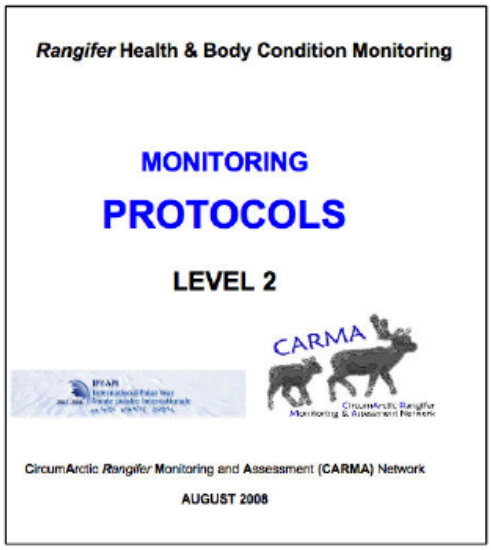
Introductory talks

Why long term health monitoring – Susan Kutz

This presentation outlined the rationale for monitoring caribou health, both at the individual (through disease and parasite surveys) and herd (through mortality, pregnancy and population estimates) scales.

The need to standardize assessment and the existing resources (CARMA manuals) of individual body condition and pathogens was identified. Further, the presentation provided examples of a number of studies that linked disease and pathogens in caribou and other species to body condition and population vital rates.

To conclude, a challenge was issued to the group on how best to incorporate caribou health monitoring into ongoing herd monitoring programs.



A successful health monitoring plan – Sylvia Checkly

In this presentation, the process of pathogen surveillance and monitoring were defined and current successful examples highlighted. In respect to CARMA's priorities, pathogen monitoring is the more appropriate approach.

Characteristics of a health monitoring plan:

- Ongoing efforts directed at assessing the health and disease status of a given population
- Data collection may be continuous or repeated
- Specific to one disease or population health in general
- Population: National, regional, herd or target group
- Focuses on trends: changes in prevalence and/or rates and direction of disease spread
- Purpose is to inform
- No intervention, control or eradication actions

Need to monitor Brucellosis globally from the Arctic to the Antarctic – Jacques Godfroid

The presentation discussed the history of Brucellosis in livestock and humans, going back to Pompeii. Brucellosis causes abortion in cattle leading to early calf deaths and can be transmitted to humans. The presentation summarized the biovars of Brucellosis common in *Rangifer*, the symptoms that have been identified and the importance for diagnosis and monitoring of the disease in *Rangifer*.

Public health research is needed to determine the baseline prevalence of potential climate-sensitive infectious diseases in both human and animal hosts in regions where emergence may be expected.

Applying the monitoring: Links to herd productivity – Bob White and Christine Cuyler

This presentation highlighted the need to consider body condition and individual health in understanding herd productivity. A number of pathways were reviewed that link between body condition and herd productivity.

Using the example of two study herds in Greenland--the stable Kangerlussuaq-Sisimiut Herd and the declining Akia-Maniitsoq Herd—and using the energetic costs of hosting warble flies and the intensity of nematode infections, the authors compare the impacts on the body condition of the samples from the two herds.

There is a need to integrate health into herd monitoring and to apply the resultant monitoring health data into assessments of herd productivity.

Breakout groups: How do we integrate health into herd monitoring?

Sub-questions:

i. What is the information that you need?
ii. How will you use this information?
iii. How can the collection of this information be best implemented?

4A. Community

Leaders: David Lee & Deana Lemke

First: What is the meaning of "caribou health"? There are different meanings of "health" depending on whether it's from a user or scientist perspective. In the communities, it is often taken to mean the ability to eat the caribou (abundance, taste, safe for human consumption). Health may be affected by the population size/density. Need also to consider how the health of the individual caribou affects the herd.

i. What is the information that you need?

Need to use all sources of information: scientific and ecological information, local and traditional knowledge/Inuit IQ, hunter knowledge (current) about caribou health.

Types of information needed by communities:

- Information that helps community people understand what a "healthy" caribou is and how to identify healthy animals

- How hunters can identify parasites/diseases in the caribou
- Contaminants monitoring
- Body condition assessments (backfat, etc.)
- Population information

ii. How will you use this information?

Getting the information to the communities:

- Report study results back to focus groups/ communities
- Develop posters or brochures with photos of healthy vs. unhealthy caribou (What does the condition that hunters are seeing on meat mean? Can it be safely consumed?)
- Provide materials in local community offices
- Community radio
- Workshops to update community members

iii. How can the collection of this information be best implemented?

Integrate the ecological information, local and traditional knowledge (TE and /IQ), and hunter knowledge into meaningful management planning.

4B. Researchers

Leaders: Bob White & Alice-Anne Simard

The group started with discussion about the nature of health and disease and defining questions regarding monitoring health. What is good health? Do we have different views of what we call health? Emotional health can be monitored with good behaviour observations because behaviour and activity budget can be indicators of good or bad health. Are individual and herd health correlated? How do we use our knowledge on individual health to understand the health of the herd?

Is stratified random sampling (pregnant, lactating, calf-at-heel, etc.) better for estimating health than completely random sampling, or do we lose information by stratifying the samples?

Population density could help to understand the general health of the herd, but density could also be related to health.

Disease is always going to be a dynamic (it will never be gone), so what is the natural dynamic of this herd, what is the baseline to say that a herd is healthy? Can we compare baselines between different herds or does a given herd have its own baseline?

