

Original Contribution

Fostering Community-Based Wildlife Health Monitoring and Research in the Canadian North

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Abstract: Many northern Canadians have continued a subsistence lifestyle of wildlife harvesting and, therefore, value sustainable wildlife populations. At a regional wildlife workshop in the Sahtu Settlement Area, Northwest Territories in 2002, elders and community leaders raised concerns regarding wildlife health, food safety, and the effects of climate change on wildlife. They requested that efforts be put toward training youth in science and increasing involvement of hunters and youth in wildlife research. In response, we initiated a long-term, integrated approach to foster community-based wildlife health monitoring and research. Annual trips were made to all schools in the Sahtu from 2003 to 2009 to provide hands-on learning for 250–460 students on a range of wildlife topics. In addition, interviews were conducted with 31 hunters and elders to document their local ecological knowledge of wildlife health and local hunters were trained as monitors to collect tissue samples and measurements to assess body condition and monitor health of harvested caribou ($n = 69$) and moose ($n = 19$). In 2007 the program was extended to include participation in the annual caribou hunt held by one community. Each year since 2005, a graduate student and/or a postdoctoral trainee in the veterinary or biological sciences has participated in the program. The program has evolved during the last 6 years in response to community and school input, results of empirical research, hunter feedback, local knowledge, and logistical constraints. The continuity of the program is attributed to the energetic collaboration among diverse partners and a unified approach that responds to identified needs.

Key words: wildlife health, community-based monitoring, youth education, local ecological knowledge, collaboration, disease, parasites

INTRODUCTION

Climate change, together with increasing human activities in polar regions, are dramatically altering the structure and

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function of northern ecosystems and the socioeconomic framework of northern communities (Wonders, 2003; McBean et al., 2005). Despite an increasing reliance on a cash economy and store-bought food, indigenous peoples in arctic and subarctic regions maintain a strong cultural connection with wildlife and many still rely on wildlife as a principal source of food and self-employment. This way of life may be in jeopardy, however, as the expansion of resource development in northern Canada, recent dramatic declines in caribou numbers, and the rapid environmental and social changes that are occurring in northern regions create important and unique risks to wildlife and human health (Kofinas et al., 2000; Furgal and Seguin, 2006; Hoberg et al., 2008; Kutz et al., 2008; Vistnes and Nellemann, 2008).

Monitoring and management of wildlife health often involves diverse stakeholders with a shared interest in wildlife and a common desire for their long-term sustainability (Peterson et al., 2007). Effective action, however, is sometimes hindered because of conflicts that arise from differing world views and insufficient meaningful two-way communication and collaboration between wildlife-using communities, scientists, and government management agencies (Brook and McLachlan, 2005, 2008). Communities in northern regions, and indeed around the world, are increasingly demanding that scientific studies respect their needs and concerns, incorporate their local knowledge, more effectively communicate the research methods and outcomes, and include local input in translation of research results into local action (Brook and McLachlan, 2005; Wallington et al., 2005).

Scientific methods and approaches that adequately incorporate local ecological knowledge (LEK) simultaneously give relevance and importance of both science and LEK, help ensure buy-in from communities and scientists, and underscore the value and importance of LEK (Berkes, 2004; Brook and McLachlan, 2008). These community-based programs are central to managing wildlife and meeting the needs of the Arctic's indigenous people. Perhaps the most successful approach to facilitating discussion among communities, scientists, and government resource agencies to integrate LEK with contemporary science has been the development of co-management boards across the north (Kendrick, 2003; White, 2008). The Sahtu Renewable Resources Board (SRRB) in the Northwest Territories (NWT) was established by a land claim agreement as the "main instrument for wildlife management" to facilitate co-management of wildlife and other renewable resources

in the Sahtu Settlement Area (SSA). Although the co-management process is challenged by conflicts about decision making and occasional disagreements between scientific data and local knowledge, it provides a formal framework for interaction among community members and government resource managers. The co-management process also facilitates considerable respect for the knowledge and attitudes of local people in making decisions that influence wildlife health and implementing monitoring programs.

Community-based monitoring (CBM) is an approach to environmental observation that incorporates local people, government agencies, academia, community groups, and local institutions to monitor, track, and respond to issues of common concern (EMAN, 2002). This approach encourages interdisciplinary methods and collaboration among individuals and groups while recognizing the sociopolitical nature of the issues. Effective CBM should be designed and implemented collaboratively to provide locally relevant information and ensure support from all parties. CBM may include participation of local citizens in data collection and interpretation, which can democratize the research process (Brook and McLachlan, 2005; Cooper et al., 2007) and function as another means of peer review (Functowicz and Ravetz, 1994). CBM may be most effective at engaging communities and scientists and provide the most relevant and useful information if it facilitates the inclusion of both local knowledge and scientific data in a way that identifies the benefits and limitations of each (Brook and McLachlan, 2005).

