PERSPECTIVES OF NORTHERN RESEARCHERS, RESIDENTS AND EDUCATORS ON SCIENCE EDUCATION AND OUTREACH IN YUKON, CANADA

by

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ABSTRACT

International Polar Year 2007-2008 renewed interest in and funding for circumpolar research. One unique element of this International Polar Year was the focus on education and outreach initiatives. This study explores outreach stakeholders' perspectives on conducting science outreach with northern Canadian schools. A total of sixty semi-structured interviews were conducted with northern researchers, residents and educators to determine culturally appropriate and pedagogically suitable methods for educational outreach initiatives in the Canadian north. I examined northern resident and educator experiences with integrating Indigenous and Western ways of knowing, identified factors supporting educational outreach initiatives, and provided recommendations on how to strengthen educational outreach partnerships. Results show that institutional barriers discourage researchers from participating in educational outreach. Northern residents and educators viewed integrative science as an effective method to engage students in Indigenous and Western science, and to encourage collaborative educational outreach partnerships amongst outreach stakeholders.

LIST OF ABBREVIATIONS USED

APECS	Association of Polar Early Career Scientists
CIHR	Canadian Institutes of Health Research
CZGS	Chief Zzeh Gittlit School
ESW	Education Support Worker
FNPP	First Nations Programs and Partnerships Unit (Yukon Department of Education)
IPY	International Polar Year
ICSU	International Council for Science
IQ	*Inuit Qaujimajatuqangit*
ITEX	International Tundra Experiment
YNNK	*Yeendoo Nanh Nakhweenjit K'atr'ahanahtyaa*: Environmental Change and Traditional Use of the Old Crow Flats in Northern Canada
NSERC	Natural Sciences and Engineering Research Council (Canada)
PCMB	Porcupine Caribou Management Board
PPS Arctic	Present day processes, Past changes, and Spatiotemporal variability of biotic, abiotic and socio-environmental conditions and resource components along and across the Arctic delimitation zone
PPS Arctic Canada	Present processes, Past changes, Spatio-temporal variability in the Arctic delimitation zone, Canada
SSHRC	Social Sciences and Humanities Research Council (Canada)
TCPS	Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (Canada)
VGFN	Vuntut Gwitchin First Nation
VGG	Vuntut Gwitchin Government
WCED	World Commission on Environment and Development

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CHAPTER 1: INTRODUCTION

1.1 Introduction to the problem

Polar regions have received considerable attention in recent years due to the disproportionately strong effects of global climate change both experienced and documented (Hamer and Peters 2007). Human-induced climate change has influenced the migration and introduction of new species into northern regions and led to an increasing severity of storms and forest fires (IPCC 2007, Rosenzweig *et al.* 2008). In a synthesis paper, Serreze *et al.* (2000) investigated environmental change in northern high-latitude environments and found that the Arctic has experienced an "amplified response … to enhanced greenhouse forcing" and the climate is currently the warmest it has been in at least 400 years. To test the impact of continued and intensified Arctic and sub-Arctic warming, researchers with the IPY-funded International Tundra Experiment (ITEX) used open-topped chambers to passively increase the temperature of the tundra-ecosystem by 1 to 3ºC (consistent with predictions as outlined by IPCC 2007), and found that this 'slight' temperature increase has resulted in decreased plant diversity and evenness following the increased growth of shrubs that shaded out lichens and lower-growing plants (Walker *et al.* 2006). This change could potentially have great impact on northern ecosystems, as lichens are an important food source for many animals, especially caribou. The caribou's diet is almost entirely dependent on lichen, with 70% of the caribou's winter food source coming from lichen foraging (Sherry and VGFN 1999).

The recent 2007-2008 International Polar Year (IPY) brought much attention to assessing the historical impacts of a changing climate, trying to situate our current climate in this history, and studying the current state of northern ecosystems (Church 2009, Barber *et al.* 2010, Callaghan *et al.* 2011). Canadian IPY funding was distributed though a competitive process through the Government of Canada's IPY National Office ($150 million) and the Natural Sciences and Engineering Research Council of Canada (NSERC) ($6 million). Forty-four projects were funded, each focusing on at least one of the two core project areas: science research of climate change impacts and adaptation; and well-being of northern communities (Government of Canada 2008b). The call for funding was made in

2006, funding was allocated in 2007, field research seasons occurred between 2007 and 2009, and currently analysis, synthesis and legacy projects are underway to ensure that the impact of IPY is both substantive and long-lasting (Government of Canada 2008b).

Recent environmental change, attributed to such climatic changes described above, have challenged northern residents who, in spite of the latest influx of modern technology and the establishment of government institutions and programs (e.g. employment programs), continue to depend upon their local environment to continue as a people and survive as a culture (Chapin *et al.* 2004, Kulchyski 2005). As the second focus of IPY funding, much IPY research investigated the past, current and future health and well-being of northern residents. Many research projects were southern-based, university coordinated projects, however there are several notable exceptions, including that of the north Yukon Old Crow Flats research project which saw the community of Old Crow form the core network and then seek outside researchers to assist in answering their ecological questions and concerns.

Rapid environmental change in northern communities (and Indigenous communities in particular) is producing new environmental and cultural vulnerabilities, and recent implications of these changes are only beginning to be studied (Ford and Smit 2004, Ford *et al.* 2006, Furgal and Seguin 2006). Nickels *et al.* (2002) explain that local environmental changes are reported in many northern communities, such as increasing frequency and intensity of extreme storms, ice instability, earlier spring ice break-up, disappearance of permafrost, changing animal migration routes and decreasing animal and fish health. In order to meet the challenges posed by global climate change and ongoing socio-cultural change, populations in the North must continue to adapt and achieve resiliency through difficult conditions, as they have done in the past (Smit and Pilifosova 2001). In order for northern scientific research to benefit northern communities, researchers must engage northern residents (such as Elders, educators, knowledge-holders, land users and managers) in the research process (Chapin *et al.* 2004). This allows research to provide relevant and responsive alternatives for northern communities facing an ever-changing climate.

In part to strengthen community resilience and as part of Canada's involvement in IPY, the federal government identified community outreach and capacity building as one of their priorities (Government of Canada 2008b, Paci *et al.* 2008). There is a need to understand how to convey the findings of the data gathered within northern communities. The International Council for Science (ICSU) IPY 2007-2008 Planning Group identified five target audiences for education and outreach activities: primary and secondary students, young polar researchers[1], Arctic communities, the general public and decision makers (ICSU 2004). The ICSU specifies that students should have access to educational projects, and all Arctic residents should have access to outreach opportunities. More specifically, Perovich *et al.* (2003) identified schools and classrooms as particularly effective venues for conveying such research. These researchers also identified the difficulty of integrating this material into the curriculum, but noted that collaboration with teachers was key for the success of this amalgamation.

Petitioned by the Arctic Council, the 2004 Arctic Human Development Report found that education can contribute to cultural loss and standardization, but it can also be a powerful "tool for renewal [and] northern revival and development" (Johansson *et al.* 2004, p. 183). A founding figure in postcolonial theory, Edward Said (1994) argued that imperialism and colonialism undermined Indigenous knowledge systems. From her experience as an Indigenous researcher, Maori activist, and professor of education, Tuhiwai Smith (1999) examines twenty-five ways in which research – when controlled by Indigenous peoples – can be part of the decolonization process by celebrating the theme of Indigenous survival, indigenizing knowledges (privileging Indigenous voices), intervening (working for positive change) and connecting (such as the interconnection of humans and the environment). Informed by such critical theory, Baker and Giles (2008) found that critical inquiry methods of inquiry allowed them to collaboratively develop a culturally relevant aquatics program in Taloyoak, Nunavut, by recognizing the cultural

[1] I use polar and northern interchangeably. However, I adhere to colloquial uses of these two terms and therefore I usually use northern when discussing the people and cultures of the three Canadian northern territories, and polar to describe the location of the science in these regions.

and geographic context of such northern communities. They found that by using a dialogical approach, they were able to reciprocally engage with the community (as an 'outsider' with values different to those in Taloyoak) and through this dialogue co-develop a relevant and effective aquatics program.

Northern teacher and land claims lawyer John Bainbridge (2007) challenges that, as in much of the Canadian North, "most of the schools in Nunavut do not offer an education that reflects Inuit societal and cultural values" (p. 762). In all Canadian northern territories, the majority of the curriculum is borrowed from the southern provinces; the Yukon primarily uses British Columbia's curriculum, and the Northwest Territories and Nunavut primarily use Alberta's curriculum. Bainbridge further explains how it is "well established that one of the core solutions to the problem of the low achievement of Aboriginal students is that the schools they attend must reflect their culture and the societal values of their people" (p. 762). To this end, all three northern territories are undertaking wide-scale projects to design and to write courses that are founded in northern perspectives and explore the knowledges and experiences of northern people and northern Indigenous cultures (Lewthwaite *et al.* 2010, CBC 2012). With the creation of locally-controlled school councils, many northern communities are gaining and deepening their influence in the content and methods used in their schools (Johansson *et al.* 2004).

There are numerous documents outlining recommendations for researchers to help negotiate their research relationship with northern communities (ITK and NRI 2006). However, as outlined in a personal communication from Nunavut Research Institute's IPY coordinator Jamal Shirley on November 20 2008, there is a lack of understanding, direction and instruction for researchers and communities interested in bridging the gaps between polar research, research outreach, and in-school science promotion; Shirley comments that there are many opportunities – often overlooked or not understood – to link research and education in the north. The purpose of this project is to explore how collaborations between northern researchers, residents and educators can support the promotion of Western and Indigenous knowledges in northern schools.

1.2 Research objectives

The thesis will contribute to the literature linking northern research with northern education and develop strategies to support more meaningful exchanges between northern residents and researchers as part of the research and learning process. The results of this thesis will be useful in better understanding effective methods in disseminating the research of northern researchers and networks. Acting as a case study for community consultations for science education and outreach projects, this research contributes to improving the understanding of how best to explore the knowledges of researchers alongside the knowledges of the northern communities in which they work.

The main goal of this thesis is:

> ***To determine the most culturally appropriate and pedagogically suitable methods to integratively use Western and Indigenous science for the purpose of science outreach in northern communities.***

The research objectives are:

i. To examine the experiences, perceptions and components of integrative education from the perspective of northern residents, educators and researchers

ii. To identify the factors of science outreach programs that support educational outreach and provide opportunities for participants to examine the world around them from two cultural perspectives

iii. To provide recommendations on strengthening polar science educational outreach that addresses the unique needs and interests of key stakeholders (residents, educators and researchers)

The primary research question is:

> ***How can the knowledge of IPY researchers and northern Indigenous residents be used to create culturally-relevant educational materials for northern students?***

1.3 Research community: Old Crow, Yukon

Several criteria guided the selection of the community whom with I would conduct this research. First, my research and academic funding came through the treeline ecology IPY research group PPS Arctic Canada.[2] As shown in Figure 1.1, my research would occur in one of the communities near a PPS Arctic Canada field study site. To reduce the number of potential partnership communities, I constructed three additional requirements: residents needed to be familiar with IPY research conducted in the area (such as acting as research assistants), residents had to be familiar with research outreach in the community (such as outreach presentations or field camps), and local leadership needed to be interested in partnering and participating in the project. To determine community suitability and interest, I inquired northern research centres, PPS Arctic Canada researchers, schools and local governments. From these inquires, as shown in Figure 1.1 below, three communities were identified that had both familiarity and interest in this research: Old Crow, Yukon, Kangiqsujuaq in the Nunavik region of Quebec, and Happy Valley Goose Bay, Labrador.

[2] PPS Arctic Canada is the short form of 'Present processes, past changes, spatio-temporal variability in the Arctic delimitation zone, Canada'.

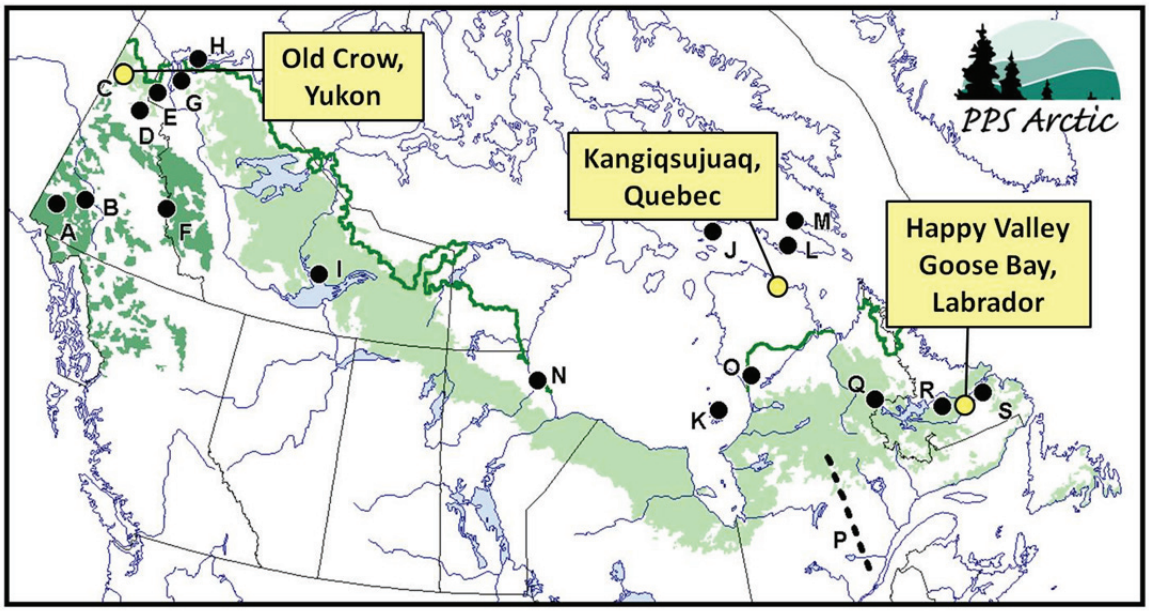

Figure 1.1 PPS Arctic Canada research area: boreal forest-tundra transition in light green, alpine forest-tundra in dark green, northernmost treeline marked with green line, transect marked with dashed black line, and research field sites marked with black dots and letters (map used with permission from Ryan Danby)

Three preliminary community visits were arranged during the spring and summer of 2009; however, the Kangiqsujuaq visit was cancelled just prior to the scheduled visit due to changes in the community. In the remaining two preliminary visits, I met with local government leaders, territorial government employees, Elders, and local teachers to determine their interest and motivation in collaborating in this project. Old Crow was determined to be the most suitable for this research project since stakeholders involved with the community demonstrated great interest in and capacity to integrate Western and Indigenous knowledge in the school program. This community selection process inherently influenced the research design and findings insofar that the community itself highly values its cultural knowledge, scientific research, and has great interest in developing integrative science programs. The Vuntut Gwitchin Government (VGG)[3] is the administrative and managerial arm of the Vuntut Gwitchin First Nation (VGFN), and thus was a central partner in this research project.

[3] The spelling of the Vuntut Gwitchin First Nation differs from the modern spelling of the Gwich'in people.

The north Yukon is the traditional territory of the Indigenous Gwich'in people. Having occupied the region from time immemorial by oral history, or for 25 thousand years by scientific inquiry, Gwich'in land ranges from northeast Alaska through northern Yukon into the Northwest Territories. The Vuntut Gwich'in translates into 'people of the lakes,' or people from the Old Crow Flats region (VGFN and Smith 2009). The culture of the Vuntut Gwich'in centres around the importance of the muskrat and caribou. Within the territory of the Vuntut Gwich'in is Old Crow, the most northern settlement in the Yukon (Figure 1.2). Old Crow is located at 67°34′10″N and 139°49′50″W, surrounded by the taiga ecozone, and is perched next to the confluence of the Crow (*Chyahnjik*) and Porcupine (*Ch'oodèenjik*) rivers 125 km north of the Arctic Circle and 110 km south of the Beaufort Sea. In order to provide context and background for the research and research community, the following section surveys the natural environment, demographics, governance, issues in transportation, natural resource use and issues, science and research, education, and significance of culture and land camps in Old Crow.

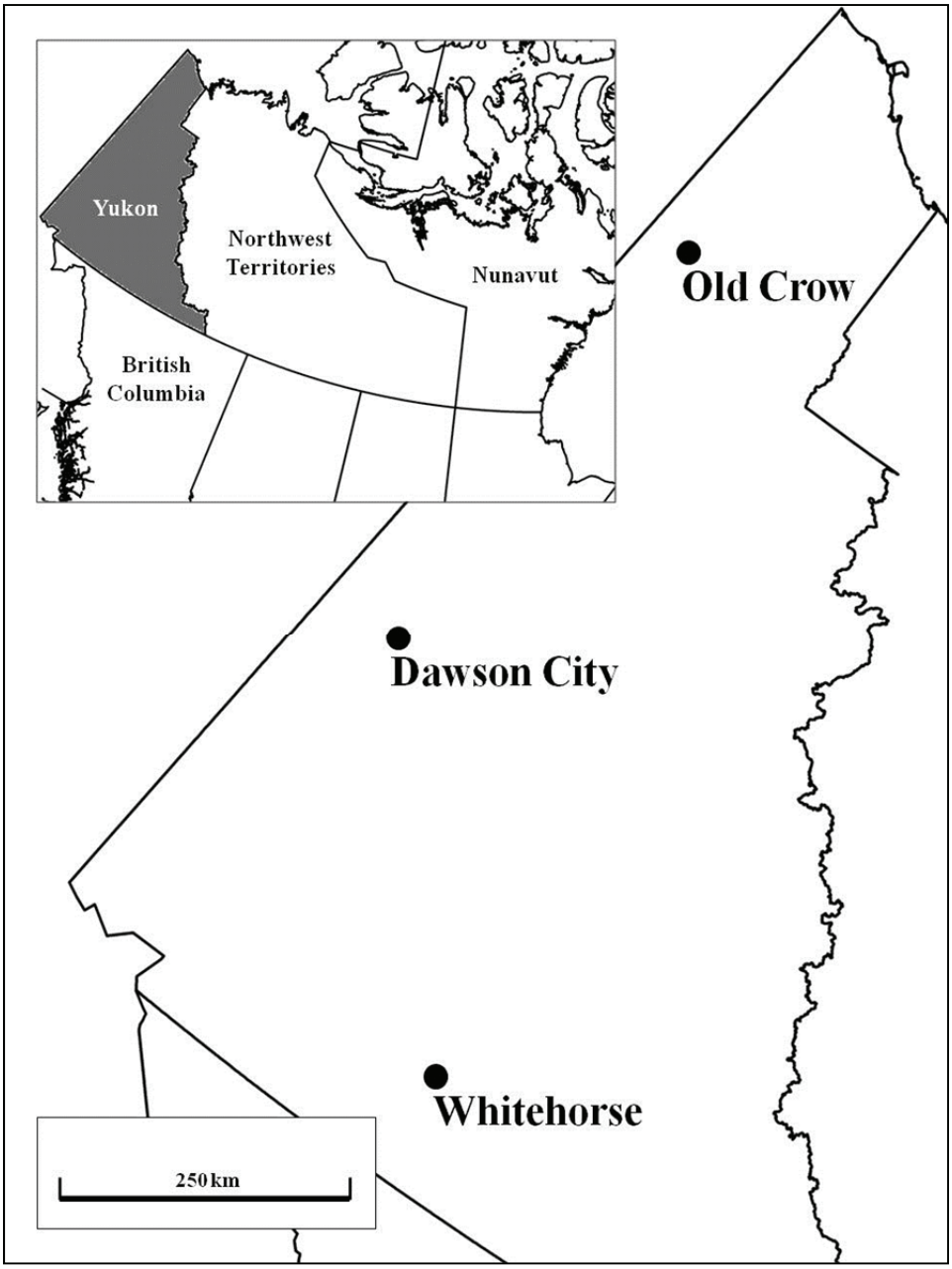

Figure 1.2. The Yukon, showing the location of Old Crow, the study community

1.3.1 Natural environment

As part of Berginia, the land bridge between Siberia and Alaska, the north Yukon has been glacier-free for at least two million years (Ehlers and Gibbard 2004). Consequently, the region was an area of refuge for flora and fauna during multiple glaciations, and the land bridge and refuge also played an important role in the dispersal of our own species.

The Bluefish Caves, located fifty kilometres southwest of Old Crow, hold evidence of human habitation as far back as 25 thousand years ago, making this the oldest site of undisturbed archaeological evidence in the Americas (Bonnichsen and Turnmire 1999).

This ecologically-rich region is dominated by the boreal forest, characterized by dense evergreen forests with shallow, nutrient-poor and acidic soil, a harsh continental climate with little rain and a short summer growing season. The Old Crow Flats to the north and Eagle Plains to the southeast feature these dense, boreal forests as well as open muskegs of wet, acidic bogs with heavy clay soils typical of the region. Although much of the area is dominated by low-lying land, there are several mountainous areas such as the Richardson Mountains to the east and North Ogilvie Mountains to the south, both of which feature alpine tundra dominated by lichen, mosses and grass-like sedges. Plant growth throughout the region is limited by a short growing season which is delimited regionally by latitude and soil quality, and locally by elevation, slope aspect, permafrost depth and moisture availability. Permafrost occurs throughout the Yukon, and is continuous (rather than scattered or widespread) throughout the north Yukon. Permafrost is thickest at over 300 metres in the unglaciated portion of the northernmost Yukon coastal plain but is, on average, 63 metres thick below Old Crow (Rampton 1982, EBA Engineering Consultants Ltd., in Burn 2009). Permafrost is thinnest, or non-existent, beneath rivers and lakes, such as in the Old Crow Flats.

Plants in the Arctic and sub-Arctic have adapted strategies to deal with these otherwise limiting conditions. They must survive the extreme temperatures of the biting winters when temperatures of -40°C are common, but, more importantly, also survive the snow and temperature fluctuations that occur regularly throughout the summers when vegetation is at the peak of its growing season (Pielou 1994). A variety of evergreen and deciduous trees are found in the region. The English names are given, followed by the Latin scientific and Gwich'in names in italics as given in the *Plant Use in Vuntut Gwitchin Territory* plant identification manual (Crewe and Johnstone 2008). The two most common, and most commonly used plants, in the region are black spruce and willow. As the hardiest of the spruces, black spruce (*Picea mariana, t'siivii*) is the

dominant tree found in region, likely because of its exceptionally shallow root system that requires a mere 25 centimetres of active layer (Pielou 1994). Willow (*Salix spp., k'àii*) grows in two forms, with the 5 to 15 centimetre-tall bush variety growing in dry and exposed tundra areas. The more common tree form, growing up 6 meters tall, is found along the moist edges of the Porcupine and Crow rivers, and along the shores of Old Crow Flats where the lakes regularly drain (Jorgenson and Osterkamp 2005, Lauriol *et al.* 2002).

Other cold-tolerant deciduous plants are also significant to the regional ecology. Alder, or red willow (*Alnus crispa, k'oh*) is found in wetlands and open woods. Common in moist boreal forests, Labrador or muskeg tea (*Ledum grownlandicum, lidii masgit*) is a low-growing, bushy plant that produces dark-green, leathery leaves often used for tea. Wild rose (*Rose acicularis, nichìh*) is found in forests, along riverbanks, and in clearings. The pink-flowered rose hips are high in vitamin C and other vitamins and minerals, and are often used in tea, juice, jellies and as medicine. Many berries found in the VGFN territory grow in acidic, low-lying or open-forest areas and are often found growing alongside Labrador tea, willows, lichens and *Sphagnum* moss. The most commonly used berries are the bright red low-bush cranberry (*Vaccinium vitis-idaea*), low-bush blueberry (*Vaccinium uliginosum, jàk zraii*), and black crowberry (*Empetrum nigrum, dineech'ùh*) (Parlee and Berkes 2006, Sherry and VGFN 1999). Other common plants include riverside wild onion (*Allinum schoenoprasum, tl'oodrik*) and caribou lichen (*Cladina spp., choodèezhùh*), both found in a variety of habitats from tundra to spruce forests (Crewe and Johnstone 2008). The caribou lichen is the primary winter food source for the barren-ground caribou (*Rangifer tarandus groenlandicus, vadzaih*).

Twice a year, the 100 000 caribou of the Porcupine Caribou Herd migrate through the VGFN territory, a journey of 1200 kilometres from their wintering grounds in southeast Yukon and Northwest Territories to the summer calving grounds to the northwest in Alaska (Porcupine Caribou Management Board 2010). The heard is named after the Porcupine River which they cross during these bi-annual migrations. Caribou give birth to a single calf in June in the calving grounds along the coastal plain of the Arctic

National Wildlife Refuge in the northeast corner of Alaska. Highly dispersed and living at low densities during the colder months, the fall rutting and wintering grounds along the Dempster Highway (which traverses the Yukon and Northwest Territories) provides abundant lichen and spruce forests (Sherry and VGFN 1999).

As the largest member of the deer family, moose (*Alces alces gigas, dinjik*) are important to the diet of both people and wildlife. An average of 500 to 800 moose are hunted by people each year, with most harvested in the fall during the rut (Environment Yukon 2010). Moose feed on willow buds and leaves, aquatic plants and, in the winter, the woody twigs of deciduous trees. For the Vuntut Gwich'in, the moose provides essential lean protein during years when there are fewer caribou. Moose are often found along rivers and near lakeshores, feeding on aquatic plants, and are plentiful in the Old Crow Flats region.

The multitude of rivers, such as the Porcupine and Crow Rivers, as well lakes, such as those in the Old Crow Flats region, provide habitat for a diversity of aquatic wildlife. Muskrat (*Ondatra zibethicus spatulatus, dzun*) live in streams and shallow lakes where they feed on roots and underground stems. They are particularly common in the Flats where, on average, five muskrats are found per hectare (Environment Yukon 2009). Key fish species in the VGFN territory include both freshwater species such as the common whitefish (*Coregonus clupeaformis/nasus, luk digai/zheii*) and anadromous species (that live in the ocean and breed in fresh water) such as dog or chum salmon (*Oncorhynchus keta, shii*) and Arctic Char (*Salvelinus malma, dhik'ii*) (Sherry and VGFN 1999, GRRB n.d.). Many of these fish spawn in the protected Fishing Branch headwaters (see Figure 1.3).

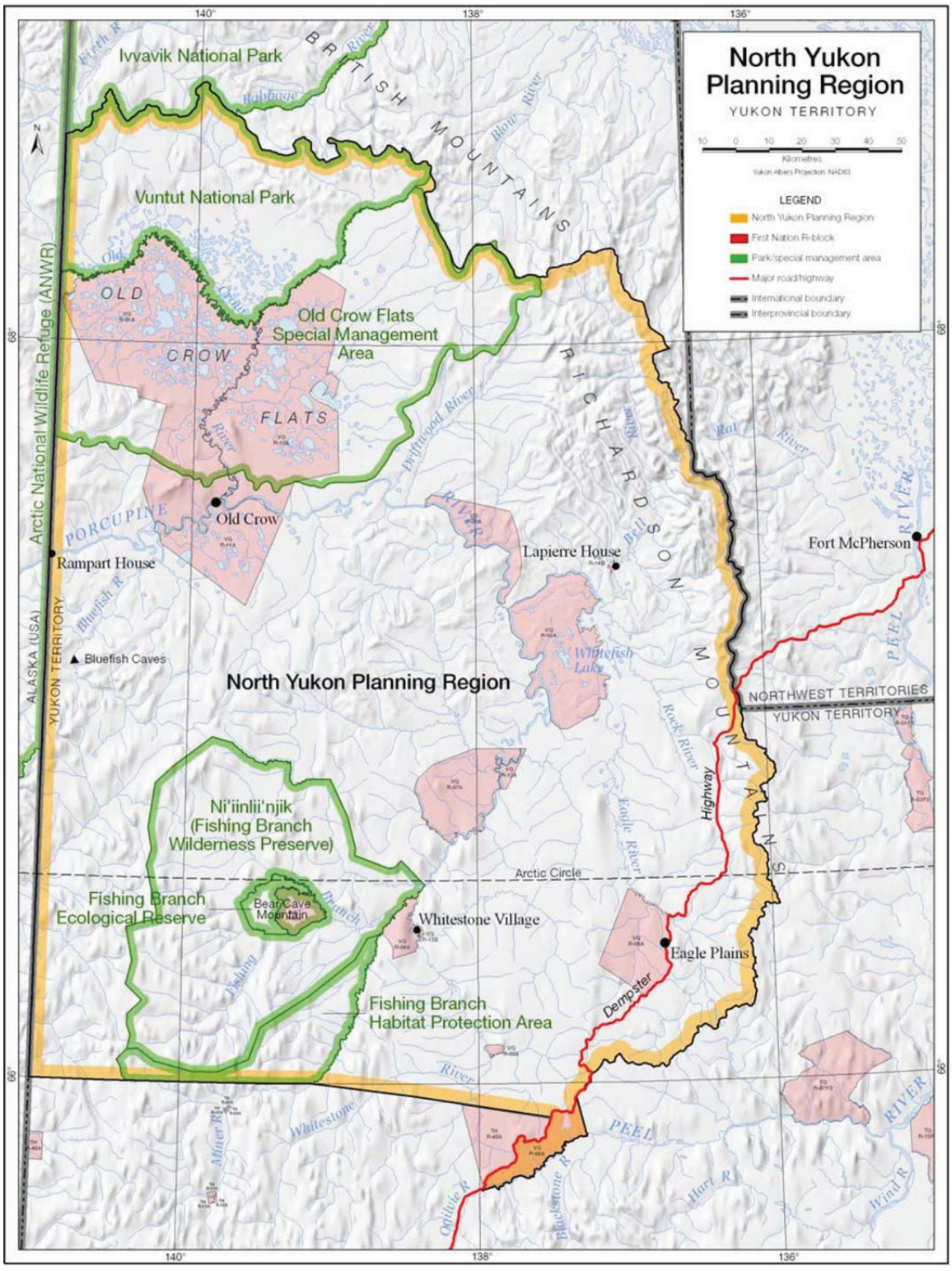

Figure 1.3: Map of the North Yukon Planning Region

(North Yukon Planning Commission 2007)

1.3.2 History and governance

The Gwich'in were traditionally a nomadic people whose territory currently covers northeast Alaska to northwest Yukon. Many Vuntut Gwich'in people began to settle into communities in the 1860s when a trading post was established at Rampart House, on the Canadian side of the border with Alaska, along the Porcupine River. When an outbreak of measles struck Rampart House in the 1950s, a new school and store were built upriver where the Porcupine and Crow Rivers met, establishing the community of Old Crow. The VGFN was established with the Land Claims Agreement of 1993. Approximately forty permanent workers are employed by the VGG to coordinate the daily activities of the VGFN. The Yukon Government maintains the airport and roads, coordinates the fire service, and shares responsibility for the treatment and provision of water and sewage with the VGFN (VGFN 2009b). However, as a self-governing First Nation in control of 5000 square kilometres of traditional territory, the Vuntut Gwich'in now control their own local government, education, heritage, and natural resource management (Sahanatien 2007).

Given the cultural and ecological significance of the region, and from the diligent work of the Gwich'in people to protect their essential natural resources, there are three protected areas of ecological significance within VGFN territory: the Old Crow Flats, Vuntut National Park, and Fishing Branch *Ni'iinlii Njik* Park (Figure 1.3). In 1982 the Old Crow Flats were designated a wetland of international importance under the Ramsar Convention, an intergovernmental treaty granting special status to ecologically significant wetlands (Ramsar 2000). It is formally protected under the federal Migratory Birds Convention Act of 1994, and was identified as a Special Management Area under the VGFN Final Agreement in 1993 (Ducks Unlimited 2009). Established in 1995, Vuntut National Park was created to complement the already-protected areas of Ivvavik National Park to the north and the Arctic National Wildlife Refuge to the northwest in Alaska, the migration and calving grounds of the Porcupine Caribou Herd (Porcupine Caribou Management Board 2010, Russell and McNeil 2002). The final protected area emerged in 1999 from the VGFN Final Agreement and the Yukon Protected Areas Strategy, Fishing Branch *Ni'iinlii Njik* Park compromises 7000 km^2 of land which includes four unique

management regions: the core Fishing Branch ecological reserve which, at its core, is the headwater for a watershed which supports the spawning grounds of northern chum salmon and the grizzly bears that congregate in the fall to feed; an adjacent land settlement area reserved for residents of the VGFN; a large wilderness reserve that surrounds the ecological reserve and settlement areas; and a small habitat protection area to the south that acts as a buffer to mitigate human activities near the wilderness reserve (Environment Yukon 2004).