A healthy ecosystem is a system that can buffer.

When the population changes, it is the disease that is going to drown the population low, but it may be the increasing population that facilitates the transmission of the disease. We need to understand that population health is not only the place of the population on the demographic curve (a healthy population increases), it is also the health of the individuals (pathogens, contaminants, stress).

How do we integrate health into herd monitoring?

i. What is the information that you need?

Can cumulative effects analysis (caribou centric or pathogens centric) be used to determine the health of the population? We need to determine the relative importance of the pathogens (the magnitude of the effect) compared to other factors. We know that the disease is important, but is it more important than hunters, for example?

We should combined data of habitat conditions with data on pathogens and body condition. We also need to collect data at the right time, for example, when warble flies are harassing caribou, not three months later. We should understand what the trends in other herds are and what we should expect.

ii. How will you use this information?

Try to involve other researchers and managers and to try to convince managers that this is a serious problem. Try to take the results a step up and see what can be done.

If the pathogen can be transmitted to humans (zoonotic diseases), an intervention is necessary. Intervention can be perceived as a problem in an area where there is agriculture. We need to define what are the most important drivers for the health of the caribou, the people and the agricultural livestock.

Before we can do anything, we need to make sure that we understand what the factors are (pathogens, contaminants, stress) and what the interactions are between those factors. Modelling is important.

The key is to open up the datasets – share your data.

iii. How can the collection of this information be best implemented?

The group's recommendation is to put all the collected data about parasites, diseases, contaminants and stress levels on a website to facilitate data sharing.

4C. Agencies

Leaders: Brett Elkin & Leslie Wakelyn

The group first discussed issues around health and health monitoring. Agreed that "health" and body condition are not the same thing. The definition of health must include the assessment of pathogens, stress, contaminants.

We need to use a "cumulative impacts" approach. We must look at multiple stressors and their cumulative effects on health, and look at the interactions of the stressors. Cumulative effects of stressors should be assessed both for the individual animal's reproductive states and for herd productivity.

We should focus on what outcome is needed, rather than on what can be sampled. The reality of limited budgets and the constant need for prioritizing must be acknowledged.

i. Information is needed...

- about key indicators of health;
- about relationships between health and body condition, pathogens, stress, and contaminants;
- about impacts of climate change on diseases and parasites;
- about the significance of pathogens as zoonoses (diseases potentially transmitted to humans); effects on wildlife; impacts of diseases on caribou reproduction, on other wildlife species or on human health;
- about how to tease out the effects from individual factors; how to priorize key pathogens to focus efforts;
- about how to determine sample size and geographic coverage required with respect to:
    - groups which need to be sampled (e.g., consider age/sex cohorts rather than sampling from general population);
    - questions asked and results desired (e.g., to detect presence, estimate prevalence, or assess change);
- about what to focus on when have a dead animal (where to begin?);
- about what methods to use for non-invasive sampling or other sampling of live animals;
- about how to monitor with bull-only harvests;
- from long-term surveillance of key issues, not just "snapshots" in time;
- for assessing impacts of stressors on condition, reproduction and survival;
- that helps to address "bigger questions" – what it means to populations, what will address management issues; and
- that can be easily collected!

Realities/challenges:

- Biologists often don't know what information is needed when they lack background (i.e., are not trained or experienced) in the animal health field; need experts to indicate what should be monitored.
- Need to balance public needs vs. scientific/management needs, for example:
    - when prioritizing monitoring for pathogens harmful to humans or transmissible to livestock over those that cause mortality or affect fertility or body condition of caribou;
    - when asked to give contaminants higher priority than diseases because of potential effects on humans;
    - when we must address public perceptions about what is important, especially when education doesn't change this (e.g., priority concerns are almost always what is visible).

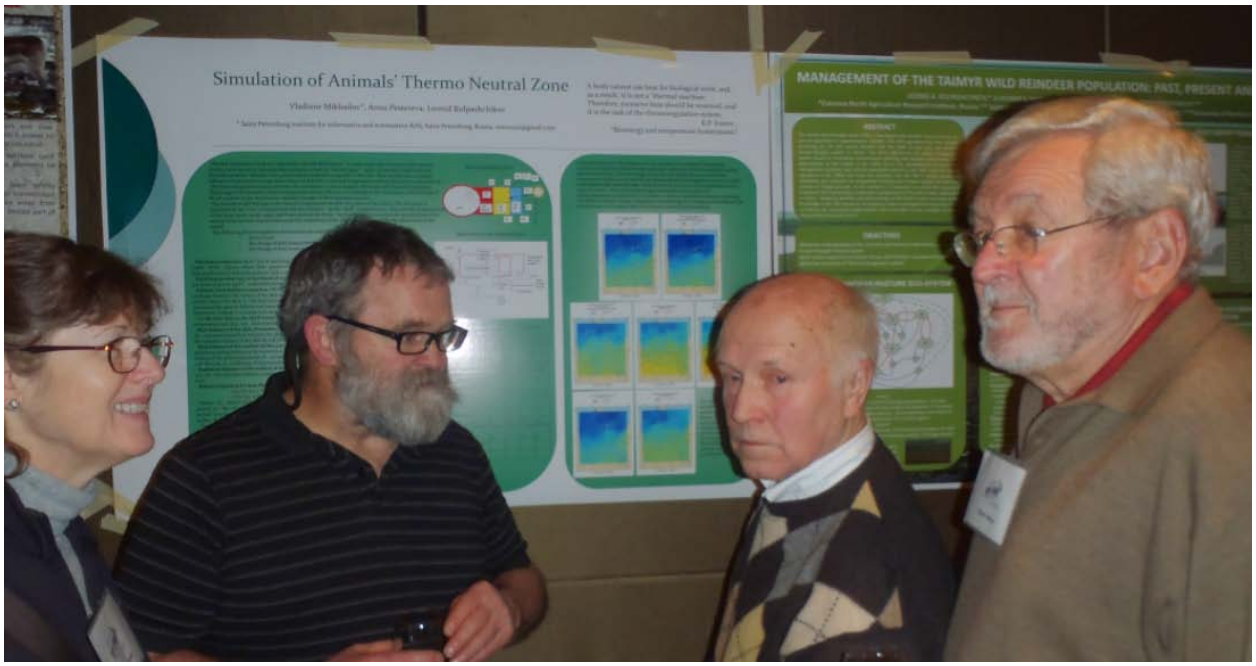
ii. Using information from health monitoring:

