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Environmental Change and Traditional Use of the Old Crow Flats in Northern Canada: An IPY Opportunity to Meet the Challenges of the New Northern Research Paradigm

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INTRODUCTION

The Old Crow Flats (OCF), northern Yukon Territory, is homeland to the Vuntut Gwitchin First Nation (VGFN) and is a Ramsar Wetland of International Importance. This vast northern area encompasses 5600 km^2 and approximately 2700 shallow thermokarst lakes, creating a freshwater landscape that has long been an important refuge for Arctic wildlife, while also supporting the traditional lifestyle of the VGFN. Observations and traditional knowledge of the VGFN indicate that the OCF is undergoing pronounced changes in temperature, precipitation, vegetation cover, lake and river water levels, and ice integrity, along with changes in diversity and distribution of wildlife. Of even greater concern to the VGFN is the apparent rate at which these changes are occurring. Placing these changes within the context of recent environmental change (decades to centuries) and within the perspective of previous change under conditions similar to those projected for the future is necessary to formulate an effective strategy of stewardship for the OCF, and to ensure future food security for the residents of Old Crow.

Here we describe the evolution of a community–researcher partnership that defines the Government of Canada International Polar Year (IPY) investigation on "Environmental change and traditional use of the Old Crow Flats in northern Canada (*Yeendoo Nanh Nakhweenjit K'atr'ahanahtyaa*; hereafter referred to as YNNK)"—one of very few fully endorsed programs led by northern-based individuals or aboriginal organizations in Canada (Church, 2009). The YNNK project, led by the Vuntut Gwitchin Government in collaboration with Yukon Environment, Parks Canada, and a multidisciplinary team of southern-based researchers, focuses on addressing the complexities of climate change impacts on the OCF and the nearby First Nation community of Old Crow. Research expertise spans the disciplines of Quaternary paleontology, dendroclimatology, permafrost science, hydroecology, terrestrial ecology, wildlife biology, community health, and traditional knowledge of the land and its processes. Overarching goals are to (1) document the history of environmental change in the OCF from a unique assemblage of archives that record natural history from the last interglacial to the present; (2) assess the distribution and abundance of vegetation and wildlife and identify the processes linking these to the changing physical environment; (3) evaluate the impact of changes in the physical and biological environment on traditional food sources of the VGFN and community adaptation options; and (4) develop a long-term environmental monitoring program for the OCF conducted by the VGFN through the IPY and into the future.

This undertaking also aims to fulfill the mandate of the new research paradigm in northern Canada—one that is collaborative, interdisciplinary, reflective of northern priorities, and policy-oriented (Graham and Fortier, 2005; Wolfe et al., 2007). Much of our progress towards achieving these objectives can be attributed to the strong community–researcher partnership that developed at the onset of this project. This partnership was made possible by the willingness of a fully engaged, motivated, and research-experienced northern community, as well as the exceptional opportunity afforded by the NSERC Northern Research Chair Program and Government of Canada IPY programs. Although YNNK, like every research project, is unique, we believe many of the project outcomes and lessons learned are applicable to community-based, multidisciplinary research across the circum-Arctic. Generalities that emerge from the YNNK experience, which are described in the narrative below, include the importance of (1) community research experience and capacity, (2) community consultation prior to proposal writing, (3) legitimate convergence of community priorities and researcher interests, (4) funding agency guidelines that reward innovative but costly approaches to community-based research, (5) ongoing communication between researchers and the community at all project stages, (6) planning for contingencies, including the timing of funding deadlines, (7) the informal social networks that populate the northern research landscape, and (8) the personal relationships and trust that emerge from working closely together on shared interests.