1.3.3 Demographics and economy

Old Crow is home to approximately 280 residents from 60 families living in 120 households (VGFN 2009b, Statistics Canada 2006). There is a low density of individuals per home (just over 2 per home) relieving Old Crow from the phenomenon of housing overcrowding that is endemic throughout much of the north (Statistics Canada 2003). The median after-tax income is $48,512 – lower than the Yukon average of $65,221 – with 70% of Old Crow residents reporting that they conduct unpaid work such as caring for children or seniors, as well as unpaid subsistence employment (Statistics Canada 2006). The local mixed economy is primarily supported by wage-based government employment and transfer payments in addition to a strong traditional economy of subsistence hunting, trapping and fishing that supports both economic and cultural wellbeing. Most residents speak English in their home (86%), however Gwich'in language development is supported through educational programs at the elementary, junior and college levels (Statistics Canada 2006). Almost 90% of Old Crow residents have recognized status under the VGFN Land Claims Agreement, although the total number of VGFN beneficiaries is over 500 (VGFN 2009b).

1.3.4 Transportation

Old Crow is the only fly-in community in the Yukon. Regular air service connects Old Crow and Whitehorse via Dawson City, Inuvik, and Anchorage, Alaska, with an average return ticket of $600. Many government services, and several residents, used to make use of the federal government food mail program that subsidized the air freight charges for nutritious and essential food and household items. However, in 2010/11 this program was

changed, and now these savings are passed on to northern stores, rather than individuals (CBC 2011). Residents now report higher food prices, and many are concerned with how they will continue to access reasonably-priced fresh foods in the future. Many Old Crow residents have their own backyard or camp gardens, and at least one family raises chickens for eggs and meat. Old Crow is considering many other options such as a long-term dry good storage facility, developing a chicken egg-laying project started by a local resident, and expanding the current community and personal garden projects in the town (Stasyszyn 2011).

Cross-country land and water travel are common in Old Crow. In the summer residents walk, use all-terrain vehicles, and use motorboats to travel along the Porcupine, Crow and connecting rivers. In the winter residents walk, use snow mobiles or public vehicles (such as the school bus) within town, and use snowmobiles and, to a much lesser extent, dog teams to travel on the land (to go to a family cabin, tent, or to collect firewood). In years when there are significant building projects, a winter road is constructed connecting Old Crow to the Dempster Highway via Eagle Plains (Figure 1.3). This road was last created in the winter of 2004 to bring in heavy machinery and materials to cut a quarry in Crow Mountain behind the community in order to provide stone to reinforce the outside bank of the heavily eroded Porcupine River in front of the town as well as to re-finish the airport runway. Many residents used this winter road to bring in their own supplies, vehicles, snowmobiles and boats.

Conceived in the 1950s, reinvigorated in the 1960s after the discovery of oil and gas in Alaska, and finally opened in 1979, the Dempster Highway greatly changed life in the north Yukon. The (nearly) all-season road connects the North Klondike Highway near Dawson City to Inuvik in the Northwest Territories over 736km of road through the Mackenzie River Delta. Feelings are mixed on how development impacted life in the region: “due to the highway, there has been exploration, which would not likely have happened to the extent it has if there was not a road. The seismic lines have allowed easier access for hunting as well as trapping. There is also increased tourism and backcountry travel” (Sherry and VGFN 1999, p. 280). Some Old Crow residents use the

Dempster Highway to avoid paying the high cost of airlifting snowmobiles and boats to town from Whitehorse or other towns to the south. The most popular route involves driving a boat or snowmobile just past Eagle Plains, around the half-way point on the Dempster highway (between Whitehorse and Inuvik, in the Northwest Territories), then travelling along the Eagle, Bell and Porcupine Rivers to Old Crow, a journey of approximately a week by canoe, or two to three days by powered boat or snowmobile (Figure 1.3).

1.3.5 Natural resources

Caribou is the most important 'country food' for the Vuntut Gwich'in. Most households harvest several caribou each year, primarily in the spring and fall when the caribou migrate close to town. In addition to caribou, many other animals and fish are important to the Gwich'in people. Muskrat is trapped for the meat and for its pelt, whereas the carnivorous weasel family (marten, mink, wolverine, ermine) are trapped for their pelts. Other small mammals, such as rabbits, are snared for their fur and meat. Fishing remains an important source of food, with a variety of salmon (king, chum) and whitefish netted for both the community's consumption, as well as for dog food. A family with a dog team nets several hundred fish in a summer in order to feed the team over the winter months.

Residents of Old Crow harvest a significant amount of wood from the boreal forest for use as firewood in their homes. The majority of homes use woodstoves as the primary source of heat. Many young men work casually harvesting wood and privately selling it in the community; many families who work fulltime, and cannot (or choose not to) harvest their own wood, purchase this wood to heat their homes. Very few homes, only those of Elders and some living in territorial government housing, use oil to heat their homes as it is an expensive form of heat given that the oil is flown in from Whitehorse. Currently, there is limited exploration and development of oil, gas and mining in the VGFN territory.

There are several prominent natural resource issues facing the community of Old Crow, and most visible and widely discussed is the status of the Porcupine Caribou Herd. There

is great natural variability in the population of all caribou herds worldwide, and the Porcupine herd is no exception. Currently, the herd size is approximately 100 000 individuals, a decrease from 123 000 caribou estimated in a 2001 aerial photo-census, which itself was a decrease from the previous 1978 photo-census that estimated 178 000 caribou (Porcupine Caribou Management Board 2010). Climate warming, leading to changes to habitat, calving ground suitability, foraging availability, and increased ice and storm events have all adversely affect the herd population size and health (Vors and Boyce 2009, Joly *et al.* 2011), and studies have shown that the herd is particularly sensitive to development within their Alaskan calving grounds (Griffith *et al.* 2002, Hinzman *et al.* 2005).

A major concern for the herd surrounds the very real possibility of oil extraction in the sensitive calving grounds of the herd. The summer grounds are protected under the Arctic National Wildlife Refuge over the border in the northeast corner of Alaska. However, the calving grounds are on the northern most part of this refuge, a disputed tract of arctic coastal plain knows as '1002 Area'. The United States continues its debate as to whether or not – as well as how – to drill in the oil and gas fields throughout the 1002 Area. This decision is expected to greatly impact the Porcupine Caribou Herd and, consequently, the residents of Old Crow as well as the 7000 Gwich'in living in Canada and the Alaska (Government of Canada 2008a). The VGFN and its Member of the Legislative Assembly vehemently oppose this development. There are events that give hope to the Gwich'in people about the security of the caribou. Over three days in the fall of 2009, an estimated 4000 caribou migrated across Crow Mountain, a mere kilometre from the community and visible from most windows in town. Elders and community members explain that this event happens only 'once in a lifetime' and has not been seen since the 1960s.

In addition to caribou, there is also great concern for the status of the fisheries of the north Yukon, namely that of the annual salmon run in late summer. During the field season, the summer of 2009, the summer salmon fishery opened three weeks later than normal. Many residents were unable to net as many fish as they had in other seasons, and had to rely on other food sources to supplement this food source.

1.3.6 Science and research

Old Crow is unique in that the First Nation has taken significant ownership and control over research in and around the community. Similar to northern and First Nations communities, the VGFN require researchers to obtain a research license through the heritage and/or natural resources departments. However the VGFN has several unique requirements that must be met to secure a research licence, particularly for research involving interviews. An important component of the license includes a clause requiring the researcher to submit transcripts of all interviews for submission to the VGFN Oral History Database. This allows the information to be available to the First Nation researchers for use in the Oral History Project. In addition to licensing, the community has taken a very active role in research. The land claims Final Agreement specifies that the VGFN has special management responsibilities in the Old Crow Flats (Ducks Unlimited 2009). This has motivated the VGG to actively seek out experts to assist them in answering their questions about how to manage this important region.

Following the call for IPY funding proposals, the VGFN conducted community consultations to see what issues were important. Informed by these consultations, as well as their own internal concerns, the VGG sought out researchers they had worked with previously, as well as new researchers, to answer particular questions. For example, there were concerns over the health of the muskrat population, and so aquatic mammal researchers were brought into the IPY project. As a consequence, their IPY project "Environmental Change and Use of the Old Crow Flats" (YNNK) was an ecological study of the historical, current and possible future conditions, health and resilience of the Old Crow Flats ecosystem, a 7000-lake wetland located 50 km north of the town. This project was unique amongst IPY projects, as it was a community-originated, owned and coordinated project. The VGFN ran local consultations to determine what environmental issues were of importance to the community, and then sought out researchers that could assist them in answering their questions. The YNNK project team was organized under several topical subgroups including food security, vegetation, water quality, muskrat populations, moose populations, and permafrost.

1.3.7 Education

As agreed in the VGFN Land Claims Agreement, the VGG oversees Kindergarten to Grade 12 education. The local school, Chief Zzeh Gittlit School, provides Kindergarten to Grade 9 education, after which students move to Whitehorse and live either in boarding homes or with family or friends. Over the past ten years, the school enrolment has been as small as 26 students (in 2008) and as high as 57 students (in 2001), which demonstrates the great variability and change that goes on each year in this small school (Bureau of Statistics 2011). Classes are organized by kindergarten (4 and 5 year olds), the elementary class (Grades 1 to 3), the junior class (Grades 4 to 6) and the senior class (Grades 7 to 9). All four of these teachers, as well as the principal who shares partial teaching duties in the junior and senior classes, are from outside the community. While two of these teachers have lived here for several years, the remaining three teachers have been teaching in Old Crow for less than a year, the newest of which had been teaching at the school for only three weeks during my second community visit in February 2010. However, there are several Gwich'in educators in the school, such as the Gwich'in language/culture teacher and the Education Support Worker (ESW). The VGFN directly hires and employs the ESW to provide a direct voice of the First Nation in the school in order to assist with enacting VGFN educational policies, to provide student guidance and counselling, and to facilitate the integration of Gwich'in culture in the curriculum. Additionally, many parents and community members are highly involved in the school, such as volunteering to cook the three hot lunches served each week for students and their parents.

A second Whitehorse-based ESW supports students through the transition to high school in the territorial capitol while in Grades 10 to 12. The VGFN provides funding for books, winter clothing, a personal allowance and a room and board subsidy if they live in the territorial dormitory (VGFN 2009a). Student attendance is tied to their funding; funding is cut by $10 for every unexplained absence from school. The Yukon territorial government arranges the scheduling and pays for the airfare for students travelling between Old Crow and Whitehorse each study period; students are flown home for the

Christmas holiday, spring break, and summer vacation. Many students find the transition difficult because they are living away from home, in a much more urban setting, and with different curricular expectations (with less cultural relevancy than is used in Old Crow).

Yukon curriculum emphasizes the development of mathematics and language arts skills. Standardized Yukon Achievement Tests are conducted in Grades 3, 6 and 9 for mathematics and language arts, and British Columbia Achievement Tests in high school for mathematics, science, English and social studies. In Old Crow, Gwich'in language and culture is also prioritized, however, the success of cultural integration has perhaps been limited to the teachers from the community, or those who have lived there for several years. These educators have taken a leadership role on integrating cultural relevancy and have had the time it takes to become familiar with the culture and build relationships with the resource people that can both teach the teacher and act as resource people in the classroom.

1.3.8 Land and culture camps

With 25% of Yukon residents identified as First Nations, many culture camps exist across the territory (Statistics Canada 2006, First Nations Programs and Partnerships Unit 2009). In Old Crow, there are at least two camps that have been regularly organized; summer science camp has been coordinated through the VGG, and spring culture camp has been coordinated by the school. For the past decade, the ESW has planned and implemented the spring culture camp in the Old Crow Flats. The First Nations Programs and Partnerships Unit of the Yukon Department of Education has prioritized the funding and support of culture camps, and has made a generous commitment of funds to Old Crow, through federal Northern Strategy funding, to spend $150 000 over three years to enrich the educational opportunities provided through the annual culture camp. With this new funding, as well as with emerging theory and experience on how to integrate Indigenous and Western sciences, the FNPP has stimulated and generously funded a revival of the culture camp to have a stronger educational focus.

In previous years students attended the camp, usually without the teachers, with the ESW and an Elder coordinating the cultural activities such as setting traps and snares, skinning, cutting dry meat, setting fish nets, snowshoeing and dog sledding. Camp staff were hired to cook, cut wood and take care of camp duties. The camp was not mandatory, and many students chose to stay behind and attend school. Consequently, there were two simultaneous programs going on during the culture camp. With the new Northern Strategy funding, the 2010 Culture Camp was a break from this style. A culture camp working committee was organized to provide direction to the planning and organization of the camp, and participants included Elders, educators and young adults with strong connections to their culture as well as experience on the land. Between this committee, the FNPP, the ESW and the teacher organizer, culture camp was conceived as an opportunity to integrate Gwich'in culture with the territorial curricular requirements of the prescribed learning outcomes.

The community, school, local government, and territorial education departments agreed that this research project explored issues important to this Northern Strategy school project, and to the ongoing challenge of bridging the gap between Western and Indigenous knowledges. Through the interviews and discussions stemming from this research project, it was determined that the culture camp would be re-organized under a three-year rotation plan that reflects the multi-grade classrooms. The culture camp is now organized as: Traditions and Science in Year 1; Traditions, History and Geography in Year 2; and Traditions, Arts and Trades in Year 3. This research project occurred during the first year of the Northern Strategy-funded rotation, beginning with Year 1 (therefore having a focus of Gwich'in knowledge and science curriculum learning objectives).

1.4 Research design

There were two components to the iterative research design. The first phase of this research involved a review of academic literature that documents traditional and scientific knowledge about climate change and the impacts on northern ecosystems, including the impact on vegetation, animals and northern residents. For example, the VGFN has published several books about their Oral History Project in which they

interview Elders and residents of the North Yukon that were reviewed. These publications include “The Land Still Speaks: Gwitchin words about life in Dempster country” (Sherry and VGFN 1999) and “People of the Lakes: Stories of Our Van Tat Gwich’in Elders/*Googwandak Nakhwach'ànjòo Van Tat Gwich'in”* (VGFN and Smith 2009). In addition, several unpublished interviews (n=12) in the VGFN Oral History Database were reviewed in order to develop a background understanding of the history, culture and practices of the Vuntut Gwich’in. This also allowed me to become familiar with the interview techniques used by the Heritage Department researchers, with which most residents are familiar. These resources (the published books and Oral History Database) were useful in informing both the style and the content of the interviews conducted with northern residents.

The second phase of the research involved consultative interviews (n=60) with IPY researchers, residents of Old Crow, and northern and/or Indigenous educators to determine key ecological research findings, Indigenous knowledge, and pedagogical approaches to how outreach programs and educational materials should be designed and how content should be developed. The interviews were conducted over thirteen months between January 2009 and February 2010. As informed by Patton (2002), field notes were taken following the interviews (such as recording participant reactions) as well as general observations around town (such as observations of uses of spruce trees). Additionally, I participated in a VGFN-run summer land-based science camp, and recorded observations during the week-long camp (such as components of the caribou hunt or how the canvas tents were put up using birch trees). Portions of these observations and notes were used to inform the interviews. These field notes also assisted with the development of categories and themes to facilitate the content analysis of the interviews. Qualitative methods including semi-structured interviews and participant observations were used to answer the question of how the knowledge of IPY researchers and northern residents can be used to create culturally-relevant educational materials for northern students. The three stakeholder groups interviewed were northern researchers, residents and educators.

1.4.1 Northern researchers

The first series of interviews were conducted with northern researchers (n=24) to determine the content and significance of their research. Due to the high financial cost that would be associated with conducting interviews with researchers spread across the country, and with the high degree of comfort and familiarity researchers have with conducting over-the-phone interviews and discussions, most interviews were conducted over the phone (n=20). The remaining interviews (n=4) were conducted in person at either Dalhousie University or in the VGG office in Old Crow. All researcher interviewees read and signed a written consent form (see Appendix A: Researcher Consent Form).[4] Using in-depth semi-structured interviews, the researchers were asked about their educational background and work experience, IPY research project, and community outreach activities (see Appendix D: Interview Guide for Northern Researchers). Researchers were purposively selected from two IPY research groups (described below) within which individuals were representatively selected to obtain a spectrum of researchers with diverse geographical research areas and research topics. Additionally, snowball sampling and self-selection was used to recruit interview participants (Sullivan 2001).

Many IPY-funded networks conducted research in VGFN territory during IPY, however, for the purpose of this research I focused on the research and outreach activities of two networks in particular. PPS Arctic Canada is a group of researchers, namely ecologists, investigating the impact of climate and climate variability on northern vegetation in Arctic and sub-Arctic areas. In particular they are interested in the potential impact of climate on the treeline in Canada's northern regions. The second group was Old Crow's *Yeendoo Nanh Nakhweenjit K'atr'ahanahtyaa* (YNNK) IPY research network (see section 1.3.6).

To answer the primary research question, I asked northern researchers:

i. What were your IPY research questions, methods and findings?

[4] Appendices A, B and C are the researcher, resident and educator consent forms, and Appendices D, E and F are the researcher, resident and educator interview guides.

ii. Why do you think your research is of interest or importance to northern communities?
iii. How do you do community education and outreach?
iv. How do you make use of Indigenous knowledge and knowledge holders in your research?

1.4.2 Northern residents

The second series of interviews were conducted with community members from the town of Old Crow (n=18). Before beginning discussions on research design and conducting interviews, I spent ten days in the community assisting with the VGFN-run land-based summer Science Camp. Following the camp, I assisted in organizing a community feast and created a slideshow of the camp activities shown at the feast that attracted 70 people in attendance out of a population of 280 residents (VGFN 2009b). At the end of the evening I gave a brief presentation about my research and requested that interested individuals talk to me if they would like to be involved. That evening three residents approached me requesting to participate in the study. I began with these three interviews and, based on recommendations from these participants as well as from employees in the VGFN Natural Resources and Heritage departments, I sought out the remaining participants (n=15). In this way, snowball sampling and self-selection were both used to recruit interview participants. Residents were purposively selected because of their experience in cultural land-based practices including hunting, fishing, trapping, snaring, berry picking, plant harvesting, dog sledding, and building log cabins. All resident interviewees read and signed a written consent form (see Appendix B).

The resident interviews were primarily conducted in person (n=16), but two were conducted over the telephone following the community visit. The in-person interviews were conducted in August 2009 and January/February 2010 in Old Crow in a location selected by the participant, usually in their home, office, or in a temporary workspace the Heritage Department and Vuntut National Park allowed me to use during my visits. The phone interviews were done in February 2010. These interviews were not conducted in person because a prominent Elder in town passed away during my community visit, and it was not appropriate to continue with the interviews. Using in-depth semi-structured

interviews, residents were asked about education in the community, traditional plant knowledge, land skills and learning, and their perspectives on local science education and outreach (see Appendix E). Most interviews were conducted in English, with a Gwich'in translator present if needed who would simultaneously translate the discussion.

To answer the primary research question, I asked northern residents:

i. What plants are the most important and why?
ii. Is the land in your territory healthy? How do you determine if it is healthy?
iii. Who taught you this knowledge, and how did they teach you? How do you pass on your knowledge?
iv. If and how has the environment changed in your lifetime? How do you observe this?
v. What skills, attitudes and values should students learn in the annual Culture Camp?

1.4.3 Northern educators

The third phase of this research determined how educational materials with this content (from researchers and residents) could be used in northern schools and communities. Interviews with northern educators (n=18) were conducted to determine preferred pedagogical approaches and curricular needs for possible educational materials. All educator interviewees read and signed a written consent form (see Appendix C). Interviews were conducted in person (n=14) and over the phone (n=4). In-person interviews were preferred, three participants were in locations that I had not intended to visit as part of this research, and one participant was not available to meet while I was in Whitehorse conducting the interviews.

Participants from this cohort were recruited using several sampling methods. Representative sampling was used to ensure that there were a variety of educators involved in the research. Sampling strata included Gwitchin educators (n=2) and non-Gwitchin educators (n=5) from Old Crow, territorial education administrators (n=3), territorial curriculum writers and developers (n=3), southern-based integrative science educators (n=3), First Nation government education administrator (n=1), and territorial education outreach worker (n=1). Similar to the previous two interview cohorts,

snowball sampling and self-selection were also used to recruit interview participants. Using in-depth semi-structured interviews, educators were asked about their work experience and educational background as well as their experience with local curricular resource development and Indigenous and Western science outreach activities (see Appendix F).

To answer the primary research question, I asked northern educators:

i. What pedagogical methods are most effective and appropriate for your students, and why?
ii. How can the ecological knowledge from northern researchers and residents be used for educational purposes?
iii. How could an educational outreach program help meet curricular or cultural educational needs in the Yukon?
iv. How do you know when learning resources are effective?

1.5 Ethical considerations

There were many ethical considerations to take into account in the creation and implementation of this research project. Ethical approval was first sought from the Dalhousie Social Sciences and Humanities Research Ethics Board (#2008-1914). Following this, several licenses and approvals were required including a territorial research licence from the Yukon Department of Tourism and Culture (#6800-20-813), a research license from the VGFN (granted June 8 2009), and access approval from the VGFN Heritage Resources Branch (granted June 8 2009) for permission to access their Oral History Database.

All interview participants were given an oral description of the research study, their involvement, and what would be done with the information from their interview. This consent structure was informed by Meadows *et al.* (2003) who explain that research consent in Indigenous communities should both recognize the importance of the oral tradition (e.g. use oral explanations) and be as unobtrusive as possible. An information letter with an attached written consent form was given and signed by all interviewees; there were three variations of the information and written consent in order to specify the information to the researchers, residents and educators alike (see Appendices A, B and

C). Informed written consent was obtained in which participants gave their consent to participate in the study, to be audio-recorded, and to be contacted in the future if I had further questions or needed additional clarification about the content of the interview. The researchers and northern residents also gave their consent for relative content of their interviews to be used in the educational materials produced, and at that time oral consent was sought for the use of direct quotes or if any identifying information was used. Additionally, in accordance with the VGFN research license, northern residents gave consent for written transcriptions of their interviews to be given to the VGFN Heritage Department to be stored in their Oral History Database.

1.6 Issues of research validity

In all three interview cohorts, I stopped interviewing at the point when the sample became reflective of the variation of the group (Seidman 1998). In person interviews were preferred for the resident and educator interviews because these participants were often not as familiar and/or comfortable with telephone interviews, or, particularly in the case of the resident interviews, the topics being discussed could not be fully addressed over the phone (e.g. they required visual cues, drawings, or motions to show what was being discussed). Telephone interviews were used when in-person interviews were not possible, either financially because the participants were spread out across the country (as was the case for most of the researcher interviews) or the participants were unavailable when the researcher was on site collecting data. Although ideally interviews with Indigenous participants should only be conducted over the telephone "after a relationship has been established with a respondent through face-to-face interviews" (Hunter and Smith 2002, p. vii), I used telephone interviews following in-person discussions with the individuals about the research (although in one case an in-person interview had begun before it was finished over the telephone).

There is no singular or standard understanding of validity in qualitative research. In this research, triangulation is used to determine validity (and was also used to determine sufficient data saturation). Triangulation includes using a variety of sources, as well as methods of analysis, in order to 'cross-examine' or analyze the results (Leech and

Onwuegbuzie 2007). Yin (1994) explains several ways to use triangulation, including the researcher making use of a diversity of data sources, methods, and people involved in the research, all of which are used to ensure validity. The first two components of this definition were applied in this research. A diversity of data sources were purposively sought out, including academic literature, grey literature, community-published studies, and the VGFN Oral History Database. Furthermore, a diversity of individuals were recruited to be interview participants in the project, both between interview cohorts (by using the three cohorts of researchers, residents and educators) as well as within each cohort (such as having a diversity of research subject areas, personal backgrounds, research and outreach experience and seniority for the researcher interviews). A variety of methods were also used, including individual interviews and participant observation. The third criteria, that of a diversity of researchers involved, was somewhat used in this study given the limited time, funding and scope of a Masters thesis research program. I drew upon my particularly diverse thesis committee to ensure credibility in my findings: my committee members included a spatial ecologist who has conducted research in the north (Karen Harper), an environmental education researcher (Tarah Wright), and a social scientist who has lived, worked and conducted research in the north (Heather Castleden). Ultimately, as Yin (1994) suggests, validity is determined how well the research stands up to scrutiny.

As a qualitative research project, the design and findings of this thesis are "grounded in the lived experiences of people" (Marshall and Rossman 2011, p. 2). Qualitative research focuses on context and is fundamentally interpretive, and consequently qualitative researchers tend to be reflexive (understanding how one's own personal identity influences the research) and use complex reasoning (Rossman and Rallis 2003). This research is informed by several critical traditions including feminist and Indigenous research. Critical theories problematize social structures and seek to understand the interrelationships between social structures, knowledge and power (Code 1991). Critical theorists argue that objectivity is not possible due to implicit assumptions, bias and values (Banks 1993). Recognizing that subjectivity shapes our point of reference, critical theory

calls upon researchers to identify our positionality, or the aspects of our identity that mark and influence our social position (Harding 1991, Tetreault 1993).

My research is also shaped by feminist epistemologies, which are concerned with the intersection of knowledge and power and how we relate social constructions of gender with other social identifiers (including race, class and sexual orientation) (Harding and Norberg 2005). Feminist methodologies seek to recognize and minimize the power differences between researchers and those they research, and yet acknowledge and use this 'social power' for the purpose of advancing social justice (Harding and Norberg 2005). As part of this development of this research project, I recognized the importance of power and identity (mine, as well as those I was working with) when defining the research project and what consisted of a 'problematic situation' worthy of research. I sought to be reflexive in my methods; my committee and I had baseline concepts of what this research would address (e.g. polar science outreach in the Canadian north, ways to make science outreach culturally relevant and useful to the partnering communities), however, we allowed the community partners ideas, questions and concerns to shape the research concepts, questions, methods and outcomes. Feminist epistemology is also "centered on the notions of affectual rationality, inter-connectedness, and holism, thus allowing for a multiplicity of ideas and truths" (Rhoten and Pfirman 2007, p. 59). In these ways, feminist research has great potential to be complemented with Indigenous epistemologies.

Indigenous epistemologies follow a moral code, are holistic, employ practical experimentation, use local verification, and are integrated in the daily life and traditional subsistence practices of Indigenous cultures (Snivley and Corsiglia 2001, Barnhardt and Kawagley 2005). As Baker and Giles (2008) recognize, "vestiges of colonialism—including loss of identity, disparities in health status, and socioeconomic inequality—are still realities in northern communities and aboriginal communities in general" (p. 235). Consequently, Indigenous epistemologies problematize mainstream, Southern Canadian, Western scientific understandings of power and knowledge and confront "ideologies of oppression… to decolonize our minds" (Louis 2007, p. 131). This research was a small

attempt, both for me to continue to decolonize my mind, and to open room in the science education and outreach arena for researchers, residents and educators to decolonize their minds, and model and support this decolonization process with their students.

Informed by Indigenous research, I sought to maintain several research principles including 'reciprocal appropriation' in which my Indigenous partners and I both benefited from the research (Louis 2007). Indigenous communities, northern Canadian research institutes, and Canadian research ethics bodies have recommended that researchers establish relationships and friendships before the research is undertaken (ITK and NRI 2006, Castellano and Reading 2010, CIHR, NSERC and SSHRC 2010). There were several ways in which I ensured this reciprocal relationship; I volunteered with two land camps (one summer camp run by the VGFN and one spring camp run by the school), assisted with the development of student workbooks and journals for the camp, and helped in the coordination and writing of a newsletter with highlights from the camp (Appendices G and H).

I also recognize that there are many ways my presence had an effect on the research context, particularly in Old Crow. For example, as a teacher who has worked in experiential settings in the Canadian north and south, I was invited by the VGFN and CZGS to assist in writing student handbooks to be used at the annual spring land camp. This experience influenced the research context as researchers, residents and educators would often refer to activities I was participating in as examples of science education or outreach. My involvement in similar outreach projects in the community gave me personal experience into the methods, approaches, problems and opportunities of educational outreach as expressed by the stakeholder interviewees.

These involvements strengthened my reciprocal relationship with the community, and allowed me greater personal and collaboratively-developed insights into all aspects of the research; the research (including my findings) is no doubt influenced by my relationship with those in the community. However, I share the view of Castleden (2007) that "academics who claim objectivity are misleading themselves and those to whom they are

communicating their results" given that our socially constructed worldviews are built upon many layers of bias that inevitably influence our research, such as our worldview socialized from infancy, life experiences, and disciplinary affiliations (p. 9). In the critical tradition, Milner (2007) explains that researchers must practice 'racial and cultural consciousness' in order to understand how our positionality influences our research. As a qualitative researcher, I recognize the "complex interplay of [my] personal biography, power and status, interactions with participants, and written word" (Rossman and Rallis 2003, p. 93).

Informed by such critical theory, and particularly because this research was conducted in a cross-cultural context, I must explicitly situate myself in this research. I am a Caucasian woman born and raised in both urban and rural areas of southern Canada. I was university educated in the south, receiving first a Bachelor of Arts (in International Relations and Women's Studies) and then a Bachelor of Education (with focuses in high school history, geography, and Aboriginal education, and later in middle school science). I have worked in outdoor and experiential education in southern Canada for more than ten years, and have worked as a teacher in the northern Canadian territory of Nunavut for two years. These personal and professional experiences have no doubt shaped my understanding of this research, its design and my findings.

Informed by critical theory, I appreciate that reason and passion are intertwined, and my own experiences led me to undertake this research. I largely established my teaching career in Nunavut because activities I enjoy for personal interest (outdoor pursuits such as camping, hiking, canoeing/kayaking, and land skills) are of even greater importance in Indigenous cultures than mere recreation: they are a fundamental part of knowledge production and transmission. Teaching in Nunavut allowed me to combine my passion for outdoor and place-based learning with greater educational and cultural goals of the communities in which I worked. My undergraduate degree in international relations and women's studies had given me much theory, and some experience, in applying of critical theory to everyday practice. I was eager to travel to another part of my own country, simultaneously similar and different from the southern Ontario community in which I

was raised, to learn from fellow Canadians about how they learned from and lived with the land. However, over the first year I was teaching high school in Gjoa Haven, in the western Kitikmeot region of Nunavut, I felt challenged on how to appropriately integrate Inuit knowledge, skills and attitudes into the standardized Alberta high school curriculum that Nunavut follows. All Government of Nunavut departments and employees are guided by the eight principles of *Inuit Qaujimajatuqangit* (IQ), or Inuit knowledge, including *Pijitsirarniq* (the concept of serving), *Aajiiqatigiingniq* (the concept of consensus decision-making), and *Piliriqatigiingniq* (the concept of working together for a common purpose) (Government of Nunavut 2004). Legally formalized in the 2008 Education Act, IQ is a fundamental part of education in Nunavut: for example, teachers are required to indicate in their daily lessons plans what IQ values are at the core of each lesson or activity (McGregor 2010). Furthermore, Nunavut continues to make strides in developing Nunavut-written, culturally reflective curriculum (CBC 2012). However teachers are often responsible for making the curriculum relevant and accessible.

To this end, I took the advice of Inuit scholars and fellow educators and attempted to use Inuit knowledge to meet the standardized curriculum, as best I could. However, as a non-Inuit with limited experience in the north, I was (unsurprisingly) only moderately successful. I engaged with parents, family members, Elders, resource users and community leaders, but I still had many questions as to how all these education stakeholders could better collaborate for the purpose of providing rigorous, culturally appropriate education. In the winter of that first teaching year, I heard of Karen Harper's IPY treeline research project, and her interest in developing science modules for the purpose of sharing their project's findings in the Canadian north. This research project has changed and developed significantly from those 'early days,' largely because we sought to have this project be something of use to our community partners.

Following my research, and during the writing stage, I returned to teaching Nunavut, this time to Baker Lake in the Hudson Bay Kivalliq region (where many of the families are closely related to those in Gjoa Haven, indeed I had some of the same students and families). I was eager to employ many of the lessons I'd learned and findings I'd made

during this research. Primarily, I sought to listen to family members, Elders and community leaders for direction on content, method and how to develop meaningful and mutually-useful relationships. With my trades and land skills class, we worked with an Elder to make *panas* and *ulus* (traditional men's and women's knives). As part of our cooking class, students retrieved fish from fish nets on the ice in front of town, brought several fish to the Elder's Centre, prepared and cooked the fish to eat, and gave the fish organs and skeletons to the senior high school class for dissection in biology class. In our science class, we went out on the land to learn and develop Western scientific and Inuit ways of identifying and using plants. We pressed these plants, and displayed what we had learnt with the school. We created science projects that allowed students to compare the travelling speeds of *kamotiks* (wooden sleds pulled behind snowmobiles) on different ice and snow surfaces based on the properties of those surfaces, and varying perspectives on the severity and impact of rising sea levels on the community. These examples demonstrate several ways I was able to use Inuit content to guide the learning. However, this research further challenged me to learn about and apply Inuit teaching and learning methodologies: having Elders guide learning using hands-on approaches, challenging students to use self and group reflection as part of the assessment process, and using our learning experiences to build community both in and outside the classroom.