In 2002, representatives from all five communities in the SSA, together with government and academic scientists, participated in a workshop co-hosted by the Government of the NWT (GNWT) and the SRRB to determine wildlife research and monitoring needs (Swallow and Veitch, 2002). Participants identified wildlife health as a priority and wanted local subsistence hunters to be involved in wildlife monitoring and research. Importantly, they also identified a critical need for youth to receive enhanced education in science and wildlife biology. One participant noted that:

Alfred was saying there is no doctor for the wildlife when the wildlife get sick, we need to preserve our wildlife. A long time ago it was not like that because our land was not disturbed, but now it's different. Now we are becoming aware of all these things happening. We need to educate our children, so they know how to preserve wildlife and fish. So before

the meetings start I just wanted to express that concern. We have two days so we will get more ideas. We are not educated in the school way, but we are knowledgeable about the wildlife and the environment. (A.J. Kenny, translated)

Another participant indicated the importance of working collaboratively to monitor wildlife health:

If we cut our hand and don't get it treated it will get infected. If we don't take care of our wildlife, if they are sick it will spread and spread if we don't take care of it. Not just wildlife, it's our environment. We need our own people with Traditional Knowledge to work with you on these studies (Leo Modeste, translated).

This meeting provided important direction for our work, including being the catalyst for the establishment of the Sahtu Wildlife Health Outreach and Monitoring Program. In this paper we describe the evolution and challenges of the Sahtu program. We put this forth as a model process for engaging communities in the Canadian North

and elsewhere in long-term monitoring of wildlife health. This approach includes collaboration and ongoing information exchange among hunters, academics, and wildlife managers, identifying and responding to locally important issues, and educating and inspiring our next generation of scientists and hunters.

MATERIALS AND METHODS

Study Area: The Sahtu Settlement Area

The 283,000 km² SSA was established through a land claim settlement agreement among Sahtu Dene and Métis and the Government of Canada and the GNWT in 1993 (Auld and Kershaw, 2005). The SSA includes five communities: Deline, Tulita, Norman Wells, Fort Good Hope, and Colville Lake (Fig. 1) accessible by winter roads and by scheduled air service throughout the year (Table 1). There were 2,629 residents in the 2006 census, of which most (75%) are aboriginal (Table 1). The Sahtu includes the alpine area of

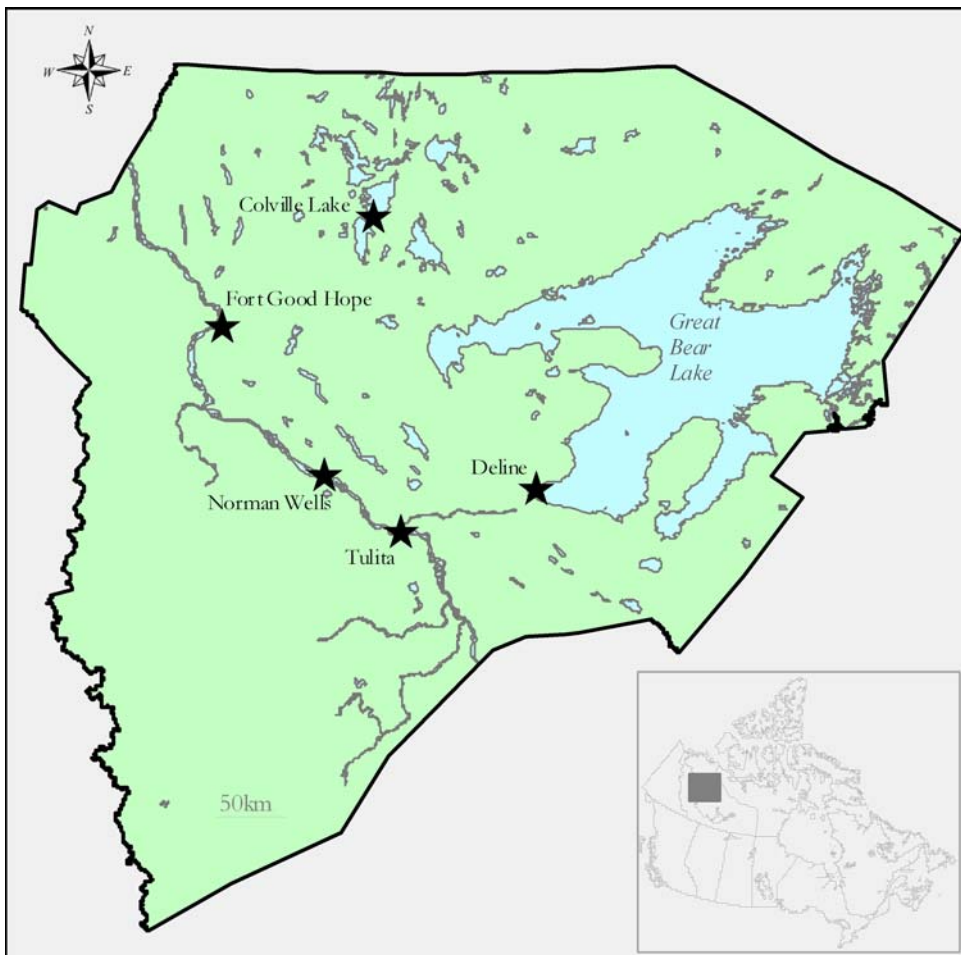


Figure 1. The Sahtu Settlement Area within the Northwest Territories and the five communities.