THE COMMUNITY OF OLD CROW

Old Crow has a population of ~300, mainly Vuntut Gwitchin ("People of the Lakes"), and is the northernmost community in the Yukon Territory. It is thought that the people of Old Crow may be the descendants of the first peoples of North America who migrated across the Bering Strait land bridge from Asia (western Beringia) into eastern Beringia (Morlan et al., 1990). They found refuge in this non-glaciated northwestern corner of Canada, where Ice Age wildlife, including bison, caribou, and mammoth, existed. The timing of this migration remains controversial, but the earliest widespread, indisputable evidence of human occupation is dated to ~12 000 years ago in eastern Beringia (Goebel et al., 2008). However, evidence from the Bluefish Caves southwest of Old Crow suggests people may have lived in the region as early as ~24 000 years ago (Cinq-Mars, 1979), and still older evidence from the Old Crow basin hints at human presence as early as 35 000–40 000 years ago (Morlan et al., 1990; Morlan, 2003). Connections between the land and the earliest peoples of the OCF have persisted to the recent past and remain central to the cultural identity of the Vuntut Gwitchin (Vuntut Gwitchin First Nation and Smith, 2009). While the lifestyle of the people of Old Crow is closely linked to the migrations of the Porcupine caribou herd, all families contain at least one member who participates in the modern wage economy.

Old Crow is a self-governing community, and the VGFN has a rich history of managing its natural resources, as well as taking an active role in scientific research within its traditional territory. For example, a long legacy of paleontological research in the region, conducted by Dick Harrington and others, has involved several generations of Old Crow residents as guides and field assistants, leaving a lasting impression that scientific research creates local employment and, at the same time, international recognition. In 1994, the community participated in the development of the Arctic Borderlands Ecological Knowledge Co-op, an ecological monitoring program for the northern Yukon focused on the impacts of climate change, contaminants, and regional development. This unique partnership highlighted the importance of integrating science with local and traditional knowledge. From these and other past initiatives, the community of Old Crow had obtained considerable experience in collaborative undertakings in scientific research and resource management, which provided a critical foundation for our YNNK project.

CLIMATE CHANGE: AN EMERGING ISSUE FOR OLD CROW

"It's really warm. I don't trust the weather. You can't read the weather anymore."

"We're getting much milder weather—warm winds from the west wind. The winter is warmer."

"Weather changes a lot and is unpredictable—cold to warm, warm to cold."

(Old Crow Citizens, ABEK Co-op, 2007)

Environmental change observations of the citizens of Old Crow are well aligned with both the instrumental record and tree-ring reconstructions of past climate (T. Porter and M. Pisaric, unpubl. data). A regional temperature composite record spanning 1930–2000 indicates that mean temperatures have warmed during all seasons except autumn. The winter season has warmed the most (+1.9˚C), followed by spring (+1.6˚C) and then summer (+1.2˚C). Autumn temperatures have decreased slightly during the same time period (-0.4˚C). YNNK has extended our knowledge of past climate by examining tree-ring records from eight white spruce sites sampled across the Old Crow region. The regional ring-width chronology extends from 1700 to 2007 and is highly correlated with annual Northern Hemisphere temperature anomalies from 1850 to 2007. From these climate-growth relations and the growth record, it is evident that warming during the past two to three decades exceeds that of any other period during the past 300 years.

Observational evidence and concerns associated with the environmental consequences of recent warming (e.g., low water levels in rivers and lakes, thawing permafrost, changing wildlife abundance) motivated the local community's interest in climate-focused research. Indeed, convergence of community needs and researcher expertise was an important factor that contributed to the formulation of the YNNK project, as described below.

GENESIS OF A COMMUNITY–RESEARCHER PARTNERSHIP

The initial connection between many of the researchers that became involved in YNNK was the Natural Sciences and Engineering Research Council of Canada (NSERC) Northern Research Chair Program (NRCP). The creation of this program was one of several recommendations of a joint NSERC and Social Sciences and Humanities Research Council Task Force on Northern Research established in 1998, which found that Canadian northern research was in crisis and that immediate action was required to train a new generation of northern researchers and to increase the amount of high-quality research being done in the North. The NSERC NRCP has the following four objectives: (1) Research: to contribute to the body of knowledge in fields of northern natural sciences and engineering, (2) Training: to train new northern researchers, (3) Partnerships: to build meaningful northern research partnerships, and (4) Communications and promotion: to communicate northern research issues and promote northern research and training within Canadian universities. The first and only NRCP competition was completed in 2002, and six university chairs were funded, with research programs focused on Quaternary geology (Alberta), permafrost (Carleton), plant

ecology (Laval), fisheries science (Manitoba), traditional food security (McGill), and hydrology (Wilfrid Laurier).