This research reaffirmed my appreciation for the 'community classroom' where we recognize and use the knowledge, skills and attitudes of students, the school community and community knowledge holders. I sought to be candid with students, fellow teachers, and parents that I was but one influence guiding students through their journey that year, and I was on a journey of learning myself. This research also influenced me as a person, and me as a teacher: it deepened my appreciation for the ongoing struggle of parents and communities in delivering culturally-relevant curriculum and gave me new strategies for teaching and working with fellow education stakeholders. In short, this research made me a better teacher, and a more reflective and responsive citizen.

1.7 Data analysis

Most interviews (n=52) were digitally audio recorded. In the interviews (n=8) that were not audio recorded, interview notes were taken. These interviews were not recorded because either the interview was conducted before the decision to use audio recording equipment was made (n=3), the quality of the audio recording was too poor to ensure sufficient accuracy in transcription (n=4), or the interview occurred spontaneously and conducted at a time when the audio recording equipment was unavailable (n=1). All of these unrecorded interviews were conducted with the largest cohort of participants, the researchers. Due to the larger number of participants in this category (n=24), the extensive notes that were made, and that I have had open access to clarify discussion points with these individuals (as well as with all other participants), it is unlikely that this variance will have significant impact on the qualitative and descriptive nature of the findings.

I alone conducted all of the interviews, although I employed three assistants to help transcribe half the interviews. I coded the interviews with thematic categories using NVivo 8 and 9, a qualitative analysis software package that facilitated a systematic approach to extracting meaning and drawing out common themes and comparisons amongst participants (QSR International Pty Ltd. 2010, Bryman and Teevan 2005). Interviews were coded based on themes that emerged from the literature, observations and interviews. Research analysis was an iterative process that used both deductive and inductive approaches as used by Weston *et al.* (2001). Broad categories were first determined by the "salient, grounded categories of meaning held by participants in the setting" (Marshall and Rossman 2011, p. 215). Once all interviews were coded with this first appraisal, codes with overlapping themes were consolidated and grouped into tree nodes (organizing themes). This determined the researcher-constructed typologies which "are those created by the researcher that are grounded in the data but not necessarily used explicitly by participants" (Marshall and Rossman 2011, p. 215). When new codes emerged that represented common or unique responses, new codes were added. Using an inductive approach I used the data to make tentative hypotheses; interviewing, coding and analysis clarified the research questions themselves (Ridenour and Newman 2008).

After these two stages of initial analysis, the coding system was organized and the interviews were re-analysed using the final coding scheme.

Based on the content of the researcher and resident interviews, and informed by the educator interviews, integrative science educational materials were created to be used at the Old Crow Spring Culture Camp as organized by the VGFN and Chief Zzeh Gittlit School. The materials were developed through a collaborative effort of the Old Crow Culture Camp Committee, teachers at Chief Zzeh Gittlit School, and myself. Copyright of these materials is held by the VGFN Education Department. At the request of the school and education department, and as part of my second research trip to the community in April 2010, I compiled a newsletter summarizing the events of the camp, called the PushUp Press. Samples of this newsletter (see Appendices G and H: Samples from PushUp Press 2010 and 2011) illustrate many ways in which the spring camp allowed students to simultaneously explore the territorial learning objectives and Indigenous Gwich'in cultural knowledge.

1.8 Operational definitions

1.8.1 Indigenous and Western ways of knowing, knowledge and science

Indigenous and Western ways of knowing are not opposite systems; such a binary understanding of knowledge is often used in colonial discourse (Battiste 2002). Diversity and nuance characterize both Indigenous and Western knowledge systems. I acknowledge the complexity and multiplicity of these knowledge systems, and recognize that they are simultaneously different and complementary. Different ways of knowing have different assumptions concerning information, interpretation, analysis and information transmission (Banks 1993). Ways of knowing refer to the *process* of coming to know, whereas knowledge refers to the *information* of what is known (Berkes 2008). Knowledge is but one part of a wider way of knowing. Knowledge is shaped by the social and cultural norms that reflect the worldview of those who define what is knowledge (Little Bear 2000).

Indigenous knowledge is the way Indigenous people come to understand themselves and their relationship to the world around them; at the base of this is the knowledge, skills attitudes and beliefs required to fully live in and with the natural world (Cajete 1999, Barnhardt and Kawagley 2005). There are many other terms use to describe particular understandings of this knowledge. For example, traditional ecological knowledge is used to describe the collective body of culturally-transmitted, ecologically-adaptive knowledge, practice and beliefs handed down through the generations about the interrelationship between living beings and their environment (Berkes 2008). However, instead of using the value-laden concept of 'traditional', I have chosen to use the more specific 'Indigenous' to specify Indigenous knowledges or ways of knowing. For the purpose of this thesis, I use the terms Indigenous knowledge and Indigenous science interchangeably.

Western knowledge is rooted in the Western canon, influential literature and art (amongst others) that has shaped and continues to define Western culture (Banks 1993). Western science, as we know it today, emerged from ideas popularized during the 17th Renaissance; natural philosophers as Galileo and Newton established a way of knowing – that we know understand as Western science – that valued objectivity and quantitative, empirically-obtained evidence (Hatcher *et al*. 2009a). Western science is typically highly organized and categorized by discipline, evident as the divisions between biology and chemistry) (Hatcher *et al*. 2009a). From a northern Canadian perspective, Western knowledge and ways of knowing are often referred to as Southern knowledge and ways of knowing.

As Barnhardt and Kawagley (2005) explain, three 'domains of knowledge' are created when Indigenous and Western ways of knowing are compared: that of Western, Indigenous and shared ways of knowing (Figure 1.4). Barnhardt and Kawagley (2005) present common ground between these two ways of knowing: they both share the organizing principle of a unified universe; they both value inquisitiveness, honesty and open-mindedness; they both develop pattern recognition, inference and prediction skills; and seek to appreciate or to understand cycles, interdependence, and the position and

motion of objects. However, there are also important differences: Western science is primarily quantitative, highly values objectivity and categorizes and breaks down nature into understandable portions (e.g. subject areas), whereas Indigenous science is primarily qualitative, highly values subjectivity, and recognizes nature as a system of interconnections (Barnhardt and Kawagley 2005).

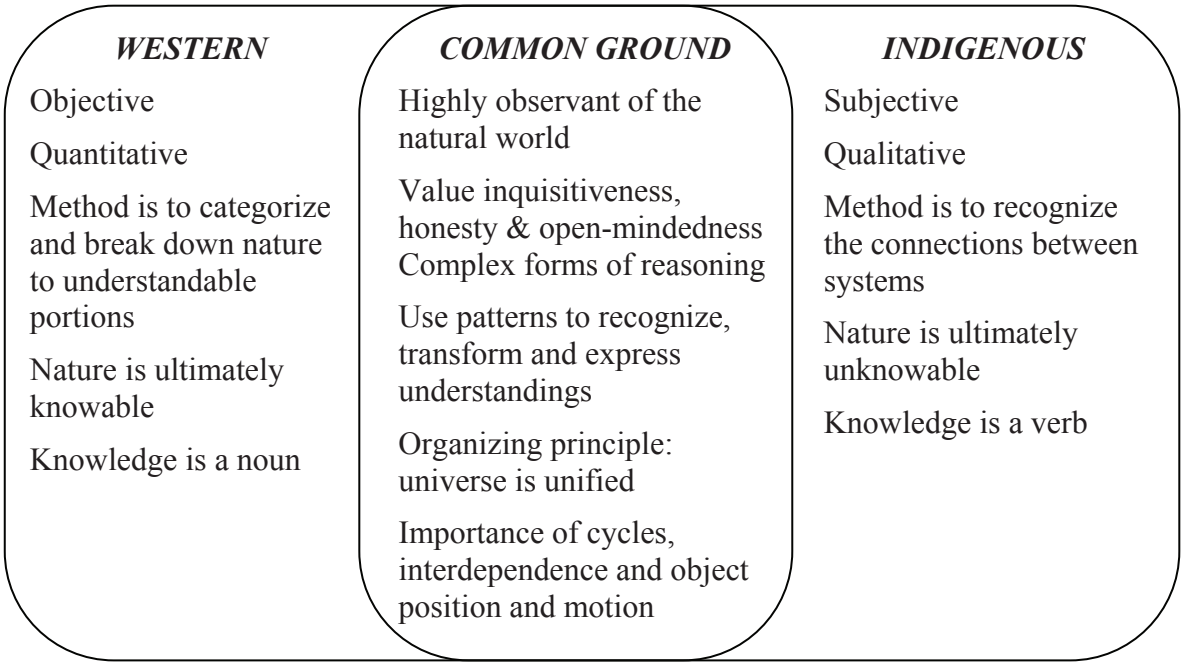

Figure 1.4 Comparing Western and Indigenous ways of knowing (adapted from Barnhardt and Kawagley 2005, Bartlett *et al.* 2012)

1.8.2 Integrative education and integrative science

Recognizing that there are such similarities and differences between these two ways of knowing, there are emerging examples of universities, colleges, schools and communities bringing "the two systems together in a manner that promotes a synergistic relationship such that the two previously disparate systems join to form a more comprehensive holistic system that can better serve all students, while at the same time preserving the essential integrity of each component of the larger overlapping system" (Barnhardt and Kawagley 2005, 16). For example, at Cape Breton University's Institute of Integrative Science and Health, Indigenous Mi'kmaw Elders Albert and Murdena Marshall and their collaborators are developing the concept of 'Two Eyed Seeing' as a way to live, study,

work and research from the methods and understandings of both Mi'kmaw and Western science (Hatcher *et al.* 2009a).

In this thesis, I use the term integrative education to explain this simultaneous use and comparison of two ways of knowing, but as part of the efforts of formal schooling. As one part of a student's wider education – which I recognize includes the efforts and impact of family, community and self-reflection – formal schooling has historically been both a site of oppressive colonialism and dehumanization and (more recently) a site of Indigenous reclamation of voice, power and autonomy (Vick-Westgate 2002, McGregor 2010, Sisco *et al.* 2012). Integrative education recognizes the 'universality of Eurocentrism,' colonial paradigms and prejudice, and is an attempt to recognize and move forward with the power and voice of Indigenous people being "actively part of the transformation of knowledge" (p. 24). Using an integrative approach to education, Western and Indigenous ways of knowing are not seen as mutually exclusive. Instead students, teachers and collaborators are challenged to weave back and forth between Western and Indigenous knowledge, seeking to more fully understand both ways of knowing (Hatcher *et al.* 2009b; Bartlett *et al.* 2012). More specifically, integrative science refers to the practice of weaving between Western scientific understandings, and those from an Indigenous perspective (Hatcher *et al.* 2009a).

1.8.3 Education, outreach and communication

This research makes a distinction between education and outreach as informed by the International Council for Science IPY framework (ICSU 2004). Education refers to formal communication efforts that most often occur within classrooms, or in conjunction with teachers. Thus education is different than the more informal idea of outreach which involves creating learning experiences outside of the school and classroom, such as through media, public presentations, exhibits and other community programs. Lastly, whereas the IPY framework considers communication to be limited to a variety of media (such as print, television, radio, internet and film), in this thesis I expand this definition to include all *methods* for education and outreach communication, not just media, but also

community presentations, educational materials, and community-focused outreach programs.

1.8.4 Curriculum, educational materials and learning resources, and exemplars

Several teaching concepts are used throughout this research that need to be defined including curriculum, educational materials and learning resources, and exemplars. While 'curriculum' is often misused to refer to all educational materials, in this thesis curriculum refers to the Ministry of Education's standardized written objectives for each grade level and subject that defines what is taught in schools. In the Yukon, which uses the British Columbia curriculum for most courses, the objectives that are met within each class are defined by Integrated Resource Packages, documents that provide teachers with unit and lesson ideas and information to implement the curriculum. Whether teachers are planning the year, a unit, or a single lesson, they must explicitly state which prescribed learning outcomes are being met with each individual lesson or activity. Curriculum is usually organized by objectives and content is not necessarily specified. For example, learning outcome 'A3' in the Grade 8 Science curriculum for British Columbia requires students to use models to explain how systems operate (Ministry of Education 2006). Using a model to explain a system is the learning objective; the specific content that is used to teach this objective is up to the teacher. They could, for example, create and examine food webs to explain trophic relationships between plants and animals, they could explore examples of how processes could be modelled, or describe the relationships between components of a model; or, do something completely different.

Whereas curriculum is a standardized guide of learning outcomes, educational materials and learning resources are the tools teachers can use deliver the curriculum. Teachers create and share their own resources (see Martlatt 2010), institutions and organizations create topic-specific materials (see Project Caribou 2010), and a plethora of (variably successful) resources can be found on the internet (see Climate Change North 2011). Lastly, exemplars are mock-ups or samples of student work, provided to guide students as well as to demonstrate to teachers what to look for when assessing student work. Many

resources do not use exemplars, but when available they are eagerly used by teachers for both examples to the class of a final product, as well as to provide guidance when evaluating student submissions.

1.8.5 Vulnerability, adaptation and resilience

This research is conducted, in part, to support community-based efforts in developing culturally-responsive community programs and resources. As Inuit political representative Watt-Cloutier (2000) explains, "the effectiveness of education is measured by how well it prepares people to handle the problems and opportunities of life in their own time and place" (p. 114). As reflected in this statement, education is inextricably linked to conceptualizations and assessments of vulnerability, adaptive capacity and resilience. The substantive funding of IPY financed an explosion of science and social science research into the vulnerability, adaptation and resilience of northern ecosystems, including the people that live there (Aunapuu *et al.* 2008, Huntington and Moore 2008, Ford 2009, Laidler *et al.* 2009, Smit *et al.* 2010). Vulnerability refers to the potential and severity of experiencing adverse impacts in an ever-changing world. In this thesis, I adopt James Ford's (2009) extended definition which specifies vulnerability as a function of exposure sensitivity and adaptive capacity.

Adaptive capacity is understood as the individual and collective responses to this vulnerability (Ford *et al.* 2007), or the ability to influence and manage resilience (Walker *et al.* 2004). Consequently, Berkes and Jolly (2001) view adaptive capability in "the usual evolutionary ecological sense to mean any response that increases a population's probability of survival" (p. 2). In this understanding, and the definition I use in this thesis, adaptive strategies are more substantive than short-term coping mechanisms, and instead refer to individual and collective long-term strategies that allow a population to continue to survive as well as thrive.

Walker and Salt (2006) suggest that resilience is the ability of human and nature systems to absorb disturbance and still retain their basic function, which closely identifies with Berkes (2007) understanding as resilience as the "capacity of a system to absorb recurrent

disturbances, such as natural disasters, so as to retain essential structures, processes and feedbacks" (p. 283). Berkes identifies several ways in which resilience can be developed, two methods of which are fostered through this research, including deepening the range of knowledge in communities and encouraging self-organization by strengthening problem-solving networks. Further expanded in O'Brien *et al.* (2009), resilience thinking refers to both scaling up to the macro, transnational levels and scaling down to the micro, individual level at which individuals, communities, networks and institutions can cope with present and future change and plan how they might face currently unknowable risks. Informed by these authors, in this thesis I accept the Walker and Salt (2006) as well as Berkes (2007) absorption understanding of resilience, understanding that this definition of 'systemic resilience' includes the resilience of individuals and groups at all levels, as outlined by O'Brien *et al.* (2009).

1.9 Structure of the thesis

The thesis is organized into four chapters. This first chapter is an introduction to the research methods and scope, as well as an orientation to the research region and relevant topics. The second and third chapters are stand-alone chapters, prepared for publication. The second chapter explores northern residents, researchers and educators perspectives on outreach partnerships, and includes an analysis of the benefits and challenges of conducting educational science outreach in northern Canada. The third chapter explores educator and residents' rationale for developing integrative studies programs (that bring together Western and Indigenous knowledge), and includes recommendations for researchers and communities wanting to engage in education and outreach projects. The final chapter provides a synthesis of the research, research recommendations, theoretical contributions, study limitations, and avenues for future research.

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CHAPTER 2: MULTIPLE PERSPECTIVES ON POLAR SCIENCE EDUCATIONAL OUTREACH PARTNERSHIPS IN THE NORTH YUKON, CANADA[5]

A unique element of International Polar Year (IPY) 2007-2008 was the focus on sharing the excitement of 'doing science' with northern communities through education and outreach projects. This article reports on the perspectives of key stakeholders in Canadian IPY research projects in their pursuit to incorporate education and outreach in culturally-appropriate ways. To identify the benefits, challenges, and common pitfalls when conducting researcher-led science education and outreach activities in the north Yukon, sixty qualitative interviews were conducted with IPY researchers, northern residents, and integrative science educators. Findings suggest that for southern-based research networks working in northern Indigenous communities, educational outreach is most successful in the eyes of northern educators and residents when it is regionally and culturally specific, people-focused, and led by the local community's vision and needs.

Keywords: science outreach, science education, K-12 education, integrative science, land camp, Yukon

2.1 Introduction

In 2007-2008, the fourth International Polar Year (IPY) ushered in a new era of polar research through "an intensive burst" of circumpolar, interdisciplinary scientific research, complimented by two features unique to this IPY: data management and communication, as well as education and outreach (ICSU 2004, p. 9). During IPY, outreach efforts focused on five target audiences: school children, young polar researchers, Arctic communities, general public and government and scientific decision-makers (ISCU 2004). While new for IPY, outreach expectations were not unique in Canada where they were often required by federal funding agencies (Andrews *et al.* 2005, Laursen and Smith 2009). My research focuses on educational outreach with two of these audiences: school children (Kindergarten to Grade 12) and Canadian Arctic communities, and the north Yukon in particular. I use the term 'educational outreach' to describe the efforts of researchers to engage with teachers and students as part of their science outreach and 'education' to describe school-based efforts of student learning.[6]

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[5] A version of this chapter is to be submitted to *Polar Geography: IPY Community Engagement Special Issue* with the following order of authors: F. Ross, K. Harper, T. Wright, and H. Castleden.

[6] This is slightly different than the IPY Planning Group that differentiated 'education' as school-based efforts (e.g. scientist guest speakers, teacher-scientist partnerships), 'outreach' as informal education

2.1.1 The cultural practices of science and education

Researchers working with Indigenous communities and in their traditional territories have an additional responsibility to collaborate and share with community partners, in part because of the reciprocal relationship in which Indigenous communities allow access to their land and people and therefore have the right to know and be involved in the research (Brown 2005). The three northern Canadian territories have a relatively high proportion of Indigenous people: 85%, 50% and 25% in Nunavut, Northwest Territories, and the Yukon, respectively (Statistics Canada 2008).[7] Consequently, science research conducted in the Canadian north often occurs in the traditional territory of an Indigenous group, and northern outreach programs will often involve Indigenous students. Research involving Indigenous people has often been defined and carried out by non-Indigenous researchers, using approaches that do not reflect Indigenous perspectives, and result in little benefit to Indigenous communities; as a result, Indigenous communities are apprehensive of research and related initiatives, particularly when originating outside of the community (CIHR, NSERC and SSHRC 2010). One step towards building mutually-beneficial and collaborative research relationships based on respect and responsibility is for all elements of the research program, from conceptualization and design to implementation and dissemination, to be developed in a cross-cultural context.

A first step towards cross-cultural learning is to respect and to seek to understand the differences between the southern/Western and Indigenous world views. The nature of one's understanding of 'science' is largely dependent on the cultural background of the scientist (Aikenhead 2002a). Science research is most often defined and understood by European-originated understandings of what constitutes science, which I specify as Western science. However, as previously expressed by Kawagley *et al.* (1998), Western science is not solely European in origin but is instead a blend of many different cultural

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opportunities (e.g. community programs, museum exhibits), and 'communication' as conducted via media (e.g. television, newsprint, and internet) (ICSU 2004).

[7] For the purpose of this chapter, I define 'north' as the area in Canada north of 60ºN latitude, an administrative line which separates the northern territories from the southern provinces.

understandings of science. Furthermore, the legacy of colonization continues today across many institutions, including education when students' culture and identity comes into conflict with Western (and in this case, southern) curriculum. There is a significant educational achievement gap between Indigenous and non-Indigenous students in Canada (Richards *et al.* 2008)[8], largely as part of the profound impact of the colonial encounter (Chisholm 1994, Battiste 2000). Colonization of the Canadian north and the introduction of Westernized formal education in the mid 1900s disenfranchised Indigenous people and undermined their culture, including their conceptualization and approaches to education (Vick-Westgate 2002). Today, the three northern Canadian territories continue to rely on curriculum designed in southern Canada, such as the Yukon using much of the province of British Columbia's curriculum. However, all three northern territories are also in the process of developing relevant, northern and Indigenous curriculum and educational materials to replace the southern curriculum (see Lewthwaite *et al.* 2010).

Southern-based teachers and researchers are typically trained from a Western paradigm and do not necessarily understand how northern Indigenous students' worldviews may differ from their own (McGregor 2010).[9] Those trained and working in the Western paradigm often do not see the latent transmission of their cultural values in the practice of Western science (Aikenhead 2002a).Consequently, an ongoing challenge of science education is developing a wider understanding of Western science with its embedded cultural values (Aikenhead and Elliot 2010). Such cross-cultural education allows different cultures to co-exist in the classroom by "studying the subcultures of students' life-worlds and by contrasting them with a critical analysis of the subculture of science … consciously moving back and forth between life-worlds and the science-world" (Aikenhead 1996, p. 38: original emphasis). Science is perceived, learned and taught

[8] Similar to Castellano (2004), in this thesis I use Indigenous in reference to the original inhabitants of Canada, as defined in the Canadian Constitution Act of 1982 and updated in the Report of the Royal Commission on Aboriginal Peoples of 1996, to specify those belonging to an Aboriginal nation.

[9] The percentage of Indigenous educators in northern schools is often considerably lower than that of the student population (Council of Ministers of Education Canada 2002).To increase the number of northern-born and Indigenous educators, territorial colleges in all three regions are currently collaborating with universities in southern Canada to jointly offer Teacher Education Programs.

through a cultural lens, just as Indigenous science is an expression of the particular Indigenous culture from which it comes (Aikenhead and Ogawa 2007). One way that educators show how culture influences science is to teach science from more than one cultural perspective (Hatcher and Bartlett 2010).

Indigenous people often speak to the challenge of 'living in two worlds,' the locally-defined Indigenous world and externally-defined global – or southern Canadian – world (Barnhardt and Kawagley 2005). An ongoing challenge of those conducting educational outreach is to allow students to explore knowledge, skills and attitudes from both these ways of knowing. To address the issue of prioritizing Western science instruction over that of the students' own culture and worldview, science education researchers have identified a gap of understanding in how educators (and researchers interested in science outreach) can use culturally diverse approaches to science (Medina-Jerez 2008).

2.1.2 A new model: Integrative science educational outreach

Developed with Indigenous Mi'kmaw Elders Albert and Murdena Marshall on the east coast of Canada, Bartlett (2011) articulates integrative science as an inclusive and realistic way in which seemingly disparate cultural knowledge systems can be brought together for the purpose of science education, outreach and research. Bartlett (2011) explains how integrative science is guided by a recognition of the strengths of Indigenous and Western ways of knowing. By overlapping these two perspectives, Hatcher and Bartlett (2010) explain that we gain a sharper image or concept in greater detail and complexity than if we considered it from only one knowledge system alone. Hatcher *et al.* (2009) describe how an integrative science program prioritizes observation of nature, holistically approaches issues (not bound by discipline), and gives opportunity for students to work with 'experts' from both knowledge systems (e.g. Indigenous Elders and academic researchers). In such ways, the conceptualization and practice of integrative science – which they call 'Two-Eyed Seeing' – is a useful tool for guiding educational outreach in Indigenous communities.

In the context of Western (mainstream) science research programs, science outreach

efforts are often based on a conventional linear model of research in which scientists act as experts that deliver their knowledge to passive recipients (Sussman 1993, Christensen 2007). Although the 'scientist in the classroom' is one of the most popular models of grade-school science outreach, the concept of educational outreach is expanding outside of this traditional 'guest speaker expert' manifestation. IPY encouraged and funded a number of creative educational outreach programs, from teacher-scientist collaborative research in which students, classes and entire schools assisted in data collection, to teacher-in-the-field research partnerships that saw students as well as their teachers spend extensive time conducting fieldwork with research teams (Provencher *et al.* 2011). This research-to-practice model asserts that research program designers manage the outreach concept, and either conduct their own outreach (e.g. LaRiviere *et al.* 2007, Laursen *et al.* 2007) or work with educators to decide upon a dissemination strategy (e.g. Krasny 2005, Ferreira 2007). This expert-driven outreach model presents several challenges (Luedeman *et al.* 2003, Miranda and Hermann 2010) that may be intensified when working in rural and remote communities, as well as in cross-cultural contexts, because of greater cultural gaps between the key stakeholders.

Developing an integrative science program requires respect, patience, and a commitment from all parties to explore different ways of knowing (Hatcher *et al.* 2009, Bartlett *et al.* 2012). Yet researchers, educators and residents are often unfamiliar with the daily experience and motivations of the other stakeholders (McKeown 2003). For example, there are similarities between the professional cultures of researchers and educators; both work in learning environments, base their practices on previous research, and solve complex problems (Tanner *et al.* 2003). However, there are significant differences; researchers are usually specialized within a particular discipline (depth of understanding), whereas educators are likely to have a broad knowledge base across many subject areas (breadth of understanding). Researchers are professionally trained to communicate with skepticism and constructive criticism, whereas educators are professionally trained to communicate with encouragement and positive feedback (Tanner *et al*. 2003). Informed by Two-Eyed Seeing, these differences can be recognized without ascribing a judgement of either as the 'right' or 'wrong' practice. Instead, being aware of these differences

allows stakeholders to more effectively communicate and collaborate in integrative science initiatives in which both the common and uncommon ground is recognized and allowed to co-exist. Furthermore, these titles (of researcher, educator or resident) are not mutually exclusive; researchers are often educators as well, residents are often educators, and there are growing numbers of northern-based researchers. Nonetheless, professional differences remain between these stakeholders.

Here I consider the experiences of those involved in educational outreach efforts during IPY, focusing on the perspectives from researchers within two IPY research projects as well as from educators and residents in the north Yukon, Canada. My research objectives were: 1) to understand researcher, resident and educator perspectives on the benefits and challenges of participating in scientific educational outreach; 2) to explore and to evaluate the experiences of stakeholders involvement in such outreach (particularly what worked, what did not work, and why they thought that was so); and 3) to develop educational outreach recommendations for those interested in developing and coordinating such programs in the Canadian north.

2.2 Study community

Four criteria guided the selection of the participating community: 1) IPY research had to be occurring in or around the community, 2) residents had to be familiar with IPY research in the community (e.g. community member research assistants), 3) residents had to be familiar with outreach initiatives from research groups previously conducted in the community (e.g. community or school presentations) and 4) the community leadership needed to be interested in participating in this project. Site selection was determined through consultations of northern research networks, four preliminary community enquiries and two community visits (Ross 2012). On the basis of these criteria, and following the policies and provisions outlined in TCPS2, leadership in the north Yukon community of Old Crow agreed to collaborate in this study (Figure 1.2).

At the confluence of the Crow (*Chyahnjik*)[10] and Porcupine (*Ch'oodèenjik*) rivers, Old

[10] These are the Gwich'in language place names.

Crow is located in the traditional territory of the Vuntut Gwich'in, meaning 'people of the lakes' (VGFN and Smith 2009). A community of approximately 280 people, Old Crow is primarily comprised of Gwich'in people, with 215 identifying as Aboriginal (Statistics Canada 2006). Old Crow's government, the Vuntut Gwitchin Government (VGG), administers the Vuntut Gwitchin First Nation (VGFN) 1993 land claims agreement. The local economy is primarily supported by wage-based government employment (territorial and First Nation) in addition to a strong traditional economy of subsistence hunting, trapping and fishing that supports economic and cultural wellbeing. Without year-round road access, Old Crow is a fly-in community, with flights connecting Old Crow to the gateway community of Whitehorse 800 kilometres to the south.

The local Chief Zzeh Gittlit School provides classes for Kindergarten to Grade 9, after which students must move to the territorial capital, Whitehorse, to complete their secondary studies. The position of a VGFN-employed Education Support Worker was created at the school to implement the First Nation's educational policies, to provide student guidance and counselling, and to facilitate the integration of Gwich'in culture into daily classes and through core projects such as an annual land camp. Since the 1970s the annual spring land camp has been running as a collaborative project between the VGFN and the school. In recent years, however, there has been interest in the school and community to expand beyond a solely Gwich'in cultural focus and instead deliver a program that integrates curricular (Western) and Gwich'in learning objectives.

Old Crow has demonstrated great capacity for coordinating their own research and education agenda; the VGFN co-led one of only a few northern and Indigenous-coordinated research programs that were fully endorsed and funded during IPY (Church 2009). Partnered with the Yukon's Department of the Environment and Parks Canada, IPY researcher Wolfe *et al.* (2011) explains that such a "partnership was made possible by the willingness of a fully engaged, motivated, and research-experienced northern community" (p. 127). The community has an extensive history of coordinating its own research on social science and cultural issues (e.g., Smith and VGFN 2009). Previous literature has posited that northern communities lack research capacity due to a lack of

training, skills, and funding amongst northern researchers, communities, and territorial and federal governments (England *et al.* 1998, Newton *et al.* 2005). But there is growing evidence of substantial capacity and collaboration amongst these key stakeholders (see Berkes *et al.* 2007, Gearhead *et al.* 2011, Huntington 2011). As demonstrated and supported during IPY, I suggest that Old Crow demonstrates such collaborative research and outreach.

2.3 Methodology

Sixty interviews were conducted amongst three stakeholder groups involved in education and outreach in Old Crow (Table 2.1). Different semi-structured, open-ended interview guides were developed for each stakeholder group. Purposive opportunistic and criterion sampling were used to ensure a variety of stakeholders perspectives, level of experience and level of involvement in educational outreach (Patton 2002, Creswell 2007). Ethical considerations and approval were obtained on many levels for this project including university ethics approval, a territorial research licence, and community approval through the VGFN's Heritage Department. Potential interviewees were given oral and written descriptions of the research study, scope of their involvement, discussion of potential risks, issues of compensation, and what would be done with the information from their interview. Following this oral agreement, interviewees gave written consent to participate.

Table 2.1 Sampling frame and characteristics of the stakeholders

Participant cohort	Researchers (n=24)	Residents (n=18)	Educators (n=18)
Sampling frame	IPY research group PPS Arctic: treeline ecology and change (n=15) IPY research group YNNK: Environmental change in Old Crow Flats (n=9)	Natural resource users (n=18)	Teachers previously or currently working in Old Crow (n=8) Yukon Government First Nation and environmental educators (n=6) Southern-based integrative science educators (n=4)
Purposive & opportunistic sampling to capture diversity	Sampling across geographical regions and subject areas (e.g., aquatic ecology, wildlife, food security, spatial ecology, paleoclimatology)	Sampling across a variety of resource users (e.g. hunters, berry pickers, fishers, wood harvesters)	Sampling across a variety of experience integrating Western and Indigenous learning objectives as well as educational outreach
Internal cohorts	Student researchers (n=10) Early career, ≤5 yrs from PhD (n=3) Mid or late career scientists (n=11)	Elders (n=4) Adults (n=14)	Gwich'in educators (n=5) Non-Gwich'in Indigenous educator (n=1) Non-Indigenous educators (n=12)
Interview location	In person (n=4) Telephone (n=20)	In person (n=16) Telephone (n=2)	In person (n=15) Telephone (n=3)
Interview topics	Education & work experience IPY research project Education & outreach activities	Education & work experience Teaching & learning pedagogy Education past, present & future Science outreach experiences	Education & work experience Teaching & learning pedagogy Learning resources & assessment Science outreach experiences

Twenty-four researchers were recruited from two groups that conducted research in Old Crow's Gwich'in territory during IPY (Table 2.1). The first group, PPS Arctic Canada,[11] consisted primarily of plant ecologists investigating the ecological impact of climate variability on northern vegetation in the transition between forested and non-forested areas or treeline (Harper *et al.* 2007). The second group, YNNK,[12] coordinated in part through the VGFN, investigated the environmental stability, vulnerability and resilience of Old Crow Flats, a thermokarst lake wetland 50 kilometers north of the town (Wolfe *et al.* 2011).

All eighteen Indigenous residents from Old Crow had some familiarity with one of the two IPY projects (Table 2.1), while several participants were extensively involved (e.g. working as research assistants or attending the YNNK community strategizing workshops). Prior to conducting the interviews with residents, I read through select interviews in the VGFN's Old Crow Oral History Project database in order to prevent question duplication, as well as to inform the style of the interviews.[13]

Eighteen interviews were conducted with northern and/or integrative science educators (Table 2.1). I defined 'educators' narrowly, as teachers and administrators (e.g. principals and government department education specialists) who were involved in school-based education rather than community-based educators such as Elders and natural resource users (e.g. hunters). These educators had varying levels of familiarity with the two IPY projects, with a handful being closely involved (e.g. having a researcher in the classroom). Most of the educators who were not involved with these two IPY projects

[11] PPS Arctic Canada stands for 'Present processes, past changes, spatio-temporal variability in the Arctic delimitation zone, Canada'.