Key use is to increase understanding of how pathogens contribute to the overall system of which caribou are part. What is the role of pathogens, stress, and contaminants?

Communities and co-management boards often have expectations that action will be taken, but in reality often not much can be done. Sometimes no action can be taken "on the ground" but the information can be used to inform models to help explain how herds can be affected. Management interventions are most common in situations when there is a threat of transmission of pathogens to caribou from other species or to humans from caribou.

In Iceland, for density-dependent pathogens, it is relatively easy to handle problems with cattle so as not to increase disease in reindeer herds.

There are differences of opinion on whether the seriousness and prevalence of disease issues may increase with climate change or not. Would it be informative to look at historical information for parallels from past to future?

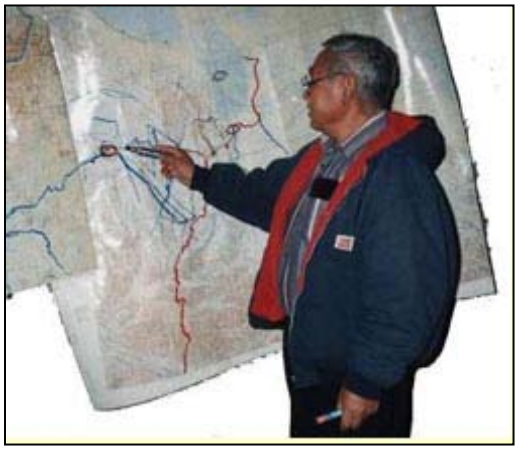


Chritine Cyler (Greenland), Don Russell (Canada), Vladimir Mikhailov (Russia) and Bob White (USA) discussing Russian research in the evening poster session and mixer.

..POSTERS COMING NEXT!

Poster presentations

Arctic Borderlands Ecological Knowledge Co-op: Contributions to ecological monitoring in the range of the Porcupine Caribou Herd (Alaska, USA, and Yukon and NWT, Canada) – Michael Svoboda



The Arctic Borderlands Ecological Knowledge Co-op coordinates community-based ecological monitoring in the range of the Porcupine Caribou Herd and adjacent coastal communities. With communities as active partners, the Co-op creates the framework for community-based ecological monitoring data to be collected and for turning the data into meaningful information. Numerous environmental valued components and indicators are reflected in the Co-op's community based survey/ questionnaire. Based on these indicators, data collected between 2001 and 2008 suggested improving caribou health while scientific models were falsely predicting drastic declines. The Co-op is a result of multiple partners coming together to better understand and monitor the ecological changes in a meaningful manner to inform both cumulative impacts frameworks and decision points within the region. Since its initiation in 1996 the Co-op has evolved to a world-class model demonstrating how collaborative programs can be effective and productive in the North.

An introduced population in an exploited ecosystem – Ran Thorarinsdottir

An introduced herd of reindeer has existed in Iceland since 1787 and in recent years has been on the increase, controlled primarily by hunting. Since the 1980s there has been a reduction in livestock on reindeer ranges and an expanding interest in more hunting opportunities. However managers wish to keep reindeer at low densities because of sparse vegetation, short summers, slow regeneration, combined with conflicts with livestock for range and in relation to transmission of disease. Further range is

being restricted to eastern portions of the country to prevent damage to sensitive areas. Recently a dam project flooded suspected calving areas and current calving distribution is quite variable.

Arctic Biodiversity Monitoring: Data to information and the Art of the possible – Michael Svoboda and Hallur Gunnarson

The Circumpolar Biodiversity Monitoring Program (CBMP) is working with partners to harmonize and enhance long-term Arctic biodiversity monitoring. Under the CBMP, the Arctic Biodiversity Data Service is a publicly accessible platform for collecting and disseminating information on the status and trends in Arctic biodiversity by creating linkages to static and dynamic data where it already resides. Developing new technologies for data integration via the web will only be considered when analyses have demonstrated usefulness and need into the future. In instances where developing data nodes is too onerous, CBMP aims to provide an alternative data management structure to host the data for partners.

New Challenges for local communities in Russia and CARMA – Olga Yetylina and others*

The poster and presentation discussed current challenges facing local communities with particular focus on the Chokotka region in eastern Siberia. Findings of current research, particularly with reference to collaborative projects with CARMA, are presented.