As the six chairs became familiar with one another's research programs and shared perspectives on northern research during annual meetings, they became interested in conducting a collective, multidisciplinary research project consistent with the objectives of the NRCP. One chair frequently mentioned the community of Old Crow as an excellent candidate partner for such research. Although he had limited direct experience working with this community, he and several of the other chairs were aware that Old Crow was a community that strongly valued traditional lifestyles and had a strong track record of support for, and involvement in, community-based research. In fact, one of the other chairs and a newly hired collaborator of yet another chair had already initiated research projects in Old Crow.

The emergence of Canadian funding in support of IPY activities created an opportunity for the NSERC NRCs to put their plans for a collaborative research project into action. The first Canadian IPY funding opportunity to be announced was a $6 million, three-year NSERC IPY Program intended to support the participation of Canadian researchers in IPY projects. One of six criteria on which projects were to be judged was the involvement of Northerners, including (1) plans to engage Northerners in the planning, conduct, and dissemination of the research, (2) relevance of the proposed research and training to the needs and objectives of Northerners, and (3) plans for inclusion of traditional knowledge in the research. The NSERC IPY program was announced in early September 2005 with an application deadline of 5 November 2005, which was later extended to 28 November 2005.

The extremely short timeline between NSERC's IPY program announcement and the submission deadline initiated a flurry of proposal and project-development activity throughout the Canadian northern research community, including the NSERC NRCs' discussion regarding a potential Old Crow-based project. After several email exchanges and conference calls, it became evident that although most of the chairs and collaborators were genuinely interested in the possibility of submitting a proposal for an Old Crow IPY project, they disagreed about the feasibility and advisability of attempting to submit a proposal in time for the NSERC deadline. One group, including two researchers who had direct research experience with Old Crow, felt there was too little time for adequate community consultation and involvement prior to the deadline and tried actively to dissuade the other researchers from moving forward with a proposal. The other group was hesitant to let this funding opportunity pass and was more optimistic about the potential for rapidly engaging the community in a project proposal. The researchers did not speak as a group with representatives from the community of Old Crow during this period, but several researchers had informal conversations with community representatives to assess the community's potential interest and support.

Around this time, it became apparent that there would be an additional, larger pool of funds available in the form of a $150 million Government of Canada IPY Program, which included a call for research proposals with an application deadline of 10 March 2006, later extended to 31 March 2006. Although this deadline was only four months after the NSERC deadline, it provided the chairs and the community of Old Crow a critical window of opportunity for communication and co-development of a community-based research proposal. Following the false start generated by the short NSERC timeline, both the researchers and the community now had at least a little more time to restart the process with a blank slate, as well as more available funding if a competitive proposal could be pulled together. In hindsight, a strong foundation to the evolving partnership between the community and the researchers was established during that four-month interval. That period has had lasting, positive impacts on the research and partnership outcomes, and it represents an extremely important juncture for the subsequent successes of the project.

SETTING THE COMMUNITY AGENDA FOR COLLABORATIVE RESEARCH

Upon invitation from the community, three of the NSERC Northern Research Chairs and two of their collaborators, along with a representative from Parks Canada and the Northern Regional Biologist for the Government of Yukon, gathered in Old Crow in January 2006 for a two-day meeting. Their goal was to explore the possibility of developing a collaborative research program aligned with the scientific priorities set out by the Government of Canada IPY Program: Climate Change Impacts and Adaptation and Health and Well-being of Northern Communities. Staff of the Vuntut Gwitchin Government (VGG) Natural Resources Department (NRD) and the North Yukon Renewable Resources Council (NYRRC) hosted the meeting, and they greeted the researchers at the Old Crow airport with agenda in hand – a welcome, tangible sign that local capacity was in place to take a leadership role in developing the research program.