[12] The Gwich'in term for this project 'Environmental Change and Use of the Old Crow Flats' translates into "looking after the land for the future" and provides the acronym used for this IPY group, YNNK.

[13] This database was reviewed prior to the interview guide being prepared in order to avoid asking the same questions, and to allow me to become familiar with the research and education priorities and concerns of Old Crow residents prior to conducting our own interviews. The database is housed in and operated by VGFN Heritage Department, and is a collection of interviews conducted by the VGFN as part of an oral history project.

had worked with other researchers conducting science outreach. Teachers not originally from Old Crow had worked there for several months to more than a decade.

Researchers were more often interviewed over the phone since they were more likely to be familiar with this method and were from various sites across Canada, compared to the educators and residents who were primarily located in Old Crow and the Yukon. Interviews were 30-90 minutes, and all but seven interviews were digitally recorded. Interviews were transcribed verbatim and coded into thematic categories using NVivo 9™, a qualitative analysis assistance software package (QSR International Pty Ltd. 2010). Using content analysis, I identified themes in the interviews (Kondracki and Wellman 2002, Hsieh and Shannon 2005). Thus, codes were developed during – rather than before – the data analysis through a constant-comparative approach (Boeije 2002).

2.4 Results

All three outreach stakeholder groups reported mixed satisfaction with current educational outreach projects. The stakeholders spoke of what they perceived as personal, institutional or program features that had the potential to either enable or block successful outreach projects. My results suggest six key features that were identified as facilitating such projects: 1) understanding the motivations of the other stakeholders; 2) ensuring local vision and ownership in the project; 3) providing opportunity for bi-directional capacity building; 4) overcoming institutional barriers together; 5) re-evaluating time and funding priorities; and 6) and developing programs that integrate Western and Indigenous sciences.

2.4.1 Recognition of stakeholder motivations

Stakeholder groups reported different motivations and concerns for participating in educational outreach (Table 2.2) and claimed they found it easier to work with the other stakeholders when they understood each other's motivations. To illustrate the importance of establishing and maintaining such a collaborative environment, one Old Crow resident reflected on their experience attending an outreach presentation, in which the community:

> … listened to the high-tech words of the biologists but [the

> community members] were on the wrong path of not understanding them.. I told them these people are real useful when you're going to have hardship. ..If you work together, you give them your traditional knowledge, they give you their scientific understanding. (Resident 4)

This resident further explained that when stakeholders shared this understanding, each could see how the other stakeholders (e.g. educators and researchers) could help each other, rather than seeing their roles or motivations as incompatible.

Table 2.2 Outreach considerations as discussed by each participant group. Sample size and number of interviewees expressing each concern are in brackets

Researchers (24)	*Residents (18)*	*Educators (18)*
Charged with meeting funding, institutional and research requirements (24)	Desire hands-on approaches that allow students to learn from Elders, other experts (17)	Interested in using cultural knowledge to meet learning outcomes (16)
Interested in developing ongoing community relationships that will lead to novel research questions (13)	Aware that local government is charged with providing high-level education that allows students to explore their environment and culture (16)	Charged with meeting government-mandated learning outcomes (14)
Saw their outreach efforts as community service, as giving back to the community (11)	Desire outreach that allows students to explore possible career paths (10)	Ongoing need to support development of scientific literacy of student and teachers (13)
Interested in authenticating the relevance of research (10)		Interested in learning 'cutting edge' science (13)

All researchers reported that as academics they had a professional expectation to conduct educational outreach to fulfill their funding requirements. Several researchers limited their interest in educational outreach to this institutional requirement, and viewed outreach as one of the many items a researcher must 'check off' in order to secure a successful funding application and complete the 'package' of research responsibilities:

> One of the things that has made [outreach] work for IPY is that [it] was really a condition of the funding. We've essentially had to do it. (Researcher 22)

However, almost half the researchers were also interested in educational outreach since it provided local insights into environmental change, and could lead to novel research questions. Through dialogue with the community, many researchers found novel as well as community-relevant research questions:

> … when I went to communities to talk about my work, it was like 'and so what? So I decided to try to work towards something for the community. And as [an ecologist] I cannot help with [social] problems… but I need to have at least some relevance so that I can at least start some exchanges. (Researcher 6)

This researcher felt challenged explaining the significance of their research to the community as part of an educational outreach initiative. Just under half the researchers, particularly those involved in the VGFN co-led YNNK project, explained that they participated in educational outreach as part of their personal and professional commitment to sharing their knowledge and learning from others. Several researchers (along with several educators) mentioned that merely acknowledging each stakeholder's expertise and lack of experience in other capacities indicates their interest in learning from each other.

Although researchers spoke about institutional barriers preventing their involvement in educational outreach, approximately half the researchers interviewed focused on these barriers and funding requirement of doing outreach as part of their science program, and did not mention developing community relationships or confirming the relevance of their research at the local level when discussing their motivations for northern outreach (Table 2.2). All researchers discussed barriers to participating in educational outreach, regardless of if they reported significant or non-existent personal involvement in such outreach. Researchers who were more heavily involved in educational outreach saw potential outreach barriers as feasible challenges, much in the way they perceived other potential barriers for conducting research in the north (e.g. high travel costs, greater need for flexibility due to weather, short summer field season, etc).

Early-career researchers, often in contrast to more experienced researchers, spoke at

length about their commitment to the community in which they conduct their research, giving numerous examples of the ways in which they established and continue to nurture relationships with community members, teachers, and young scientists. Later-career researchers were more likely to speak about their conversations with Elders and community residents, although their interactions were often more anecdotal than substantial in influencing their research and outreach agenda. Conversely, early-career researchers spoke enthusiastically of their personal and professional need to serve the wider community in which they work. Five out of ten graduate students and one of the three early-career researchers reported extensive involvement in such outreach, demonstrating a high level of commitment and enthusiasm for educational outreach that was noted by several other researchers and residents. Because they were current or recent students, they were engaged in creative new methods of teaching at the university level and motivated to share this enthusiasm with students and teachers in the community. They also explained that patience and time were needed to conduct meaningful educational outreach, although they often spoke of their uncertainty and frustration of finding a 'right way' to go about conducting outreach. Several of the mid-career researchers assisting in the coordination of research programs also reported extensive involvement with educational outreach. As one scientist noted, "I think I have ways of getting in as many levels of interaction as possible, so that's why it's worked successfully" (Researcher 6). These leaders spoke of outreach not as a requirement for successful funding applications, but instead spoke of the value of reciprocity with the wider community.

Residents spoke of many ways in which science outreach could help them to share cultural and land-based knowledge with youth in the community. Residents explained that content the youth in Old Crow are learning at school should – and often does – reflect their Vuntut Gwich'in culture. However, as one community leader lamented,

> You don't want your children to [just] read [about their history] in school. You want them to practice it, you want them to continue to practice it, not read it out of schoolbook. (Resident 4)

Several residents, as well as educators, explained how knowledge is only one part of

learning, and skills and attitudes are equally – if not more – important but that their transmission and development cannot easily happen in the classroom, and should be learnt in a more authentic setting. However, many residents lamented that traditional Gwich'in knowledge is not necessarily being passed down in the most authentic method, through the family. Such residents explained that families alone cannot develop the 'whole person'; instead the wider community – and consequently the school – must be part of these efforts. In addition, residents specified that it was essential to go beyond 'surface features' of Gwich'in culture and science curriculum. In the same way that students were expected to reach beyond cursory understandings of scientific concepts, residents were interested in engaging in science outreach to allow students to engage in comparative learning, and develop deeper understandings of their Gwich'in culture.

Educators reported that they were motivated to participate in order to ensure that both Western and Indigenous knowledge were used to meet curricular objectives (Table 2.2). Teachers structure their classroom content on prescribed learning outcomes as set by the territorial government. In the words of one northern educator discussing the components of muskrat trapping,

> So this breaks down in a whole bunch of particular learning outcomes .. one's a skill set and one's a knowledge set and one is an attitude. .. In fact you want to embrace all three of those components. It's not so much traditional knowledge as it is knowledge, skills and attitudes that reflect on those traditions, Gwich'in traditions. (Non-Indigenous Educator 9)

Continued in the words of another educator,

> Elders ... [are] always very encouraging of the fact that their knowledge should not limit their children's knowledge and that if there's something that can be learned in a different perspective or in a different way, they want their students or their children to also have that opportunity to learn that… which is an incredibly inclusive value that endorses the opportunity to have an integrative way of approaching topics. (Non-Indigenous Educator 18)

As expressed by such educators, the knowledge, skills and attitudes being observed,

practiced and learned during educational outreach can be assessed by the students themselves and the educators involved (such as the Elder or teacher).

Working closely with researchers allows educators to be exposed to emerging scientific understandings, methods and theories:

> Unfortunately the scientific literacy amongst most teachers ... is not that high. .. So probably the researchers need to understand that there's some real basic stuff that needs to be conveyed first before you get into the kind of theoretical research stuff that's going on. (Non-Indigenous Educator 15)

Many teachers spoke to the greater impact of researchers when they shared their passion for science and focused on supporting science education – such as science fundamentals or grade-specific learning outcomes – rather than the specific findings of their research. Educators explained that educational outreach initiatives should serve the wider community:

> So, what happened with the IPY funding, and how to use IPY within the school? Well, it became problematic. Because this is sort of like saying, 'come and do a presentation for us'. Presentations by their very character don't engage [students and community members] much. Isn't it far better [to engage in] experiential learning [using] hands on activities? [One group] sort of missed it a bit, because they hadn't got project based work. (Non-Indigenous Educator 9)

This educator explains how science educational outreach initiatives can support the type of science education and skill development both needed and wanted by northern communities: hands-on programs that allow students to understand problems that are of interest and concern to their community. Furthermore, when creating educational materials, several educators (as well as residents) reflected on the importance of their relevance: "The most important thing is that… education is reflective of the people who are 'being educated'" (Educator 18). In Old Crow, educators expressed that the structure and content of educational materials and programs must reflect the Gwich'in culture in order for the educational experience to be relevant to Gwich'in students.

2.4.2 Local vision and ownership

Stakeholders reported that successful outreach initiatives had the community itself directing the vision and sharing in ownership of the outreach project by using the project to meet locally-defined objectives, collaborating with the territorial government to meet territorial-defined objectives or using culturally-relevant student and program assessment techniques. Educators and residents agreed that IPY educational outreach would be best directed as supporting initiatives and priorities already discussed and agreed upon by the community or territory, with researchers finding where their interests and skills fit in to this community agenda. Several researchers also explained how they allowed the community to direct the research and outreach agenda, "we're being very sensitive to not rushing in... not saying 'this is what we're going to do'" (Researcher 8). Residents and educators alike appreciated working with patient researchers that would allow discussions to churn and ideas to form before making decisions concerning educational projects.

Many researchers explained how they allowed the community to have input in both the content and timing of the outreach program. Three researchers attributed low attendance at their outreach events to their failing to either seek or to follow this community input:

> [many community members] … are out in the land in the summertime. You can go into the band office and there is maybe one or two people there because somebody's off on holidays, or somebody's either at their cabin for the week or they're out doing their field monitoring. But I have to teach in winter and I really can't afford to go up multiple trips every year so I have to sort of lump that into the summer. (Researcher 4)

Many researchers explained how they attempted to 'tag-on' their northern education and outreach initiatives onto their fieldwork during these summer months, often with little success as many northern residents often take these summer months to fish, hunt and camp out on the land. Given their university-based teaching responsibilities and that most natural science research has to be conducted during the growing season, several researchers spoke to the mistiming between when researchers are available to travel, to when the school and community is least likely to be able to participate due to holidays

and land activities (in the summer). However, a few researchers reported successful educational summer initiatives with First Nation-run land camps offering experiential education programming for local youth. As one scientist remarked, "you just have to be there, and be there with enough time that you can take advantage of opportunities" (Researcher 22). All stakeholders reported facing a limited amount of time available. In a community with a lot of visiting researchers and ongoing research programs, many residents and educators chose not to be involved in outreach initiatives that were conducted without local input and direction.

Another way the community can direct the vision of education outreach is collaborating with territorial government departments, but the potential usefulness of this approach was overlooked by many researchers according to the educators. Instead, six educators reported that most researchers contact teachers or principals directly, and fail to see potential connections between their research and curriculum development at the territorial level. One educator commented that only one IPY research group contacted the territorial Department of Education to seek advice on how to best direct their educational outreach efforts:

> [the research network's education and outreach coordinator] went back to [their] board of directors and they said 'amazing, we would love to support an integrative education effort, do whatever they want you to do!' And so what is neat is that [research networks] have recognized that the context that we're trying to write [this curriculum] and deliver this education system in is going to be a better way to educate about science than if they just created their own web portal. (Non-Indigenous Educator 18)

Educators working in administrative positions and assisting in the curriculum development reported that scientists would have been welcomed to collaborate on science curriculum development as part of their outreach program. However, my research identified a gap between researchers' awareness of collaboration with curriculum departments with no other examples of any IPY networks contacting territorial curriculum writers.

In addition to front-end curricular design, stakeholders explained how outreach programs could consider local direction on developing culturally-relevant student and program assessment. Educators and residents explained how, in contrast to the Western mainstream education system of students receiving feedback at the end of a project in the form of comments and a grade, Indigenous assessment is ongoing in the form of both direct and indirect feedback. Historically, students would receive immediate feedback when learning traditional skills:

> As a student was learning something, there was someone there to give a critical word, give encouraging feedback, but the student knew how they were progressing all at that same time. (Non-Indigenous Educator 18)

Educators expanded on this, explaining how they use both formative (during a project) and summative (at the end of a project) assessment strategies to give students feedback. Furthermore, educators spoke to the importance of students reflecting on their own learning as part of the assessment strategy. Educators explained that students should be aware of their own skill development in order to track their learning, take pride in their successes and be aware of what skills and knowledge they still need to learn. Educators and residents reasoned that a locally-informed outreach project would include such formative, summative and personal forms of assessment.

2.4.3 Bi-directional capacity building

The community of Old Crow demonstrated significant capacity to envision, organize and facilitate a complex research program, including educational outreach components. However, many stakeholders reported issues with their or others' ability to organize and conduct educational outreach. Half the researchers and educators specifically stated that many researchers do not have the training or experience to effectively conduct educational outreach on their own:

> [Scientists are] trying to do it themselves but they're way too busy and they then get to the part of doing the outreach and realize like they don't have time, their own mandates are taking over, or they don't know how to generate something at a high school level or an

elementary level. (Non-Indigenous Educator 18)

Several researchers also voiced frustration over this inability, but most added that they also found outreach experiences humbling and motivational. When asked what was learnt as part of their involvement in education and outreach, one researcher sat back quietly and then exclaimed,

> Wow! Learned lots, for sure! A major learning curve! First, it is really stimulating to [work with schools and communities], but it is not necessarily 'natural' – we were not trained to do that. (Researcher 6)

Scientists explained how they are trained to communicate using critical feedback and scepticism with other scientists, which can be in direct opposition to the teaching culture in which teachers are trained to communicate using enthusiasm and positive feedback.

The capacity of the community members, such as local leaders, was also important for researchers to conduct educational outreach:

> The interactions with the community, for us, really hinged on getting people in [the community] involved, as sort of mediators for the community. (Researcher 22)

Researchers commonly remarked how important it was to find 'the right person' to be their main contact, whether it is a teacher, someone at the band office, or territorial government. Researchers and other stakeholders alike identified that researchers cannot be local organizers. All three participant groups explained that most researchers working in the community – but not all – were based at southern universities where they had teaching responsibilities for eight months of the year, and typically visited the community for a few weeks for summer fieldwork, and perhaps for a mid-winter or spring-break community presentation. Consequently, educational outreach projects were often coordinated by a local resident.

2.4.4 Researchers overcoming institutional barriers

Researchers, in particular, spoke of many institutional barriers that prevented them from conducting the type or depth of educational outreach they reported they would have

otherwise conducted. The majority of researchers working full or part-time in a university setting reported that the importance of research in current reward structures greatly eclipses the perceived importance of educational outreach. Many researchers (n=18) expressed frustration with barriers they faced prior to conducting field research, and thus before conducting any educational outreach: internal ethics reviewers unfamiliar with northern Indigenous communities, institutional and staff instability in the North (e.g. high staff turnover), duplication of the many license and ethics reviews required (e.g. un-streamlined applications amongst territories and communities), and research capacity issues within communities (e.g. training a qualified northern research assistant). When asked what the biggest challenge was to doing field-based educational outreach, one researcher replied with gusto:

> Oh! That's a really easy one! I hate paperwork and all the wonderful roadblocks the university puts in your way when you do fieldwork. (Researcher 8)

Several researchers reported that they are interested in participating in educational outreach, but feel they have limited time to conduct the outreach properly given other institutional requirements. Many researchers (n=18) expressed frustration with a lack of recognition, financial as well as professional, for their efforts coordinating and participating in educational outreach initiatives:

> I think one of the big challenges for academic researchers .. is that getting involved in outreach is personally fulfilling but professionally is really undervalued. And so there is not a lot of incentive for the amount of time and effort you have to put in to do these things. It's very hard to get that recognized as an achievement professionally. (Researcher 22)

Several researchers also noted that in applications for tenure or new funding, research accomplishments (e.g., academic publications) are significantly more important than involvement in educational outreach. Mid and late-career researchers were more likely than early-career researchers to report this lack of institutional recognition and support. Although all researchers spoke about institutional barriers preventing their involvement in educational outreach, about half of the researchers interviewed focused on these

barriers and only mentioned funding requirements when discussing their motivations for northern outreach (Table 2). Researchers who were more involved in educational outreach saw potential barriers as feasible challenges, much in the way they perceived other potential barriers for conducting research in the north (e.g. high travel costs, short field season).

2.4.5 Prioritizing time and funding

All stakeholders spoke to the importance of providing sufficient time and funding to appropriately conduct educational outreach. Most researchers (n=21) felt they could not take full advantage of potential educational outreach opportunities due to limited time and/or funding. When asked if they participated in community outreach, one researcher lamented:

> No, not in this research in particular… we were really pressed for time and money because we were working in expensive areas. It really comes down to time and money. (Researcher 3)

Many researchers reported seeing great value and importance in outreach, but giving greater priority to other professional tasks more highly rewarded amongst their peers (e.g., research grants, supervising students, writing articles, presenting at conferences) given an inherent time limit. Many educators were clear on the importance of leaving adequate time and funding to build community relations prior to creating educational outreach initiatives:

> Quite often outreach groups have identified that there's a lack of time for them to stop into the community or all of their time needs to be spent in the field because that maximizes their research dollars. .. outreach groups need to build time into their visits, and they need to make that part of their process, and tap into whatever existing research is happening or whatever local research networks are in existence and really spend time figuring out how to communicate and how does that community want to engage you? (Non-Indigenous Educator 18)

As this educator explains, all stakeholders reported that many researchers or research groups do not spend sufficient time in the community (particularly compared to the time

committed to their fieldwork) to appropriately engage in community outreach.

Furthermore, all stakeholders recognized that there are additional costs involved with conducting culturally-relevant educational outreach:

> We had a school group from some northern … community come to the university and we do a little outreach here … and people seemed excited about the idea. But it's always coming up with the resources to actually make it happen. (Researcher 22)

> It would be nice to do more of this [educational outreach], but you would need more funding. It's not possible. (Researcher 2)

Travel, food and lodging in the community, printing of resources, and remuneration for Elders, teachers and other partners are potential costs. Several educators, residents and researchers lamented at what they saw as a lack of available funds for educational outreach, funds that several researchers reported having diminished during their research as the funds were put to other uses such as field-based research. Researchers either had a lack of available funding for outreach, or they prioritized the fieldwork component of their project and there was less funding 'left over' for outreach. However, several researchers explained how they integrated educational outreach into their research program, lessening potential travel and associated costs. For example, researchers spoke of partnering with teachers for classroom visits over the winter during consultative meetings, assisting with summer camps or inviting students and teachers to work as summer research assistants.

2.4.6 Integrating Western and Indigenous worldviews

Many residents, educators and researchers spoke of a need to integrate Western and Indigenous understandings in order to reflect the cultural identity of many northern students, and to provide a foundation for locally-focused, culturally-relevant learning. In the words of one resident, students require place-based education because:

> They've got to learn about culture and history, about the land. And also to learn about warming and climate change, how it affects the trees, water, snow, drinking water, our animals, our muskrat, and

> how it's all connected. (Resident 9)

Residents spoke to the importance of developing the 'whole student,' such as recognizing their Indigenous heritage and identity, the importance of developing personal and professional skills that allow youth to pursue their choice of career and the potential strength of their Indigenous background in moving them towards their goals. Several residents explained that they weave between Indigenous and Western knowledge each day, and this is both a practical and essential skill for students to develop. Residents also spoke about the importance of students learning skills that will allow them to survive on the land (e.g., the insulative value of different furs and materials, the accumulation of pollutants in body fat). Elders in particular spoke about 'hard times coming,' often citing the recent local observations of environmental changes such as increased willow growth which makes land travel more difficult at certain times of the year. Residents shared concern and uncertainty about the future, and saw importance in their youth having strong skills in both 'worlds.'

Researchers and educators spoke to the many ways that they have benefited from intercultural discussions:

> There are compatibilities and synergies between [Western] research and traditional knowledge. An open dialogue between both of those ... reinforces and often helps to articulate those. (Researcher 21)

Researchers demonstrated a wide range of understanding of and appreciation for embracing different ways of knowing, and explained how discussions of different forms of knowledge lead to novel research questions and methods. Educators also shared how they integrated different forms of knowledge in order for the curriculum to be relevant and meaningful to their students:

> So if we take ice, it would be important primarily for the students to begin with looking at [their cultural] context for ice, and then move on to how scientists observe and conceptualize ice. And then we identify a way in which we can develop outcomes and assessment for their learning in both systems. (Non-Indigenous Educator 18)

Several administrators and curriculum developers explained how bi-cultural education is being used to allow teachers and communities to develop their own educational programs that use Indigenous content to meet Western-defined curricular outcomes. Most educators were interested in using cultural knowledge to meet the standardized learning objectives (Table 2), and many shared similar examples of how they integrated these two ways of knowing. Educators, like the researchers, reported often turning to Elders as well as natural resource users (e.g. hunters, fishers, berry pickers) to act as guides or co-teachers in their development of an integrative science program. Residents echoed the importance of such cultural specialists, however a small number also commented that greater focus could be placed on the 'soon to be Elders' that are still active resource users, further demonstrating to students that learning is a life-long process.

2.5 Discussion

My research suggests that while many stakeholders are interested in partnering for the purpose of educational outreach, several barriers prevent them from doing so. Both educators and residents expressed the need to bring together Western and Indigenous knowledge as part of education and outreach programs. The practice of integrative science is a potential approach to integrate two worldviews for the purpose of educational outreach.

2.5.1 Researchers views: Overcoming barriers to educational outreach

Although researchers perceived many barriers that prevent them from participating in educational outreach, I found that researchers remain committed to include educational outreach as part of their wider research program (also see Laursen *et al.* 2007, McBride *et al.* 2011, Provencher *et al.* 2011). Yet my findings contribute to the growing discourse that suggests current professional reward structures function as barriers to scientists' participation and interest in outreach. Thiry *et al.* (2008) further explain that in most organizational structures (e.g. universities), research is valued over all other considerations, such as teaching and service. Although most scientists perceived outreach as a responsibility inherent to their job (Mathews *et al.* 2005), lack of time (also reported by Brown *et al.* 2004, Andrews *et al.* 2005) and little or no recognition of outreach in the

tenure review process (Gravestock and Greenleaf 2008) remain as barriers to involvement in outreach. Yet 'time' as a barrier reflects how researchers prioritize the various demands of their profession, illuminating the personal as well as professional value systems of the researcher and their employer (e.g. university). Many researchers choose to pursue their research agenda at the expense of participating in outreach activities in order to increase their likelihood of professional success. In order to motivate and support researchers who use their limited time towards educational outreach, professional reward structures, such as tenure and research funding review, could be restructured to include a valuation of education and outreach to reflect the changing responsibilities of researchers.

The majority of researchers were most interested in educational outreach that would lead to academic and therefore professional advancement. In an overview of the tenure and promotion guidelines of Canadian universities, Gravestock and Greenleaf (2008) explain that most Canadian universities prioritize research, teaching and service to the institution for tenure-stream promotion, although the policies related to research are usually more rigorous, thought-out and specific. These authors did not comment on the degree to which educational outreach was considered in tenure and promotion guidelines. As Provencher *et al.* (2011) explain, education and outreach "must be advocated for in the science community … for science funding agencies and institutions, science EOC [education, outreach and communication] should be an expectation, not a bonus" (24). The wording of promotion guidelines further reinforces the priority of research over all else; faculty must demonstrate 'excellence' in their research, but only 'competence' in their teaching (Gravestock and Greenleaf 2008). Institutional policy change would support effective and meaningful outreach amongst those already committed to reaching out to the community in which they work, and has the potential to support those who have not yet made the same commitment to community service.

Scheduling also served as a barrier to many researchers who mostly worked in a university setting where the standard academic teaching year runs from September to April. Researchers could consider aligning their educational outreach initiatives into the

school year (September to June) and the community year (taking into consideration popular hunting, fishing, and camping seasons). For example, the IPY-group YNNK facilitated meetings, workshops and outreach initiatives during the university spring-break sessions in February, when more residents were in Old Crow. However, researchers preferring to conduct their outreach during their summer data collection season have other options, including participating in land camps and including students and teachers in their data collection (Balasubramaniam 2009, Provencher *et al.* 2011).

Although funding issues were also cited by researchers as preventing them from conducting the type or depth of educational outreach they would have preferred, the funding structure of IPY-related support in Canada was supposed to include an education and outreach component for a successful application but it might have been inadequate or misused. In order to support the consistent and appropriate use of research funds allocated to education and outreach in multi-year projects, funding agencies could consider a roll-in funding implementation strategy in which researchers would have to demonstrate they have begun a thoughtful, meaningful and effective educational outreach program before receiving funding for subsequent years. Additionally, to ensure that researchers pursue collaborative and research-informed educational outreach projects, outreach specialists and educators could be involved in the evaluation of grant proposals. In Canada, many national-level grant and endowment programs require a communication and outreach plan (NSERC 2011); however, it is uncertain whether or not these components of potential research programs are as closely scrutinized for feasibility, suitability and relevancy as the 'core' research agenda.

Northern researchers also face logistical issues in their research agenda that could be prevented with a local 'go-to' coordinator or support person (Balasubramaniam 2009). More scientists become involved in outreach programs when there are other people to manage the logistical aspects of outreach (Waldman *et al.* 1996). However, researchers must recognize the inherent burden (in addition to the potential benefits) their program places on the administrative abilities of small northern communities. Professional communication experts were often used in IPY outreach activities, but most IPY groups

did not use professionals in their education coordination and instead these responsibilities were taken on by researchers (Provencher *et al.* 2011). Administrative components of outreach could be jointly managed through the research network and the community, and, for large science programs, dedicated personnel are needed to support education and outreach initiatives (Provencher *et al.* 2011).

Similar to Tanner (2000), despite such barriers, researchers reported many personal and professional benefits of participating in educational outreach such as challenging them to explain science effectively and reflect on their enthusiasm for science. Nonetheless, researchers were often frustrated at being unprepared or unfamiliar with the classroom setting since most did not have pedagogical teacher training nor the skills and experience to appropriately direct their outreach to K-12 students. I recommend professional development opportunities – such as workshops and outreach shadowing – for researchers who are interested in partnering with K-12 schools (Thiry *et al.* 2008, Light *et al.* 2009). In particular, educators need to work with researchers to familiarize them with the language and culture of K-12 schools, and to allow scientists to share their own educational outreach initiatives.

Researchers who were interested in personal and professional co-learning as part of their educational outreach demonstrated a community-service perspective that more closely aligns with Indigenous research methodologies founded on the principles of responsibility and reciprocity. However, many researchers interviewed for this study did not express an interest in discussing and validating their research and findings at the community level. Such an approach perpetuates a colonial 'us and them' attitude in which researchers maintain control and power over the research agenda, points to a continuance of the researcher that parachutes in and out of the community, potentially leaving behind little of benefit to the community. It also further alienates Indigenous people from having a voice in research. Louis (2007) argues that given the colonial past and present of Western science and researchers who have either ignored or objectified and problematized Indigenous knowledge and cultures, "if research does not benefit the [Indigenous] community by extending the quality of life for those in the community, it

should not be done" (p. 131). I agree with this statement as extended to educational outreach; it should be done in a way that benefits the students and the community. This represents a paradigm shift in the responsibilities of researchers working in the traditional territories of Indigenous people, or otherwise indirectly or directly involving Indigenous people in their research; researchers have the responsibility to ensure that the research will be of use or interest to the community (Louis 2007). Research is much more likely to be useful or relevant if local people have had the chance to give input and feedback at all stages of the research, and ongoing educational outreach is one way that researchers can cultivate these relationships within the community.

It is interesting to note that the early career scientist sub-set of researchers reported higher interest and involvement in educational outreach. Although these researchers have the most to gain from prioritizing research over outreach in a university setting, many spoke of and demonstrated greater commitment to educational outreach than more senior counterparts. This new generation of researchers appears to be pursuing the recent call for 'de-stigmatizing' and actively rewarding outreach (Andrews *et al.* 2005, Thiry *et al.* 2008, McBride *et al.* 2011). However, these findings disagree with those of Ladd *et al.* (2009) who found that early-career scientists focused on the 'internal practices' of science, and later-career researchers both had more time and were increasingly professionally responsible to consider the 'societal implications' of their research through communication and outreach. Perhaps early-career researchers have more time available for the extensive involvement with the community required for northern outreach since they have fewer professional higher-level commitments (e.g. guest speaking at international conferences, leading and coordinating research programs) and therefore. In addition, the climate of polar research, such as the development of the Association of Polar Early Career Scientists (APECS), has supported early-career researchers in conducting K-12 educational outreach (Baseman and Pope 2011, Provencher *et al.* 2011) including a half-day of education and outreach sessions, one of which focused on 'school children and teachers', at a 'Knowledge to Careers' workshop (Baseman and Pope 2011, Association of Polar Early Career Scientists 2012). Although later-career researchers appear to have less interest in collaborative outreach, perhaps they have greater influence

over institutional frameworks such as tenure and promotion guidelines.[8] Research is needed into the differing motivations, opportunities and barriers for conducting K-12 educational outreach at each career stage (early, mid and late), as well as if their needs are being met by their faculty associations and universities.

My results show an imbalance of the extent to which these stakeholders are willing to integrate diverse forms of knowledge. Researchers were far less likely to report an interest in integrating Indigenous knowledge than residents and educators were interested in integrating Western scientific knowledge. This is likely due to the colonial relationship between these ways of knowing; due to their training and life experience, researchers may not be as aware of the depth, breadth and rigour of Indigenous science and therefore do not see potential linkages between Western and Indigenous science. Colonial education systems and Eurocentric science view Indigenous ways of knowing as inferior to Western ways of knowing (Louis 2007). The ongoing decolonization of education and science will only occur if the influence of culture on worldview is an explicit part of the discussion (Aikenhead 2002a, Kulig *et al.* 2010). Indigenous residents have experience in both Indigenous and Western ways of knowing, and therefore see value in exploring reality from more than one cultural perspective and are in fact advantaged by their cultural identity to acutely see how culture influences worldview compared to Euro-Canadian students (Aikenhead 2002b). In my research most residents and many educators reported integrating these two forms of knowledge regularly. Instead of the externally-defined researcher 'expert' sharing information with the community, this model of outreach empowers the residents and educators as the 'experts' who have experience developing integrative educational programs.

In Canada, the new ethics guide that informs Canadian research ethics structure and approval now includes requirements that research programs with Indigenous partners must satisfy including a respect of Indigenous culture, traditions and knowledge, conceptualizing and conducting research together with Indigenous partners, involving these partners in the design of the project, and advising the research ethics board on the community engagement plan (CIHR, NSERC and SSHRC 2010). This re-visioning of

mainstream research design and ethical considerations at the national level is promising for the potential for further re-visioning and re-valuing of otherwise unconventional research issues (e.g. outreach) at the institutional level.

Researchers who do make the choice to pursue educational outreach in the north as part of their outreach initiatives could play a role co-developing respectful, pedagogically sound initiatives that are both welcomed and needed by the northern communities in which they work. IPY encouraged and funded education, outreach and communication as part of science projects: 76% of polar science projects were conducting outreach prior to IPY, and 90% plan to continue outreach following the end of their project (Provencher *et al.* 2011). As demonstrated during IPY, exposure to and training for education and outreach has the potential to support researchers already conducting educational outreach, and to encourage all researchers to pursue new avenues in their education and outreach initiatives.

