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Teaching and learning about climate change with Innu Environmental Guardians

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Impacts related to climate change are commonly reported in northern Canada. Labrador Innu have a multi-millennial history in this area, putting them in a good position to document and interpret these changes. Western Science monitoring initiatives are commonplace throughout northern areas and offer one approach for answering questions related to ecosystem change. Since 2001, the Innu Environmental Guardians Training Program has offered modules covering topics including fisheries, caribou, archaeology and most recently on climate change and forest ecosystems. This article provides an approach for detecting changes to the boreal forests of Labrador using empirical monitoring protocols that were determined in consultation with Labrador Innu and university-trained scientists, which ultimately led to the establishment of Innu Permanent Sample Plots (IPSPs). In our experience facilitating these modules, much has been learned regarding the importance of culturally appropriate place and module content. Challenges encountered throughout the modules, including sustaining attendance, dealing with remote locations and attention to accuracy and precision, are explored. In our experience, the establishment of long-term monitoring plots with continued Innu involvement will go far in bettering our understanding of how the boreal forests of Labrador are responding to climate change.

Introduction

In northern Canada, impacts related to climate change are being observed in most aspects of the natural environment (IPCC 2007). Both empirical studies and local knowledge are showing shifts in patterns that have persisted through recent memory. From berry productivity to sea ice coverage, there is a growing body of knowledge showing that the climate of the arctic and subarctic is changing (ACIA 2005). In Labrador, there has been an increase in summer surface air temperatures by 1.0–1.5°C in the past decade (2000–2010), compared to the previous 30-year period (1970–2000) (Bell et al. 2008; Environment Canada 2011). This recent warming has important implications for the resources and people of Labrador.

It is recognized that forest ecosystems in the boreal region are particularly vulnerable to climate change, with major shifts expected within a century as global temperatures rise (Fischlin et al. 2007). For central Labrador, climate scenarios for

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the 2050s show winter temperatures warmer by 3–4°C and spring, summer and fall by 2–3°C, with precipitation increasing by 10–20%, relative to late twentieth century climate baseline averages (Lemmen et al. 2008). With these changes, one can expect more fall and winter rainfall events, later freeze-up and earlier break-up of water bodies, an earlier peak in spring runoff, but reduced summer streamflow due to increased evaporation and transpiration. Wildfire frequency and area burned can be expected to increase as well (Flannigan et al. 2005). The effects of such changes on forest ecosystems will include changes in phenology (Körner and Basler 2010) and potentially higher productivity, offset by effects of increased insect herbivory and disease (Fischlin et al. 2007).

In Labrador, trees are being supported across ecoregions ranging from high boreal forest to high subarctic tundra (Meades 1989). As a result of this variability, the forests play a diverse role in providing habitat, shelter and sustenance for the animals and people of Labrador. As climate warms, shifts in the number of growing degree days, seasonal temperature extremes and length of growing seasons are all contributing to trees having the potential to establish and persist beyond that historic range limits. Some species can track suitable climate poleward (e.g. Malcolm et al. 2002; Thomas 2010), but in many other cases the responses are more subtle. Shifts in species growth rates (Trant et al. 2011) and productivity (Lévesque et al. 2011) are some of the early responses being documented for Labrador. For Labrador Innu, and many other northern peoples, the concern with climate change is focused primarily on the quality, quantity and access to renewable resources (Bell et al. 2008).

Innu occupation of Labrador extends at least 6000 years across much of inland and coastal regions (Loring 1992; Tuck 1975). Throughout this multi-millennial history, ecological processes and seasonality have become incorporated into Innu culture. Innu synchronicity with migratory resources allows for changes to be detected in the abundance and timing of these resources. However, changes like shifts in vegetation community composition, tree growth and soil/air temperature can be more difficult to detect due to the vastness of the Labrador landscape but these base components of the ecosystem will play a fundamental role in how the rest of the ecosystem will respond.