*Author list: Olga Yetylina, Marina Kholodova, and Vladislav Nuvano

A Nearctic parasite in a Palearctic host: *Parelaphostrongylus andersoni* (Nematoda; Protostrongylidae) infecting semi-domesticated reindeer in Alaska – Verocai and others*

Parelaphostrongylus andersoni is a protostrongylid muscle-worm that causes muscular and lung pathology in caribou and deer. We found *P. andersoni* in a herd of introduced, semi-domesticated reindeer on western Seward Peninsula, Alaska. Infection of this reindeer herd might be due to indirect contact with native Western Arctic caribou, likely through reindeer of adjacent herds that had direct contact with caribou. This nematode may cause subtle deleterious impacts on commercial herding activities. Perhaps herders could implement periodic and effective deworming protocols.

Dorsal spined protostrongylid larvae of *Parelaphostrongylus andersoni* extracted from reindeer feces

*Author list: Guilherme G. Verocai, Manigandan Lejeune, Greg L. Finstad, and Susan J. Kutz

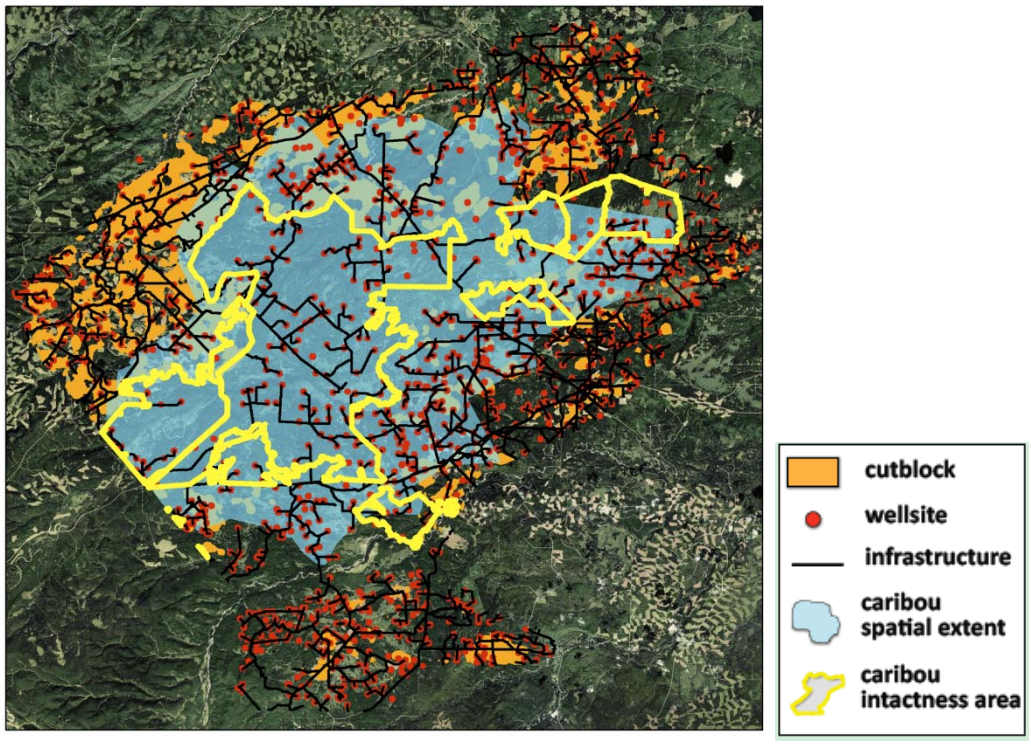
The devil's in the diversity – Jillian Steele and others*

We identified the gastrointestinal parasites of female caribou (*Rangifer tarandus groenlandicus*) from the populations of Kangerlussuaq-Sisimiut and Akia-Maniitsoq, west Greenland. Surprisingly, although these populations are closely related and neighbouring, significant differences in trichostrongyline parasite diversity were found between them. Further, in both caribou populations several indices of body condition were negatively associated with intensity of the dominant species of trichostrongyline nematode present. However, an effect on caribou fecundity was only seen in those animals infected with *Ostertagia gruehneri*.

*Author list: Jillian Steele, Karin Orsel, Christine Cuyler, Eric P. Hoberg and Susan J. Kutz

Forecasting the impact of land-use change on boreal caribou – Christina A.D. Semeniuk and others*

We developed an agent-based model (ABM) to explore how caribou of the Little Smoky (LS) herd in west-central Alberta, Canada, respond to and are affected by current and future changes in their landscape. Agents were given fitness-maximizing goals of acquiring energy for maintenance and reproduction, and minimizing predation risk and exposure to disturbance. Five landscape scenarios were simulated to represent different types of development of forestry and oil-and-gas. The caribou ABM was combined with the future landscape scenarios to examine how caribou respond both spatiotemporally and energetically to the various land-use developments. Results from the coupled ABM/CA model indicate that the spatial distribution and bio-energetic consequences of caribou agents are a function of behavioural responses to the landscape, and that seemingly 'high-quality' habitat, if coupled with a high industrial footprint can still negatively impact a caribou's probability of reproductive success. These findings have implications for the designation of what is considered 'critical' habitat.

