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Non-Timber Forest Products, Maple Syrup and Climate Change

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Abstract

Non-timber forest products (NTFP), including maple syrup, are an important source of income in rural and remote spaces. NTFPs also contribute to other aspects of rural wellbeing including the provision of environmental services and opportunities for the development and maintenance of social capital and aesthetic/spiritual values. NFTPs are thought to be threatened by climate change, yet little research has been undertaken to assess the potential impacts and adaptive capacity of affected Canadian rural spaces.

Maple syrup is one of Canada's most important NTFPs and an important resource in central Canada and Atlantic rural spaces. However, virtually no research has assessed the value of maple syrup as an NTFP, or the potential impact of climate change. This paper, which is part of a larger on-going study, will report on survey work that assessed perceptions of institutional contexts, climatic variability, climate change risk, and resiliency within the maple syrup industry. The results will be of interest to decision-makers in many areas including the maple syrup industry, Canadian rural policy and climate change policy. Drawing from the survey work and broader study findings, the paper identifies existing capabilities and challenges for dealing with climate change and outlines potential opportunities to increase the adaptive capacity of the maple syrup industry and rural spaces.

Keywords: maple syrup, climate change, policy, adaptation, Canada, Ontario

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1.0 Introduction

Maple syrup is one of Canada's most important and highly visible non-timber forest products (NTFPs); it is a cogent symbol of Canadian identity, both nationally and abroad as well as a harbinger of spring for many Canadians. Beyond maple syrup, this NTFP is also associated with Canadian identity through the maple leaf and the blaze of autumnal colours supplied by maple tree ecosystems.

The Canadian flag sports a highly stylized maple leaf designed to represent ten varieties of maples, with at least one of these species native to each province. Moreover, the autumn season, marked by the progression of the foliage colours and highlighted by the brilliant hues of the sugar maples *(Acer saccharum)*, is iconic in both rural and urban landscapes as well as a key tourist attraction. Despite the importance of this NTFP, beyond the work of biologists and ecologists, there is a dearth of research about the long-term sustainability of maple ecosystems and maple syrup production and about management, policy and governance issues. There is also only limited information about the challenges and opportunities facing the NTFP, including the impact of climate change. This paper is part of a research program that seeks to address these various lacunae.

NTFPs are defined as the biological resources, products and services, other than timber, that can be harvested from forests for subsistence and/or trade (Shanley, Laird, Pierce, & Guillen, 2002). NTFPs, from primary and secondary forests, forest plantations and agro-forestry systems, involve a range of products and services including medicinal plants, fibres, resins, latex, oils, gums, fruits, nuts, foods, spices, flowers, crafts, dyes, construction materials, and fuel wood, as well as related value-added products, tourism and festivals (Food and Agriculture Organization of the United Nations (FAO), 1995; Laird, McLain, & Wynberg, 2010; Shanley, Pierce, Laird, & Robinson, 2008). Given the wide scope of products, services and ecosystems involved, governance of NTFPs involves a plethora of geographies, actors, and time-space scales as well as both formal government instruments and informal norms and policies. Formal policies include the suite of binding legislation and regulations as well as the operational level directives, strategies and rules developed by governments at all levels (national, provincial-territorial, municipal). Informal societal policies and norms are the general system of institutional, political and cultural arrangements through which NTFP resources are coordinated and controlled (Laird et al., 2010). This includes a range of actors, agencies and institutions that have local, customary, flexible, or voluntary approaches to NTFP management (e.g. approaches informed by traditional and local knowledges, guidelines proposed by the Food and Agricultural Organization of the United Nations, and certification opportunities offered by the Forest Stewardship Council and harvester associations such as the Ontario Maple Syrup Producers' Association (OMSPA)).

This paper is drawn from a research program focused on maple syrup, resilience and climate change. The program, ongoing over the last three and a half years, has involved several projects including the development of an interdisciplinary research approach, pilot interviews/survey and exploratory climatologic data gathering (Murphy, Chretien, & Brown, 2009); Geographic Information Systems (GIS) work projecting future viable areas of sugar maples for the periods 2070 and 2100 in Ontario (Lamhonwah, 2011); assessing the contribution of the Elmira Maple Syrup Festival to social, economic and ecological wellbeing[1]; and the evaluation of current maple industry challenges, opportunities and perceptions including views on weather variability, climate change and the potential for adaptation. This paper draws from these various projects and reports more specifically on the methods, results and conclusions from this latter study.

[1]See for associated documents: http://www.wlu.ca/homepage.php?grp_id=12610

Using insights drawn from the NTFP[2] and climate change literatures and results from our ongoing research program, the purpose of this paper is to describe and evaluate maple syrup policies and management within the Canadian rural landscape and to assess the impacts, adaptation opportunities and adaptive capacity in relation to climate change. The paper will conclude by outlining a set of policy recommendations aimed to increase resilience in the maple industry and the rural spaces and ecosystems within which it operates.