In terms of resources, Labrador Innu depend on many species of animals and plants throughout the year. For animals, the migratory woodland caribou (George River Herd) have long-played a dominant role in the seasonal movement patterns and diet of Labrador Innu. Climate variability and change play a central causal role in the numbers and distribution of caribou in Labrador. Caribou are particularly vulnerable to changes in winter precipitation patterns as they affect forage availability (Couturier and Brunelle 1990; Jacobs et al. 1996; Jeffery 2008). In terms of plants, berry picking is an important cultural activity with berries representing a significant component of peoples diet (Armitage 2011). While warmer temperatures can result in increased plant growth (e.g. Kelly and Goulden 2008; McMahon et al. 2010), other factors such as increased variability in temperature extremes and summer moisture deficits may play a significant role in decreasing fruit set (Bokhorst et al. 2008) and net primary productivity (Zhao and Running 2010).

Detection of ecosystem change requires extensive knowledge and landscape-specific experience (Lauer and Aswani 2010). When the objective is to detect long-term changes, one Western Science approach, henceforth referred to as ‘Science’, is to use monitoring programs to address specific questions and concerns. Science places value and importance on research questions and outcomes despite being
perceived by many (including Science practitioners) as being objective. While often thought of as a method for uncovering universal truths, what the scientific method offers is a possible explanation for observed phenomena. When Science is perceived as being universal, it has the potential to displace or discredit other knowledge systems (Snively and Corsiglia 2001). Science is perhaps better seen as one approach that enables the answering of questions but still incorporates subjectivity when identifying what questions to ask. From a Science perspective, Indigenous Knowledge can direct these questions and identify important components to focus on when assessing the extent of ecosystem change. This is not to say that Indigenous Knowledge is incorporated into Science but rather that there would be communication between these different but complementary knowledge systems (Aikenhead 2001; Huntington 2000).

The purpose of this article is to provide an overview of the climate change modules and a discussion focusing on the successes and shortcomings of these modules. This article will begin with an overview of the Innu Environmental Guardians Program, which provides the framework for climate change monitoring initiatives followed by an examination of monitoring ecosystem change across the Labrador landscape. The successes and challenges of this monitoring initiative will be presented followed by possibilities for moving forward with future work.

**Innu Environmental Guardian Training Program**

The Innu Guardian Training Program began in 1992 in partnership with the Innu Nation and the Department of Fisheries and Oceans. In 1997, the Gorsebrook Research Institute at Saint Mary’s University (GRI/SMU) in Halifax became involved when the federal environment department, Environment Canada, began collaborating with the Innu Nation (First Nation) of Labrador and social scientists from the GRI/SMU. The initial goal was to create a comprehensive baseline of ecological data of the Labrador landscape from both Innu Knowledge and Science perspectives, acknowledging the difficulty in establishing baselines in ever-changing environments. To provide an initial focal point for research, consultations were held with members of the Innu community to identify an aspect of the landscape that was deemed culturally significant and distinct. The landscape feature the Innu chose was *ashkui*, areas of open water in the river and lake ice where Innu camped every spring for subsistence and cultural livelihood activities, giving rise to what was referred to as the *Ashkui Project*. Funding for this research was primarily through the Environment Canada’s Northern Ecosystems Initiative and Environment Canada, Atlantic Region (Sable et al. 2007).

In 2001, the Innu Nation Environment Office requested the GRI/SMU assist in developing culturally relevant educational programs to assist and strengthen the Innu Environmental Guardians, henceforth referred to as ‘Guardians’, in monitoring and sustainably developing their ancestral lands, Nitassinan. This would be the beginning of a series of modules referred to as the Innu Environmental Guardian Program and henceforth as the ‘Guardians Programme’, over the next 10 years and involved up to 14 Innu Environmental Guardians at various times. These modules included topics such as Understanding Ecosystems, Migratory Bird Management, Ethnographic Mapping, Caribou Management, Archaeology, Geology, Statistics, and, for the last three years, a series of modules concerning climate change. In 2006, The GRI/SMU through the Office of Aboriginal and Northern Research received
two Social Science and Humanities Research Council (SSHRC) grants – the Aboriginal Program Research Grant and the Northern Development Research Grant – to continue the Guardian program and support ongoing research. Another grant program from the Environment Canada’s Northern Ecosystems Initiative (NEI) specifically focused on developing indicators for Climate Change from an Innu perspective. In 2008, the Office of Aboriginal and Northern Research was successful in obtaining further funding through the International Polar Year’s Educational Outreach Program Grant in partnership with the Innu Nation, the Smithsonian Institution’s Arctic Studies Centre, University of Alaska, and the University of the Arctic.