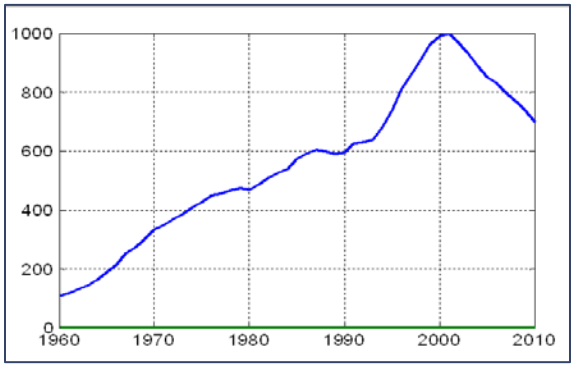


Predicted spatial distribution in "business as usual 2010", with excluded future development in intactness area

*Author list: Christina A.D. Semeniuk, David Birkigt, Marco Musiani, Greg J. McDermid, Mark Hebblewhite, Scott Grindal, and Danielle J. Marceau

Management of the Taimyr wild reindeer population: Past, present and future – Leonid A. Kolpashchikov and others*

The Taimyr Wild Reindeer Herd (TRH) has been steadily increasing for the last several decades until the 1990s. Over that time, the complex Human-Rangifer system in Taimyr has been affected by the Soviet management system based on centralized science-based planning and punitive enforcement. The deterioration of this system in the 1990s led to the abandonment of sustainable management practices and extreme population growth in the TRH. Amid the lack of regulation in the 2000s the trend has reverted, and the TRH is rapidly declining due primarily to unregulated hunting and increased impacts of industrial activity on forage grounds. Analyzing benefits and shortcomings of the Soviet system and state of the knowledge in the TRH dynamics we propose a new co-management framework based on a bottom-up, community-based system that is founded on the principles of shared responsibility and social justice.



Taimyr Wild Reindeer Herd population dynamics (thousands)

*Author list: Leonid A. Kolpashchikov, Vladimir V. Mikhailov, Andrey N. Petrov, and Anna V. Pestereva

Taimyr Wild Reindeer Spatial Fidelity and Calving Grounds Dynamics in a Changing Climate – Andrey N Petrov, and others*

The purpose of this study was to investigate the spatial fidelity of the Taimyr wild reindeer herd (TRH) to calving locations and identify possible climatic factors that influence the geographic shift of calving grounds. Spatial fidelity was confirmed through concentration of calving range, overlap between calving ranges, deviation from the geographic mean, and temporal variation of calving ranges. These measures showed three calving areas that TRH use more than 50% of the time. Although the TRH show spatial fidelity, they have experienced subtle, but significant shifts in calving locations. Our models found that the distance traveled from the winter concentration, cloud cover, humidity, and concentration of calving range plays a significant role in determining calving locations. In the future a multi-criteria model should be developed to better understand the causes and consequences of the spatial shifts as well as to assess the role of climate change in reindeer herd dynamics.

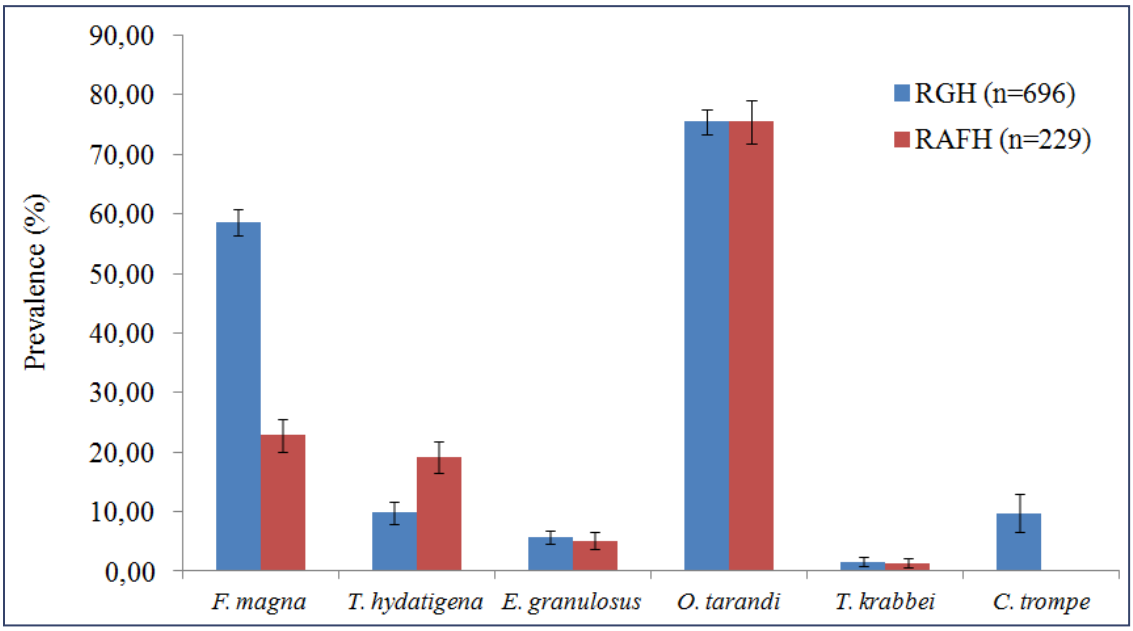
*Author list: Andrey N. Petrov, Susan K. Meerdink, Leonid A. Kolpashchikov, Anna V. Pestereva, Vladimir Mikhailov

Relationships between parasitism and body condition in migratory caribou – Alice-Anne Simard and Steeve D. Côté

The objectives of this study are:

1. To describe the changes in parasitism rate − measured in terms of prevalence and intensity of parasites − of migratory caribou over time.
2. To evaluate the impact of the prevalence and intensity of parasites on the body condition of migratory caribou.

