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### *Brief Communication*

## CircumArctic *Rangifer* monitoring and assessment (CARMA) network – origins, goals, accomplishments and future

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### Origins

The CircumArctic *Rangifer* Monitoring and Assessment (CARMA) network is an informal group of scientists, community representatives, and management agencies who formed to better understand the impacts of global changes on migratory tundra caribou. In this report we outline how that network evolved, discuss some of the accomplishments of the group, and look forward to CARMA's future. CARMA was formally launched in Vancouver in 2004. This launch was preceded by several events. In 1998 the Arctic Council ministers directed the Conservation of Arctic Flora and Fauna (CAFF) to “identify elements of a program to monitor circumpolar biodiversity” and to “assess the effects of climate change on Arctic ecosystems”. Concurrent with that initiative, in 1999 in Rovaniemi, Finland, the International Arctic Science Committee (IASC) and the US National Science Foundation funded an interdisciplinary conference of *Rangifer* managers, users, and scientists to discuss elements of a circumpolar monitoring and assessment

network for human-*Rangifer* systems and the formation of a community to implement the plan (Russell *et al.*, 2000). After a meeting to implement the Arctic Council's directive, *Rangifer* was confirmed as a key indicator species and the CARMA network was officially endorsed by CAFF. With that endorsement and the plan from the Rovaniemi conference in mind, the IASC human-*Rangifer* study group met in Minery, New Hampshire, in 2001 and fleshed out the elements of a *Rangifer* network, leading to the official launch of the CARMA network. Subsequently, in 2005, CARMA was invited to become an official network under the Circumpolar Biodiversity Monitoring Program (CBMP). The CBMP reports to the CAFF.

### Goals

CARMA has held annual meetings since 2004. At the initial meeting CARMA adopted the mission to: “monitor and assess the impacts of global change on human-*Rangifer* (reindeer, caribou) systems across the circumArctic, through cooperation, both geographically and

across disciplines". In 2005, two large grants provided support. One was through the Canadian International Polar Year (IPY) program and the other through the US National Science Foundation. CARMA's Canadian IPY project, "Starting the clock for the CARMA Network: Global Change, Resilience and Human-*Rangifer* Systems of the CircumArctic", aimed to develop protocols for monitoring at the individual and population level, and funded a number of projects to either initiate standardized monitoring programs or develop monitoring methodologies that could be incorporated into monitoring manuals. The funding also gave us an opportunity to: 1) develop a communications website ([www.caff.is/carma](http://www.caff.is/carma)), 2) develop data sharing and handling policies, 3) initiate programs to better understand how change is affecting communities across the north, 4) document local knowledge about changes in human-caribou relationships, 5) provide educational tools to schools, 6) provide materials and training for hunters to participate in monitoring the health of caribou, and 7) further our capability to synthesize data and assess herd-specific vulnerability and resilience to global change through modeling.

In the December 2010 meeting, collaborators of the program discussed the products produced by CARMA, highlighting the strengths and weaknesses so that we could improve and make these resources more accessible to our collaborators. Below is the summary of feedback received after reviewing the specific tools and resources.

## Accomplishments

### *CARMA standardized protocols*

CARMA has developed two protocol manuals. The body condition and health manual (Kutz *et al.*, 2013) presents three levels of field procedures to assess and monitor *Rangifer* health and body condition (<http://caff.is/resources/field-protocols>). Level 1 is designed for hunters

in the field to make a quick assessment of the condition of caribou, collect very few samples, and record a limited amount of information. The advantage of using this method is that it greatly expands the sample size and geographic scope of collections and provides communities with capacity-building and educational tools. Level 2 is designed for hunters, accompanied by trained technicians, to provide an expanded amount of information and collect more samples. Level 3 is the most detailed and thorough sampling, conducted by veterinarians or biologists, and expands our knowledge of parasites and disease in populations.

The demographic manual (<http://caff.is/resources/field-protocols>) reviews population estimation techniques and presents tools to be used to report trends and variance in population parameters. The manual offers an overview of monitoring methods applied to migratory tundra caribou. The protocols associated with this manual give details on how to report on the monitoring of demographic indices that differs from the approach used in the CARMA health and condition manual and protocols.