Most important to the modules was the incorporation of the following seven key ethical guidelines and pedagogical components in the delivery of the Guardians Program: First, the program is Innu driven, which means the Guardians decide the priorities, and learning is geared toward the preservation of their own land use and cultural practices. This knowledge is then used as the basis of decision-making processes in any development project; Second, learning and course content are related to on-going projects such as the forestry co-management agreement with the provincial government; Third, courses are offered in 1-2 week modules and delivered within the Innu communities (generally Sheshatshiu) or at field sites relevant to current projects affecting Nitassinan; Fourth, tshishennuat (Elders) are involved as advisors of Innu Environmental Knowledge to foster a dialogue and holistic learning from both an Innu and Western Scientific perspective; Fifth, programs are bi-lingual (Innu Aidum and English) when tshishennuat are present, with the Guardians acting as translators.; Sixth, modules are scheduled around ‘real’ life situations, for example, seasonal work, family obligations and time at camps in the country; Seventh, training crosses disciplines so that the Guardians gain experience in all aspects of environmental monitoring, for example, Fishery Guardians attend Caribou Management modules, and Forestry Guardians attend Fishery related modules (Sable et al. 2007). Beginning in 2007 to 2010, five modules examining climate change and boreal ecosystems were run in and around the Innu community of Sheshatshiu and the traditional caribou hunting area of Kamestastin (Figures 1 and 2, Table 1). While each of the modules focused on a different component of climate and boreal ecosystems, they were all structured around incorporating ecosystem components that the Guardians identified as being important.

**Approach to monitoring**

The primary objective of the climate change and boreal ecosystem modules was to create an ecosystem approach to monitoring that was regionally specific and Innu appropriate. It was important to incorporate all components of the ecosystems (i.e. the soil, the plants, the animals and the climate) and input from the Guardians and Elders, in order to tell the story of climate change in the Labrador boreal forest in a holistic way. In consultation with the Guardians, Innu Nation forestry staff and a review of the current provincial forestry guidelines and monitoring techniques used in other northern landscapes, a monitoring protocol for the climate change modules was created. On recommendation by one of the Guardians, David Hart, the monitoring sites would be referred to as Innu Permanent Sample Plots (IPSPs; figure 3). In doing so, the Innu were taking ownership of the plot as part of their ancestral land, as well as the process for monitoring it. Different modules would
focus on different components of climate change and boreal ecosystems that would ultimately be integrated into the IPSPs. The overall intention with this approach is that there would be a legacy left behind of ecologically robust measurements that could one day be used to address questions relevant to the Guardians and other Labrador Innu.

The interplay between Innu Knowledge and Science is not intended to rank one knowledge system as being more important or relevant than the other. The monitoring approach draws on Science for methodology and epistemology but is directed and contextualized by Innu Knowledge and Guardian participation. Given that the effects of climate change manifest at multiple scales (e.g. from changes in berry size to the expansion of forests into the tundra), it is important for monitoring initiatives to focus on a similar wide-range, or scale, of ecosystems processes and components. In the following section, monitoring approaches for climate and forest components will be introduced and justifications will be made for the methodology used in our monitoring initiative. The climate and forest components will be addressed separately in order to explore the importance of each component and the required methodologies for detecting change. This separation is only for the purpose of clarity and in no way meant to detract from the interrelatedness of climate and forest processes.
Climate

Permanent climate stations in the region provide baseline observational data and analyses that can be referred to when discussing long-term trends and variability in seasonal climate (e.g. Vincent et al. 2002). These may be supplemented at the community level by maintaining a narrative of seasonal and annual weather events based on observations and informal reports by members of the community. A limited suite of climate variables is monitored at the level of the IPSP. These include temperature and snow cover (duration and late-winter depth); two variables that best reflect local variation in bioclimatic conditions. It is generally not practical to maintain instruments for recording air temperature at the IPSP sites. However, as tree growth has been found to be tied to a critical soil temperature threshold in the root zone above approximately 3°C (Körner and Paulsen 2004; Sveinbjörnsson 1992), it is possible to deploy miniature temperature loggers in the root zone (10 cm depth) at several points within the site. The sensors are deployed and retrieved annually. Set to sample on a 3-hourly interval, the records can be used to estimate the beginning and end dates of snow cover from changes in the amplitude of the