Discussions during Day 1 focused on sharing information regarding the nature of previous research conducted in the Old Crow Flats, knowledge gaps that inhibited comprehensive development of an ecosystem management plan, and directions of scientific enquiry that researchers thought could help to fill the knowledge gaps. A community dinner was held at the end of Day 1, which was followed by introductions and presentations by the researchers to the community. The evening concluded with compelling testimonies by community members, who recounted their observations on the effects of the accelerating rate of climate change (e.g., thawing permafrost and slumped banks along the rivers, vegetation changes, falling water levels in lakes and rivers, and declining wildlife populations). The instrumental weather record from Old Crow airport for 18 January 2006

indicates that outside air temperature while this meeting took place was -42˚C. Hearing the community speak with such consensus about the reality of a warming climate and the widespread impacts it was having on their land and lives, on such a cold night, made a strong and lasting impression on all of the researchers present at the meeting. The observations shared with researchers that evening are echoed in Old Crow contributions to the Arctic Borderlands Ecological Knowledge Co-op around the same time period.

> "The water in the rivers is low. Everything is drying up."
> "I see a lot of land slides and a lot of lakes drying up."
> "I notice that the willows are growing bigger and the trees are growing faster"
> (Old Crow Citizens, ABEK Co-op, 2007)

> "I see a lot of bank erosions along the river and permafrost melt."
> "The land is drying up and the permafrost is melting fast."
> "The weather is getting warmer and warmer. Plants are growing faster, especially the willows."
> "There are lots of willows—lots of growth."
> (Old Crow Citizens, ABEK Co-op, 2008)

While several community members welcomed the opportunity to share their stories, many also welcomed the researchers to offer their expertise to complement local understanding of their traditional territory.

This first community meeting was particularly effective and important for two main reasons. First, it provided the community with the opportunity to set the agenda for the research program at the outset of the research planning process, thereby establishing community engagement, which has been a strong feature of the project throughout its existence. Secondly, the community clearly conveyed its main concerns, which armed the researchers with the knowledge necessary to start formulating research objectives for the IPY pre-proposal on Day 2. The pre-proposal was written on various laptops spread around a large table in the NYRRC office, with the active participation of community members and local leadership, including the NYRRC chair, the VGG NRD director, and the VGG Chief, who were present throughout the day. By the end of Day 2, the pre-proposal was largely complete, including a section on community consultation written by the Chief. Further defining of specific roles among the researchers and NRD staff laid the groundwork for preparing the full proposal over the following three months, a task which was adeptly and efficiently coordinated by staff of the NRD.

A year later, after learning that the full proposal had received a positive review but before any funding was granted, several of the researchers as well as prospective graduate students once again met in Old Crow on 23–26 February 2007 to make tentative plans for the summer field season. Because of the time required to address various logistical needs for fieldwork, such as arranging

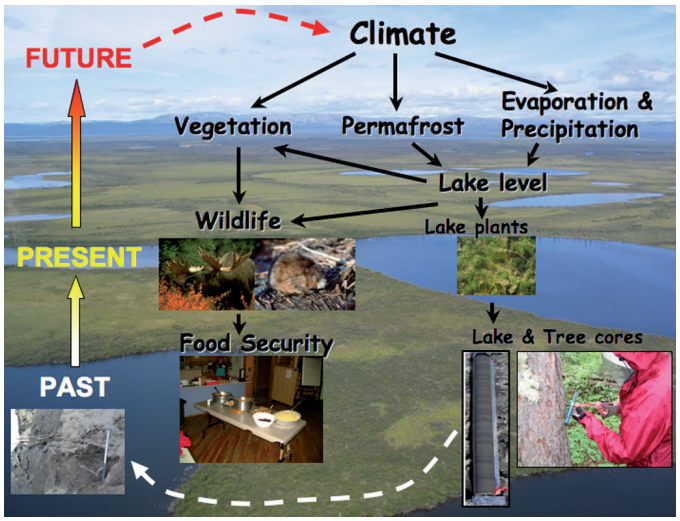

FIG. 1. Graphic used to explain research elements and interactions within the YNNK IPY project "Environmental Change and Traditional Use of the Old Crow Flats in Northern Canada" to the community of Old Crow.