2.5.2 Educator and resident views: Supporting integrative science

Researchers, residents and educators expressed varying degrees of importance of using an approach of bringing together Western and Indigenous understandings. As interviewees discussed, the content of integrative science is holistic and ecological and stresses the importance of linkages and connections; it uses systems thinking, or seeing the parts from the whole, and examines how the parts influence the whole (Kay 2008). Many of the residents and educators gave examples of how they used such systems thinking to support an integrative science program through the land camp. Both the Elder and teacher were present, learning from each other and picking up on each other's threads of understanding.[14] Educators and residents agreed with Berkes (1993) perspective that although there are inherent differences between Western and Indigenous knowledge,

[14] Based on the content of the researcher and resident interviews, and informed by the educator interviews, educational materials that integrate Gwich'in and curricular knowledge were created to be used at the 2010 Old Crow Spring Culture Camp as organized by the VGFN and Chief Zzeh Gittlit School. The materials were developed through a collaborative effort between the Old Crow Culture Camp Committee, teachers at Chief Zzeh Gittlit School, and F. Ross, and will be publically available through the education departments of the Vuntut Gwitchin Government and Yukon Territorial Government following the commencement of the Old Crow Experiential Education project in June 2012.

these two worldviews need not be in conflict with each other so long as participants commit to recognizing the value and strengths of 'other' ways of knowing. Instead, residents explained how they must 'weave' back and forth between two knowledge systems on a daily basis, and many educators explained how they were developing (and/or in need of) educational programs and resources that allowed students to explore these cultural boundaries.

Requests from scientists to be involved in educational outreach are well-intentioned but lacking in awareness about the grade school context or curriculum requirements (McKeown 2003). I found that such misunderstandings went in both directions; teachers do not necessarily stay abreast of the new developments in science. However, this can leave room for shared learning between these partners. Both scientists and teachers work in learning environments, deal with complex cases and situations, base their practice on previous research or experience, and are usually passionate about their profession. None of the educators or the researchers spoke to these similarities, which may be due to the interview questions and discussion. However it could indicate a lack of partnership between educators and researchers, while other studies (e.g. Laursen *et al.* 2007) have shown that such partnerships support co-understanding between the stakeholders.

2.6 Conclusions and Recommendations

Science outreach stakeholders identified a variety of features that enable a successful educational outreach program in the Yukon. Educators indicated that their engagement in such outreach allowed them to creatively meet mandated learning outcomes, while using current science and experiential learning methods. As teachers' training is focused on understanding how students learn and develop, they do not necessarily have extensive background knowledge in specific subject areas. In this way the researchers, specialists in their field, can offer novel methods and new hands-on opportunities that investigate current topics in science. Through their participation in educational outreach, many researchers were reminded of their interest and enthusiasm for science and to think more broadly about their own work.

There is still room for institutional change at the university level, allowing educational outreach to be valued as a significant contribution to tenure and promotion schedules, and supporting outreach-focused professional development opportunities for researchers. I recommend that funding agencies that require educational outreach as part of their requirements institute a funding percentage hold-back until evidence of community engagement has been demonstrated. Furthermore, just as scientists review other scientists funding applications, trained and experienced educators could be part of the funding review process in order to offer feedback, direction and evaluation of the suitability of outreach programs.

Building capacity for integrative educational outreach at the local, regional and network level remains a concern for engaged researchers, educators and residents of the north Yukon. During IPY the community of Old Crow demonstrated their capacity for both leading and supporting collaborative science and outreach programming. Allowing additional time and funding in research and outreach initiatives would provide communities the time they need to consider their involvement, and to determine an action plan. Northern researchers have exciting opportunities to use outreach to share knowledge and to develop integrative programs desired and currently under development in northern communities. Ultimately, as part of their educational outreach partnership, researchers, educators and residents have much to share, and many lessons yet to teach each other. Through my research, stakeholders have voiced a call for greater effort and more effective collaboration between partners in culturally-responsive education and outreach.

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CHAPTER 3:
EDUCATOR AND COMMUNITY PERSPECTIVES ON DEVELOPING INTEGRATIVE SCIENCE PROGRAMS IN NORTHERN YUKON, CANADA[15]

This chapter examines northern Indigenous residents and northern educators' perspectives on how they live and teach science from two worldviews: that of Indigenous and Western perspectives. I conducted 36 qualitative interviews with educators and residents and identified the need for a sound pedagogical approach that allows educators to respect and encourage the cultural identities of their students. Integrative science was found to be an effective method of engaging northern students in Indigenous and Western knowledge, as well as exploring both the shared and divergent strengths between these two ways of knowing. My findings suggest that key features supporting a successful integrative program include recognition of the multiplicity of ways of knowing and a shared commitment to the principle of co-learning, a pedagogy informed by systems thinking and multiple intelligences, and the provision of an educational program that builds relationships and supports authentic learning opportunities. Educators and residents identified many challenges in providing an integrative program – such as the role of spirituality in Indigenous knowledge – that also raise interesting questions about the future development of integrative studies.

Keywords: co-learning, experiential education, Indigenous science, Western science, integrative science, land camps, traditional ecological knowledge, Two-Eyed Seeing

3.1 Introduction

Over the past decade in Canada, and further facilitated by the third International Polar Year 2007-2009, northern residents including Indigenous peoples have been increasingly contributing to northern research. Examples include studies that document baseline traditional ecological knowledge (Fox, 2002; Ford *et al.,* 2008), involve communities in environmental monitoring programs (Lyver and Łutsël K'é Dene First Nation, 2005; Berkes *et al.,* 2007), and explore connections between Western and Indigenous understandings of environmental change (Huntington *et al.*, 2004a; Huntington *et al.*, 2004b; Carmack and Macdonald, 2008; Gearhead *et al.,* 2010; Knopp, 2010). While there is great need and opportunity for northern and Indigenous youth to become involved in

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conceptualizing, defining, and conducting northern research, there have been many barriers to participation to date (NSERC *et al*., 2004).

Low graduation and high drop-out rates persist as a confounding challenge for northern Indigenous students, families, educators, and policy makers (Richards *et al.*, 2008; Sisco & Stonebridge, 2010; Sisco *et al.*, 2012). Since the 1990s, drop-out rates have continuously improved across southern Canada; nationally, one in twelve 20-24 year olds have not obtained their highs school diploma, a drop-out rate of 8.5%; however, this rate is significantly higher in the territories with 15.5% in the Yukon, 28.4% in the Northwest Territories, and 50.0% in Nunavut (Statistics Canada, 2010a). Low levels of Indigenous student enrolment in high school sciences has resulted in Indigenous[16] students continuing to be seriously underrepresented in post-secondary science programs and science-related fields (Aikenhead and Elliot, 2010; Kulig *et al.*, 2010). In her report on Indigenous education to the Canadian Minister of Indian and Northern Affairs, Battiste (2002) advised that for Indigenous students to succeed in their education and wider lives, they require opportunities to explore Indigenous and Western ways of knowledge side-by-side. In this paper I explore this intersection of two diverse ways of knowing, and the knowledge, skills and attitudes of each system. Through qualitative interviews with northern educators and Indigenous residents, I examined their perspectives on how they live and teach from both the Western and Indigenous worldviews.[17]

3.2 Background and central concepts

[16] In this paper Indigenous refers to all Aboriginal people, such as First Nation and Inuit. When specifically referring to people of the Vuntut Gwitchin First Nation in the North Yukon, I use the term First Nation.
[17] 'Northern' is not meant to be synonymous with 'Aboriginal,' although northern culture is heavily influenced by First Nation, Inuit and Metis cultures. Aboriginal people have much higher proportional representation in the northern territories: 25% of the Yukon's population identifies as Aboriginal, 50% in the Northwest Territories, and 85% in Nunavut (Statistics Canada, 2010b). Since this research was conducted in the context of the Canadian north, I use the term 'northern' to explain ideologies and cultural understandings from people in the Canadian north, and 'southern' to refer to those from southern Canada. 'Southern', unless otherwise specified, can also be understood as 'Western' as in 'Western Science', or the body of science that emerged post-Renaissance which uses the quantitative and objective traditions of understanding.

3.2.1 The social context of knowledge

Science and other disciplines are shaped by the social and cultural norms that reflect the worldview of those who define them (Little Bear, 2000). Emerging from the 17th century Renaissance, natural philosophers such as Galileo and Newton established a system of knowledge generation built upon the primacy of quantitative and empirical evidence, a process that involved securing objectivity, or a disconnection between the observer and the observation (Hatcher *et al.,* 2009a). Before the 17th century 'science' referred to all knowledge, not solely knowledge generated from the scientific process as we understand the term 'science' today (Aikenhead and Ogawa, 2007). In this article I refer to this canonical form of science as Western science.

As explained by Battiste (2002), I do not essentialize Western and Indigenous ways of knowing as opposite systems, which is an approach commonly used in colonial, hegemonic discourse. Informed by Aikenhead and Ogawa (2007), I recognize that the concept of 'Indigenous science' is limited in that it does not fully express the Indigenous concept of knowledge which includes knowledge and experience-informed action, such as living in nature. I would extend this understanding, recognizing that Western science is similarly complex and diverse. However, for the purpose of this thesis, I understand action to be part of 'Indigenous science' and, in this way, equate Indigenous science as an expression of Indigenous ways of knowing.

Western science is often discipline-specific (as evident in the separation between the disciplines of biology, chemistry and physics) whereas Indigenous science is usually place-specific (Hatcher *et al.*, 2009a). In Indigenous science objectivity is of relative concern and observers and their observations are inextricably connected, as the person cannot be disconnected from their relationship with the environment around them (Hatcher *et al.*, 2009b). Guided by the wisdom of Elders and one's own life experience, Indigenous science is generated through understandings of interconnectiveness and balance, such as how one lives in and with their natural environment (Battiste, 1998; Cajete, 2000). For example, in a study using both meterological data and Inuit knowledge, Gearhead *et al.* (2010) explain how their scientific observations of wind "are

gathered by instruments that individually and separately measure the variables that Inuit understand together, such as precipitation, wind speed and temperature" (p. 287). Indigenous science does not describe variables, but instead focuses on how variables interconnect and balance each other (Nichols *et al.*, 2004). Highly organized and categorized by discipline, Western science views the world as ultimately knowable, and has the goal of fully understanding how the universe works (Hatcher *et al.*, 2009a). Holistically linked by how the environment is used, Indigenous science views the world as ultimately unknowable, and the individual's goal is to fully participate in the natural world (Cajete, 1999). After recognizing and appreciating the diversity between these two ways of knowing, it is encouraging to find much similar ground. Both ways of knowing are highly observant of the natural world, use complex forms of reasoning and recognize and use patterns to understand the universe (Barnhardt and Kawagley, 2005; Bartlett *et al.*, 2012) (Figure 1.4).

3.2.2 Environmental and place-based education

Palmer (1998) reminds us that education about the environment has evolved over time, and on the international stage. Rooted in the nature study movement of the late 1800s and the conservation movement of the mid 1900s, environmental education was internationally articulated in the 1970s and was followed by a flourishing of new trends in environmental education, from outdoor education to field studies, development studies and action research. The 1987 World Commission on Environment and Development led to the Bruntland Report, *Our Common Future*, which said that education should focus on the environment (WCED, 1987). Canada responded to this report with regional round tables and tasks forces that led to *The Green Plan* (Gale 1997) which called for a national environmental education strategy. From this plan emerged the national non-profit organization Learning for a Sustainable Future that integrates sustainability concepts and practices into the Canadian educational system (Nazir *et al.,* 2011; LSF, 2012a). Of interest to educators is their Resources for Rethinking which is a clearinghouse database of "exemplary classroom resources reviewed by teachers for teachers" (LSF, 2012b). Researchers interested in developing educational materials and outreach resources may find the LSF *Resources for Rethinking Review Tool* instructive as it outlines sustainability

principles and helpful pedagogical approaches, allowing researchers and reviewers to assess and to evaluate potential educational outreach materials (see LSF, 2008).

Evolved from ecological science, policy, management and conservation studies, environmental education seeks to recognize values, develop skills and foster attitudes that allow one to see the interconnectedness of our actions and our environment (IUCN, 1970; Palmer, 1998). Similarly, place-based education, or pedagogy of place, bases student understanding on one's own place, a student's own environment, such as the school or community. Based on the concept of sustainability, environmental education often makes use of systems thinking, or the recognition of the many ways natural and man-made products and processes are connected (Porter and Córdoba, 2009). Lastly, education for and about the environment is often based on the inquiry-discovery pedagogical method in which students are challenged to develop their knowledge and understanding through hands-on activities and 'real-world' projects.

3.2.3 Indigenous education

For thousands of years, Indigenous people in Canada had effective, family-based, experiential education (Kawagley *et al.,* 1998). Contact with Western culture brought great, often uninvited, change across the country. Although the 'deprogramming efforts' of residential schools and the federal and territorial governments undermined Indigenous cultures, many Indigenous people recognized the rigour and discipline of these schools and policies, as they had great rigour in their own land-based education previously led by their families (Watt-Cloutier, 2000). Nonetheless, the majority of northern Indigenous people's experiences in residential schools were personally and culturally demoralizing. Policies of cultural assimilation, Indigenous language erosion and educational systems focused on schooling the Indian out of the child, and eroded the cultural identities of Indigenous people (Battiste, 1998).

Over the past several decades there have been many attempts to decolonize education at both the at the macro level, such as the territorial educational system, and at the micro level, such as within particular schools (McGregor, 2010). Curriculum writers and other

educators have often misunderstood their 'adding' Indigenous culture to status-quo education as a decolonizing practice. However, other researchers emphasize that this instead works against a decolonizing philosophy, and by merely adding in Indigenous culture to the traditional curricular framework the cultural knowledge becomes distorted and ultimately changed (Hermes, 2005; Hatcher and Bartlett, 2010). Similarly, Inuit educational activist Sheila Watt-Cloutier (2000) cautions that generalizations of 'Indigenous learning styles' is often detrimental to all parties, particularly to students whose academic standards are lowered in the name of these differences. I do not essentialize Indigenous students to have different learning styles, but instead I acknowledge that all students benefit from examining how knowledge is generated, and how power and cultural norms shape that knowledge generation (Aikenhead and Elliot, 2010). Standards and rigour are not compromised; if anything, the bar is raised as students are challenged to recognize the cultural underpinnings of knowledge creation, as well as to understand the content itself.

In the 1980s, policy makers began the process of decolonizing education in acknowledging that self-defined concepts of education were valid for Indigenous people (Castellano *et al.,* 2000), and education has become a crucial element of Indigenous people's pursuit of self-determination (Lewthewaite *et al.*, 2010). Yet students and teachers with Indigenous backgrounds often find their interests and identities absent in education and anonymous in the school's goals (Corson, 1999). In order to address these gaps, many policies, programs and partnerships have been created across northern Canada (Vick-Westgate, 2002; McGregor, 2010). Bi-culturalism has been used by many northern Indigenous people when developing their own culturally-specific educational policies and curriculum. The Yukon Department of Education is currently assisting several First Nations in conceptualizing and actualizing place-based education through the development of First Nations-run elementary school educational programs. In the Yukon, bi-culturalism has been understood as a way in which formalized, southern-based curricular objectives can be met using northern Indigenous knowledge. This approach recognizes that students live between two cultures, that of the southern (or Western) externally-defined culture, and their own northern Indigenous culture.

Many Indigenous communities have negotiated with provincial or territorial governments to develop integrated programs that are both feasible and meet appropriate educational objectives (Vick-Westgate, 2002; Herbert, 2008; Wood and Lewthwaite, 2008; Aikenhead and Elliot, 2010; Lewthwaite and McMillan, 2007; McGregor, 2010). However, Berger and Epp (2005) remind us that much research and work remains, particularly in the areas of curriculum design and development, the creation of relevant educational resources, and cross-cultural teacher training. All northern territories are currently striving to improve the graduation and success rates of students in their region, and have identified cultural inclusion as an essential component. In their study examining Inuit students' perspectives on teaching and their own learning, Lewthwaite and McMillan (2010) identified that most successful learning practices were culturally located; when teachers responded to the linguistic and cultural identity of the students, students reported higher levels of interest, engagement and personal success.

3.2.4 Two-Eyed Seeing

In this study, I sought the perspectives of northern educators and Indigenous residents who have attempted to find linkages between these two knowledge systems. The concept of Two-Eyed Seeing is an Indigenous Mi'kmaw concept from Albert Marshall, developed by Elders, educators and scholars at the Institute for Integrative Science and Health at Cape Breton University on the East Coast of Canada (Hatcher *et al.*, 2009a). Two-Eyed Seeing steps beyond bicultural understanding. It shares the recognition that students identify with, and live between, two (or more) cultures, and that there is value in understanding the world from these two ways of knowing (Hatcher *et al.,* 2009b). Several studies have shown that two forms of knowledge can be complementary and tell a more complete story; careful comparison of traditional and scientific observations can increase the depth of knowledge, increase confidence and reduce uncertainty of conclusions (Krupnik and Jolly, 2002; Huntington *et al.*, 2004a; Laidler, 2006).

Two-Eyed Seeing often requires a 'weaving back and forth' between these two ways of knowing: some circumstances require the understandings of Indigenous sciences, and

other times Western science is required (Hatcher *et al.*, 2009b; Bartlett *et al.,* 2012). For example, the Two-Eyed seeing approach uses and fosters several principles that are shared amongst Indigenous cultures: respect, reciprocity, relevance, and responsibility (Kirkness and Barnhardt, 2001; Bartlett *et al.,* 2012). Integrative science educators Bartlett *et al.* (2012) differentiate the Western process of un-weaving parts and wholes from the Indigenous process of weaving together relationships of interconnections, and the achievement of balance and wholeness. The key concepts in Western science used in Two-Eyed Seeing include exploring the scientific method, hypothesis making and testing, and theory construction (Bartlett *et al.,* 2012). Using this approach, students and teachers (Elders and classroom teachers) alike explore the various ways that these two cultures come to know and explain the world around them. This approach also recognizes diversity in ways that students learn and demonstrate their understandings. Developed by Howard Gardner (1993; 2006) and expanded by many educational researchers (Campbell *et al.,* 1996; Armstrong, 2009; Chen *et al.,* 2009) the theory of multiple intelligences posits that there are at least eight different intelligences; logical/mathematical, linguistic, musical, spatial/visual, interpersonal, intrapersonal, bodily-kinesthetic and naturalist intelligence. Teachers using the Western scientific approach often rely on developing the logical/mathematic and linguistic intelligences, whereas Indigenous science is more likely to use the remaining six intelligences (Hatcher *et al.,* 2009b).

As a decolonizing practice, Two-Eyed Seeing embraces the idea of co-learning. It is inherent that most learners (teachers being learners as well) identify with or have a greater understanding of and experience in one culture. All participants have varying strengths in their cultural identity – from beginner to experienced understandings – and thus there is the principle of co-learning. For students to fully explore these two cultures, each party must commit to deeply exploring their own understanding of both cultures. Particularly if the educator is not from the community, engaging in community dialogue is an obvious early step in developing a culturally responsive program (Baker and Giles, 2008). The relationships that develop have the potential to incorporate local perspectives and culture into the local educational system, if not to transform the motivation, method and content of student's schooling experience. Integrating two often dissimilar ways of

knowing is not without great challenges. Educators and residents report difficulties linking or integrating certain elements such as spirituality, or differences in methods of data collection such as storytelling and quantitative data (Cruikshank, 2001; Hatcher *et al.*, 2009a; Iwama *et al.*, 2009). These challenges are likely to continue, but it has yet to be determined if they are truly irreconcilable differences or not. This issue will be more easily resolved with ongoing collaborative partnerships and greater representation of Indigenous scholars leading the research agenda. Mi'kmaw Elder Albert Marshall of the Eskasoni First Nation shared his appreciation of the principle of co-learning through Iwama *et al.* (2009);

> we need each other – each other's ways – it we are to perform the weighty task of legitimizing traditional knowledge in the minds of the young people who often lack an understanding of their cultural knowledge and doubt the very worth of that knowledge (p. 8).

Although Two-Eyed Seeing often provides this legitimization for many participants, my intent is not to compare two ways of knowing in order to legitimize either form of knowledge, but instead to find shared meanings and greater understandings that mirror the northern Indigenous student's lived experience.

The goal of this chapter is thus to present and discuss findings from a study on culturally appropriate and pedagogically suitable methods to share key scientific findings from research networks and Indigenous science from northern residents within northern communities. The three research objectives were: 1) to examine the experiences, perceptions and components of integrative education from the perspective of northern educators and residents; 2) to identify factors of science outreach and educational programs that support looking at the world from two cultural perspectives; and 3) to provide recommendations on strengthening polar science educational outreach that addresses the unique needs and interests of these key stakeholders (educators and residents).

3.3 Study context and design

Semi-structured interviews were conducted with 36 northern educators and residents in order to determine their experiences of incorporating knowledge from two worldviews. The majority of participants interviewed were involved in the coordination or implementation of the local schools' annual spring land camp outside the town of Old Crow in the north Yukon. The remaining participants were involved in Indigenous-informed integrative science programs and/or curriculum development.

3.3.1 Community of Old Crow, Yukon

Surrounded by forest taiga near the boreal treeline, Old Crow (67° 34′ N, 139° 49′ W) is situated at the confluence of the Crow (*Chyahnjik*) and Porcupine (*Ch'oodèenjik*) Rivers in the north Yukon, Canada.[18] Old Crow is a remote, fly-in community of approximately 280 residents, 85% of whom identify as Aboriginal (Statistics Canada, 2006; VGFN, 2009b). The Vuntut Gwitchin First Nation (VGFN) was established with the Land Claims Agreement of 1993. As a self-governing First Nation in control of 5000 km^2 of traditional territory, the Vuntut Gwich'in now control their own local government, education, heritage, and natural resource management (Sahanatien, 2007). Subsistence hunting and fishing are major activities. The bi-annual migration of the Porcupine caribou herd through their traditional territory plays an important part in the cultural identity and food security of the Vuntut Gwich'in people (Wolfe *et al.,* 2011). Caribou and moose are a staple of the local diet, along with several fish species including dog and chum salmon, whitefish and occasionally Arctic char (Sherry and VGFN, 1999). Cranberries, blueberries, cloudberries and crowberries are picked in the summer and fall (Parlee *et al.*, 2005; Crewe and Johnstone, 2008). Firewood is regularly harvested from the surrounding area and from the forest following the Porcupine River as the majority of homes are heated by woodstoves.

Old Crow's Chief Zzeh Gittlit School (CZGS) provides K-9 education for approximately 40 students. There are four classes in the school: kindergarten (4 to 5 year olds), elementary (Grades 1 to 3), junior (Grades 4 to 6), and senior (Grades 7 to 9) classes.

[18] These are the Gwich'in language names as ascribed by the Vuntut Gwich'in people.

Following their Grade 9 graduation, students move to Whitehorse, the capital of the Yukon, to complete their secondary education and their travel and living expenses are partially covered by the First Nation. There are twelve staff members at the school including six teachers who share a myriad of responsibilities in addition to their core teaching load such as principal, librarian and reading recovery specialist. Six additional employees include educational assistants, remedial tutors, custodians, a secretary and an Education Support Worker. This instructor and support position is filled through the First Nation's Education Department. This individual – who is Gwich'in – is charged with providing culture classes and assisting teachers with integrating Gwich'in Indigenous knowledge into the classroom.

A pillar in the yearly calendar at CZGS is the spring land camp, an opportunity for the students to spend several days and nights at an established experiential learning camp near town. Under the umbrella of the Yukon Department of Education, the First Nations Programs and Partnerships Unit has prioritized the funding and support of culture camps throughout the territory, and in 2009 they applied for and received $100 000 in federal Northern Strategy funding to spend over two years in order to enrich and develop educational opportunities provided through the annual camp (Yukon Government, 2010). Under this new funding an Old Crow Experiential Education Project committee was formed by Elders, teachers, former students and First Nation Department of Education employees. This committee is charged with providing guidance to the school and community in remodelling existing programs (such as the land camp) and creating new programs in order to provide experiential education programs and "on the land activities that combine cultural competency along with western educational learning outcomes" (Chief Zzeh Gittlit School, 2010, p. 2). As a teacher with experience teaching in the northern Canada (in the territory of Nunavut) and ten years in experiential education programs in southern Canada, I was asked to assist in writing student manuals that were used before, during and after the camp (Figure 3.1). I also assisted in the compiling the camp-end newsletter that featured stories, photos and the lessons learnt by the camp participants (for samples from this newsletter from Year 1 2010 and Year 2 2011, see Appendices G and H). This contribution was part of my outreach efforts and in part

demonstrates the reciprocal relationship between myself, the school and wider community as part of this research initiative.

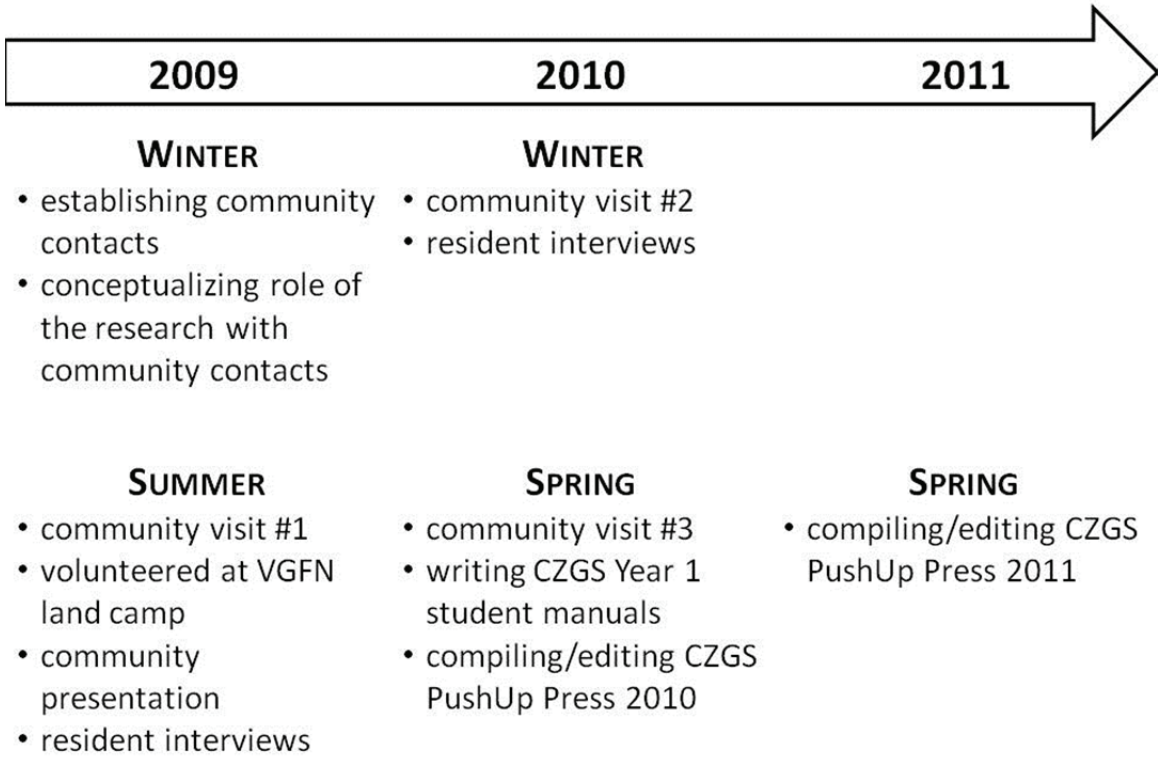

Figure 3.1 Timeline of the research and outreach activities in Old Crow

3.3.2 Methods

Data were collected between August 2009 and April 2010, within two years of the experiential education project's funding. I recruited a total of 36 participants in two cohorts: residents and educators. Recruitment for each group was undertaken in different ways. For the resident cohort, I first traveled to Old Crow in August 2009 to be involved with the Vuntut Gwitchin First Nation's (VGFN) summer science camp, assisting with camp programming and facilitation.[19] This VGFN land camp is organized through the

[19] There are two annual land camps in town: the CZGS spring land camp, and the VGFN summer land camp. The CZGS camp is organized on a three-year rotation, with each year covering Gwich'in traditional knowledge and skills together with curricular learning objectives in science, history and trades and art. The

Natural Resources Department by either the Lands Manager or a summer intern (see Balasubramaniam, 2009). At the science camp slideshow and community feast, I presented and discussed this research project with the approximately 60 residents in attendance, and invited interested individuals to participate. Self-selection and opportunistic sampling was used for recruiting; interviewees either came forward wanting to be involved in the research or were identified by stakeholders in the Vuntut Gwitchin Government (VGG), CZGS and Yukon Government's Department of Education Programs and Partnerships Branch.

I interviewed 18 Indigenous residents of Old Crow to determine how they wove between Gwich'in and southern/Western knowledge in their own lives, as well as to obtain their recommendations for how to integrate these two knowledge systems in the spring land camp. Residents ranged in age from their early-twenties to their late seventies. All interviews were conducted in English, and a translator was available for all interviews, but requested only by one interviewee in order to further articulate particular words or concepts. Interviews were complemented by a review of select interviews in the Old Crow Oral History Project database as held by the VGG's Heritage Department.

The resident interviews were open-ended and semi-structured (see the resident interview guide in Appendix E). Questions focused on traditional approaches to teaching, current experiences, and goals for the future of education in the community systems. For example, residents were asked: how has the community and environment changed over your lifetime or time living here? Tell me about education and learning in this community. What do people learn here? How, when and where do they learnt it? How are you involved in teaching the young people here? How do you know when young people are learning? What do you think is a good way to teach young people? How do you learn new things? How do you envision/wish you could be involved in education in this community? What do you see will be the biggest educational challenge or opportunity in the future?

VGFN camp is organized by an employee of the Natural Resources Department and the focus changes year to year depending on the interests and experience of the staff and volunteers.

For the 18 interviews in the educator cohort, I first bound the study by limiting participation to Yukon educators and administrators involved in developing or coordinating integrative programs for northern Indigenous youth (n=14). However, several participants identified the influence of key educators and researchers in southern Canada in shaping their integrative programs; thus I identified and recruited four participants from outside the Yukon. Stratified sampling was used to ensure that there were a variety of participants involved in the research. Educator sampling strata included Gwich'in educators (n=2) and non-Gwich'in educators (n=5) from Old Crow, territorial education administrators (n=3), territorial curriculum writers and developers (n=3), southern-based integrative science educators (n=3), First Nation government education administrator (n=1), and a territorial education outreach worker (n=1).

The interviews were open-ended and semi-structured, allowing participants to have input into the content and direction of the interviews. The questions focused on how the educators conceptualized their role in education, how they teach from two worldviews, and the issues and challenges they face in integrating knowledge systems (see the educator interview guide in Appendix F). For example: How do you know when students are learning? What are your most common issues or challenges? How do you address these challenges? Where are you from, and do you think where you are from shapes your ideas about education? What is your philosophy of education? What have you learnt working as an educator? What have you found to be the most effective teaching methods or pedagogical approaches? Is there benefit to developing learning resources at the local or regional level? What has been your experience using or teaching traditional and Western knowledge side by side? What has worked well, and what has not worked well? What have been the facilitators and barriers of such programs?

Most interviews were conducted in person, with the exception of two conducted via telephone due to timing and prohibitive travel costs. The interviews were transcribed verbatim and then explored using qualitative content analysis. Transcripts were coded by theme using the qualitative analysis assistance software NVivo. In the first reading I

developed over 700 codes (free nodes) and then, though continual re-reading and as informed by relevant literature and my observations while in the community, the codes were organized into several themes that will be identified and explored below.

3.4 Results

Residents and educators expressed many reasons why and how they have developed integrative programs in their communities. I explore these stakeholders' rationale for establishing such programs, and then examine the many teaching and learning pedagogies that are used to integrate Western and Indigenous ways of knowing.

3.4.1 Motivations and laying the groundwork for integrative education

The majority of residents of Old Crow are Gwich'in, and all educators and residents commented that education in Old Crow should, therefore, reflect Gwich'in culture.

> The most important thing is that it's important that education is reflective of the people who are being educated. So in order to be able to foster identity and be relevant and for learning experiences to be real, a student needs to be able to have a context which they relate to personally in order to springboard from that experience. (Non-Indigenous Educator 18)

I identified seven factors that residents and educators expressed as important to the students identity as found in Gwich'in and southern/Western culture (Table 3.1): students' perception of themselves, definitions of success, relationships, effective actions, progress and personal development, knowledge, and importance of place.