Figure 2. Photographs from climate change modules from (A) 2007: John Jacobs, Innu Youth Film Group, unidentified participant, Anthony Jenkinson and Hank Rich, (B) 2008: Paul Pone and Sebastian Piwas (Photo credit: Valerie Courtois), (C) 2009: Hank Rich and (D) 2010: Sebastian Piwas, Hank Rich and Innu Youth Film Group.
temperature signal. Snow conditions at the IPSPs are sampled in late winter, using a central pit to measure depth, relative hardness, density and presence of ice layers, with additional depth sampling using probes along 10 m transects outward from the pit. Site visits also provide opportunities for observations related to phenology, wildlife behaviour and effects of weather-related effects such as blow-downs.

Forest

A multitude of approaches exists for monitoring long-term change in forest ecosystems. While many include establishing labour-intensive plot boundaries (e.g. see Dallmeir 1992, for descriptions of SIMAB plots), others only require one stake in the centre of the plot (e.g. see Maroni and Harris 2010, for description of Temporary Sample Plots). From this centre stake, it is possible to monitor a variety of forest attributes (e.g. forest density, age structure, species composition, wildlife trees). With specific objectives of incorporating climate change monitoring into this framework, an emphasis is placed on detecting changes to forest processes. An example of this would be changes to the frequency or abundance of forest pests, like insect herbivores, which may be more prevalent in a warming climate (e.g. Dale et al. 2001). Another monitoring component is plant communities that may be more sensitive to a changing climate and exhibit a faster response time compared to slower growing tree species. Monitoring shifts in plant communities can be accomplished by comparing relative abundance, changes to plant indicator species and documenting changes to exotic and uncommon species.

Innu Permanent Sample Plots

A total of four IPSPs were established throughout the climate change modules with the intention being that additional IPSPs would be established by Guardians in other parts of Labrador, as they saw fit. Three of these are located off the Trans Labrador Highway (53°07’ N, 60°29’ W; figure 1A) and the fourth is located at Kamestastin, which is a traditional hunting area for Mushuau Innu at Mistastin.
Lake (55°52’ N, 63°26’ W; figure 1B). The location of the IPSPs was selected based on their close proximity to Guardian activity to make it convenient to revisit the plots. The IPSP at Kamestastin is remote but this is a traditional caribou hunting site that is visited multiple times a year by some of the Guardians and numerous other Innu. At each location, the IPSP was established in what the Guardians decided on as being representative of forests in that area. Another important criterion when selecting the location of the IPSPs was that they be in areas that are culturally and ecological significant to Labrador Innu, as determined by the Guardians. For example, the approach to selecting an appropriate site in Kamestastin involved meeting every morning in a communal cabin to decide where the Guardians wanted to go – taking into account the weather, group size, available time and other planned activities. The Guardians decided the specific location of the IPSP after spending time walking around different forests, having discussions about the significance of each area and how representative it was of forests in that region. The location of the IPSP is important for a few reasons. First, valuable information
about climate change will be amassed at these locations. Second, these plots offer the possibility of long-term protection to areas where the surrounding landscape may be threatened by commercial forestry (e.g. near Sheshatshiu). While this consideration is less relevant for remote locations, emphasizing the idea of permanence while selecting sites may influence the ultimate placement of the IPSP. Third, these plots are supportive of ongoing monitoring mandates of the Innu Nation Environment Office especially in light of Innu moving towards self-governance.

The initial round of data collected from the IPSPs are summarized in Table 2. Due to the inherent differences in forest types represented by the four IPSPs, it was expected that there would be a lot of variability between sites. The reason why the Innu were interested in establishing long-term monitoring plots was to understand how their forest ecosystems are changing, so the value of these data lie in comparing changes through time and not between forests. Because we expected different forest types to show a differential response to climate change, the high level of inter-site variability can be interpreted as indicating that the selected IPSPs are capturing the natural variability present across the Labrador landscape. One of the most striking differences between the IPSPs is the amount of forest regeneration in sapling and seedling abundance. Differences in site-specific moisture levels, species composition, nutrient availability and stand ages are possible factors that could be driving the observed differences in regeneration rates. Moisture levels and nutrient availability are often cited as variables that are vulnerable to climate change (Aitken et al. 2008; Finzi et al. 2011) and should, therefore, be given appropriate attention when these sites are re-sampled.