accommodation and hiring local field research assistants, it was not possible to delay this meeting until confirmation of the grant, which was not expected for several weeks. Two evenings were set aside to meet with the community, mainly to remind people of the IPY project that they had helped to design and provide another opportunity to contribute to the research now that general objectives were about to be translated into specific research activities. This was a challenging transition because some community members had not participated in the previous year's meeting or needed to be reminded of the extent to which this research project was motivated by their previous input. After the first evening of community meetings, the researchers realized that an effective graphic was needed to explain various components of the project and how they related to each other. Thus, Figure 1 was crafted later that evening by several of the researchers with their laptop computers around a kitchen table. It was introduced during the second evening and has been used as a visual aid and reminder of the project in subsequent meetings and written reports produced for the community. While these efforts were aimed at improving our ability to communicate to the community, collective design of the figure also challenged the researchers to identify clearly the links between the several individual projects and where integration could potentially occur. Thus designing the figure was also an important team-building exercise.

Furthermore, now that funds were soon to start flowing and research activities would soon begin, the logistical complexities and funding allocations involved in remote, collaborative research had to be addressed. Where would researchers and their equipment stay in town, and at what cost? How would local hiring of guides, equipment, and research assistants be arranged? When can you travel from Old Crow to Old Crow Flats by skidoo or boat, and where can you go once you get there? It quickly become apparent

FIG. 2. Photographs of a mapping workshop held with the community of Old Crow (February 2007).

that project logistics and research activities would require at least as much innovative community-researcher partnership and communication as was involved in the project proposal development. Thus, a particular focus and highlight of the second evening of community meetings was a successful mapping workshop that provided opportunity for community members to identify locations of interest and travel routes in the OCF, which served to help establish lake study sites for the hydroecological research group (Fig. 2). Discussions with community members focused mainly on whether they had recently observed changes in water level and the timing and location of these observations. This reporting was another key element in the process of directly engaging community members and incorporating traditional knowledge in the study design. For example, during the mapping workshop, one member expressed concern over the impending drainage of a large lake in his family's traditional territory, which, as predicted, came to pass in June 2007 (see Wolfe and Turner, 2008).

Notably, the initial two research planning meetings in Old Crow occurred before any fieldwork took place—the first, more than one year in advance of receiving IPY funding. The collective estimated cost of travel and accommodation for these two meetings was roughly $50 000, which was absorbed by a small group of northern scientists, most of whom were fortunate to have access to NSERC NRC funding that prioritized northern partnerships. Certainly, these are unique circumstances upon which a northern research program has been constructed. A key outcome, however, is that these efforts to build relationships before the research was designed and implemented have created a positive framework that has ensured ongoing applicability of the research to community needs. Indeed, these key early steps may serve as a model for effective collaboration among northern communities, researchers, and funding agencies to address environmental consequences of climate change.

ONGOING KNOWLEDGE EXCHANGE ACTIVITIES AND TRAINING

Subsequent field seasons and annual winter meetings in 2008, 2009, and 2010 have formed the cornerstone of knowledge transfer and exchange. Numerous research presentations and posters have been provided to the community, and plain language pamphlets summarizing research activities,

progress, and findings have been distributed. These activities have not only kept community members informed of the research progress, but also provided excellent opportunities for them to contribute directly to the research endeavour by sharing their knowledge, observations, and concerns, as described above. Many local residents have been hired to work with YNNK research teams, and several of these assistants have gained experience with multiple research teams focused on diverse aspects of environmental research. For example, the muskrat research component of YNNK has relied heavily on a carcass collection program involving local trappers and administered by the NYRRC. Local trappers record the location of trapped muskrats and the date. Carcasses are then shipped to a university facility to be analyzed for nutritional and health status, which is reported back to the community. In addition, interviews on muskrat ecology, harvesting, and processing have been conducted with local knowledge experts to formally document and broaden the scope of the traditional knowledge that has already been contributed informally and incorporated into the project.