Table 3.1 Contrasting concepts in self-identity

(adapted and extended from Nisbett, 2003; Barnhardt and Kawagley, 2005; Keane, 2008, Hatcher *et al.,* 2009a; Bartlett *et al.,* 2012)

Aspects of identity	Gwich'in/Indigenous	Southern/Western	Study examples of Gwich'in self-identity
Self-concept	Collective self	Autonomous self	"The young people here are a part of everybody, part of large extended families. In small communities the youth are really a big part of how we live our culture." (Resident 15)
Success	Collaborative Community	Competitive Self-advancement	"We only have so much time and then there's everybody else after us. We have to prepare it for them too." (Resident 4)
Relationships	Essential Includes ecological relationships	Useful Often does not include ecological relationships	"There is a lot of science with no human face on it, right? However when we look at the way traditional knowledge is, it's holistic and it's always in reflection back to a relationship. It always comes back to people." (Non-Indigenous Educator 18)
Effective actions	Context-dependent Uncertainty is part of life	Can be simplified to standardized rules (e.g. scientific method) Uncertainty is undesirable, should be limited	"It's important for us to learn how to live off the land because it's our heritage, our culture, and important for survival. I think growing up here, it was just a way of life. It was not necessarily 'you have to do this or you have to do that.' It was just that because you were living it, into it, you were always ready, prepared." (Resident 8)
Progress	Consultative Cyclical Grows through mentors	Self-identified Linear Grows through external critique and inner reflection	"I taught my kids [during] hunting time. I do it and then I get them to watch me, and then I let them cut their own meat. That's how I taught them, and that's how I was taught; by watching and then doing it. I make mistakes - that's alright… [I] can do it over again." (Resident 14)
Knowledge	Apprenticeship Goal and behaviour directed	Formal schooling Abstract**,** but often goal directed as well	"You don't want to see your grandchildren's children to read [of their culture] in school – their history. You want them to practice it, to continue to practice it, not read it out of a schoolbook. That would be the saddest part." (Resident 4)
Connection to place	Place-based community	Expected to move often as part of individual achievement	"You got to know your trails, your land, so you know what's coming up. And if you don't… well, there'll be surprises like a drop or a fast up and down [in the trail] and you've got to be ready." (Resident 16)

Residents and educators gave many examples in which students are – in their lives and, ideally, in their schooling – faced with contrasting concepts in their self-identity, straddling Indigenous Gwich'in and southern/Western concepts. For example, when discussing their connection to place, one young resident explained how they felt great tension between the Gwich'in valuation of being highly connected to (and staying within) the community, and the southern/Western expectation that they would attend high school in Whitehorse, and then pursue university away from the Yukon, in southern Canada. Although they felt such tensions, this resident also explained that they found shared ground between these two cultural identities; in both Gwich'in and southern culture, hard work, creativity and tenacity are all elements of success. Residents and educators alike explained that all stakeholders interested in developing and contributing to integrative science programs should familiarize themselves with these differences in order to better understand the motivations of their fellow stakeholders.

Educators shared many stories of how they were influenced in part by Elders in seeking an integrative education program in the community. Many non-Indigenous educators shared that their journey began with acceptance, and then proceeded with appreciation, of the critical influence of ways of knowing. In the words of one educator, Elders will:

> …speak to the fact that there are multiple ways of knowing something, not just one, not just two, but several. And they're also always very encouraging of the fact that their knowledge should not limit their children's knowledge. And that if there's something that can be learned in a different perspective or in a different way, they want their students or their children to also have that opportunity to learn that, which is an incredibly inclusive value that endorses the opportunity to have an integrative way of approaching topics. (Non-Indigenous Educator 18)

Sharing this perspective, several hunters emphasized:

> You learn new things out here all the time. It's not practicing one thing over and over - you need to learn new ways. There are easy ways and hard ways. You need to learn how to live off the land and survive, like our grandfathers did. That's how I was taught up. Living here and experiencing it every day you learn new things all the time. (Resident 5)

> [Our youth] need to learn. They've got to learn about culture and history, about the land. And for themselves, too, to know all these things. And also

> to learn about everything about warming and climate change; how it affects the trees, water, snow, drinking water, our animals, our muskrat. (Resident 8)

Many interviewees from the Yukon spoke about the support the First Nations Programs and Partnerships Unit has had in providing schools with culturally-responsive educational materials, teacher training, and funding (or assistance in locating funding) for research and to conduct integrative education programs. This unit, a new division in 2006, was established by the Yukon Department of Education to support cultural inclusion in Yukon schools, amongst other goals (Yukon Government, 2009). However, many teachers continued to report a need for greater territorial organization in accessing Indigenous and northern-specific educational materials. Several educators referenced the Alaskan Native Knowledge Network as a successful example of how they would like to structure community and university programming, networking and capacity development opportunities, and a central holding facility through which educators could share resources. As one participant noted of the Alaskan Native Knowledge Network's presence, "I wish we had something like that [here] where we could start putting our materials… some sort of web clearinghouse where everyone can put their First Nations curriculum" (Educator 7). Several participants echoed this call for greater online presence and networking between the Department of Education, associated branches, university programs and educational research, teachers and classrooms.

Most educators and residents spoke to the importance of relationships and relationship building when reflecting on teaching and research best practices. One educator reflected that in their experience:

> Relationships [are] the starting place for determining how knowledge is going to be shared. It's important that someone spends the time building that relationship. (Non-Indigenous Educator 18)

An experienced integrative science educator stressed the importance of patience, and explained that they start and continue this relationship building:

> …in a respectful way. [I] chat at a personal level; 'I heard you have a new addition to the family' or 'I heard Johnny's not been well'? I have to be very patient. The most important thing is the personal connection. In order

> to get the level of conversation and information exchange you're looking for, they have to know you as a person. (Non-Indigenous Educator 4)

These educator comments are reflected in those of nearly all the residents. As one resident suggested for visitors and new employees in the community:

> Just learn how we live and respect our tradition and our ways and understand maybe, people are a little different… it's different up here, I guess, you know? Old Crow's a small community and everybody knows each other and it's good to get to know people and talk to people and ask them. Respect the land and just know what you're getting yourself into when you go out there. You're not walking down Main Street anymore. You're out in the woods! (Resident 8)

Educators in particular stressed the importance of developing these relationships so as to allow for integrative opportunities in the classroom. If teachers did not make this connection, residents reported that they would not be comfortable working with the teacher. Educators and residents alike reported that long-standing relationships, developed with patience, humour and mutual respect, were much more likely to lead to ongoing and fruitful integrative projects, particularly when compared with the 'guest Elders' in the classroom model in which Elders are randomly invited into the classroom to 'add on' culture to the existing program.

In order to develop and maintain such relationships between educators, students and their families, educators identified communicative assessment as a key element of relationship building. This form of assessment is ongoing and provides both direct and indirect feedback.

> When we look at what Elders have identified, is that learning and assessment has to happen all at the same time. It was very immediate. So as a student was learning something there was someone there to give a critical word, give encouraging feedback, but the student knew how they were progressing all at that same time. So recognizing that that is a formal way of assessing is important in a system that is going to be looking at truly decolonizing even assessment. (Non-Indigenous Educator 18)

Teachers shared many ways that they employ communicative assessment practices, including portfolios, parent-teacher meetings, feasts and community presentations.

Most educators and residents explained learning as a process of exploration, and that they must practice the skills they are learning in addition to understand the theory behind them. Several educators and residents described this cyclic process of learning; "young people need to know their traditional knowledge, they need to practice it and learn" (Resident 5). When asked about how students connect their modern and historical understandings of the cultural background, one educator responded that it is imperative to provide:

> …real-life learning. It's important to learn from someone and not be learning from a book. And the whole idea of using natural material in a purposeful way – that's something I like to see. I don't like to see somebody doing little tiny snowshoes as a model. I mean when you make them … you know when to collect the materials and you make them life-sized and then you use them. (Indigenous Educator 7)

Educators and residents both spoke to the importance of co-learning in order to develop a successful integrative program. For example, the role of the educator is that of a learner as well as a facilitator.

> In order for teachers to be accountable to two knowledge systems, primarily [to] one culture which isn't necessarily their cultural lens, it remains important to be comfortable in the role of facilitator of a knowledge system. [The] facilitator is [also] a learner, a student in oneself. (Non-Indigenous Educator 18)

3.4.2 Teaching pedagogy in integrative education

In their pursuit of an integrative education program, educators and residents spoke at length about the importance of interconnectedness, such as connections between ways of knowing, connections within ways of knowing, and connections in the environment.

> If it's more local, a grassroots context from which comparative understandings can go full circle, I call it a cycle of familiarity. For instance, if I go canoeing, there's equipment and skills involved, but also an awareness of what's going on up there. Loons arrived: at what stage of nesting? How seasonal patterns change and what's happening in the landscape. This understanding is closer to a cycle of knowing, and involves an environmentally sensitive context. (Non-Indigenous Educator 8)

> I've heard that even using the word 'environment' separates us. You know, it's us and then environment. Whereas it isn't; that's not the reality. So it's at our peril in the long run if we're just ignoring the world around us and what supports us. And that's probably the biggest thing … the message that it's all interrelated and that we aren't separate. And then that's difficult because we've got centuries, at least in our [Western] culture, there's perhaps a millennia of setting ourselves apart and not seeing that connectedness. That's why it's important, because we know from ecology and we know from traditional knowledge that's so true, that we are interconnected. (Non-Indigenous Educator 15)

> And [in middle school they are] beginning to be able to investigate and follow a path of 'if this happens, then this happens.' So starting to look at cause and effect, starting to be able to look at predictions, starting to understand that there's a link and a connection between different things – that there's an interconnectedness between things that exist. And that's a little bit different than Western science. I mean, that's maybe coming more from the [Indigenous] side. (Non-Indigenous Educator 18)

Integrative educators explained the many ways they challenge students to think holistically, to look for and understand the processes that support sustainable relationships in our environment. Many residents spoke to the many ways they experienced an interconnectedness, or learnt it through their families.

> My parents took me out quite a bit, and a lot of our family things would take place in an outdoor setting, [like] camping and big family reunions. It was always about big cook-outs and being by one of the lakes nearby Whitehorse. And then [my interest in the natural world] just grew from there… being interested in insects, and then plants, and then it was just endless. There are endless things to learn about in the environment. It just never stopped! And I think that's another important thing… to show these connections and those links; that nothing happens separate from something else. You just follow the bread crumbs (laughing). (Resident 15)

However, several educators and residents explained that "a number of other students don't have that [familial guidance], or are at a time in their life where they've abandoned the family structure" (Educator 8). These educators and residents explained that for all these reasons, schools – in addition to families, and other community-building initiatives – must also be responsible for developing the 'whole student,' including their cultural identity.

Educators were quick to mention that, particularly because of the holistic view of the student's Gwich'in identity, their education must explore the natural environment in which the students live. In the words of one educator,

> I think that's one of the things as a northerner and now as an educator that I see: students graduating from Grade 12 and not knowing anything about the boreal forest or the tundra, their local environment and the local plants and animals. So you could point to a spruce tree and they wouldn't necessarily be able to say it's a spruce tree, much less be able to talk about the importance of the tree traditionally and currently. And I think 'gosh, we teach so much!' We might even talk about the jungle and, not saying that students don't have to know about the whole world, but you'd think that at least in the Yukon they would have that circumpolar understanding… [I think it's important to make their] learning relevant to their own understanding. (Indigenous Educator 7)

All educators agreed that a culturally-responsive educational program must reflect understandings of the natural environment of the community as well as the cultural teaching and learning methods.

> The traditional ways of passing on information have been disrupted. We're at a time right now where that knowledge is not being passed on. And it's not being done in a way that it would have, traditionally, because of all the disruptions. And so there's a huge risk of losing this information. And even if that's contained into an audio tape or videotape somewhere, if it's not being passed on in the traditional way, well, then, that's all tied in to the loss of our language and culture. (Indigenous Educator 16)

In this way, many educators viewed culturally-responsive content and pedagogy as equally important in their integrative programs and classrooms.

Several northern educators reported that an ongoing challenge is the lack of northern-specific educational materials that are focused on the learning objectives in language and math courses. When discussing potential areas of opportunity for researchers interested in engaging in educational outreach, one teacher commented:

> We have so many [integrated] resources for social studies classes, but little for English or Gwich'in language classes, and even less for math class. I

> don't have a single locally-relevant resource, that I haven't created, that I can use in a math class. (Non-Indigenous Educator 2)

Many integrative materials are focused on meeting curricular objectives in history or geography subjects; one educator commented that this pattern may be evidence as these subjects often explore the connections between different ways of knowing, and this examination occurs less in the subjects of science, language and math.

Educators reported that science outreach materials often made use of skills valued in the Western science tradition: logical/mathematical and linguistic intelligences. Educators explained their need for science materials that explored and encouraged the development of other intelligences including interpersonal (understanding of others), intrapersonal (understanding of oneself), musical, bodily-kinesthetic, spatial and naturalist intelligences. For example, educators and northern residents commented that the majority of their students and children expressed strengths in bodily-kinaesthetic and naturalist intelligences.

> My students respond best when they can hold, can touch what they're learning about. There needs to be a mix of learning and teaching styles. There are so many different indicators of learning and understanding [and] here I go back to the platform of understanding: emotional, spiritual, physical and ecological understandings. And you cannot do it entirely in a classroom without an element of physicality and nature. You can do it by going back to classroom and back out again. And in that transition there is comparative time. To do this, I use multiple intelligences to some extent. (Non-Indigenous Educator 8)

Educators and residents observed that students often learn best when they are first engaged on levels and with subjects in which they are successful; after students are engaged on the topics and in ways that they find interesting, educators then begin to expand to corresponding topics, employing the other intelligences. Educators reported that they found greater skill development and interest from students when they used these six intelligences in their lessons. For example, educators spoke of developing students intrapersonal, bodily-kinesthetic and naturalist intelligences by using on-the-land, experiential laboratory activities such as snowshoeing to a local pond to trap and skin muskrat, using the muskrat for dissection to learn about body systems, and then learning

how to prepare and cook muskrat. Residents involved in these lessons, such as Elders that assisted with the trapping and participated in the cross-cultural dissections, explained that the students showed more interest and knowledge retention from these hands-on, realistic learning opportunities than if they had learnt the knowledge from a textbook or photos. Residents and educators reported that students needed to work together with their peers to develop their intrapersonal skills, use the activity of snowshoeing to understand the physical elements of their Indigenous culture, and experience this activity outside in the natural environment to develop their naturalist intelligence.

Consistent with the community's aspiration for community-focused education, several residents described their involvement in the school's annual land camp. One resident commented that the camp:

> …buys the gas, pay us our rental and pay us labour. But everybody should be involved. I think it would work good. And then you teach them [the camp staff], even me. If I do it again, I'll be still learning. About everything, about the land … so even when I was done out there I came back and I thought, for me, usually anything I do when I finish my job I always like to say 'did I gain anything from it?' (Resident 9)

An early-career Gwich'in scientist continued,

> I remember one summer I came up and we were doing helicopter trips around. And in geography we learned about the behaviour of water and streams and rivers it was a big moment for me because I could actually see it from the helicopter and I was like oh, wow - it really is relevant! It really does work this way! So those are small successes where you are like ok I'm actually really learning something here and I'm actually now being able to now read the land in the way that I was taught down south. (Resident 15)

Authentic learning experiences need not require a helicopter, yet this experience does illustrate the power of what many residents reported as seeing the 'real life' example of what is learned in school. Educators and residents agreed that such authentic experiences, which offer insight into Indigenous or Western knowledge, provide students with a greater sense of personal connection to the lesson being explored. Furthermore, providing authentic learning opportunities allows students to connect to their cultural heritage through the land, their Elders and in a cooperative environment:

> The worst part of things is that you don't want to see your grandchildren, or your grandchildren's children, read in a schoolbook of what we're interviewing right now. You don't want your children to read that in school - their history. You want them to practice it. You want them to continue to practice it, not read it out of school book. That would be the saddest part. (Resident 4)

In addition to hands-on practice, residents stressed the importance of observation in Gwich'in pedagogy. When discussing land skills and the skills required to run a dog team, one Vuntut Gwich'in resident explained that "nobody taught me - I just watched people" (Resident 16).

As a set of traditional land-based skills, almost all Vuntut Gwich'in residents interviewed stressed the importance of students' learning survival skills, particularly because of uncertainty of what the future might bring;

> 'Cause one day if the world ever falls down, people are going to have a hard time surviving. [There will be a] shortage of everything. So you might as well learn now. (Resident 14)

> It depends on the new generation that is coming up, how you envision it. If you don't catch them now, then in the future there's going to be hardship for them. If there's a big eruption or world disaster, well, we're isolated. Only way to come in is by air, and if [a world disaster] ever happens then you're going to have hardship on fuel … because you have no planes, and you got generators, but with no fuel, no power. Communication, phone - going to have no phone. How you going to operate your Ski-doo, how you going to operate your outboard motor [for your motorboat]? So you need to prepare. Like I say we have to educate our young people for those kinds of disasters, and how to survive. (Resident 4)

Many of the older residents spoke to the cultural changes and potential worldwide disasters that could sever the air link to the south Yukon, and the challenges that would come from the loss of those supplies to this fly-in community. However the younger residents were more likely to speak to the future challenges of climate change and local responses to this change. When discussing their concerns over how climate change has affected the traditional land of the Vuntut Gwich'in people, one resident looked for action:

> There are changes and I think the biggest thing now is how we're going to adapt. We can't expect the world to change their behaviours tomorrow, but we certainly can prepare for how we're going to change with it in the next few years. And I think that's something we'll really need to focus on. What these changes mean for us and our culture and our life style and how we're going to mitigate those changes. What is the next food source we're going to change to? Like fish is doing really bad right now and caribou might be changing their patterns and lakes may be drying up. How… what are we going to do when those things start to have an impact on our lifestyle? And they have to some degree already. And I think that's what we have to figure out as a community, what the next steps are, how we're going to adapt to those challenges. (Resident 15)

Most residents spoke to the importance of students learning cultural knowledge and skills because it is part of their cultural and historical identity, and most residents continued that learning these skills were equally important because of uncertainty over the future.

3.5 Discussion: Factors that support or hinder integrative education

Through this study, I uncovered many perceived factors that these science education stakeholders saw as either supporting or preventing the development of integrative study programs in the north Yukon. I have organized these factors into several categories that serve to support the development and maintenance of an integrative educational program: institutional support and organization, recognition of multiple ways of knowing, relationship building and co-learning, reflection of culture, multiple intelligences pedagogy, holistic and ecological approach, provision of authentic learning opportunities, and respect of knowledge divergences (Table 3.2).

Table 3.2 Supporting principles of integrative science programs

Principle	*Description*
Institutional support and organization	There is institutional direction, funding and support from the territorial and local government and educational authorities.
Recognition of multiple ways of knowing	Government officials, educators, and residents recognize that there is no one 'right way' for students to learn (or of what to learn), and that there are many different ways of learning as well as expressing knowledge and understanding.
Relationship building	All participants (including teachers, Elders, administrators, students, and parents) commit to building positive relationships that support life-long student learning in the school and wider community.
Principle of co-learning	This principle should be shared by teachers, residents and students. All stakeholders should commit to learning about other knowledge systems and knowledge holders.
Education reflects student's culture	Integrative programs that reflect the local Indigenous culture inherently explore the local environment and traditional ways of passing knowledge through Elders, parents and the community.
Multiple intelligences	Teachers recognize and challenge students diverse intelligences, such as their spatial, musical, inter/intrapersonal and kinesthetic abilities.
Holistic and ecological approach	Education programming makes use of systems thinking to find interconnectedness between systems and ways of knowing, and supports sustainable ways of living in our environment.
Authentic learning opportunities	Programs provide 'real-world' learning experiences, such as on-the-land, hands-on research and volunteer/work experiences that allow students to apply their classroom understandings to their daily lives, and personal and employment goals.
Respect for knowledge divergences	When perspectives differ, stakeholders share a respect for knowledge divergences. It is important that these differences not be glossed over, but instead further investigated by participants. It is critical that these differences be recognized, as Indigenous students face such divergences each day. Mindful ways of reconciling these differences must be modeled for and practiced by students.

Many participants spoke to the importance of structural and institutional supports in developing, funding and building community capacity for integrative opportunities. This institutional organization must go "far beyond superficially adding fragmented pieces of cultural knowledge to the existing structure" (Hermes, 2005, p. 53). Similar to Aikenhead and Elliot (2010), several educators spoke about the challenges they faced in developing their own integrative programs when they were expected to follow the standardized curriculum or national educational frameworks (e.g. Pan-Canadian Science Framework) such as students' inability to resolve discrepancies between the intellectual tradition (the cognition of the individual) from their own experience. Institutional support and funding for multi-year programs allowed teachers and community members to develop integrative programs. Furthermore, high teacher and administrator turnover remains a concern for many educators and residents, and Old Crow has not escaped this common problem across the North. However, Old Crow has had several educators that have lived in the community for several years, and residents and educators alike spoke to the importance of this stability in building community relationships and capacity, as well as developing and maintaining their integrative program.

With the inclusion of Elders and Indigenous knowledge holders in the development of educational programs, residents and educators both spoke to the differences between how Western and Indigenous knowledge is generated and passed on. In the Western scientific tradition, knowledge is generated through the scientific process, a method that views objectivity as attainable, and yet in the Indigenous tradition, individuals come to understanding through personal, subjective experience (Hatcher *et al.* 2009a). Using these diverse approaches to examine multiple ways of knowing and living provides opportunities for students to explore and gain insight into their world, in all its personal, environmental and social complexity. For example, similar to other studies (Parlee and Berkes, 2006; Ford *et al.,* 2008; Gearhead *et al.,* 2010), northern residents and scientists alike are careful to explain that natural climate variability is part of daily life in the north. However, cultural changes and sustained anthropogenically-forced climate and environmental change confound Old Crow's residents' concern for the future. Research shares their concern for future (Fox, 2002) as well as the growing importance of learning

new ways of working on and with the land in light of these changes (Ford *et al.* 2008), including new applications of Indigenous science (Gearhead *et al.,* 2011) , and incorporating science into their current ways of living on and with the land (Carmack and MacDonald, 2008).

Educators and residents identified a variety of ways that relationship building supported integrative programming and led to a positive learning environment. As previous studies have demonstrated (Berger and Epp, 2005; Baker and Giles, 2008), open dialogue is a common feature of successful integrative educational programs. When working together on integrative programs, the principle of co-learning guides many residents and educators in their journey to explore and to understand different cultural perspectives on how we create knowledge. Le Heron *et al.* (2006) conceptualize co-learning as an approach that allows for synergy to develop between research and teaching, allowing students and teachers to engage prior learning (from home, school and other experiences). Similarly, in their exploration of transdisciplinary research, Pohl and Hirsch Hadorn (2008) stress the importance of discussing key terms and ensuring that all parties are clear on the definitions and central concepts. Similarly, in trans-cultural education, this translates into common group learning through which diverse groups of individuals work together to have a greater understanding of each other's perspectives. In Old Crow's annual land camp, the First Nation-appointed Education Support Worker (a prominent Elder) and teacher contractor work together to develop the content and curriculum for the spring camp. Through the daily programming, students observed this co-learning, and were also challenged to develop their ability to make connections between these two ways of knowing.

Participants explained many ways in which education should and could reflect the student's own identity and culture. Western science can seem foreign to many students for many different reasons. As Aikenhead (2001) found, learning science is determined by several factors including the difference between a student's own culture and that of the school program, a student's ability to cross cultural boundaries between their own cultural identity and that portrayed in the school program, and finally the support students

receive to navigate those boundaries. In order to be reflective of the Indigenous culture, education must also reflect the local environment. As previously discussed, Indigenous cultures, and the residents in this study, did not disassociate person and place. Instead, people and all animals are part of the environment in which they live. To fully explore the interrelationships therein, as expressed by these Gwich'in residents, students must be challenged beyond the conventional in-seat exercises that focus on developing skills prioritized in Eurocentric Western science. In order to recognize and support the many different ways people understand the world around them, educators reported that many of their pedagogical choices are informed by the theory of multiple intelligences, particularly in their conviction to diversify their instructional strategies. My findings agree with Lewthwaite and McMillan (2010) who conclude that effective teachers use multiple instructional strategies and change their practice in response to student learning and success.

Although interviewees valued holistic approaches to the curriculum, in their rationale for pursuing an integrative program, they took different approaches to explaining relationships within and amongst systems. Porter and Córdoba (2009) outline several ways in which interrelationships can be understood as functional (e.g. environmental management), interpretive (e.g. self-awareness), and adaptive systems approaches (e.g. innovation). Residents most often spoke of functionalist approaches to systems, which is perhaps not surprising since many residents of Old Crow are involved in natural resource and wildlife management, whether hunting, trapping or harvesting trees for heat. Likewise, residents spoke to the inseparability of humans and the natural environment, and the importance of responsible harvesting. However, educators most often spoke to the interpretive systems approach that sees 'the whole as greater than the sum of its parts.' Educators' views are greatly influenced by bi-cultural educational policies, and principles of Two-Eyed Seeing. In this way, educators were more focused on understanding *how* they develop knowledge, and how this development is different in different cultural systems. Again this is not surprising since many educators interviewed were teaching in a culture that is not their own, and have thus been personally challenged

to examine cultural influences of knowledge generation, and are perhaps more likely to see this process as important in their teaching.

In Indigenous education, learning and living occur simultaneously; even more, they are the same thing (Watt-Cloutier, 2000). However, herein lies what several educators identified as a potential limit of culturally-responsive education: the provision of authentic learning opportunities. Much responsibility lies with the family and wider community in educating youth, and several residents commented that there are limits to what is possible with school-based programs, particularly when dealing with sacred Indigenous knowledge that individuals, families or communities believe should be not learnt in school. Instead, residents viewed families and spiritual communities as responsible for passing this information down through the generations. Several residents reported that, from their experience, families and parents need to take more personal responsibility for the education for their children, and need to be more active in sharing cultural and land knowledge with their children. Educators agreed that some knowledge is sacred, and they would not be comfortable, even in a bi-cultural program, working with such content. Similar to other studies (Smylie *et al.,* 2009; Brown, Varcoe and Calam 2011), several residents and educators shared in the observation that, in some families, these traditional links have been broken due to the loss of culture and language through assimilative federal and territorial policies and practices, such as residential schools. Particularly for these students, and to allow students to explore and celebrate their own heritage as part of their education, schools must do what they can to provide culturally-responsive schools and, where possible, do so in tandem with families and the wider community (Battiste, 1998; Bainbridge, 2007; Lewthwaite and McMillan 2010).

Interviewees did not explicitly explain how they dealt with divergences between these two ways of knowing. However, several educators mentioned that they often come across discrepancies between how Western science and Gwich'in understandings would explain a particular phenomenon. Differences between the conclusions made from two diverse knowledge systems can be most revealing (Huntington *et al.*, 2004a). When observations informed by Indigenous knowledge do not agree with scientific understandings, there are

several avenues to consider. The Indigenous observations and scientific records might be observing different phenomenon altogether (Gearhead *et al.*, 2010) or sometimes the two ways of knowing might be inherently incompatible. For example, three educators spoke to the ongoing challenge of the importance of spirituality in Indigenous ways of knowing. In the Indigenous sciences, this sacred and personal connection one feels to the environment and their place within it often forms the basis of understanding from which an individual makes sense of the world around them (Cajete, 1999). However, in Western sciences that value objective quantitative analysis, there is little room for spirituality (Hatcher *et al.,* 2009a). Further study is required to shed light on whether or not spirituality is in fact an irreconcilable difference between Indigenous and Western education, or is perhaps the next stepping stone in the process of co-learning in integrative science.

The 2010 CZGS's land camp incorporated many features of integrative science. Following cultural as well as curricular understandings of scope and sequence, students explored Gwich'in knowledge (as guided by Elders) and explored Western science (as guided by their teachers). These integrative lessons allowed students to see the implicit and explicit connections between these two ways of knowing. While out on the frozen lakes behind the land camp, students learned Gwich'in knowledge as to how to locate muskrat push-ups (feeding areas), how to set and release the traps, as well as skin, stretch and cook the muskrats. Throughout the camp, Elders told legends and family stories about life on the land and the importance of muskrats. At the appropriate time in this series of events, the students learned their science curricular objectives such as muskrat habitat, trophic relationships within that habitat, and conducted a muskrat dissection to closely examine the body systems. Together with their teachers, Elders, visiting family and community members, students were weaving between these two ways of knowing, sometimes exploring each knowledge system on its own, and other times exploring the connections between these two ways of knowing. In this way, teachers could use the principles of Two-Eyed Seeing to appropriately implement integrative science in their programs (Hatcher and Bartlett, 2010). Whereas Two-Eyed Seeing is the guiding principle of recognizing the strength of using two worldviews, integrative science is the

action of bringing together these perspectives together for the purpose of science education and research (Hatcher *et al.,* 2009a; 2009b).

To allow for each year of a student's participation to be distinct from all previous years, the teaching team together with the Old Crow Experiential Education Project committee decided on a three-year rotational focus. Each year the camp examines the linkages between Gwich'in knowledge and curricular learning objectives from Western math/science (completed in 2010), social studies, geography and history (completed in 2011) and trades/arts (anticipated for 2012). This rotation allows for the three multi-grade classes (Grades 1 to 3, 4 to 6, and 7 to 9) to experience each of the focuses at their grade-level before beginning the rotation again. CZGS's land camp has now become a case study of how other northern communities can implement an integrative land program into their school calendar. The school is currently planning extensions of this annual event in order to build momentum towards the spring camp, as well as to provide students with additional on-the-land learning opportunities in other seasons and in diverse environments.

In addition to illuminating the factors leading to the success of such school-level projects, my research found northern and Indigenous people in need of further networking and resource-sharing opportunities, as well as national and territorial policy that supports the development of such programs. There is limited resource sharing and training opportunities. I agree with the call by Pearce *et al.* (2010) for "policy that supports the teaching and transmission of environmental knowledge and land skills in order to strengthen the competence" of young northern Indigenous people, and thus their community's capacity to adapt to a changing climate (p. 6). In addition to policy change, there is a need for more forums through which researchers, residents and educators alike can share the lessons they learn along the integrative science journey, as well as the learning resources produced. One educator reflected on the positive impact of the Alaska Native Knowledge Network in developing relationships and resource sharing; a similar organization has the potential to foster similar collaboration in northern Canada. However, the ANKN is hosted by the University of Alaska Fairbanks. As the only Arctic

country without an Arctic-based university, I agree with other northern scholars and residents (Douglas *et al.,* 2008; CBC, 2009) in the call for the establishment of a northern Canadian degree-granting university through which northern research can be coordinated, allowing northerners greater access and control over research and therefore giving space for research of interest and importance to northern people.[20]

3.6 Conclusions

From this research, I found nine key elements that supported successful integrative programs (Table 3.2). Further research is needed to explore the limits of integrative programming, such as if it is necessary and possible to reconcile Indigenous spirituality with Western science. Longitudinal studies examining the influence of these programs on students' lives will also serve to identify more specifically how these programs serve to support students' educational success and personal lives. Individual and comparative case studies examining the journey of specific communities on the road to integrative educational programming would identify the factors that support programming sustainability, as well as point other communities towards the many ways they can move forward on similar projects.

Northern educators and residents have highlighted the need for educational programs that weave together two forms of knowing, establish this skill development at an early age, and provide opportunities for students to challenge themselves to explore their own identity and world in which they live. As explored in this study, many north Yukon educators and residents are interested and motivated to develop or to maintain strong collaborative working relationships that demonstrate the Indigenous values of respect, relevance, reciprocity, and responsibility. Given historical and recent social, economic, environmental and cultural changes, it is an exciting time for northern educators and residents looking to collaborate in the development of knowledgeable young leaders with the experience and confidence to successfully meet these challenges head-on.

[20] Each northern territory has its own college: Yukon College, Aurora College (Northwest Territories) and the Arctic College (Nunavut). However, these three colleges are in fact leading the push for a pan-Arctic Canadian university (see CBC 2009).

3.7 References

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CHAPTER 4: CONCLUSION

4.1 Introduction

The goal of this research was *to determine the most culturally appropriate and pedagogically suitable methods to integratively use Western and Indigenous science for the purpose of science outreach in northern communities.* As indicated by my research goal, I sought to understand *how the knowledge of IPY researchers and northern Indigenous residents can be used to create culturally-relevant educational materials for northern students?* To answer this question I formulated three research objectives: to examine northern resident and educator views on integrative education; to identify factors supporting educational science outreach; and to provide recommendations on strengthening polar science educational outreach. The findings of these objectives will be discussed and synthesized below.