Lessons learned

Education is a dynamic process that is in a continual state of critique and self-improvement. These climate change modules reflect this iterative approach to education in which the facilitators and the Guardians are continually learning from the module content and from each other. The following two sections will examine those approaches and content inclusions that were considered to be successful, followed by those that presented challenges which in some cases were overcome, and in other cases abandoned. The perspectives being offered are those of the module facilitators (university-trained natural and social scientists) and, therefore, do not reflect those of the administrators (host university) or the Guardians.

Successes

Throughout the three-year process, the climate change modules had many successes. Geographic place was an important consideration when planning these modules. Place is more than location: it includes interesting human and non-human interactions (Acevedo et al. 2008; Oakes 1997). With Indigenous Knowledge being not only content but also process, it is important that the place and the learning space reflect this (Simpson 2002). Simpson (2002) reinforces this point by stating that since Indigenous Knowledge comes from the land, Elders and other knowledge holders are more comfortable teaching and learning while on the land rather than in a classroom. To accomplish this, we gave priority to field-based over classroom-based activities, whenever possible. In our experience, it was easier to generate excitement and discussion with the Guardians about forest ecosystems when
Table 2. Descriptive statistics for forest structure, vegetation, soil and climate data from the Innu Permanent Sample Plots (IPSP). IPSP-4 has only been partially set up. Tree species are listed throughout the table are: black spruce (bS), white spruce (wS), balsam fir (bF), eastern larch or tamarack (eL), white birch (wB). All numbers in parenthesis correspond to abundance values. Climate data are based on miniature temperature loggers placed a 10 cm depth in October 2008 and retrieved in June 2009. Snow surveys were carried out at site IPSP-4 on 18 March 2009. LHF = Litter - Humus - Fermentation.