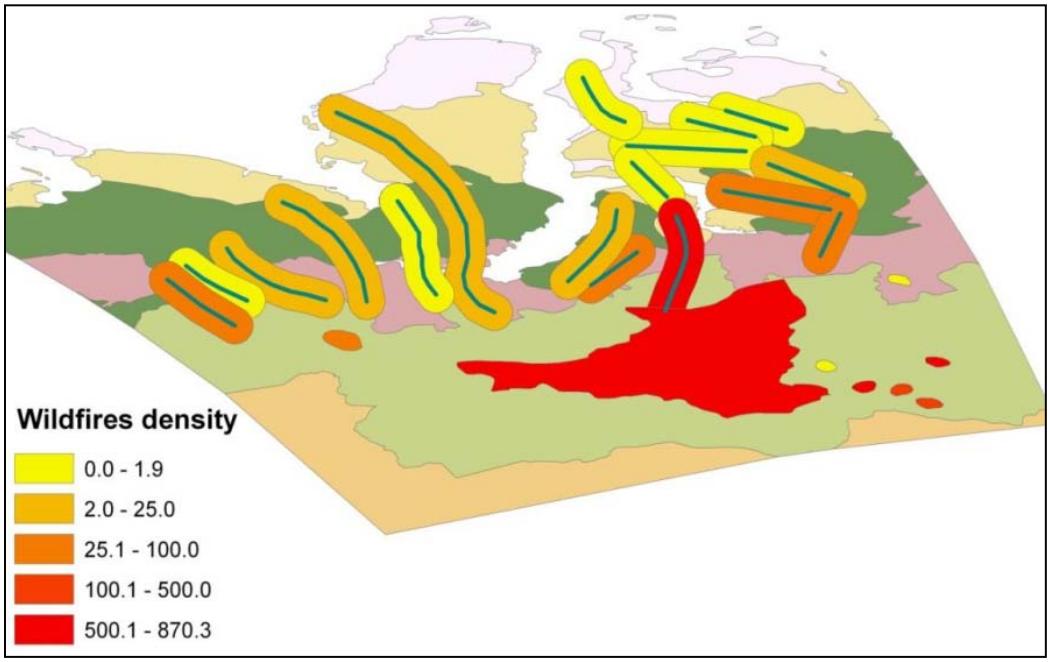
We studied six of the main macro-parasites of migratory caribou, which are liver flukes (*Fascioloides magna*), liver cysts (*Taenia hydatigena*), hydatid cysts (*Echinococcus granulosus*), warbles (*Hypoderma tarandi*), muscle cysts (*Taenia krabbei*), and nose bots (*Cephenemyia trompe*).



Prevalence (proportion of infected individuals in the host population; ± SE) of six of the main macro-parasites of migratory caribou for the Rivière-George herd (RGH; n=696) and the Rivière-aux-Feuilles herd (RAFH; n=229) since 1978 and 1987, respectively

Climate change, wildfires and reindeer in northern Eurasia: Modeling impacts of possible wildfire increase on domestic and wild reindeer habitats inYamal-Nenets and Taimyr regions – Jonathon Launspach*

This paper provides spatial and temporal analysis of wildfire occurrence and intensity in Arctic tundra using satellite data for five seasons between 2000 and 2010 in the Russian Arctic. We explore a possible relationship between increased fire incidence, changing climate, and increasing anthropogenic disturbance to land-based activities. Based on the dynamics of fire occurrence propensities and relationships between fire prevalence, intensity, and climatic characteristics, we developed wildfire risk models for different seasonal reindeer habitats. Our models estimate that the increased impacts of wildfires due to possible climate change will be especially noticeable in eastern Yamal and western Taimyr, where they will mostly affect migration routes and winter habitats.



Wildfire density and the domestic reindeer habitats

*Author list: Jonathon Launspach, Andrey N. Petrov, Anna Pestereva

Rangifer health: Scientific and educational cooperation in reindeer health – Carlos das Neves