4.2 Integrative education

My first research objective was *to examine the experiences, perceptions and components of integrative education from the perspective of northern residents, educators and researchers*. Interviews with residents and educators revealed that integrative education, informed by the principle of co-learning, provides a culturally appropriate and pedagogically suitable way to teach Indigenous and Western knowledges' side-by-side. Educators and residents spoke about many factors that support (or hinder) integrative education. Top-down institutional support and organization is important in order to have program stability. Successful integrative programs do not merely 'add-on' cultural understandings to the standard program but instead 'infuse' Indigenous cultural understandings into the curriculum and educational materials (Kawagley *et al.* 1998, Hatcher and Bartlett 2010). Northern residents spoke to the importance of valuing multiple ways of knowing. The principle of co-learning informs the relationship between participants; students are teachers, teachers are learners, and individuals seek to understand observations and phenomena from both Indigenous and Western perspectives. Education should reflect the culture of those being educated in order to foster identity and to allow students to springboard from their own experience to wider understandings about

the world. Integrative education supports a holistic perspective, also known as systems thinking, in which relationships within and between systems (such as ecosystems) are examined. The theory of multiple intelligences illustrates that there are diverse ways of understanding the world around us, including the linguistic and logical-mathematical intelligences valued in the Western scientific ways of knowing, as well as the bodily-kinesthetic and naturalistic intelligences valued in Indigenous ways of knowing. Fostering relationships within a community of learners – such as amongst students, teachers and parents – allows for greater understandings to be shared amongst learners, in addition to building trust and making room for communicative forms of assessment. Authentic learning opportunities allow students to make connections between school and 'the real world,' in addition to encouraging life-long learning. Finally, educators must not gloss over discrepancies between two ways of knowing and instead openly encourage discussion of these divergences.

4.3 Educational science outreach programs

My second research objective was *to identify the factors of science outreach programs that support educational outreach and provide opportunities for participants to examine the world around them from two cultural perspectives*. Interviews with northern residents, educators and researchers included a discussion of the perceived supports and barriers when conducting educational science outreach programs. The importance of local vision and direction was emphasized by all stakeholders. Capacity development was a concern to all stakeholders, and spoke to the ongoing challenges of building capacity for educational science outreach in their communities of practice. Researchers spoke of their struggle to overcome institutional barriers (such as professional recognition of outreach efforts), and the often severely limiting factors of time and funding. Educators spoke to the necessity of researchers to give similar time, funding and thought in conducting educational outreach as they do in their own research. Residents spoke of their need for integrative programs that challenged students to meet both Indigenous and Western learning objectives. Stakeholders' perspectives on the sustainability of their educational outreach programs varied; however, a commitment to prioritizing an

integrative program and maintaining mutually-beneficial research partnerships shaped their vision of the future.

4.4 Study recommendations

My third research objective was *to provide recommendations on strengthening polar science educational outreach that addresses the unique needs and interests of key stakeholders (residents, educators and researchers)*. Here I present recommendations based on the results of this study for stakeholders interested and involved in educational outreach and integrative science in northern and Indigenous communities in Canada (Table 4.1).

Table 4.1 Stakeholder-specific recommendations for educational outreach and integrative science as informed by this research

Group	Recommendations for educational outreach and integrative science
All stakeholders	1. Work with fellow stakeholders to develop 'communities of practice'
	2. Work with fellow stakeholders to develop multi-year outreach initiatives
	3. Work with fellow stakeholders to develop educational initiatives in which students themselves create locally-informed educational materials and programs
	4. Educate oneself on integrative science, Two-Eyed Seeing and other practices that seek to bridge the 'gap' between Western and Indigenous sciences
	5. Contact other stakeholders who have been successful in similar projects
Residents	6. Develop a community inventory of interested Elders and experts
	7. Work with educators to develop culturally-reflective seasonal calendars
	8. Attend land camps and local initiatives to support family-based learning
	9. Residents working at land camps and for outreach initiatives should take part in scheduling and decision-making
Educators	10. Ensure schools and land camps are open and welcoming to families and residents
	11. Organize and support family-based learning and assessment
	12. Organize and support cross-curricular learning activities
	13. Work with residents to develop culturally-reflective seasonal calendars
	14. Use these seasonal calendars to align the school year with cultural activities
	15. Work with researchers to determine when and how their research can be integrated into the mandated learning outcomes
Researchers	16. Work with educators to determine when and how one's research 'fits' the mandated learning outcomes
	17. Contact educational leaders –policy makers, curriculum developers, local education departments – during conceptualization stage of the research and outreach planning
	18. Recognize and value education and outreach initiatives of fellow researchers
	19. Petition faculty associations, university tenure review boards and university senates for professional recognition and reward of researcher involvement in education and outreach initiatives
Funding, licensing and research coordination agencies	20. Encourage and provide support (e.g. training, logistics, funding) to all stakeholders in conceptualizing and planning outreach before the start of the research program
	21. Ensure designated outreach funding or establish a funding 'hold-back' to be released once education/outreach commitments have been realized
	22. Provide financial support to researchers interested in participating in educational outreach
	23. Establish a funding program that supports research conducted in collaboration with northern communities
	24. Assist in the coordination and sharing of information amongst researchers, communities and educators, in part to prevent duplication/reinvention
	25. Professional recognition and reward of researcher involvement in education and outreach initiatives (e.g. consideration of outreach success in funding proposals)

4.4.1 Recommendations for all stakeholders

All stakeholders can work together to develop 'communities of practice' in which people who share a common interest – science education and outreach, or integrative science – work together and share experiences and knowledge (Lave and Wenger 1991). Based in social learning theory, Lave and Wenger (1991) coined the phrase 'communities of practice' when studying how social relationships develop and how co-learning occurs between apprentices and their mentors. Communities of practice develop their skills through many activities including problem solving, documenting projects, and visiting initiatives from other projects (Wenger 2000). I propose that the concept of 'communities of practice' can be useful to inform the collaboration – not merely cooperation – between the variety of stakeholders involved in science education and integrative science outreach. As other research has shown (Conway 2006), communities of practice allow engaged stakeholders to work together to address society's changing needs, and allow each stakeholder to learn from their own and the other stakeholders knowledge and experiences. Communities of practice already exist within each of these stakeholder groups. I found examples of collaboration occurring within, but not across, stakeholder groups: teachers share methods, content and practices amongst each other, as do researchers, residents and funding agencies. However, without additional learning occurring *across* these stakeholder groups, 'stove-piping' of science research and outreach efforts will continue. Old Crow, perhaps due to their coordination role in IPY research, has made great strides in developing a collaborative network of researchers and residents; this research demonstrated that educators are also interested in collaborating in this network. A community of practice that engages all stakeholder groups might look like the following: when a water quality specialist is scheduled to come to town to test the water supply, the First Nation government department coordinating the visit would connect the school and water quality specialist, inquiring if any class/teacher would be interested in hosting a classroom visit. In turn, this water quality specialist would contact with water-related researchers conducting research in town, and would pass along new areas of concern to the researcher (as a potential novel research question).

I recommend that all stakeholders work towards developing multi-year professional relationships. In this study I found that relationship building was viewed by most stakeholders as an essential component of developing a useful, meaningful and practical science outreach program. High turnover of teachers and researchers (such as graduate students) remains a barrier for this development. However, leaving sufficient time in the planning and program stages of the outreach project opens time for relationships to develop, which in turn supports the fostering of communities of practice. For example, a wildlife biologist planning to study moose in the region could work with educators which would open many potential benefits for the school and community, including scientist-in-the-classroom visits, teacher-in-the-field opportunities, and potential student and adult summer employment (as research assistants or logistics support people).

In order to support the development of useful, innovative local resources that meet the educational needs of the community, students could be involved in making resources, such as handbooks or video clips, that engage them in knowledge while simultaneously challenging them to think about knowledge and skill transmission. For example, in preparation for the spring land camp, students could spend some time each week learning from local seamstresses how to make moose mukluks (boots), making a pair of their own, and then developing an instructional handbook, children's story or DVD that shows this process. Furthermore, this research demonstrated many ways in which educators and researchers are using the ideas of 'Two-Eyed Seeing' and integrative science (Hatcher *et al.* 2009a, 2009b, Bartlett 2011, Bartlett *et al.* 2012) in science education and science outreach. For example, together the CGZS and I created integrative and/or bi-cultural materials for the CGZS experiential education project and spring land camp. In the first part of a muskrat 'lesson,' students discuss or interview Elders about muskrat trapping in the past, asking questions such as who was trapping, where they trapped and why, when they trapped and why (season and time of day), how they trapped, and why they trapped. Then, using figures from the Hunters and Trappers Association, students calculate their current and past/historical potential income for their week's worth of muskrats. Then students discuss how they could support themselves now and in the past, considering the current and historical costs of muskrat trapping (e.g. dog food, electric bills), and then

predict how many muskrats they would need to catch each day to take care of their family (see VGFN and CGZS 2012). Students could also extend this to measure how many muskrats would be needed to support a family, and how that harvesting would impact species populations, the local environment, and family planning (particularly in regard to food security). Self-education on integrative pedagogies, such as Two-Eyed Seeing, will be useful for all stakeholders, both to give stakeholders the opportunity to explore the cultural dimension of knowledge, as well as to help them make linkages with Indigenous students who are challenged in their everyday lives to negotiate the space between Western and Indigenous understandings.

4.4.2 Recommendations for residents

To support the development of a community-focused educational system that links diverse ways of knowing, community inventories could be developed that list knowledgeable individuals (e.g. Elders, researchers, etc.) and the particular skills or subjects they would be comfortable teaching. In this study I found that many researchers and educators reported not knowing 'who to turn to' in the community that has experience with particular cultural knowledge or skills, and would be interested in sharing and collaborating with other stakeholders. As recommended above, developing communities of practice and multi-year relationships and programs will give stakeholders the experience needed to know who key resource people are in each community. There is sufficient researcher and educator turnover to warrant the need for a 'cultural knowledge' list. For example, First Nation governments, perhaps with educators, could develop a list (with consent of the individuals on the list) that outlines local resource people and the cultural skills they would be interested in sharing (e.g. trapping, storytelling, berries, traditional medicine, safety, land travel, and weather prediction). Similarly, communities, perhaps with educators and students, can develop seasonal calendars that illustrate the natural processes and observations at particular times of the year, and the way the land is conceptualized and used during specific times. In this research I found that residents, and often educators, wanted the school curriculum to more closely follow the cultural calendar, and the development of such a seasonal calendar would be a resource to all other stakeholders (also see below).

A handful of residents and educators lamented the lack of parental interest in their children's schooling and development of their cultural knowledge and skills, although several residents and educators also spoke to the great involvement of other parents and family members in their child's education. Parents and family members could be encouraged to visit or attend the land camp in order to share in the excitement of learning with their children, as well as to offer opportunities for family members to offer personal insights and understandings to the knowledge students are exploring and employing at the camp. Thus, families and northern governments (particularly at the community level) should continue to encourage each other to participate actively in the development of such integrative science outreach programs.

To support authentic, life-long learning of all participants, integrative science land camp staff could ensure they are included in decision making in both planning and organization of land camps, as well as the daily activities. Several residents spoke about a lack of involvement and power they felt, even if they were employed at the camp. To share input and direction with these employees (and fellow stakeholders), regular daily camp meetings, such as after dinner, could be organized to allow camp staff to discuss the next day's schedule and determine which camp staff (e.g. cooks, drivers) could be involved in the land activities throughout the next day. Both educators and residents could work towards stakeholders feeling that their input is valued and they are actively involved in decision making, as well as to allow these adult (but often not Elder) leaders to demonstrate a passion for life-long learning (also see below).

4.4.3 Recommendations for educators

Educators should ensure that residents are involved in the planning and decision making of integrative science programs, particularly land camps, in order to empower residents and support family and life-long learning. Similarly, schools should support and use family-based activities and family-based assessment. In this study, I found that residents and educators often wished to increase family involvement in the school to allow a more authentic, Indigenous method of assessment which includes the family and wider

community. There are many ways in which the family and community could be involved in assessment. Examples include: science and heritage fairs; school-based family hunts in the fall to collect meat, fur, berries and other land-based resources to use in programming throughout the year; public feasts and celebrations of learning where students develop displays that show what they have learnt, and community members offer feedback on their projects and learning; regular home visits; family member guest speakers; and reading buddies.

Educators could work with residents to develop culturally-reflective seasonal calendars that show the connections between seasonal environmental changes and cultural practices that occur at particular times of the year. Curriculum and educational materials developers could consider using such seasonal calendars to structure the scope and sequence of learning activities throughout the year. Teachers could also consider using such calendars in order to align the school year – including units, content, and special events – with important events in the local community and environment. For example, if one of the science learning themes or objectives involves studying animal physiology, this could occur during the spring or fall caribou migration so the caribou can be used to study body systems; teachers and residents could plan a caribou hunt in which students learn how to hunt caribou and learn about the cultural importance of caribou, and then the caribou could be used for physiological study in the science classroom before being used for a cooking classroom or for donation to a hot lunch or Elders lunch program.

In order to open room for the holistic approach of Indigenous knowledge and prevent the compartmentalization of knowledge, cross-curricular activities could be encouraged. For example, in many small northern communities it is possible to integrate a variety of subject areas in one lesson, activity, project or week. For example, physical education, science, and language objectives could all be met with a weekly land-based activity of skiing to the local ski-hut while stopping to observe, track and monitor wildlife (e.g. count songs birds, record animal tracks and direction), having classes at the hut, and skiing back for lunch. Such cross-curricular lessons and programs are essential to opening room to make connections between Western and Indigenous knowledge.

Researchers and teachers should work together to come up with examples of where particular research methods or findings tie in to the curriculum or specific learning objectives. Educators should not expect that researchers understand the language of these objectives, or the particular scope and sequence of the learning outcomes, and instead see themselves as 'translators' that can help the researchers tailor the research to fit the needs and current understandings of the students.

4.4.4 Recommendations for researchers

In order to support the above recommendations to educators, researchers could make themselves available as a guest speaker or student resource throughout the year. Although most stakeholders agreed that in-person visits were preferred, this need not be a limitation to involvement. If the school or class cannot 'fit' the researcher in during the researcher's yearly visit (e.g. the researcher is often in the community only in the summer), researchers can still act as resources online, by phone or using video call-ins. For example, if a treeline ecologist primarily visits the community in the summer growing months, they could instead be involved in educational outreach by making themselves available to students for an online video session, such as before or after a September plant identification walk in which students collected and identified various plants in the area. For researchers studying the relationship between climate and the environment, researchers could work with teachers to have students take notes in weekly nature journals, recording observations made that week, such as the first signs of spring, wildlife sightings, and so on. Recording such observations is an often-used research activity, and researchers could work (in person or virtually) with students to interpret their observations. Researchers need not limit their educational outreach involvement to the few days or weeks they are in the community each season or year. If a researcher plans on making an 'off-season' (fall/winter/spring) trip to the community (e.g. for a research results presentation or workshop), then researchers are encouraged to contact educators early on, to perhaps time their community visit at a time in the school calendar that fits the sequence of events in the school and classroom (e.g. for Earth Day spring celebrations, a community hunt or feast, or at a time in the year when students would be

studying a topic that relates to the research, or when they would be exploring future careers).

To find meaningful topics of interest for communities and schools, researchers and research networks could contact educational leaders (e.g. principals and curriculum writers and designers in the territorial Departments of Education) in the conceptualization stage of their research. Several education administrators and curricular writers spoke to the many needs and questions that they have that would be of great interest as new areas of research, or ways in which researchers could be involved in the shaping of new curriculum currently being developed in various northern territories. Again, researchers need not limit their educational outreach to classrooms and teachers, and are encouraged to contact various levels of administration.

4.4.5 Recommendations for funding, licensing and research coordination agencies

In order to support the development of meaningful educational science outreach programs and partnerships, I recommend a continued commitment of research networks and funding agencies in supporting educational science outreach. However, this study illustrated that outreach is often left to the end of the research project, as something that is done to communicate results. In order to develop meaningful educational outreach opportunities, researchers and research networks must commit similar time, effort and greater funds at the start of their outreach initiative. I recommend that funding agencies institute a funding 'hold-back' that would be released once education and outreach promises have been met. Furthermore, since early career researchers reported a higher level of interest and involvement in developing long-term community relationships and educational outreach, research networks and funding bodies could make available special financial sponsorship for all researchers – but perhaps with an emphasis in attracting early career researchers – demonstrating leadership in developing meaningful, collaborative and innovative educational outreach programs.

Although many IPY research networks employed or interviewed northern residents, very few programs truly collaborated with northern communities. In this study northern residents spoke to the importance of northern-led research agendas that allow communities to determine the questions asked, such as was done with the IPY initiative YNNK, organized through the Vuntut Gwitchin First Nation in Old Crow in collaboration with researchers from various research backgrounds. NSERC funds many collaborative initiatives under their Partnerships Program, such as the Engage Grants Program which provides short-term funding to start collaborations between researchers and commercial partners to address company-specific problems (NSERC 2011b). I encourage all Tri-Council partners to continue their funding of Partnerships Programs that allow researchers and communities to establish collaborative research programs.

All participants reported a lack of communication, collaboration and networking amongst researchers – and other stakeholders – interested or involved in educational outreach projects (a 'stove-piping' of experience and knowledge). However, collaboration amongst stakeholders supports the development of such communities of practice, and can lead to an increased awareness to researchers regarding the science going on in the communities in (or associated with) the regions in which they work, allowing for more sharing of educational outreach best practices amongst all stakeholders.

4.5 Study limitations

In all research projects there are some limitations that must be acknowledged. I have made many decisions on what to include or not to include in this thesis. I have attempted to both situate myself in this research, and be explicit about the seemingly arbitrary temporal or spatial boundaries that I established during this research project that have shaped both the research and my findings. For example, I chose to focusing on school-based learning (and not other forms of knowledge transmission), I chose to partner with the community of Old Crow (and not another community, or several communities) and I chose not to interview students (due to constraints from time and additional ethics approvals and research licenses required).

The iterative design of this qualitative research allows for greater depth and detail than a 'snapshot' of survey-style research, and consequently provides a context-specific description of experiences, relationships, and variation (Marshall and Rossman 2011). The research design, findings and recommendations are situated in my interpretation of IPY researchers and their science outreach, and integrative education in Old Crow. My findings and recommendations most fully apply to the research community (of Old Crow). However, as Flyvbjerg (2006) explains, these research findings may find applicability in other settings, particularly those that share similar features; for example, some of these recommendations can be scaled up, and may apply to other northern and Indigenous communities (Table 4.1).

This research is also limited by a shortage of literature on polar science outreach, northern Canadian integrative education, and collaborations between education and outreach stakeholders. Instead, I consulted academic literature from southern Canadian, and American (Alaskan) integrative education scholars and programs, as well as reports written from IPY polar researchers on their outreach initiatives.

4.6 Theoretical contributions

Due to this gap in the literature, this research contributes to our theoretical understanding of cultural expressions of where and how knowledge is created. My research examined how 'science' is understood, explored and expressed through Indigenous and Western knowledge, skills and attitudes. This research recasts Eurocentric understandings of who is traditionally perceived as the 'outsider expert' (the southern-trained researcher specialist) and instead acknowledges the 'insider expert' by valuing the northern-trained experience specialist (the Elder) in collaboration with the southern researcher.

This research contributes to the theoretic understanding of the pedagogy of polar science outreach, and the potential room for collaboration between such northern education stakeholders. My research gives examples from one northern Canadian Indigenous community, during one uniquely concerted research cycle (that of IPY). By exploring the experiences (lived and potential) of these stakeholders, I have initiated a scholarly

conversation of what these communities have long been discussing amongst themselves: the obligation of northern researchers to share knowledge in a culturally-responsive way. In this way, it is my hope that this research stretches southern Canadian understandings of the roles and responsibilities of researchers when working in northern, Indigenous communities.

4.7 Future research

This research has sought to present perspectives of key stakeholders involved in defining, developing, providing and using integrative science and integrative educational outreach programs. However, the findings suggest that more research is needed. In-depth studies of key topics (e.g. co-learning, authentic learning experiences) emerging from this research would strengthen the understanding of key stakeholders. Specific areas for further research include:

1. A longitudinal study of the educational outreach efforts of an International Polar Year research network. Many researchers, educators and residents noted that they wished they had a more complete picture of how particular research networks conducted such 'successful' educational outreach projects. Such research would illuminate both best practices when conducting educational outreach and common pitfalls to avoid. Fortunately, Provencher *et al.* (2011) have documented over 550 IPY education and outreach activities in their IPY report, and now focused studies are needed on how particular research and education/outreach collaborations unfolded during IPY (see Balasubramaniam 2009).

2. A comparison between two or more Indigenous communities in their journey towards developing integrative science programs. This would provide meaningful insights into similarities and differences between groups, as well as the influence of geographic location. A comparison of one of the emerging Yukon integrative programs with an established Alaskan program would allow the Yukon (or another region in Canada) to benefit from the lessons already learnt from the more established Alaskan programs

3. A systematic, mixed-methods analysis of the perceptions of key stakeholders involved in providing integrative educational programs. Stakeholders could rate the strength of the dis/agreement with particular statements concerning their key epistemologies and methodologies that inform their understanding of integrative

education, and elaborate on their responses to these questions through in-depth interviews. This would allow a more nuanced examination of the importance (or unimportance) of the key elements of integrative education.

4. A longitudinal study that examines the short and long term impacts for students who have had a culturally integrative education. Integrative science is in its infancy, and such as study would be of interest to designers of integrative programs, and could potentially be interesting in the future in providing an historical understanding of the student's experience of the program. Furthermore, integrative science is still being defined and contextualized, quite often by academics, educators and community leaders, and such a study would allow for the student's voice to come to the forefront.

4.8 Concluding comments

Through this study I collected and compared the perspectives and experiences of residents, educators and researchers on polar science educational outreach and integrative science. My research challenges the 'status-quo' of how mainstream researchers perceive their responsibility and potential involvement in educational outreach, and provides direction for collaboration between stakeholders in science education and outreach. As shared by educators and residents in particular, the principle of Two-Eyed Seeing shapes the pedagogical approach of integrative science which educators explained is an effective method to engage northern, Indigenous students in Western and Indigenous knowledge. This research was conducted in response to researchers, educators and communities looking to engage in culturally-responsive education projects as part of their ongoing partnership, as well as for communities seeking an innovative approach to engaging, inspiring and supporting the resiliency and adaptive capacity of their youth. Through such programs, residents, educators and researchers can collaborate, contributing to developing strong cultural identity amongst northern and Indigenous youth, and ushering in the next generation of highly qualified northern leaders.

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APPENDIX A: RESEARCHER CONSENT FORM

School of Resource and Environmental Studies
Faculty of Management

INTERVIEW SCHEDULE 1: IPY RESEARCHERS/SCIENTISTS
CONSENT FORM: PAGE 1 OF 3

Title of the Research:

Northern Knowledge: Creating locally-relevant educational materials from community consultations and northern ecological studies

Principal Investigator:

Frances Ross
Master's of Environmental Studies Candidate
School for Resource & Environmental Studies
Dalhousie University, Halifax, Nova Scotia
Email: frances.ross@dal.ca
Phone: 902-455-8920
Fax: 902-494-3728

Academic Supervisors:

Dr. Karen Harper
School for Resource and Environmental Studies, Faculty of Management
Dalhousie University, Halifax, Nova Scotia

Dr. Tarah Wright
Environmental Science, Faculty of Science
Dalhousie University, Halifax, Nova Scotia

Introduction

We invite you to take part in research being conducted by Frances Ross, a graduate student at Dalhousie University, as part of her Master's of Environmental Studies degree. Your participation in this study is voluntary and you may withdraw from the study at any time. The study is described below. This description tells you about the risks, inconvenience, or discomfort which you might experience. Participating in the study might not benefit you, but we might learn things that will benefit others. You should discuss any questions you have about this study with Frances Ross.

Purpose of the study

The purpose of this study is to gather information on the best practices for northern communities and researchers when creating educational materials from such research. This interview will provide insight into potential best practices.

Study Design

This study will involve first interviewing northern researchers, then northern residents (Elders in particular) and then northern educators. The educational materials produced will introduced by local teachers in the classroom and at on-the-land camps. Those who indicate they can be contacted may be contacted for follow-up questions.

With permission from the study participants, this interview will be digitally recorded and transcribed. The transcripts of these interviews and focus groups will be analyzed by Frances Ross using computer software to find common themes among the responses. Results will be presented in an academic thesis and educational materials for PPS Arctic Canada, and may be communicated in academic articles, at academic conferences and the thesis (including recommendations) will be made available on the internet. A short summary of study results may also be sent by email to you and other study participants upon request.

Who can participate in the study

You may participate in this study if you are a researcher that conducts ecological research in the north.

Who will be conducting the research

Frances Ross is the Principal Investigator for this project. She will conduct the interviews, transcribe the audio files, and analyze the transcripts. Only the PI will have full access to the audio files or transcripts. The Academic Advisors (Dr. Karen Harper and Dr. Tarah Wright) may be called upon to assist with the analysis of portions of the files or transcripts. In all cases, confidentiality will be preserved.

What you will be asked to do

As an interviewee, you will be contacted by email or telephone and an interview time will be arranged at your convenience. The interview will take approximately 30 minutes to one hour.

Possible risks and discomforts

This study is expected to involve minimal risk. If you feel discomfort at any time, you may decline to answer questions and you may withdraw from the study at any time. In the event that you experience any stress or discomfort from your involvement in this study, we ask that you contact a local counselling service or mental health professional to discuss the situation.

Possible benefits

No direct benefits are anticipated for this study. The information gained from this study and the resulting recommendations will contribute to knowledge about educational collaboration as pursued by researchers and communities.

Compensation

There will be no monetary compensation for taking part in the study.

Anonymity and confidentiality

The Principal Investigator will make sure that the confidentiality of all participants is protected throughout their participation in this study as much as possible.

With your permission, direct quotations will be included in the presentation of final results. Direct quotations may be associated with your area of research. If your name or any other identifier will be used in the thesis, educational materials or academic presentations or publications, the PI will contact you by telephone or email seek oral consent at that time.

Only the Principal Investigator will hear the full recordings of the interviews and focus groups; the Academic Supervisors (as listed at the top) may see or hear portions of the transcripts so long as this is needed to assist with analysis. In this case, the anonymity of the participants will be ensured. Only the Principal Investigator will have access to electronic files containing transcribed interviews and focus groups. Your name will not be associated with the audio files or transcripts. The written transcripts of the interviews from this study will be kept in a locked filing cabinet at the School for Resource and Environmental Studies at Dalhousie University.

Questions

If you have any questions about this study, please contact the principal investigator, Frances Ross (contact information is on the first page of this consent form).

Problems or concerns

If you have any difficulties with, or wish to voice concern about, any aspect of your participation in this study, you may contact Frances Ross (the Principal Investigator of this study) or Patricia Lindley (the Director of Dalhousie University's Office of Human Research Ethics Administration) for assistance by phone at 902-494-1462 or by email at patricia.lindley@dal.ca.

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Faculty of Management

IPY RESEARCHERS/SCIENTISTS INTERVIEWS
CONSENT FORM: SIGNATURE PAGE 1 OF 1

Researcher: Frances Ross
Title of the research: "Northern Knowledge: Creating locally-relevant educational materials from community consultations and northern ecological studies"

_____ *Participant Initials*

Consent to participate in the study: I have read the explanation about this study. I have been given the opportunity to discuss it and my questions have been answered to my satisfaction. I hereby consent to take part in this study. However I realize that my participation is voluntary and that I am free to withdraw from the study at any time.

_____ *Participant Initials*

Consent for audio recording: I hereby consent to allow this interview to be audio recorded and used for the purposes described above.

_____ *Participant Initials*

Consent for use of quotations: I hereby consent to allow the researcher to use quotations from my interview in writing and presenting study results, as well as in the educational materials developed. If my name is to be used, the PI will contact me for oral consent at that time.

_____ *Participant Initials*

Consent to be contacted for follow-up questions: I hereby consent to allow the researcher to contact me with additional questions, if needed.

_____ _____
Signature of research participant *Date*

_____ _____
Signature of researcher obtaining consent *Date*

APPENDIX B: RESIDENT CONSENT FORM

INTERVIEW SCHEDULE 2: NORTHERN RESIDENTS
CONSENT FORM: PAGE 1 OF 3

Title of the Research:

Northern Knowledge: Creating locally-relevant educational materials from community consultations and northern ecological studies

Principal Investigator:

Frances Ross
Master's of Environmental Studies Candidate
School for Resource and Environmental Studies
Dalhousie University, Halifax, Nova Scotia
Email: frances.ross@dal.ca
Phone: 902-455-8920
Fax: 902-494-3728

Academic Supervisors:

Dr. Karen Harper
School for Resource and Environmental Studies, Faculty of Management
Dalhousie University, Halifax, Nova Scotia

Dr. Tarah Wright
Environmental Science, Faculty of Science
Dalhousie University, Halifax, Nova Scotia

Introduction

We invite you to take part in research being conducted by Frances Ross, a graduate student at Dalhousie University, as part of her Master's of Environmental Studies degree. Your participation in this study is voluntary and you may withdraw from the study at any time. The study is described below. This description tells you about the risks, inconvenience, or discomfort which you might experience. Participating in the study might not benefit you, but we might learn things that will benefit others. You should discuss any questions you have about this study with Frances Ross.

Purpose of the study

The purpose of this study is to gather information on the best practices for northern communities and researchers when creating educational materials from such research. This interview will provide insight into potential best practices.

Study Design

This study will involve first interviewing northern researchers, then northern residents (Elders in particular) and then northern educators. The educational materials produced will be introduced by local teachers in the classroom. Those who give consent may be contacted for follow-up, individual interviews.

With permission from the study participants, this interview will be recorded and transcribed. The transcripts of these interviews will be analyzed by Frances Ross using computer software to find common themes among the responses. Results will be presented in an academic thesis and educational materials for PPS Arctic Canada. Recommendations may be communicated in academic articles and at academic conferences, and will be made available on the internet. A short summary of study results may also be sent by email to you and other study participants upon request.

Who can participate in the study

You may participate in this study if you are a resident of a northern community.

Who will be conducting the research

Frances Ross is the Principal Investigator for this project. She will conduct the interviews, transcribe the audio files, and analyze the transcripts. Only she will have full access to the audio files or transcripts. The Academic Supervisors (Dr. Karen Harper and Dr. Tarah Wright) may be called upon to assist with the analysis of portions of the files or transcripts. In all cases, confidentiality will be preserved.

What you will be asked to do

You will be contacted in person, by email or telephone and an interview time will be arranged at your convenience. The interview will take approximately 20 minutes to 1 hour.

Possible risks and discomforts

This study is expected to involve minimal risk. If you feel discomfort at any time, you may decline to answer questions and you may withdraw from the study at any time. In the event that you experience any stress or discomfort from your involvement in this study, we ask that you contact a local counselling service or mental health professional to discuss the situation.

Possible benefits

No direct benefits are anticipated for this study. The information gained from this study and the resulting recommendations will contribute to knowledge about educational collaboration as pursued by researchers and communities, and will support the provision of locally-informed educational materials.

Compensation

There will be a monetary compensation of $50 for short consultations (ie. interviews lasting an hour or less), and $100 for more involved consultations (ie. interviews lasting more than 1 hour).

Anonymity and confidentiality

The Principal Investigator will make sure that the confidentiality of all participants is protected throughout their participation in this study as much as possible. With your permission, direct quotations will be included in the presentation of final results. Direct quotations may be associated with your role as a natural resource user (ie. hunter, trapper, plant gatherer) or age-status in the community (ie. resident, Elder). If your name or any other identifier will be used in the thesis, educational materials or academic presentations or publications, the PI will contact you by telephone or email to seek consent at that time.

Only the Principal Investigator will hear the full recordings of the interviews; the Academic Supervisors (as listed at the top) may see or hear portions of the transcripts so long as this is needed to assist with analysis. In this case, the anonymity of the participants will be ensured. Only the Principal Investigator will have access to electronic files containing transcribed interviews and focus groups. Your name will not be associated with the audio files or transcripts. The written transcripts of the interviews from this study will be kept in a filing cabinet at the School for Resource and Environmental Studies at Dalhousie University and also by the Heritage Manager of the Vuntut Gwich'in First Nation's Department of Heritage.

Questions

If you have any questions about this study, please contact the principal investigator, Frances Ross (contact information is on the first page of this consent form).

Problems or concerns

If you have any difficulties with, or wish to voice concern about, any aspect of your participation in this study, you may contact Frances Ross (the Principal Investigator of this study), the academic supervisors (as listed on the first page) or Patricia Lindley (the Director of Dalhousie University's Office of Human Research Ethics Administration) for assistance by phone at 902-494-1462 or by email at patricia.lindley@dal.ca.

NORTHERN RESIDENT INTERVIEWS
CONSENT FORM: SIGNATURE PAGE 1 OF 1

Researcher: Frances Ross
Title of the research: "Northern Knowledge: Creating locally-relevant educational materials from community consultations and northern ecological studies"

_____ *Participant Initials*

Consent to participate in the study: I have read the explanation about this study. I have been given the opportunity to discuss it and my questions have been answered to my satisfaction. I hereby consent to take part in this study. However I realize that my participation is voluntary and that I am free to withdraw from the study at any time.

_____ *Participant Initials*

Consent for image and audio recording: I hereby consent to allow this interview to be audio recorded, as well as digital images taken, and used for the purposes described above.

_____ *Participant Initials*

Consent for use of direct quotations and audiovisual material in educational materials: I hereby consent to allow the researcher to use direct quotations from my interview and audiovisual material collected in writing and presenting study results as well as in the educational materials developed.