Table 1. Characteristics of the Five Communities Within the Sahtu Settlement Area (SSA) (Bureau of Statistics, Government of the Northwest Territories, 2007)

	Colville Lake	Déline	Fort Good Hope	Norman Wells	Tulita
Population (2006)	142	543	585	849	510
% Aboriginal	96	95	90	35	97
% < 15 years old	n/a	27	27	25	31
% Households consuming country food ^a	82	39	36	12	56
% That hunt and fish	59	43	47	46	52
% With high school diploma (2004)	33	32	38	85	39
Average family income (2005) (\$)	n/a	62,929	69,346	129,760	64,358
Cost of living relative to Edmonton, AB (%)	168	163	163	153	158
% Employed (less than high school diploma)	38	29	41	54	42
% Employed (high school diploma or greater)	69	66	78	92	77
Scheduled air service	Yes	Yes	Yes	Yes	Yes
Summer ground access	No	No	Barge	Barge	Barge
Winter road access	Yes	Yes	Yes	Yes	Yes

^aMost or all meat consumed from wildlife sources.

the Mackenzie Mountains to the west, tundra northeast of Great Bear Lake, and the boreal forest of the Mackenzie River Valley in the center. In 2006, hunting and trapping was practiced by 47% of residents and 32% of households subsisted mostly on wildlife (Bureau of Statistics, GNWT, 2007). The SSA is still largely wilderness but has developed oil and gas operations and expanded hydrocarbon and mineral exploration. The SSA has many locally important wildlife species, particularly barren-ground and woodland caribou (*Rangifer tarandus*) moose (*Alces alces*), muskoxen (*Ovibos moschatus*), and Dall's sheep (*Ovis dalli*).

Initiation of an Integrated Approach

The initial regional workshop in 2002 indicated a clear need for a wildlife health monitoring and research program in which local people were meaningfully involved. Under the leadership of two of us (SK and AV), the initial monitoring program included community workshops and classroom visits and evolved to incorporate traditional knowledge, community-based wildlife health monitoring, graduate and undergraduate student education, and targeted research projects (Table 2; Fig. 2). This process required participa-

Table 2. Timeline in the Evolution and Learning for the Sahtu Wildlife Monitoring and Education Program

Year	Graduate students and postdocs	Local students	Biological theme	Veterinary theme	Wildlife health monitors
2003	0	~ 400	What is a biologist?	What is a veterinarian?	0
2004	0	464	Trap line ecology and management	Lynx anatomy	2
2005	2	457	Marten ecology	CSI (crime scene identification)	6
2006	1	466	Snowshoe hare population cycles, barren-ground caribou population cycles	Diseases of caribou and hare	4
2007	1	401	Bird migration	Bird disease (West Nile Virus, avian influenza)	4
2008	2	250 ^a	Ecology of wolves, foxes, and coyotes	Dog health, welfare and dog safety, rabies, wild-domestic interactions	9
2009	1	258 ^a	Ecology of muskoxen	Health of muskoxen	9

^aSevere weather school closures and examinations in some schools.