### *The Rangifer Anatomy Project*

The *Rangifer* anatomy project (RAP) grew out of a need for better resources to enhance *Rangifer* health monitoring, to promote responsible hunting, and to facilitate knowledge exchange across generations among *Rangifer* users including northern community members, wildlife managers, scientists, and educators. RAP was initiated at the Faculty of Veterinary Medicine, University of Calgary, in December 2007 and has since grown into a much larger collaboration in the *Rangifer* world. The project revolved around the detailed dissection of two domestic reindeer which produced hundreds of high quality images of *Rangifer* anatomy. A webpage has been created, and posters produced and distributed to a number of schools (<http://www.ucalgary.ca/caribou/index.html>).

### *Hunter training video*

The hunter training video ([http://caff.is/index.php?option=com\\_content&view=article&id=661&Itemid=1310](http://caff.is/index.php?option=com_content&view=article&id=661&Itemid=1310)) complements the body condition and health protocol manual. The video presents a step by step procedure for recording information and collecting samples for Level 1 and Level 2 protocols. Although the target audience is primarily hunters, the video has also been used for education purposes in a number of schools in the north.

### *Voices of caribou people*

The Voices Project (<http://caff.is/caribou-people-ii>) is a video-based project to document the knowledge of indigenous peoples who traditionally have a close relationship with caribou. The project was carried out in partnership with indigenous peoples of North America who subsist on caribou and identify themselves as “caribou people”. The project: 1) captured local perspectives on global changes (*e.g.*, climate, industrial, and institutional change) and local understanding of the impacts to the environment and their way-of-life, 2) documented community strategies for coping with these changes, 3) shared knowledge and information with other northern communities, researchers, and the general public, and 4) took a snapshot of current concerns regarding caribou and caribou hunting during the IPY as a legacy for future researchers. In 2007 over 100 hours of video footage of more than 95 caribou people were recorded and included youth, elders, harvesters, and community leaders from six communities across North America: Anaktuvuk Pass (Alaska), Old Crow (Yukon), Wekweeti (Snare Lake; Northwest Territories), Lutsel K’e (Snowdrift; Northwest Territories), Arviat (Nunavut), and Kawawachikamach (Quebec). Two video features were produced and a website that makes all videos accessible is in production.

### *Climate database*

CARMA has developed a climate database (Russell *et al.*, 2013) based on NASA’s Modern Era Retrospective Analysis for Research and Applications (MERRA) dataset. The database contains daily data for 25 variables that are relevant to caribou ecology and is spatially explicit, includes 22 herds and 5 seasonal periods (calving, summer, fall, winter, and spring) and two habitat types (taiga and tundra). The period covered is 1979 – 2010 and will be updated annually. Currently the dataset has been entered into a Microsoft Access® database and is being made available through the CARMA website.

### *Energy/protein model*

CARMA has provided funds to further develop an energy model (White *et al.*, 2013) for caribou that has been in development for the last 20 years (Russell *et al.*, 2005). The model will be used to help identify data gaps and research priorities and assess the impacts of development and climate change on individual caribou.

### **Future**

Following an intensive four years under the International Polar Year program, CARMA is now in the data synthesis and herd assessment phase and is developing a strategy on how it should function in the future. At the 2010 meeting, collaborators discussed a number of future priorities for CARMA. Collaborators stressed that CARMA should continue to produce products that are relevant to managers, academics, co-management boards, and local communities. Providing products that can be used as educational materials was also felt to be a key role for CARMA. To enhance CARMA’s engagement, collaborators suggested CARMA: 1) strengthen its profile and role in circumpolar affairs, 2) design and promote products to engage target audiences, 3) identify missing collaborators, and 4) broaden CARMA’s scope by including work on boreal caribou and domestic reindeer. The

group also recommended new “product lines” for CARMA to enhance its relevance. CARMA should develop tools to help management and renewable resource boards cope with rapid change in their herds including: 1) protocols to prepare for herd declines, 2) an action framework for communities and resource managers to use throughout fluctuating caribou population abundance, but especially during population declines, and when conducting herd management with less-than-adequate data, and 3) an easy-to-access system for sharing the collective experience of management actions under different situations. Collaborators also identified the need for CARMA to use its tools and models to develop a generalized, user-friendly cumulative effects model for resource managers and users. Finally collaborators identified four possible options for CARMA’s future: 1) as an information source to academics, managers, and user communities, 2) as a think tank for cutting edge basic and applied research, 3) as a place for inter-regional and international exchange, and 4) as an educational node for training future managers and scholars. In the near future CARMA will have to decide on which of these options to adopt over the next five years.

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