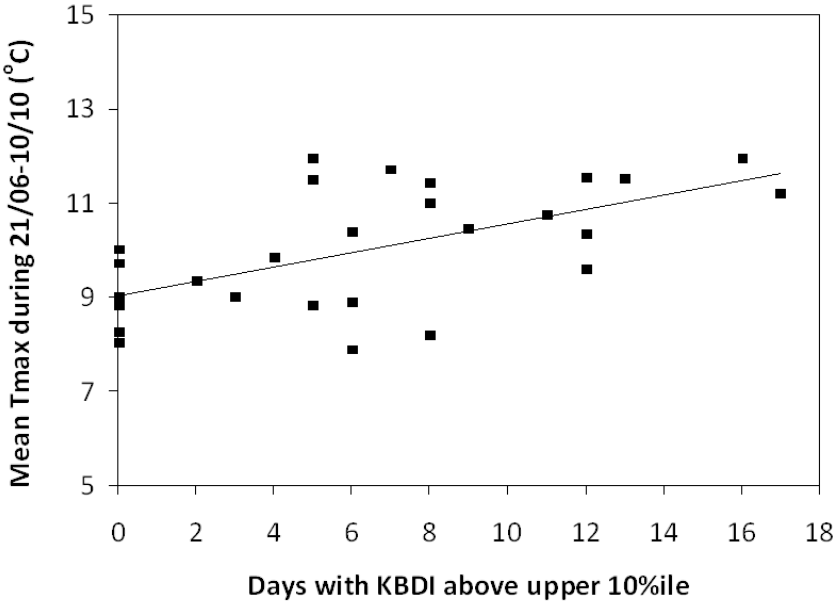
Many studies carried out in the last 20-30 years have identified several different health problems affecting reindeer in all northern European countries. Viruses, bacteria, fungi and parasites have been identified as causative agents of diseases with a vast range of clinical signs and implications for reindeer survival and husbandry. The lack of structured, long-term cooperation in studies related to reindeer health has meant that different countries have worked on individual health problems according to national relevance, many times on the follow-up of disease outbreaks. The lack of organized reindeer health research in the Nordic countries makes it difficult for scientific agents/institutions to provide counseling for political/management authorities of the Arctic, for the reindeer industry or even for the protection of cultural and traditional values of arctic and sub-arctic indigenous populations. One solution was to establish a long term cooperative strategy where research and teaching in reindeer health could be understood as both a global Nordic need and a global Arctic achievement: a Rangifer health network.

Network members during the annual meeting in Iceland in 2012

Exploring correspondences among Bathurst caribou demographic variables, summer range anomalies and climate during 1985-2011 – Wenjun Chen and others*

In this study, we aim to: (1) investigate potential correspondence between summer range forage availability and quality anomalies derived from satellite remote sensing and caribou demographic variables (e.g., calf:cow ratios, survival rates, start date of peak calving), and (2) assess impacts of climate variability on these anomalies.

Following the principle of limiting factors, we developed relationships between the minimum values of summer range mean anomalies (SRMA) and caribou demographic variables. Considering that there were many other factors that might influence these demographic variables as well (in other words, even if the summer range conditions were favourable, calf:cow ratios or survival rates could still be reduced due to other factors), we use the upper-envelope line to quantify the impact of summer range anomalies. To understand the impact of climate on these summer range anomalies, we examined the relationships between summer range anomalies and climate variables (e.g., maximum temperature and the Keetch-Byram Drought Index (KBDI)).

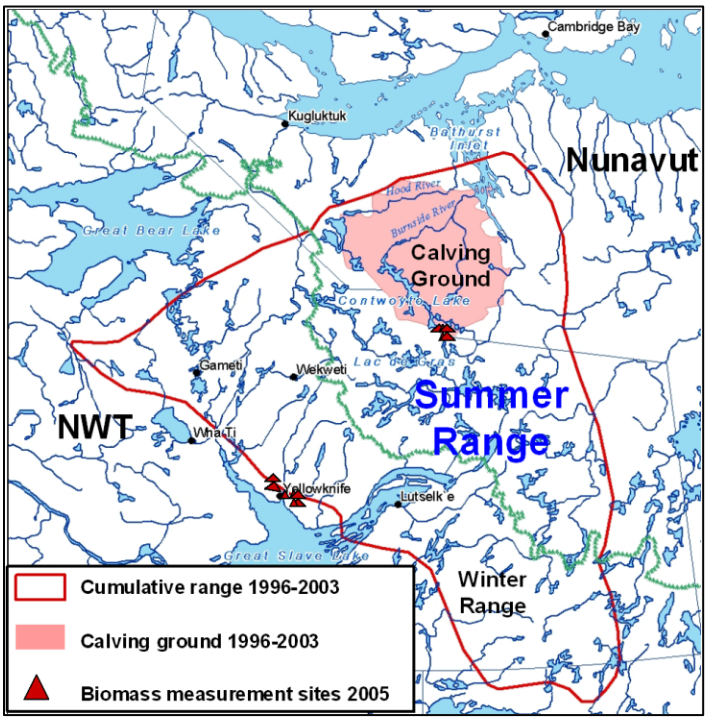


Relationships between days with KBDI above upper 10%ile and mean T_{max} from 21/06 to 10/10 at the Lupin climate station from 1985-2011

*Author list: Wenjun Chen, Lori White, Jan Z. Adamczewski, Bruno Croft, Donald E. Russell, Anne Gunn, Jody Snortland Pellissey, Karin Clark, Kerri Garner, Ian Olthof, Risam Latifovic, Greg L. Finstad, and Robert G. White

Detecting anomalies in forage availability and quality of the Bathurst caribou summer range using satellite remote sensing – Wenjun Chen and others*

Sustainable northern development is a shared goal among governments and northern residents in Canada. The NWT Cumulative Impact Monitoring Program (CIMP) is one of the tools being used to achieve the goal. Caribou and their habitats have been identified by CIMP as one of the key priorities. In this study, we aim to: (1) apply and refine an unbiased and objective method to the Bathurst caribou summer range for monitoring leaf biomass and seasonality changes using satellite remote sensing and field measurement data; and (2) detect anomalies in forage availability and quality by land cover classes within the summer range on the basis of leaf biomass and seasonality monitoring results.