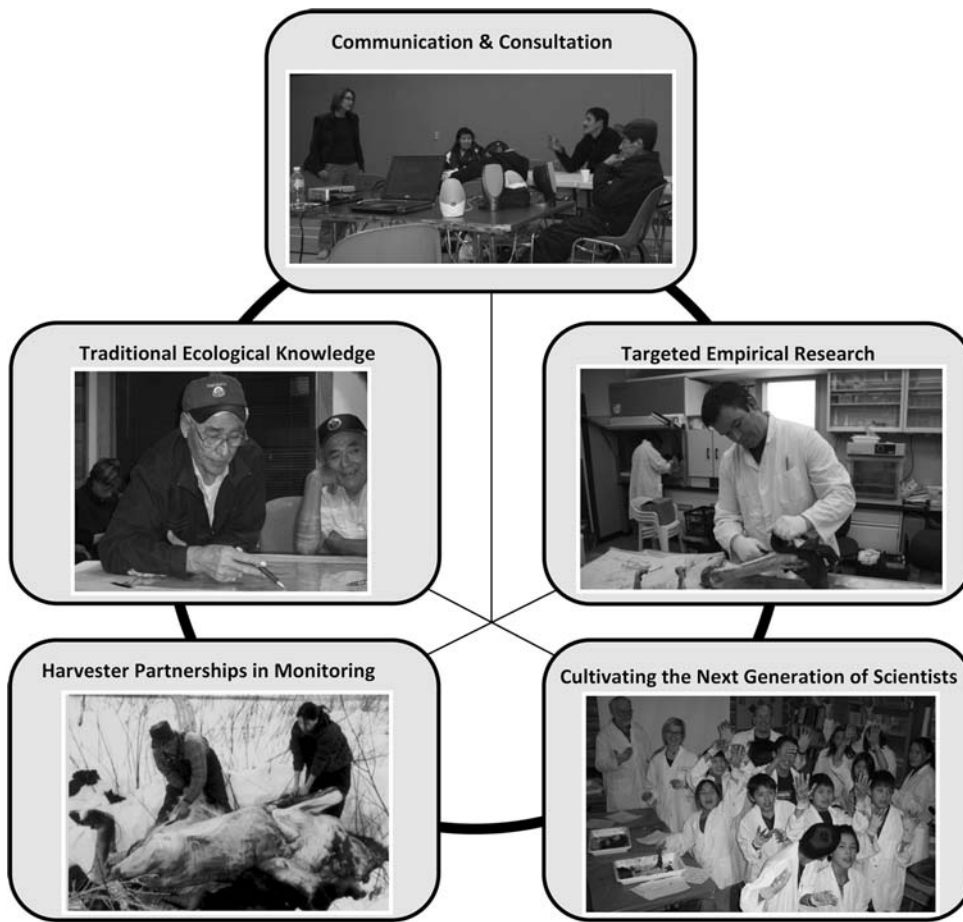


Figure 2. An integrated approach to wildlife health monitoring in the Sahtu region of the Northwest Territories that emphasizes the important linkages among all aspects of the program.

tion of diverse partners in academia, government, and communities, including veterinarians, wildlife biologists, resource managers, educators, hunters, elders, and youth.

Community Workshops

We hosted workshops within each community in the Sahtu region each year from 2003 to 2005 and in subsequent years offered to provide these workshops as requested by each community. We presented updates on research methods, study findings, an overview of common diseases of local wildlife and food safety, and we generated discussion and obtained feedback on study design, data interpretation, and local priorities, while building relationships with local people and fostering trust. Local translators were used when required.

Cultivating the Next Generation of Scientists

We interacted with students from kindergarten to grade 12 through annual visits (2003–2009) to all five community

schools. Each year had a theme (Table 2), and active participation was encouraged, particularly with senior students (see Box 1). We provided education on wildlife topics of local interest and relevance, encouraged student involvement in wildlife monitoring, and promoted careers in science, veterinary medicine, and renewable resource management. Visits were typically 1 to 2 days per school and included slide presentations tailored to the different grade levels, demonstrations, games, hands-on wildlife dissections, and handling of furs, bones, and preserved parasites. In some years, additional guests were invited on the tour to provide complementary skills on the annual theme and/or educational methods, such as training of the principal investigators in youth education methods.

In 2007 and 2008, on invitation by the community of Colville Lake, we expanded the youth program to the field and participated in the annual community caribou harvest. This involved teaching youth about caribou sampling and working with select hunters to train them in sample collection methods. We also used this opportunity to work with a young local videographer to film a hunter training

Box 1. Theme summary of the 2008 Sahtu tour

As with many northern communities, veterinary care and vaccination for pets in the Sahtu is not readily available or utilized widely if offered and the issue of roaming dogs is an important local concern. In 2008 we conducted a student survey of dog ownership and care as part of a needs assessment for veterinary care in the region. During the 2008 winter tour we then provided dog safety training and discussed the important disease risks between domestic dogs, wildlife, and humans using video, slides, furs, skulls, and samples of parasites and canid anatomy. Interested local senior students were given the opportunity to participate as assistants during free dog vaccination clinics that were provided in each community and they were taught how to prepare vaccines for injection, complete animal health records, and learned general roles and responsibilities of veterinarians (Fig. 3). Students also helped administer additional questionnaires to dog owners regarding their attitudes toward dogs and their overall dog care practices. The survey and vaccination clinics were conducted to determine the needs of the communities in terms of long-term veterinary care, the current attitudes and care of dogs, and to help prevent disease transmission among dogs and between dogs and wildlife.



Figure 3. Veterinary clinics in communities of the Sahtu region that are not currently serviced provide important opportunities for vaccinating animals to protect pet, human, and wildlife health, as well as training opportunities for local youth.

video on caribou sampling and caribou diseases (view the video at <http://www.carmanetwork.com/display/public/Hunter+Training+Video+%28Summary%29>).

Since 2005, one or two graduate students and/or a postdoctoral fellow in veterinary medicine or biology who had relevant research and career interests were selected to participate in the community tour and more recently in the Colville Lake caribou harvest. The goal of graduate student involvement was to provide an active learning experience in northern research, cultivate an appreciation of the unique benefits of working with indigenous people, and develop

skills in the unique challenges of conducting northern research.

As the program evolved, it became evident that a more formalized assessment process was needed to ensure that the program was meeting the needs of the communities. As a first step in developing an assessment process, in January 2008, during the tour, one of us (RB) conducted semi-directed interviews as a preliminary evaluation of the school program and to identify the key issues in developing a more formalized assessment process. School teachers ($n = 9$), school principals ($n = 3$), and local community members ($n = 11$) were interviewed individually. Students ($n = 147$) were asked which of the offered activities they most enjoyed. Participating graduate students ($n = 4$) also were interviewed to document their perspectives on the program as well as how the program had influenced their subsequent activities and attitudes.