Highlighted among our knowledge-exchange activities was an NSERC Northern Research Internship awarded to PhD student Ann Balasubramaniam during the summer of 2008 (Balasubramaniam, 2009). Ann's internship activities, supported by the partnership with the VGG, were numerous, far-reaching, and lasting. She provided expertise to the NRD, trained NRD staff in field activities that will lead to the development of a community-based hydroecological monitoring program, delivered a research seminar at the Biennial Gwitchin Gathering, led a science camp for the children of Old Crow, and overall raised the profile of the research program while serving as an excellent role model for the community's younger generation. Ann's efforts strengthened what were already strong ties with this community, which has had long-lasting positive effects as YNNK has evolved. She continues to work with NRD staff on YNNK-related projects, which included serving as a liaison between NRD staff and researchers to coordinate and lead subsequent community–researcher winter meetings in 2009 and 2010.

Indeed, the northern training experiences for graduate students participating in YNNK have been particularly enriching. Four graduate students began their programs at the MSc level but decided to fast-track to the PhD program to take greater advantage of research opportunities within YNNK. Many of the participating graduate students have been to Old Crow on numerous occasions to conduct fieldwork and to meet with the community to report research progress. Some PhD students have been to the community for as many as four consecutive winter meetings to plan their research, share their findings, and obtain feedback from the community. They, in particular, have developed vitally important skills in communicating their science in language that is understandable and relevant to community members, as shown by the comments one community member sent to the NRD director following the 2010 winter meeting:

> I was very much impressed with the outcome of the International Polar Year, Annual General Meetings held in Old Crow last weekend from February 19 to 21, 2010. Each time I was there, there were many local people in attendance. I think that was because many of the local people were involved with the researchers, helping them out in some way either by skidoo or boats or by sharing of their traditional knowledge. And seeing the number of people there at the meeting that told me they were interested in the findings of the researchers, the findings of the research that took place in Vuntut territory and also the relationships that had built up as a result of this amount of research for a small remote community.
>
> This IPY research as was stated many times was a collaborative effort from the beginning. It was made clear to the researchers from the beginning to always be in touch with the community and keep it simple. That is what they did last weekend, they brought it home to the folks here, their information, their presentations with many pictures in an easy to understand simple language format.
>
> I think all future joint meetings whether it be with Parks, Fisheries etc, should be done in this manner. Maybe it is done but this weekend sure showed how well things can go if everyone is on the same page going in the same direction at a good pace, not rushed, not slow, just right.
>
> *Mahsi' Choo* [Thank you] for all your coordinated efforts in seeing the IPY file going in a good way from the beginning. This is a huge amount of work that has accumulated over 3 years but work that has good results also and that is what we need to see as a community and we need to continue to see it so we are always kept in the loop and kept informed about the scientific changes and mesh this with the traditional knowledge, the changes that we ourselves see on our lands.

This project has thus provided necessary and excellent opportunities for graduate students to learn what communities, as well as government agencies and funding bodies, expect from northern researchers. Training of the next generation of northern researchers has been of exceptionally high quality.