<table>
<thead>
<tr>
<th></th>
<th>IPSP-1</th>
<th>IPSP-2</th>
<th>IPSP-3</th>
<th>IPSP-4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Forests</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Species present</td>
<td>bS &gt; eL &gt; wS &gt; wB</td>
<td>bF &gt; bS &gt; wS &gt; wB</td>
<td>bF &gt; bS</td>
<td>wS</td>
</tr>
<tr>
<td>Minimum age (years)</td>
<td>107</td>
<td>220</td>
<td>225</td>
<td>14.5</td>
</tr>
<tr>
<td>Trees (stems/ha)</td>
<td>23.5</td>
<td>12.0</td>
<td>11.9</td>
<td>8.5</td>
</tr>
<tr>
<td>Saplings (stems/ha)</td>
<td>31.9</td>
<td>4.0</td>
<td>4.0</td>
<td>392.5</td>
</tr>
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<td>Seedlings (stems/ha)</td>
<td>15.7</td>
<td>816.4</td>
<td>200 cm</td>
<td>30 cm</td>
</tr>
<tr>
<td>Height</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–5 cm</td>
<td>bS(1)</td>
<td>bF(52)</td>
<td>bS(1)</td>
<td>bF(24)</td>
</tr>
<tr>
<td>5–15 cm</td>
<td>wS(1), bF(12)</td>
<td>bS(6), bF(7)</td>
<td>bS(6), bF(7)</td>
<td>bS(6), bF(7)</td>
</tr>
<tr>
<td>15–30 cm</td>
<td>bS(3)</td>
<td>bS(12), bF(17)</td>
<td>bS(7), bF(6)</td>
<td>bS(4), bF(10)</td>
</tr>
<tr>
<td>30–200 cm</td>
<td>bS(10)</td>
<td>wS(1), bS(2), bF(26)</td>
<td>bS(4), bF(10)</td>
<td>bS(4), bF(10)</td>
</tr>
<tr>
<td><strong>Plants</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moss cover (%)</td>
<td>79</td>
<td>73</td>
<td>72</td>
<td>72</td>
</tr>
<tr>
<td>Most abundant species</td>
<td>Kalmia angusifolia</td>
<td>Cornus canadensis</td>
<td>Cornus Canadensis</td>
<td></td>
</tr>
<tr>
<td>Exotic species</td>
<td>Not present</td>
<td>Not present</td>
<td>Not present</td>
<td>Not present</td>
</tr>
<tr>
<td>Rare species</td>
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<td>Not present</td>
<td>Not present</td>
<td>Not present</td>
</tr>
<tr>
<td><strong>Soil</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thickness of LHF layer (cm)</td>
<td>8</td>
<td>10</td>
<td>8.5</td>
<td>2.2</td>
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<tr>
<td>Depth of A layer (cm)</td>
<td>12.5</td>
<td>&gt;30</td>
<td>3.5</td>
<td>2.2</td>
</tr>
<tr>
<td>Depth of B layer (cm)</td>
<td>&gt;30</td>
<td>Not present</td>
<td>27.5</td>
<td>7.8</td>
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<tr>
<td>Average thickness of organic layer (cm)</td>
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<td>8.5</td>
<td>7.8</td>
<td>7.8</td>
</tr>
<tr>
<td><strong>Climate (2008–2009)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum soil temperature (°C)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>16 November</td>
</tr>
<tr>
<td>Snow-on date</td>
<td>21 October</td>
<td>3 November</td>
<td>19 May</td>
<td></td>
</tr>
<tr>
<td>Snow-off date</td>
<td>5 June</td>
<td>1 June</td>
<td>143</td>
<td></td>
</tr>
</tbody>
</table>
we were in the forest – closer to the origin of Innu Knowledge of forests. For the 2008 module, an Innu canvas tent was set up near the locations of IPSP 1–3, approximately 30 minutes from Sheshatshiu. This space served as our classroom and communal space throughout the module. The advantages of this approach were many. First, an indoor space that was available to us was at an office where many of the Guardians from Sheshatshiu work. There, it was difficult to maintain focus on the modules when the Guardians were inundated with disruptions related to daily work life. In situ learning, especially when the Innu tent was set up, is less formal than classroom scenarios allowing for more hands-on rather than theoretical discussions. The tent, as a warm shelter with food and tea available, served as a familiar and comfortable space for discussions. Lastly, maintaining attendance is a challenge for most educators and while unfavourable weather in field-based modules deterred some individuals, the majority of the Guardians put in long days in the field.

Innu-specific content was a key component to the climate change modules. Not surprisingly, when the impacts associated with climate change were appropriately contextualized, the information and application was more interesting to the Guardians. One way of ensuring that modules had an Innu focus was to have a loosely structured agenda in which daily activities can be responsive to the Guardians’ interest. This free flowing approach is more engaging than following a rigid syllabus, as even a question can alter the direction of the day. In our experience, the lack of predictable punctuality and sustained attendance makes it unrealistic to have a firm agenda with exact timelines. This lack of structure also contributes to an informal atmosphere that encourages knowledge sharing and a freer exchange of information.

While Science is often thought of as being time sensitive, objective and able to provide definitive answers, what Science really provides are tentative explanations that change when better explanations become available. The informal nature of the modules provides a forum to discuss the importance and function of ecosystem components from both Science and the Guardians’ perspective. This exchange benefits both perspectives by exploring complementary or alternative approaches to knowledge acquisition. In our experience, the Guardians were critical for determining the importance of ecosystem components while Science provided an option for acquiring knowledge when the Guardians’ knowledge was incomplete. For example, Guardians do not have explicit knowledge of tree growth rates in the remote areas of Labrador but by using dendrochronology, the study of tree rings, a complete growth record for any individual tree can be obtained while the Guardians’ knowledge of Innu land-use patterns that predates the individual tree in question helps to contextualizes the Science.