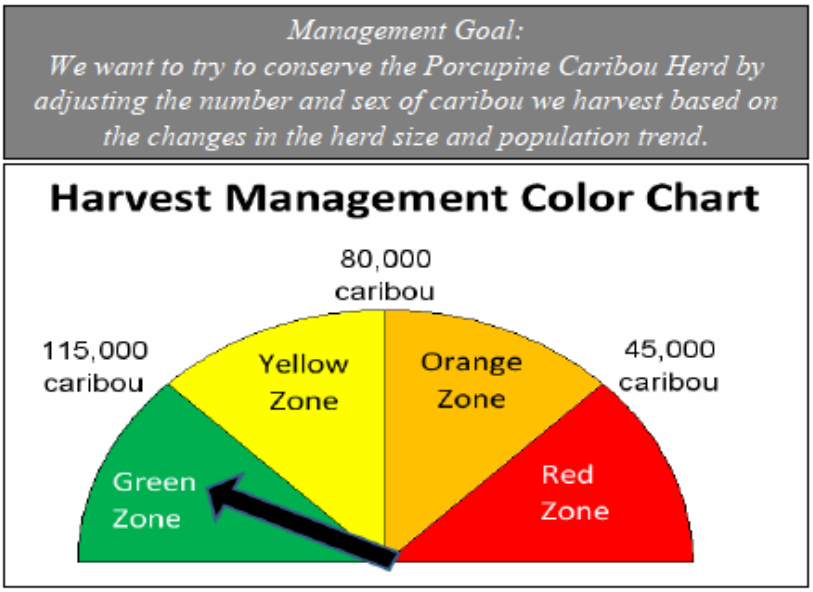
Location of Bathurst caribou summer range (between red boundary line and green tree line) and field leaf biomass measurement sites

*Author list: Wenjun Chen, Lori White, Jan Z. Adamczewski, Bruno Croft, Donald E. Russell, Anne Gunn, Jody Snortland Pellissey, Karin Clark, Kerri Garner, Ian Olthof, Risam Latifovic, Greg L. Finstad, and Robert G. White

Harvest Management Plan for the Porcupine Caribou Herd in Canada – Porcupine Caribou Management Board

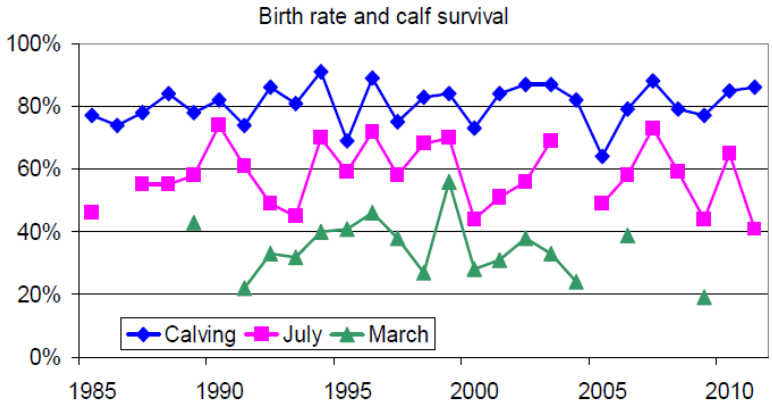
The Porcupine Caribou Herd is a magnificent population of migratory caribou that we must conserve for all time. When the herd is large, harvesting caribou poses little or no threat to it.

The plan is a plan for all times—one that will respond to the status of the herd whether the population is high or low. The plan allows us to be proactive, with many hard decisions already made if the herd numbers decline. Each year, the Porcupine Caribou Management Board (PCMB) will meet to review all available scientific, local and traditional knowledge about the current status of the herd and recent harvest information from all parties. The PCMB will then decide which colour zone the herd is in and will recommend management actions for the next fall hunting season. Engagement of Alaskan parties began in 2012 with initial discussions with the International Porcupine Caribou Board. Allocation of harvest limits on Aboriginal hunters will be detailed in Native User Agreements for Yukon and NWT.



Monitoring the status of the Porcupine Caribou Herd – the Porcupine Caribou Technical Committee and the Porcupine Caribou Management Board (presented by Mike Suitor)

The Porcupine Caribou Herd is a population of barren ground caribou that ranges across northeastern Alaska, Yukon, and northwestern Northwest Territories, providing an important source of sustenance for user communities. Cooperative monitoring and research on the herd is guided by two co-management boards in Canada and Alaska. This poster summarizes the current management program for the herd and some of the major results that have been documented for the herd since 1985.



Calf survival monitoring is ongoing. Several March composition counts in recent years were cancelled due to overlap with other herds.

CARMA bibliography of caribou and wild reindeer research and monitoring – Megan Osmond-Jones and Joan Eamer

This bibliography was prepared for CARMA in order to catalogue and archive research and monitoring reports. It came out of several CARMA initiatives that involved compiling data on caribou status and trends. The bibliography, containing abstracts where available and with all reports or articles in pdf format attached, is available on request (askcarma@gmail.com) in EndNote format, or it can be exported into another format. The bibliography was transferred to interested participants at CARMA 8.

Nunavut	37	Russia	5	Parasites	88	Cumulative	16
Alaska	131	George	26	Climate	100	Energy	32
NWT	100	Porcupine	30	Model	94	Traditional	30
Norway	50	Bathurst	52	Trend	49	Monitoring	67

Scope of the reports and articles in the database: some examples of searches (search string and number of hits). Total number of reports and articles: 779.

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