During the community–researcher meeting of winter 2009 in Old Crow, the researchers and their graduate students had a special opportunity to participate in a very successful outreach program. Organized by leaders of the Arctic Health Research Network (including an Old Crow community member), with funding from Health Canada, the "Our Changing Homelands, Our Changing Lives" youth conference brought ~25 students from Whitehorse (many originally from Old Crow) to Old Crow to participate in the annual community–researcher meeting. A major focus of the conference was climate change workshops (including Historical Air Photos, Permafrost, Wildlife, Fossils, Tree Rings and Hydrology; Fig. 3) conducted by YNNK team members. Each research team was challenged to construct

FIG. 3. Photographs of climate change workshops offered to youth during the "Our Changing Homelands, Our Changing Lives" youth conference (January 2009). Clockwise from upper left: Tree Rings, Wildlife, Historical Air Photos, and Permafrost.

an interactive, fun workshop that would run for two to three hours and present research in a way that young people could easily understand. The northern students who participated in these workshops became much more aware of both the changes that are occurring in their traditional territory and the natural science approaches researchers are using to understand how the Old Crow Flats landscape is responding to a warming climate. For instance, one of the workshops used sprouts (representing moss) and broccoli (representing trees), among other ingredients, to examine the effects of different surface features on thawing "ice-cream" permafrost. This workshop was particularly effective in delivering its scientific message (and made for an interesting post-experiment snack for workshop participants!). Senior members of the community of Old Crow also participated in these workshops and made important contributions. For example, during the Tree Ring workshop, a YNNK co-investigator was showing samples of tree cores collected from the OCF, all of which displayed remarkably thicker growth rings over the last few decades (as described above). After the presenter explained that these rings are thicker than any other decade since ~AD 1700 because of the positive growth response to recent climate warming, a community elder remarked that his personal experience also told him that changes in the Flats began in the 1950s. Thus, findings from a natural science IPY-supported study and traditional knowledge converged, and the youth who attended the workshop had the special opportunity to experience this firsthand. Committed local leadership combined with the creativity of researchers and their graduate students in workshop design generated considerable energy that translated into a memorable experience for all.

CHALLENGES

The successes we have highlighted above were accompanied by challenges that are common to many collaborative research undertakings in the North. Some of these have been overcome, while others remain to be addressed. Below we describe some of these challenges in the context of our project, offer insights into how they have been met, and lay out plans for achieving future goals.

The consistency and continuity of research engagement with northern communities over a multiple-year collaborative study can be strongly influenced by the high staff turnover in local government positions (e.g., Wolfe et al., 2007). During the very early phases of project development, an

individual who served as the Lands Manager for the NRD played a pivotal role in coordinating elements of the IPY proposal, which included writing key sections on behalf of the VGG and organizing and leading the community–researcher meeting in 2007. This individual's tremendous leadership and communication skills contributed substantially to the successful outcome of the grant application to the Government of Canada's IPY Program. She played a similarly critical role in helping to launch many of the project components once funding was in place (e.g., coordinating fieldwork logistics such as arranging accommodation and hiring local field assistants). Upon learning in early 2007 that she was leaving her position to go back to university, many researchers were concerned that her departure could derail the project since she had all of the local corporate memory of the collaborative project from its initial conception, was well respected by members of the community, and communicated extremely well with the researchers. Around this time, however, a new NRD director was hired, and YNNK-related roles and responsibilities of the Lands Manager were effectively and successfully transferred. Thus, the project has not suffered but rather thrived in this respect because, while different community-based individuals have held important leadership positions over the five years that span project conceptualization, development, and execution, an integral constant has been the presence of strong local capacity. In the absence of key staff members committed to project goals, researchers may commonly find themselves revisiting issues they thought had previously been addressed to the satisfaction of community representatives (e.g., research objectives, methodology), which can significantly impede research progress. While steps such as these may very well be a frequent reality of the collaborative process, the consistent presence of effective local leaders has meant that we did not need to spend much effort on revisiting old issues.