Local Ecological Knowledge

We regularly obtained LEK informally through conversations with local people at workshops, schools, casual encounters, and regular meetings with our wildlife health monitors. Formal documentation of LEK was done in 2005 as part of a broader project that also included nearby regions (Kutz, 2007). Thirty-one experienced harvesters and elders from all five communities in the Sahtu participated in focus group interviews to document their knowledge of past and current distribution of diseases in caribou, muskoxen, Dall's sheep, and moose. Participants were shown photographs of various diseases, some that were already known to be present in the region and others that were considered at risk of emerging in the region. We also asked participants if they had observed changes in disease frequency or distribution and if they felt there was any impact

of the diseases on wildlife health. Renewable Resources Councils (RRCs) assisted in identifying potential participants and recommended community assistants who helped organize and implement the sessions. Protocols for focus group interviews followed University of Saskatchewan and Aurora Research Institute ethics protocols.

Harvester Partnerships in Wildlife Monitoring

We trained local wildlife health monitors (WHMs) to collect samples and record health and condition data on animals that they harvested for subsistence. A pilot project was developed in 2004 in Déline. Two aboriginal hunters that were recommended by the local RRC were trained by a wildlife veterinarian in sample collection techniques and data recording using a caribou that they had harvested. Hunters were given an information binder that described the purpose of the program and collection kits, which consisted of a field clipboard with data sheets, sampling diagrams, and pre-labelled sample collection bags and tags. The WHMs were financially compensated for each set of samples and each annual training and update session that they attended. The program was expanded in 2005 to include four additional hunters from Colville Lake (barren-ground caribou) and Fort Good Hope (moose and boreal woodland caribou) and was continued through 2009. When carcasses of caribou or moose have not been available for direct demonstration we have used slide presentations together with props to highlight the key data needed and procedures for sample collection from each harvested animal. In 2008 a draft of the hunter training video was shown to WHMs and copies were distributed to communities once the video was finalized. We communicate with WHMs in person annually during the winter tour, provide feedback and results on the sampling from that year, and obtain feedback from hunters on challenges, unusual observations, concerns, etc. One of the graduate students that participated in the program in 2005 did an independent review of the wildlife health monitor program (Neimanis, 2005).

Targeted Empirical Research

In conjunction with the community-focused aspects of our Sahtu program, we also developed targeted scientific studies. These studies, largely driven by the concerns of local people, the local knowledge of hunters and elders, and past scientific research, have included: evaluation of the

effectiveness of blood filters strips for caribou disease surveillance, dental enamel development and lesions in caribou, caribou bone density and composition studies, gastrointestinal parasite ecology, caribou anatomy, parasite diversity and distribution, and a needs assessment for veterinary services for domestic animals in the region.

RESULTS

Community Workshops

Community workshops during the first 3 years were variably attended but did provide a forum for meaningful two-way sharing of information. In 2005, however, attendance at community workshops was extremely low and local people stated there were just too many other meetings on a wide range of subjects (health, justice, education, municipal issues, Band Council, community consultation by resource exploration companies, etc.) almost every week and “meeting fatigue” was felt by virtually everyone who normally attended wildlife-related meetings. In response, in 2005 we discontinued our workshops and informed the RRCs that we were willing to attend meetings at their request. We also continued to schedule specific sessions to discuss important issues as needed. For example, in January 2008 we held a community feast in Colville Lake to show the first draft of the hunter training video on the caribou monitoring research. We had an open discussion about the video and caribou health and received consent to produce the video as well as useful feedback that was incorporated into the final version. In January 2009, we had community workshops to discuss dog health issues, forthcoming veterinary clinics and a project on caribou anatomy that were attended by 2–12 people and generated useful discussion around these topics.

Cultivating the Next Generation of Scientists

During the annual school visits, we interacted with an average of 385 students per year (range 250–466), which represented the majority of school-aged youth in the five communities. The teachers and students that were interviewed in 2008 were all very positive about their experiences (Fig. 4) and expressed unanimous support for continuing the program. Although the preliminary interviews in 2008 did not include detailed quantitative evaluation of student responses to the program, the feedback has