2.0 Non-Timber Forest Products and Maple Syrup

Products and services obtained from the forest have always been important to societies. Indeed, since antiquity botanical knowledge of forest plants has been recorded and highly valued, and forest products are among the oldest traded commodities (FAO, 1995). Even today products other than timber and fibre constitute a large part of the overall economic outputs of forests (Arnold, 2010). This is especially true in rural spaces where forest products may contribute directly to subsistence needs and/or help diversify and supplement rural incomes. Yet despite their widespread importance, these products, including maple syrup have often been referred to as *minor* forest products because of the divide between internally focused (siloed[3]) government administration units (forestry, agriculture, horticulture) and the wide range of forest commodities produced (Hinrichs, 1998). This results in statistics that do not provide an aggregate accounting of all the important commodities and services originating from the forest. Other reasons include the dominance of the timber industry and the marginal status of rural people and spaces in modern society (FAO, 1995). Further, since NTFPs, including maple syrup are often highly localized, part of a 'hidden' or subsistence economy and often a part-time economic activity, they contribute to rural livelihoods in ways that are largely invisible to outside authorities. Due to these various circumstances, these products have tended to be overlooked and poorly regulated by all levels of government (Laird et al., 2010; Mitchell, Tedder, Brigham, Cocksedge, & Hobby, 2010).

The regulation of maple syrup is somewhat of an exception to this situation with official Statistics Canada data collected each year about, among other things, the quantity and price of syrup sold in each province. There is also a set of rules that govern maple as an agricultural product (see Section 2.1). However, even though this industry has a more robust regulatory and reporting framework, the monitoring of woodlot harvesting and production activities and farm gate sales is largely driven by public complaint, unless the producer has voluntarily undergone a certification process, wishes to commercialize, develop value-added products, or is interested in the export market.

Further, even less is known about the value of this NTFP, beyond the dollars generated through direct sales, including the importance within cultural, spiritual, aesthetic and

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[2] About 80% of all NTFPs and services are produced in the 'less developed world', particularly in tropical forest areas. Thus, the NTFP literature is significantly dominated by these geographies. The emphasis in this paper is to focus on the relatively slim literature available in a developed world context and to extract and re-interpret key insights from the broader literature.

[3] The term 'silo' is a metaphor that references a farm storage silo containing only one grain type. Siloing refers to high levels of insularity or integration existing within an organization or department that limits communication or effective management across the units. Especially within complex policy environments, siloing tends to prevent or undermine system-wide thinking and coordinated decision-making.

recreational/tourist contexts. Carlson (2009) notes that the fall foliage season, highlighted by the brilliant yellows, oranges and reds of the sugar maples accounts for one-quarter of the tourist season in New Hampshire, bringing in $6.2 million annually; this equals the total value of the agricultural industry for that state. Hinrichs (1998, p. 509) demonstrated that the importance of maple syrup was closely tied to helping rural households, "manage risk, cope with seasonality, define and identity and be part of the local community".

Currently, NTFPs, including maple products are experiencing a renaissance within public discourse. Increasingly, they are being positioned as a sustainable alternative to extractive forest timber activities (Laird et al., 2010; Shanley et al., 2008) and are being explicitly valued as an important part of a rural lifestyle (Hinrichs, 1998; Mitchell et al., 2010). At the same time, urban interest in NTFPs and services including nature-based tourism and the consumption of organic, 'wild', or 'green' products has an increasingly attractive cachet (Mitchell et al., 2010). Within this context, NTFPs are said to facilitate the 'triple bottom line' of sustainable development, both for current and future generations, namely: social wellbeing, economic viability and ecological health (Carter, Kreutzwiser, & de Loe, 2005; Shanley et al., 2008). Social wellbeing includes the promotion of human health, local empowerment, strong community networks, as well as spiritual and cultural values. Economic viability involves facilitating sustainable livelihoods in both the market and subsistence sectors. Ecological health refers to the maintenance of ecological integrity as well as the valuation and maintenance of the environmental services provided by forests including carbon sequestration, watershed protection, recreational opportunities, habitat for flora and fauna, etc. For instance, in the case of maple syrup, Murphy et al. (2009)[4] demonstrated the contribution of maple syrup production and the Elmira Maple Syrup Festival to the community and surrounding region. This one day event attracts over 60,000 visitors, involves over 2000 volunteers, supports numerous local charities, provides financial profit to the local producers (Mennonite and non-Mennonite) and encourages harvesters to highly value their 'sugarbush'[5].

Further, for Indigenous peoples around the world, including Canada's First Nations, Métis and Inuit peoples, NTFPs have traditionally been vital to their societies and have been actively managed to provide food, clothing, and medicines as well as featuring prominently in their cultural and spiritual practices (Laird et al., 2010; Murphy et al., 2009). Today, knowledge and use of NTFPs is sometimes diminished; however, these products continue to be important in Indigenous spaces and are often seen as tools to revitalize culture and as the basis for new community-owned businesses (Mitchell et al., 2010). In the area of maple syrup production, the Kitigan Zibi Anishinabeg Awazibi facility is an excellent example of combining traditional values with modern methods and marketing.[6] While the spiritual aspects of sap and syrup are celebrated, since the harvest is sold commercially, mostly as a wholesale product, production is subject to the same rules and regulations as other Canadian producers.