Guardians that were involved in all of the climate change modules were often looked to by other Guardians to explain concepts developed in previous modules. The excellent attendance record and engagement of certain Guardians is considered to be an overall success of the project. In the most recent climate change module in Kamestasin, an Innu youth film group was simultaneously being trained in interviewing, filming and editing techniques. Throughout this module, the youth were interviewing the Guardians on various scientific techniques and skills acquired through the climate change modules. These interviews were then edited into short videos that were integrated into an interactive website (www.kamestasin.com).
Challenges

Attendance by the Guardians throughout the climate change modules was a constant challenge. This was especially an issue when the modules were based nearer to Sheshatshiu, where there was no sharp boundary between work and personal life. While accommodating and being understanding of the importance of unexpected personal situations is a tenet of the Guardians Program, it remains a major challenge from the perspective of the module facilitators. We do not have detailed knowledge of what factors facilitated or restricted participation, but we did find that holding the modules in remote areas improved Guardian attendance and allowed for more in-depth discussions of module topics.

The majority of the climate change modules were based near Sheshatshiu rather than Natuashish because it was more convenient for the majority of the Guardians and also provided good indoor facilities, when needed. As a result of this, there was less involvement with the community of Natuashish and fewer IPSPs were established in that area. Some remotes sites of importance to the Innu could not be considered because of logistical costs and potential conflicts with other commitments that the Guardians may have had. With the climate change modules focusing on detecting change across Nitassinan, greater spatial coverage would have increased the diversity of landscapes captured in the IPSPs and would also have provided insight into potential differences in local and regional climate change impacts.

Finally, difficulties arose in the emphasis that Science, specifically ecology and climatology, places on numerical accuracy and precision in field measurements and analysis. The hypothesis testing Science approach depends on the use of statistics to answer specific research questions. This attention to accuracy and precision is an integral component of Science training and in our experience, requires more exposure than the climate change modules provided. Perhaps one of the major challenges in complementing Innu Knowledge with Science is that without statistics and reliable field measurements, the emerging story that Science can tell may not be fully understood.

Discussing ‘Climate Change’

Supporting materials prepared for the modules made reference to the usual authorities on climate changes and its impacts, namely the Intergovernmental Panel on Climate Change (IPCC 2007) and the Arctic Climate Impacts Assessment (ACIA 2005). Given the setting, it seemed appropriate to briefly discuss changes in the landscape since the end of the last major regional glaciations (e.g. Lamb 1985); however, the focus was primarily on recent climate trends and variations from the mid-twentieth century, which is the period of instrumental record for meteorological stations in the region, and within the life experience of the more senior Guardians and Innu Elders. It became clear from the progress of discussions that, while most grasped the concept of climate change, it was short term, even inter-annual variability that was of greater interest. Thus, an exceptionally warm winter and spring, such as occurred in 2009–2010, was noteworthy for a variety of indicators, such as late freeze-up, early break-up and difficult winter travel conditions for lack of firm snow and ice, and unusually large numbers of overwintering birds and the early return of migrants. Better than any graphs or charts, it was the examination of
the tree-rings, as noted, that best conveyed the concept of variability on decadal and longer time scales. Any discussion of future climate, assuming anthropogenic warming, was in terms of the likelihood of more or worse episodes of a kind they have experienced.

The distinction between adaptation to variations in climate as opposed to adaptation to some significantly different climatic regime is an important one in climate change adaptation studies (ACIA 2005), since boreal and arctic subsistence cultures have generally been found to acquire resilience under a varying and even changing climate, at least up to a point (Ford et al. 2010; Kofinas et al. 2010). However, in the context of monitoring for biophysical changes in a boreal forest environment, such distinctions remained academic.

Moving forward

Like many regions of the subarctic, the forests of Labrador are currently experiencing significant climate change, though the specifics for how they will respond are relatively unknown. Increased fire frequency and abundance of forest insects like hemlock looper (Soja et al. 2007) figure largely into the overall vulnerability of the forests. We also expect that exotic plant and animal species which could previously not tolerate the harsh climate of Labrador will be able to establish and persist (ACIA 2005). Documenting and understanding these changes require detailed baseline information, such as that which is has been captured by the IPSPs.

Throughout the time that the climate change modules have been running, monitoring plots, which will be important for documenting change, have been established. In order to answer questions about how this ecosystem is responding to climate change, the IPSPs need to be re-sampled at regular intervals. The frequency of site revisits depends on the resources and schedules of the Guardians but we suggest returning to the IPSPs annually to document qualitative change and at five-year intervals for detailed quantitative surveys.

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