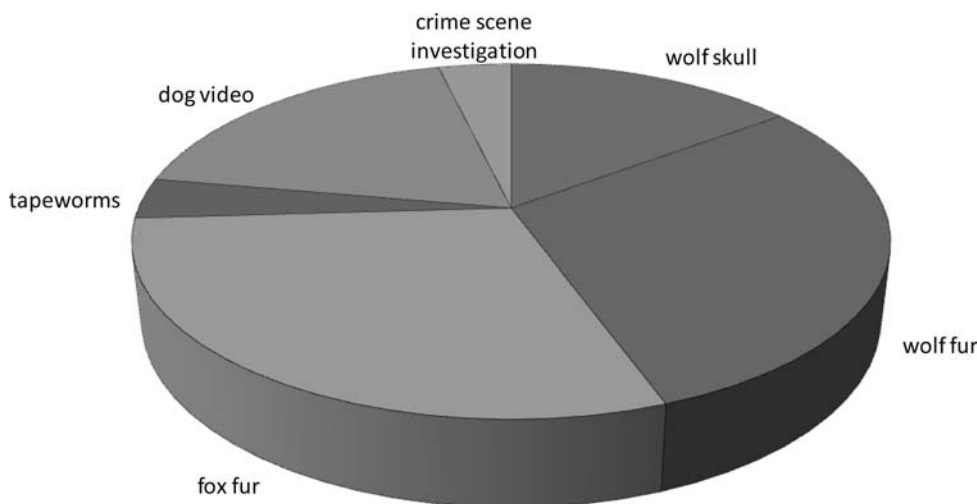


Figure 4. Student selection of their favorite aspect of the classroom education component of the 2008 Sahtu tour.

been useful for developing a more comprehensive appraisal in the future. One teacher noted that:

The information that is presented is fabulous. I particularly like that the program is so adaptable and fits well with all grades. Everyone enjoys the hands-on stuff. (Grade 4 Teacher)

Another teacher observed the need for these types of programs: *“There are very few other resource people like this coming into our community”* (High School Teacher). An important element in the school program is the dissections of local wildlife species (obtained from trappers or GNWT Officers and Technicians) and opportunities to handle diverse specimens, including bird wings, animal fur, bones, and preserved parasites. The interactive elements of the school program were identified by all teachers and principals who were interviewed as being the part that students enjoyed the most and many teachers noted the value of the practical skills as well:

All of the kids really like what they can touch like fur, bones, and feathers. I also appreciate the information on dog safety because dogs come around at recess and the kids tease them with treats and I’m worried someone will get hurt. (Grade K-4 Teacher)

Of the 12 teachers and principals that were interviewed in 2008, only three had been present for all 6 years of the program, but those that had observed several different years all noted how students’ responses changed:

I arrived 5 years ago and in the first year there were no graduates at all and the sciences that we offered

were, I would say, on the low end in terms of quality, but things have improved a lot and the program that your group provides helps getting people to think differently than the basic sciences that we teach. In the first year, the students were very apprehensive, but with each session they began to accept it and started looking forward to it. We have many different groups of people that come to town but never visit the schools, or they commit and then back out. Your program is the only one we have that keeps coming back year after year. Certainly 5 years ago the students would not have asked such smart questions, so I can tell what you are doing is making a difference. (School Principal, 2008)

The 12 local school students that participated as assistants during the 2008 community veterinary clinics all indicated during the interviews that the experience was worthwhile and interesting. Six of the adults who brought dogs in for vaccination commented, without prompting, that they hoped one of the local youth would become a veterinarian and stay in the community to provide regular services rather than the existing sporadic contact with veterinarians. Indeed, in the 2006 Mackenzie Mountain School Yearbook, 45 students from grades 3 to 8 listed their future career plans: 7 wanted to be veterinarians, 3 wanted to be biologists, and 1 each zookeeper and forensic scientist; 22% of the students chose a career along the lines of what is covered in the Sahtu program. Students and teachers from Colville Lake have been very enthusiastic about our participation in the community harvests in 2007 and 2008, and we would like to develop school lead caribou health monitoring projects for this community.

Graduate students were immersed in many aspects of planning and executing the annual tour and participation in the community harvest, including logistics of travel in remote conditions and developing and delivering educational materials for a wide range of youth and adults from a different cultural background. Most of these students received course credit for this experience within their graduate program. One student produced a report on the WHM program that has led to improvements in the program. Another produced a report on the need for veterinary services for domestic animals, and this has led to follow-up activities in this area (Brook et al., 2009).

The graduate students who participated in the tour between 2003 and 2009 all stated that it was a life-altering experience, and one noted that:

Now I do diagnostic work in a lab, but when a sample comes into my lab from the North, I realize the importance of the sample—this is their livelihood and I feel responsible to the northern people. Community capacity building is by far the most important and unique aspect of the program. It helps people make sound decisions about how their resources are managed. (Aleksija Neimanis, 2008)

Another student indicated that her perspectives on community engagement were broadened:

Because of my experience on the Sahtu tour, I am more open to involving northern communities in my research because now I see how much they are affected. This year I am hiring an aboriginal northern resident as a research assistant, whereas in the past I have hired mostly from the south. (Bryanne Hoar, 2008)

Local Ecological Knowledge

Local knowledge obtained informally through community interactions and formally through interviews has produced a wide range of new information that complements our empirical research. For example, hunters identified the presence of a “slimy, yellow/green tea-colored fluid under the skin” of caribou as a recent and unusual observation that was subsequently identified through pathological analysis as fasciitis with eosinophilic infiltration, suggestive of a parasitic disease. Wildlife Health Monitors also

observed that the number of frogs in the region was increasing, the number of swallows was decreasing, and that snow conditions were changing. Elders and hunters were enthusiastic about our school programs and encouraged us to continue these:

Anything that happens to animals we should work on it together. Peter says he'd like to thank you guys for all the information that you gave us, and he's always telling his son that if he sees anything wrong with a moose or caribou that they kill, just to make sure they bring it back home and give it to the [wildlife officer], so that you know, they can talk to the younger people about it so that they know how to care for the animals. You're going to talk to the students tomorrow, too? How you try to work on this kind of research. You can ask for money and you can keep on working. And keep going to the school. You have to keep on working. Keep working for the people. You have to keep working with the animals. For the community. That's what they were trying to do for the past year because only the elders always do things like that, but we always leave the youth behind, but now it's time for our youth to learn things about their own land, about their own animals around. (Hunter from Déline, 2005)

Harvester Partnerships in Wildlife Monitoring

Hiring local hunters as WHMs has resulted in increased, regular, and productive interactions between hunters and scientists as well as new data from 69 caribou and 19 moose harvested for subsistence from 2004 to 2009. We have adapted our sample collection protocol and our hunter training program in response to logistical and communication challenges identified by hunters, graduate students, and biologists. This protocol now serves as the foundation for other hunter-based monitoring programs in Canada. One government wildlife technician observed the broader benefits of the program in informing other people in the community: “*With the information that is out there and the contacts made, if people see something abnormal they are much more likely to report it*” (Richard Popko, personal communication, 2008). A more detailed description and assessment of the Wildlife WHM program will be presented elsewhere.

Targeted Empirical Research

The Sahtu program has facilitated four graduate thesis-based projects, three non-thesis veterinary graduate student projects, one veterinary internship, three undergraduate student projects, and one post-doctoral project; each included empirical research, as well as a community component. Our on-going relationship with the communities has initiated and facilitated research in many ways. For example, in 2006 when we required a large sample of caribou mandibles for a project examining dental enamel hypoplasia, hunters provided 71 mandibles from caribou harvested during 2005 and 2006 for a fraction of the cost to obtain a sample of this size ourselves.

DISCUSSION

Participatory action research (PAR) focuses on 1) responding to the needs of communities, 2) fostering collaboration among scientists, managers, and local people through the research process, and 3) promoting a shared knowledge and increased community awareness (Finn, 1994; Checkland and Holwell, 1998). Communities across northern Canada have expressed a desire for PAR to be meaningfully engaged in research and management of their wildlife resources. The Sahtu program was initiated and has evolved and adapted during the last 6 years to respond to these requests through youth education, hunter engagement, and integration of local ecological knowledge and scientific knowledge. The program has been at times challenged by: extreme cold temperatures ($< -50^{\circ}\text{C}$), difficulty of accessing the communities, uncertainty in funding, low turnout at meetings, high turnover of teachers and other community contacts, declines in caribou, communication challenges, the high cost of travel and accommodations, and several unforeseen circumstances. The strength of the program comes from its integrated nature with mutually supportive elements.

We have developed the “stool model” that recognizes the critical supports needed for a program such as this (Fig. 5). A champion is needed who works to keep all participants informed and engaged in the process and who ensures continuity in knowledge exchange, as well as doing the necessary long-term planning, funding applications, and logistical coordination. Collaboration among all participants is essential to facilitate knowledge and resource sharing, because no one person or organization has the



Figure 5. The “stool model” of collaboration for community-based monitoring and education. Based on our experience, the four legs of success held together by a local “champion” are central to long-term success (adapted from S. Carriere, GNWT, May 2008).

resources or abilities to operate this program on their own. At the same time, collaboration facilitates the shared learning that is regularly occurring among all partners. Long-term funding is fundamental because the costs of accommodation and travel are approximately five times what they would be in the south; each annual 2-week tour costs approximately \$25,000. Educational opportunities for northern students and southern graduate students helps to ensure that we will have effective and experienced veterinarians, biologist, hunters, and community leaders in the future, as well as tapping into an important source of inspiration and new ideas that come from young minds. Designated individuals also are needed to collect, store, analyze, and report data that are collected and share outcomes with all partners.

Throughout the program, we have capitalized on the integrated nature of the different components: community workshops, cultivating future scientists, documenting and using local knowledge, harvester partnerships to monitor wildlife, and empirical research, which are both complementary and mutually supportive. For example, in 2005 the public meetings were not well attended, but we were able to work with students in the schools. In 2008, two of the schools were closed due to the cold temperatures, but we still were able to offer dog vaccination clinics and include local youth as assistants and, in Colville Lake, arrange a community feast and show and obtain feedback on a

hunter training video. These diverse offerings have ensured that each year we have many opportunities to interact with the community and share information on wildlife health, even if one or more components are unsuccessful in a particular year. This combination of components, particularly youth involvement in science, also contributes considerably to generating good relationships among participants. For example, it is unlikely that we would have been invited to participate in the Colville Lake community caribou harvest unless we had a history of doing elder interviews, and establishing the WHM and school programs in this community.