_____ *Participant Initials*

Consent for release of transcriptions to Vuntut Gwich'in Oral History Study: I hereby consent to allow the researcher release the transcription of this interview or focus group to the Vuntut Gwich'in Government's Heritage Department for use in their Oral History Study.

_____ *Participant Initials*

Consent to be contacted for a follow-up interview: I hereby consent to allow the researcher to contact me for a follow-up interview, if needed.

_____ _____
Signature of research participant *Date*

_____ _____
Signature of researcher obtaining consent *Date*

APPENDIX C: EDUCATOR CONSENT FORM

School of Resource and Environmental Studies
Faculty of Management

INTERVIEW SCHEDULE 3: NORTHERN EDUCATORS
CONSENT FORM: PAGE 1 OF 3

Title of the Research:

Northern Knowledge: Creating locally-relevant educational materials from community consultations and northern ecological studies

Principal Investigator:

Frances Ross
Master's of Environmental Studies Candidate
School for Resource & Environmental Studies
Dalhousie University, Halifax, Nova Scotia
Email: frances.ross@dal.ca
Phone: 902-455-8920
Fax: 902-494-3728

Academic Supervisors:

Dr. Karen Harper
School for Resource and Environmental Studies, Faculty of Management
Dalhousie University, Halifax, Nova Scotia

Dr. Tarah Wright
Environmental Science, Faculty of Science
Dalhousie University, Halifax, Nova Scotia

Introduction

We invite you to take part in research being conducted by Frances Ross, a graduate student at Dalhousie University, as part of her Master's of Environmental Studies degree. Your participation in this study is voluntary and you may withdraw from the study at any time. The study is described below. This description tells you about the risks, inconvenience, or discomfort which you might experience. Participating in the study might not benefit you, but we might learn things that will benefit others. You should discuss any questions you have about this study with Frances Ross.

Purpose of the study

The purpose of this study is to gather information on the best practices for northern communities and researchers when creating educational materials from such research. This interview will provide insight into potential best practices.

Study Design

This study will involve first interviewing northern researchers, then northern residents (Elders in particular) and then northern and integrative-science educators. The educational materials produced will introduced by local teachers in the classroom. Those who indicate they can be contacted may be contacted for follow-up, individual interviews.

With permission from the study participants, this interview will be digitally recorded and transcribed. The transcripts of these interviews will be analyzed by Frances Ross using computer software to find common themes among the responses. Results will be presented in an academic thesis and educational materials for PPS Arctic Canada, and may be communicated in academic articles, at academic conferences and the thesis (including recommendations) will be made available on the internet. A short summary of study results may also be sent by email to you and other study participants upon request.

Who can participate in the study

You may participate in this study if you are involved in education of northern students, or with integrative-science education.

Who will be conducting the research

Frances Ross is the Principal Investigator for this project. She will conduct the interviews, transcribe the audio files, and analyze the transcripts. Only she will have full access to the audio files or transcripts. The Academic Advisors (Dr. Karen Harper and Dr. Tarah Wright) may be called upon to assist with the analysis of portions of the files or transcripts. In all cases, confidentiality will be preserved.

What you will be asked to do

As an interviewee, you will be contacted by email or telephone and an interview time will be arranged at your convenience. The interview will take approximately 20 minutes to one hour.

Possible risks and discomforts

This study is expected to involve minimal risk. If you feel discomfort at any time, you may decline to answer questions and you may withdraw from the study at any time. In the event that you experience any stress or discomfort from your involvement in this study, we ask that you contact a local counselling service or mental health professional to discuss the situation.

Possible benefits

No direct benefits are anticipated for this study. The information gained from this study and the resulting recommendations will contribute to knowledge about educational collaboration as pursued by researchers and communities.

Compensation

There will be no monetary compensation for taking part in the study.

Anonymity and confidentiality

The Principal Investigator will make sure that the confidentiality of all participants is protected throughout their participation in this study as much as possible. With your permission, direct quotations will be included in the presentation of final results. Direct quotations may be associated with the nature of your involvement in education (ie. teacher, administrator). If any other identifier will be used in the thesis, educational materials or academic presentations or publications, the PI will contact you by telephone or email seek oral consent at that time.

Only the Principal Investigator will hear the full recordings of the interview; the Academic Supervisors (as listed at the top) may see or hear portions of the transcripts so long as this is needed assist with analysis. In this case, the anonymity of the participants will be ensured. Only the Principal Investigator will have access to electronic files containing transcribed interviews and focus groups. Your name will not be associated with the audio files or transcripts. The written transcripts of the interviews from this study will be kept in a locked filing cabinet at the School for Resource and Environmental Studies at Dalhousie University.

Questions

If you have any questions about this study, please contact the principal investigator, Frances Ross (contact information is on the first page of this consent form).

Problems or concerns

If you have any difficulties with, or wish to voice concern about, any aspect of your participation in this study, you may contact Frances Ross (the Principal Investigator of this study) or Patricia Lindley (the Director of Dalhousie University's Office of Human Research Ethics Administration) for assistance by phone at 902-494-1462 or by email at patricia.lindley@dal.ca.

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NORTHERN EDUCATOR INTERVIEWS
CONSENT FORM: SIGNATURE PAGE 1 OF 1

Researcher: Frances Ross
Title of the research: "Northern Knowledge: Creating locally-relevant educational materials from community consultations and northern ecological studies"

_____ *Participant Initials*

Consent to participate in the study: I have read the explanation about this study. I have been given the opportunity to discuss it and my questions have been answered to my satisfaction. I hereby consent to take part in this study. However I realize that my participation is voluntary and that I am free to withdraw from the study at any time.

_____ *Participant Initials*

Consent for audio recording: I hereby consent to allow this interview to be audio recorded to be used for the purposes described above.

_____ *Participant Initials*

Consent for digital images: I hereby consent for my participation in this study to include digital images (photos) that may be used in writing and presenting study results.

_____ *Participant Initials*

Consent for use of quotations: I hereby consent to allow the researcher to use quotations from my responses in this interview in writing and presenting study results. I understand that these quotations may refer to my area of involvement in education. If further identifiers are to be used for specific quotations, I understand that the Principal Investigator will contact me to obtain oral consent before proceeding.

_____ *Participant Initials*

Consent to be contacted for a follow-up interview: I hereby consent to allow the researcher to contact me for a follow-up interview, if needed.

_____ _____
Signature of research participant *Date*

_____ _____
Signature of researcher obtaining consent *Date*

APPENDIX D: INTERVIEW GUIDE FOR RESEARCHERS

1. Identification

A. What university are you affiliated with? What department?
B. What is your educational background and work experience?
C. What is your research background and areas of study?
D. What courses do you teach? What theses have you supervised?
E. Explain any other relevant affiliations (IPY research group, professional associations).

2. Research (to be used for the content of the educational materials)

A. Explain your IPY research study, focusing on your methods.
B. What is the most significant contribution your research makes to
    i. Science?
    ii. Government/environmental policy?
C. What are your preliminary findings?
D. What makes your research unique?
E. Why/how is your research:
    i. Important?
    ii. Timely?
    iii. Relevant to northern communities?
F. What is most important for northern students to know about climate change and effects on or responses of vegetation/animals?
G. Name three researchers/publications that most contributed to or influenced your IPY research study.
H. What are the challenges and opportunities of doing your type of research?

3. Extensions (interesting facts/background to enrich/personalize the educational materials)

A. How did you join your IPY research group? (motivation/interest in becoming involved)
B. Explain any leadership roles you have in your IPY research group.
C. What do you enjoy most about your research? What do you enjoy least?
D. Where were you born? Where did you grow up?
    i. For southern-raised researchers: Tell me about the first time you traveled to the north. What do you most look forward to when you are heading north? What do you most miss from home when you are in the north?
    ii. For northern-raised researchers: What is it like working with southern researchers? What have you seen to be the hardest thing for southern researchers?
E. Tell me about an interesting find or observation from your field studies this past year, or while conducting your research.

4. Community

A. How did you involve the community in your research project? Do you have any 'lessons learned' to help inform and shape this research project?
B. What have you considered doing to involve the community in your research project? Have you been able to do this? Why or why not?
C. What community contacts (organizations, people, councils, etc) do you have that would be helpful to this project?

APPENDIX E: INTERVIEW GUIDE FOR RESIDENTS

1. Community and participant profile

When/where were you born?

How long have you lived here?

How has this place/people changed over your lifetime or time living here?

2. Education profile

Tell me about education in this community.

What do people learn here?

How do they learn it? (prompt: land, family, classroom, school)

Are you involved in teaching the young people here?

What do you see will be the biggest educational challenge in the future?

How do you envision/wish you could be involved in education this community?

3. Traditional plant knowledge

I would like to turn now to a few questions about local plants.

What plants are most important to you? (prompt: cultural value, usefulness)

Could you share with me how you identify these plants?

I was wondering if are allowed to talk to me about how you use these plants.

Are these plants important to the wider ecosystem? (prompt: food security, connectivity)

4. Land skills

I would like to ask you a few questions about land skills.

What land skills do you think are important for students to learn?

Why are these skills important? (prompt: values)

Could you share with me who taught you these skills?

How could Culture Camp help students develop these skills?

5. Environmental change

Would you say that the land (in your territory) is healthy?

How has the land changed in your lifetime? (OR: Your parents lifetime?)

Have you had to change the way you live because of changes on the land? How so?

6. Northern scientific research

(PI will have previously discussed the general findings of PPS Arctic and YNNK researchers who have conducted research near the host community)

What would you say is the most important thing for white, southern-based researchers to know before coming to this community?

Tell me your experiences with researchers. (prompt: memorable/funny story? What is the biggest mistake you have seen researchers make?)

7. Creating educational materials

(PI will have previously introduced potential materials/samples)

What kinds of teaching have you seen be effective? (prompt: pedagogy, fieldtrips, Elders/hunter collaborations with the schools)

What do you think is a good way to teach young people? How do you like to learn new things? (OR What methods/approaches do you think would be fun? Interesting?)

What would you say is the best way to evaluate the teaching materials we've produced? (prompt: What knowledge should the students come away with? Assessment?)

APPENDIX F: INTERVIEW GUIDE FOR EDUCATORS

1. Identification, role and responsibilities (TEACHERS)

A. What school do you work for? What department are you in?
B. What do you teach? What other teaching duties do you have?
C. What is your educational background and work experience? How did you come to work in this job?
D. What are your departmental or grade-level responsibilities? (ie. subjects, roles, programs)
E. What are the current priorities of your school? Where do these priorities come from? (ie. who sets these priorities?)
F. How do people (such as students, parents, and community) report to you to voice their opinions or ideas? Is there a reporting system?
G. What has been an important lesson you've learnt from working as a teacher here?
H. Tell me about an interesting educational project you have been involved with. Why is it interesting, exciting or important?

1. Identification, role and responsibilities (GOVERNMENT)

A. What department and what level of government do you work for?
B. What is your job title, description and/or duties?
C. What is your educational background and work experience? How did you come to work in this job?
D. What are your department's roles and responsibilities?
E. What are the current priorities of your department or your job? Where do these priorities come from? (ie. who sets these priorities?)
F. How do people report to you to voice their opinions or ideas? Is there a reporting system?
G. What has been the most important lesson you've learnt from working in this position?
H. Tell me about an interesting educational project you have been involved with. What makes it interesting, exciting or important?

2. Education

I would like to know your ideas on education such as your teaching philosophy, what works for you in your teaching, and what doesn't. First let's start with your community.

A. Tell me about education in this community.
B. What do think are the most effective teaching methods or pedagogical approaches?
C. How do you know when students are really learning?
D. What are the most common issues or challenges you face in your job?
E. Where are you from? Does where you come from shape your ideas about education?
F. What is your philosophy of education?

3. Learning resources

I have questions about how learning resources are used, and how we can create them to be both useful and effective teaching aids. First I have some questions about learning resources that have been developed in the community or region.

A. Should learning resources be developed at the local or regional level? Why?
B. Have you been involved in local resource projects? How can locally-produced learning resources be developed?
C. Do you have experience using or teaching Gwich'in and Western knowledge side by side? Is this an important skill?
D. Where does Gwich'in knowledge fit within curriculum? Are there gaps in your learning resources that locally-developed resources could fill in?

4. Science education and outreach projects

I am interested in how researchers can work with government and communities on educational outreach projects.

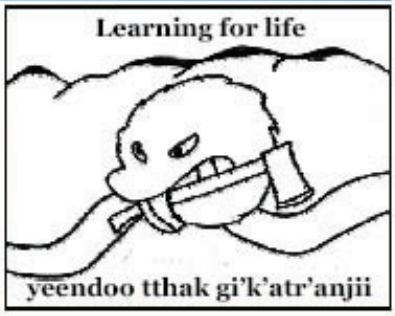
A. Do you have any experience with these groups working together on educational outreach projects?
B. When have these groups worked well together? When has it not worked?

C. Do you think it is important for researchers to be involved in educational projects in communities near to where they do research (such as on Indigenous traditional lands)?
D. Do you think it is important for northern students to know about the scientific research going on in their region?

APPENDIX G: SAMPLES FROM PUSHUP PRESS 2010 (CHIEF ZZEH GITTLIT SCHOOL'S CULTURE CAMP YEAR 1: TRADITIONS & SCIENCE)

Push-up Press

Chief Zzeh Gittlit School, Old Crow, Yukon



Welcome to the first issue of the Push-Up Press!

Over 8 days in April, 27 Chief Zzeh Gittlit School students attended the 2010 Culture Camp at Whitefish Lake, as did 100% of CZGS staff! We named this newsletter after all the muskrat pushups we looked for and trapped at during our camp. Muskrats make pushups, or frozen plant and snow-covered domes, to allow them to travel further across a lake from their burrow on the shore. We're excited to share our stories and photos with you. Enjoy!


Culture Camp Hoodie Day!

2010 Spring Culture Camp

in this issue >>>

A message from our Principal

I am excited to say that the 2010 version of the students' Culture Camp reflects the level of partnership between Chief Zzeh Gittlit School (CZGS) and Vuntut Gwitchin First Nation (VGFN) that both parties wish to promote. While VGFN remains primarily responsible for the delivery of the Culture Camp, and the transmission of the Gwich'in language, culture, and traditional land-based skills, CZGS staff are proud to be included this year in the delivery of an academic component that is in alignment with territorial learning outcomes. As you read through this wonderful account of the camp experience, you will easily notice the partnerships and community involvement that made this cultural and academic camp experience a memorable one. Mahsi', Steve Climie

Gwitchin knowledge: How to skin a muskrat

By Cheyanne Kapuschak

Stanley and Lance showed us how to skin a muskrat, and then let us try it ourselves. We started skinning the muskrat by it's two back legs. We cut the skin to it's tail.

You put your hand under the skin and you skin the muskrat with a really sharp knife. We sharpened the knife twice during Culture Camp using a file.

You hang the muskrat by it's tail up on a stick and grab the skin and slowly cut it off. You have to make sure that you don't cut any holes in the skin and make sure that you don't get any fat on the skin. It takes lots of practice.

We ate lots of muskrats, and also dissected them to check and see if the muskrat was healthy. We checked for tapeworms. You can find them in the intestine.

A healthy muskrat has a dark purple and brown liver. There should be no white eggs on the liver – you don't eat those ones. It was interesting to find the livers and check to see if the muskrat was healthy.

School science: How to dissect a muskrat

By Willow Frost and Melayna Kyikavichik

When we came back to camp from trapping, Stanley and Lance showed us how to skin the muskrat and then Kerri showed us how to do a dissection. In our science class we are supposed to learn about body parts, so we did this with a muskrat so we could learn what the body parts are on this animal.

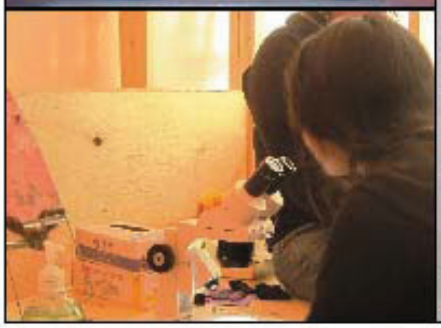
We learned both the Gwich'in and English words for the body parts. The easiest organ to find was the heart. The hardest to find was the pancreas; we couldn't find it at all. We liked looking in the journals at the picture so we could tell what we were looking at. Kerri and Stanley also walked around and showed us the body parts.

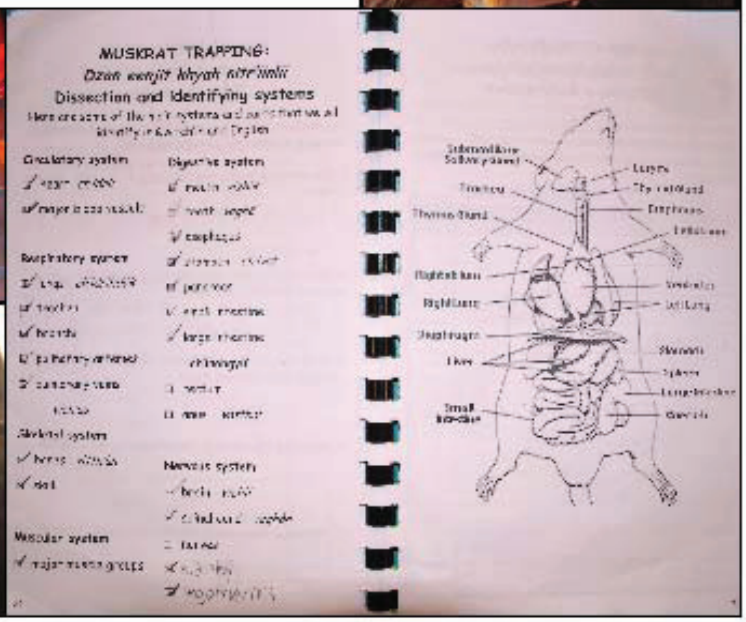
First you had to put on gloves and get a sharp dissection knife. We put the muskrats in trays so that the body parts wouldn't go all over. We put the muskrat in the tray on it's back and the first cut was made from the anus to the neck. We opened it up, pinned the sides and opened the chest. We had sharp scissors to open the ribcage. We took all the parts out of the chest and belly.

The coolest body part was the liver because it was so bloody. Can you see the small intestines in the picture? They are really curly. The lungs were pink and squishy.

Then we went to the head and cut open the skull with the scissors. It sounded like something breaking. We then looked at the brain. It was pink and squishy too. That was the first time either of us saw the brain.

We took some of the food from it's stomach and the scat and looked at it under the microscope. The food was mushy and green, the scat was dry and the eggs on the liver were lumpy. It was cool and fun to dissect a muskrat.





Seeing the world through two eager eyes!

By Frances Ross, *Treeline PPS Arctic Canada (Dalhousie University, Halifax, Nova Scotia)*

International Polar Year (IPY)

As part of my work with International Polar Year, I have had the fantastic opportunity to work with many knowledgeable and enthusiastic people in Old Crow. I have been meeting with people to ask how students should learn about traditional knowledge and science, and how researchers can work with communities to share IPY research. I have also helped with the VGFN Science Camp and with preparing the Culture Camp student workbooks and this newsletter.

Seeing with two eyes

This year students at Culture Camp learned about both traditional knowledge and southern/western science in the same on-the-land program. This is to allow the students to see how both Gwitchin and southern/western knowledge can be used in different ways at different times. Students need strong skills in both these areas in order to be successful in school and in life.

There are lots of different names this process; some people call it "**two-eyed seeing**" because you look at the world with one traditional eye, and one western/southern eye. The Yukon Department of Education calls this "**bi-cultural**" because it means looking at the world through the perspective and knowledge of two cultures.

This exciting program allows students the opportunity to develop both these ways of knowing at the same time. It also promotes life-long learning, showing students that there is always something more to learn, and there are lots of Elders and people in the community who are eager to share their knowledge and experience.

A big thank you to Old Crow, VGFN, Dept of Ed. and the staff at CZGS for allowing me to work with you in this new and exciting project. I have learned so much from you all. Mahsi'

Watching an Elder

Trying the skill

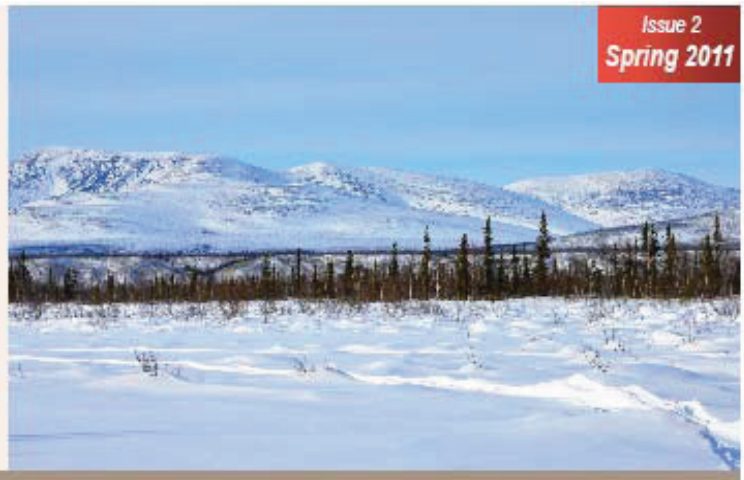
Learning & using Cultural Skills

Learning & using Science Skills

APPENDIX H: SAMPLES FROM PUSHUP PRESS 2011 (CHIEF ZZEH GITTLIT SCHOOL'S CULTURE CAMP YEAR 2: TRADITIONS, HISTORY & GEOGRAPHY)

Learning Every Day

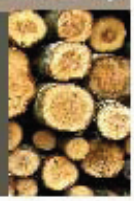
Drin Tagwinaach'uu
Gi'k'atr'aanjii



Issue 2
Spring 2011

Annual newsletter from Vuntut Gwitchin Government & Chief Zzeh Gittlit School's Culture Camp

PushUp Press



in this issue >>>

Welcome to the 2nd Edition of the Push-Up Press

From March 23 to April 9, students, teachers, staff, and volunteers were busy at VGG and CZGS's annual spring camp at Whitefish Lake. We hope you enjoy our 'Push-Up Press.' Important to Gwitchin tradition are muskrats and their **push-ups**, made of snow and plants. Place your trap in a push-up, and you may find yourself a tasty dinner, and some fur to sell!

A message from the Principal of Chief Zzeh Gittlit School

Year 2: Traditions, History & Geography

Building upon the successes of last year's camp, the 2011 version of the students' Culture Camp was a highly engaging and memorable learning experience. The Vuntut Gwitchin Government (VGG) Education Department once again invited and encouraged the participation of the entire staff of Chief Zzeh Gittlit School (CZGS) in the delivery of the Culture Camp. We were honoured to be involved in such a partnership. Old Crow's students get to develop their Gwich'in language, culture, and traditional land-based skills while also achieving territorial learning outcomes. Such a rich learning experience is only possible through the shared vision and tremendous community partnerships that have been strengthened over the past two years of this camp. I encourage you to read through the following pages to get a taste of the camp experience through the eyes of the future leaders of Old Crow.

Old Crow's students get to develop their Gwich'in language, culture, and traditional land-based skills while also achieving territorial learning outcomes.

Mahsi' Choo,
Steve Climie

Old Crow Experiential Education Project

Northern Strategy: A partnership between governments
Vuntut Gwitchin Government (VGG) and Yukon Education

By Kerri Ceretzke, Contractor

Did you know Culture Camp is *only one* component of the Old Crow Experiential Education Project funded by Northern Strategy? Along with three years of camp programming, student guide booklets for Crow Mountain and Caribou Look Out were developed.

Also in the works is a draft copy of a Field Trip Inventory of the area, so teachers and resource people can learn about and participate in various traditional and western educational land-based opportunities. Resource development and field trip inventory were two of the main objectives of the Old Crow Experiential Education Project. Here are 2 more objectives from the Northern Strategy project:

1. Incorporating local resources into experiential education projects.

In Year 2: Traditions, Geography & History Culture Camp – 5 local resources were used: People of the Lakes; How Did the Shanaghan Help Her People?; Who were Ch'eeghwalti', Shahnuuti' and Shahvyah?; Rampart House; and the Gwich'in-English Translation Booklet. Resources were developed by the Vuntut Gwitchin Government's Heritage Department.

2. Facilitate community involvement with students, School Council and parents to be involved in the planning and implementation phase along with sharing out the project results.

In Year 2: Traditions, Geography & History Culture Camp – most resource people participated: Elders, VGG Chief & Council, VGG Heritage, VGG Natural Resources, VGG Health & Social, VGG Recreation, Parks Canada, local musicians, RCMP, youth from Whitehorse and more!

By the end of the three-year planning and funding cycle (March 2012), Vuntut Gwitchin Government, Yukon Education and Chief Zzeh Gittlit School will have a great start at combining First Nation culture, land-based opportunities and western education through the development of Culture Camp resources, the Field Trip Inventory booklet, incorporation of more local resources, and increased community involvement.

Thank you to everyone for their assistance and enthusiasm!
Yeendoo tthak gi'k'atr'anjii

Yearly rotation >>

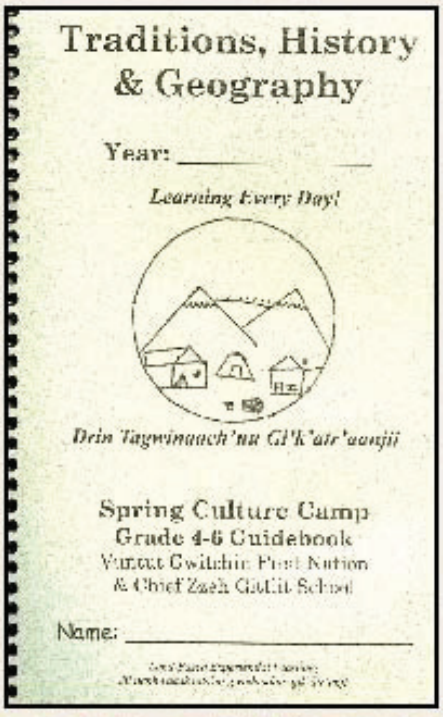
This was Year 2 of the 3 year rotation for our annual Culture Camp.

Year 1 (2010)
Traditions & Science

Year 2 (2011)
Traditions, History & Geography

Year 3 (2012)
Traditions, Arts & Trades

*** Year 2 logo developed by Dakota Foster & motto by Teryn Kassi*



TTKTT: Top traditional knowledge tips today!

While on the camp, students learned about trapping and location traditional knowledge: *Nijin khyah deek'it goo'ail.* It is so important to have knowledge about the land.

Stephen Frost, Esau Schafer and Stanley Njootli Sr. spoke to the Grade 7-9 class on how not to get lost and how to be prepared. Here are the students' TTKTT (Top Traditional Knowledge Tips Today):

- ***Look at the hills and know the land***
- ***Work together***
- ***Have a knife on you at all times***
- ***Always bring toilet paper and matches***

Pre- and post-contact hunting methods

By Marlon Abel-Kendi

Gwich'in Hunting - PAST (Pre-contact)

Ye'eenoo dai' nits'oo nagaazrii

Guest Speaker: Steven Frost

What does 'pre contact' mean? Before Europeanes came

Draw or write (Gwich'in is preferred!) the various tools and methods used to hunt animals.

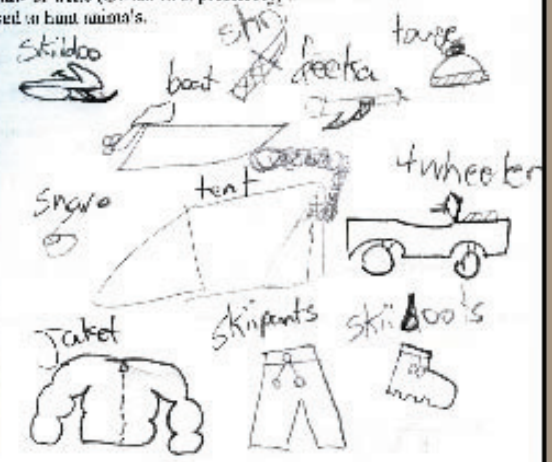
Gwich'in Hunting - Present (Post-contact)

Juk gweendoo nits'oo nagaazrii

Guest Speaker: _____

What does 'post-contact' mean? Gwitchin people came in contact with Europians

Draw or write (Gwich'in is preferred!) the various tools and methods used to hunt animals.



Which tool or method would you like to try? Why?

Camp Crossword

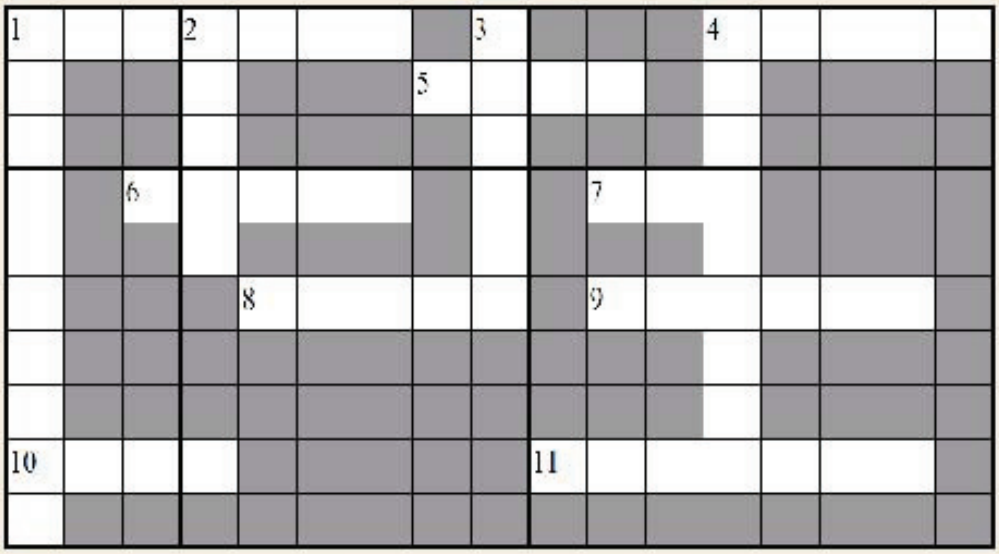
Use these Gwitch'in words to find the English words in the crossword. This website will help: **www.firstvoices.com/en/Vuntut-Gwichin/words**

Across

1. łaii tl'yah dadàach'ii
4. han
5. van
6. geek'ii
7. łuu
8. łaii tsal
9. geh
10. zhoh
11. dzan

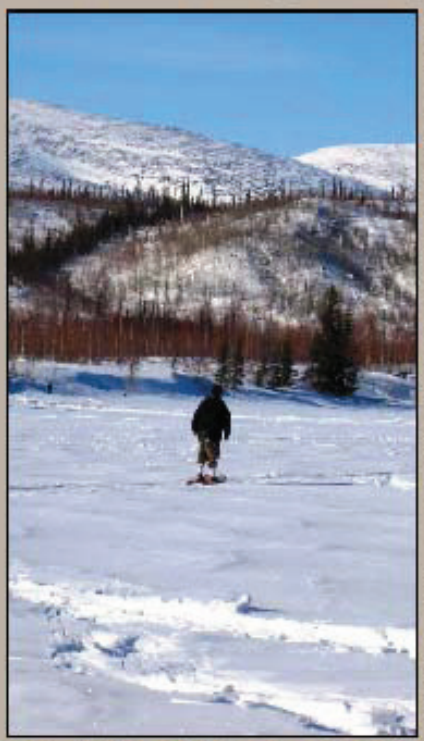
Down

1. łaii tl'yàa
2. taii
3. antl'it
4. tl'eedik, vihzràii



Match the Gwich'in and English place names

1. Porcupine River ____
2. Crow River ____
3. Mouth of Crow River ____
4. David Lord Creek ____
5. Driftwood River ____
6. Fishing Branch ____
7. Rampart House ____
8. Crow Mountain ____
9. Eagle River ____
10. Hershel Island ____
11. Bluefish Creek ____
12. Whitefish Lake ____
13. Bell River ____
14. Crow Flats ____
15. Burnt Hill ____
16. Canoe River ____
17. Ogilvie ____
18. Lone Mountain ____
19. Shaeffer Mountain ____
20. Shahtlan/2nd Mtn. ____



A. Teechik
B. Van Tat
C. Chuuts'aii Nalk'at
D. Ni'iinlii njik
E. Shriijaa Njik
F. Ch'izhìn Njik
G. Ch'oodèenjik
H. Ch'icheechih
I. Troochoonjik
J. Chyàh Ddhàa
K. Tl'iyèenjik
L. Chihshòo
M. Chyahnjik
N. Than Natha'aii
O. Chii Vee Njik
P. Chuu Choo Vee
Q. Gwak'an Choo
R. Tr'ihnjik
S. Gindèhchik
T. Ts'iizhùu

Using cartoons to share Elder's stories

By Nathaniel Schafer