The cost of conducting northern research is a perennial challenge, and our YNNK project is no exception. While our ~$1.7M grant application was fully funded, it represented only a small proportion of the real cost of conducting this research program. For the hydroecology group, for example, funding from IPY has been used almost exclusively to charter a helicopter for repeated water sampling of lakes and rivers in the OCF. Overall, this research component has had an operating budget of ~200K/yr. Approximately 30%–40% has been supported directly by IPY, and the remainder (e.g., research assistantships, local field assistants, analytical costs, travel for fieldwork, community meetings and conferences) was covered by other sources (including NSERC NRCP, the Polar Continental Shelf Program, the Northern Scientific Training Program, and Parks Canada). Leveraging to obtain a new NSERC Strategic Project grant has also been successful. This new grant has further strengthened partnerships between researchers, the NRD, and Parks Canada, and it has provided additional resources to support development of a hydroecological monitoring program for the OCF—a key objective of the IPY project. Assembling various funding sources to support Canadian research in the North is certainly not a new reality, but the magnitude and corresponding impact of the research has very clearly benefited from implementation of the Task Force on Northern Research recommendations and the IPY. Although unprecedented resources have recently been available, concerns over our ability to sustain such research activity post-IPY are frequently mentioned by Old Crow residents during our annual meetings and indeed expressed by many in the Canadian northern research community (e.g., England, 2010). Certainly, many of the researchers would like to continue their Old Crow research beyond the IPY grant period, although new funding opportunities are required to develop formal plans.

A key criterion of the Government of Canada IPY Program was for projects to leave a legacy, and proposals were asked to address long-term benefits, such as knowledge translation to communities, capacity building, and future collaborations. While considerable progress has been made, especially with regard to knowledge translation, other legacy aspects remain to be achieved. For example, one of our collective goals outlined in our proposal is to establish community-based environmental monitoring activities (e.g., measurements of snow and active-layer depth to monitor permafrost, water sampling to monitor lake water balance, and animal tracking to monitor wildlife abundance) to maintain the integrity of observations from the YNNK into the future. The benefits for the community of continuing these activities are clear. Establishing a long-term monitoring program for the OCF will generate the necessary knowledge to provide ongoing assessments on the status of the OCF landscape and responses to changes in climate, so that appropriate adaptation plans can be developed and implemented to sustain traditional ways of life. Preliminary discussions with NRD staff have been positive, but concerns about sufficient local capacity to fully commit to such a program are an unfortunate reality, as for many northern communities. On the other hand, productive and ongoing discussions with Parks Canada staff regarding a collaborative undertaking to implement an aquatic ecosystem monitoring program for both Vuntut National Park and the VGFN Special Management Area of the OCF suggest that this may indeed be possible. Much work is still required to design a monitoring program that balances scientific rationale with logistical constraints in a post-IPY funding environment, however, and accomplishing this work is a major goal of field activity planned for the final two years of IPY-funded research.

CONCLUDING COMMENTS

"Vision, capacity and partnership": these words by Bob Van Dijken of the Yukon IPY Coordination Office in his opening address at the 2010 YNNK community–researcher winter meeting in Old Crow eloquently expressed why this project had succeeded. Leaders of the community of Old

Crow had the vision to engage with researchers collaboratively to identify the effects and consequences of climate warming on their traditional territory, although convergence of community interest, researcher expertise, and funding opportunity cannot be overemphasized. Local capacity was in place to ensure the research agenda spoke to the needs of the community from the outset of the planning process, through conceptualization, development, and execution, while the community also welcomed the skills and knowledge that government scientists and a group of southern university researchers could bring. The partnership not only has been sustained, but also has evolved over a five-year period—from designing research questions, to conducting field-based research, to delivering collaborative outreach activities, to communicating findings in an effective format—which speaks to both the vitality and uniqueness of this northern community and the commitment and energy of the researchers and graduate students.

We acknowledge that much of what we have described is seen through the lens of the researchers involved in this project. Certainly, no one would disagree that the community perspective is likewise essential to capture and relay, and thus it is the subject of an ongoing PhD thesis within our program (Brunet, 2010). It is our hope that documenting our collective experiences of a collaborative community–researcher undertaking that strove to meet the challenges of the new northern research paradigm will also leave an important IPY legacy.

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