A key strength of this program has been the collaborative nature of all of the participants, particularly the north–south connection of local communities and government management agencies with southern university-based researchers. The university researchers provided key leadership in applying for funding, recruitment of graduate and undergraduate students, expertise in wildlife health and sample analyses, and functioned as the lead on initiating and implementing specific empirical studies. The local collaborators were essential to ensure that the program was relevant to the needs of each community and provided a critical bridge to local community members and teachers and logistical support for all elements of the program. They also provided expertise in wildlife management and accessed funding through other government agencies and co-management boards.

The suite of experience and specialized knowledge brought to the team by each member allowed presentations and discussions that included a broad range of wildlife health issues and put regional wildlife population and health issues into larger territorial, national, and global monitoring frameworks. For example, in 2006 we included a GNWT public education specialist who shared her expertise in youth engagement and a researcher from the University of Guelph who shared his experience developing a web-based environmental education curriculum. The linking of these people through our program was a catalyst to developing a caribou-based curriculum for NWT schools (GNWT caribou program, 2009, unpublished data) that extends resources from our program to regions outside of the Sahtu. We continue to forge new partnerships within the communities and with professionals within government, co-management boards, and universities as required by the ever-changing demands of each element of the overall program.

The school program has provided meaningful connections between students, biologists, and veterinarians so

that future hunters, trappers, and community members and leaders better understand the role of science in wildlife management. Ideally, some of the students will be motivated and empowered to become scientists themselves. The overall impact on the students, however, will only become clear years down the road. Challenges during the 6 years of the program have included cancelled or disrupted school visits due to a scabies outbreak, the death of an elder, weather, and loss of a school to fire. Schools also are limited by access to scientific equipment, so in 2004 we secured a private industry donation to provide a microscope and dissecting equipment for each school. Another challenge has been high teacher turnover in the schools, which has reduced the “institutional memory” and at times disrupted the continuity of the program. Remaining committed, resilient, and adaptable has been essential throughout the program.

The initiation of the wildlife health monitor program was the first step in developing a community-based process for monitoring health for caribou and moose in the Sahtu and also a mechanism for ongoing information exchange among hunters and scientists. Perhaps more important than the physical samples and data obtained was the development of a *process* for monitoring wildlife health. This experience has been instrumental in refining hunter protocols for data collection and sample handling and archiving as part of the CircumArctic *Rangifer* Monitoring and Assessment Network (CARMA), an International Polar Year initiative. Involvement in the community caribou hunt facilitated meaningful extended interactions with caribou hunters and elders and time to offer field classes on caribou health to youth. The combined approaches of linking formal local knowledge interviews with informal annual discussions with WHMs and the broader community, as well as scientific analysis of data and samples from harvested animals provides a comprehensive monitoring and research approach worthy of further consideration. Challenges to the WHM program have included hunter continuity, time conflicts with “wage” jobs, availability of caribou and moose, and misunderstanding regarding details of sample and data collection.

There are many diverse wildlife health monitoring programs globally that incorporate some of the elements of community, education, service, hunter involvement, and empirical research that we describe in our Sahtu program; however, we are unaware of any other programs that incorporate all of these simultaneously. We have learned much from our experiences implementing the program

Table 3. Key Lessons Learned After 7 years (2003–2009) of Implementing the Sahtu Wildlife Health Outreach and Monitoring Program

1. Respond to an identified need.
2. Identify the goals and outcomes and a plan for regularly evaluating if these are met.
3. Expect a mix of support, criticism, and some initial mistrust.
4. Recognize and address the diverse needs, interests, and perspectives of different genders and ages from youth to elders.
5. Integrate science and local knowledge when appropriate and where supported to do so by the community.
6. Seek community engagement and support before proceeding, formally through the local band council and informally through community contacts.
7. Maintain a long-term commitment.
8. Always be open to new ideas and prepare to be versatile.
9. Do not expect things to always go according to plan.
10. Must have a local “champion” and community partners who see the value to the community over the long-term.
11. Recognize the strengths each community has and the unique and common challenges they face.
12. Form diverse, collaborative alliances that span multiple disciplines.
13. Sometimes, despite the best of intentions, a project idea does not work at that time.
14. Ask for and respond to feedback from everyone involved.

thus far (Table 3), but perhaps the most beneficial lesson has been the value and importance of integrating these unique elements and collaborating with people having diverse experience and expertise. We have learned that developing an effective long-term program requires a considerable commitment of time and energy from many people. Identifying trends in disease requires decades of data and achieving this requires capacity building, formation of trust-based relationships with local people, and long-term funding. Diverse, complementary, and effectively integrated approaches to education, outreach, and community-based scientific research are needed to ensure backup when one element does not work as initially intended. This strategy will help to ensure that the program continues to evolve and respond to community needs and produce rigorous scientific results far into the future. Initial feedback from teachers, students, elders, hunters, and collaborators on the Sahtu program thus far has been positive and encouraging; however, more detailed evaluation is needed to ensure that we are meeting community and wildlife management needs, and this is something that we will continue to work toward. We recommend that any similar programs should develop explicit objectives and an evaluation plan at the onset to ensure that the stated goals are being met.

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