The extent to which an NTFP can contribute to the triple bottom line in rural spaces is an open question that must be empirically (re-)evaluated over time and space (Laird et al., 2010). Unfortunately, collecting data about NTFPs is challenging. NTFP harvesting changes over time and space and is undertaken within a changing, dynamic,

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[4] http://www.wlu.ca/homepage.php?grp_id=12610

[5] http://www.elmiramaplesyrup.com/

[6] http://kzadmin.com/awazibi.php

globalized world. Harvested products may or may not be obtained sustainably; consumer taste for these products ebbs and flows; forest ecosystem health is impacted by local to global environmental changes, including climate change; forest ownership and management regimes shift; and institutional policies, oversight and regulations evolve. For instance, the current association of maple syrup as part of an 'eat local' discourse is increasing its popularity and encouraging industry growth and commercialization (Section 4.3). At the same time, the dwindling population of active farmers means that finding enough help during the often intense, physically demanding periods of sap flow is an ongoing issue (Hinrich, 1998). Both of these situations impact the long-term sustainability of the industry.

Further, within the maple industry, ecosystem health can be affected by broader-scale problems such as air pollution (acid rain, ozone, carbon dioxide), invasive species (especially the Asian Long-horned Beetle) and climate change. At the local scale, sugarbush management may impede sustainability goals. In particular, 1) Management tends to reduce biodiversity because it involves culling unwanted species and removing saplings that hinder movement (Pierce, 2002); 2) Sap sweetness is variable amongst trees of a given stand and management preference is often oriented towards the 'sweeter' trees; 3) Tapping causes wood defects that reduce the value of the wood as a timber resource and improper tapping can cause longer-term damage to tree health; and 4) Sugarbush management runs counter to timber 'best management' practices and associated certification guidelines. For example, sugarbush management encourages broad tree crowns and maximum foliage to maximize sap production rather than the tall straight trunks demanded by the timber industry. While the pilot work conducted by our research team suggests that producers highly prize and carefully manage their sugarbush woodlots (Murphy et al., 2009), there does not appear to be any comprehensive evaluation of the sustainability of management practices (see Box 1 for additional facts about maple syrup).

Box 1: The Sweet Facts About Maple Syrup

- Sugar maples, *Acer saccharum* are the maple species most commonly tapped (due to species abundance and sugar levels in sap)
- Due to selective cut and sugarbush management practices along with fire suppression, sugar maple-beech forests have virtually replaced oak-dominated sites (Pierce, 2002)
- Sap is the starch produced by maple trees in the fall that is stored in the trees' roots
- Maple sap harvesting and boiling originated as an Aboriginal technology[7]
- Maple trees must be 25.4 cm in diameter to be tapped (approx. 30-40 years old)
- Trees can be tapped for over 100 years and can live to be 400 years old
- Large trees can have up to 4 taps, although some guidelines suggest no more than 2 taps
- Sap was traditionally collected using buckets; today many harvesters use a tubing system
- Sap collection on *healthy* trees does not damage trees: Harvesters only collect about 10% of available sap and properly installed taps heal over in 2-3 years
- The season lasts about 4-6 weeks ranging from February to April, depending on location and local/yearly weather patterns
- Nightly temperatures of -4˚C and daytime temperatures of 5˚C are optimum for sap to run
- Sap must be boiled quickly (typically same day) or it deteriorates
- It takes about 40 litres of sap to make 1 litre of maple syrup

[7] http://www.hanksville.net/food/maple.html

- Traditionally, the sap was concentrated using evaporation (wood and oil evaporators). Today reverse osmosis may be used as a preliminary step to remove water
- To make syrup the sap is concentrated from 2.5%-5% to 66.5% sugar content
- Syrup is bottled at 87˚C to sterilize the containers and prevent mould formation
- The season ends when the buds break; this contaminates the sap with a bitter, 'leafy' taste
- Syrup Grades (current):
  - Canada #1: Extra Light, Light and Medium (for table use)
  - Canada #2: Amber (stronger flavour—for table use, ideal for cooking)
  - Canada #3: Dark (for commercial use only)
- Canadian maple syrup is exported internationally to over 25 countries

2.1 Governance of Canadian Maple Syrup

Maple syrup and other maple products (e.g. maple sugar) are among the most important NTFPs in Canada. Others include berries, honey, Christmas trees, wild pelts, and mushrooms. In Canada, NTFPs contribute up to $1.26 billion annually, yet this is a mere three percent of the value of timber and pulp products (Mitchell et al., 2010). This wide economic gulf further marginalizes this NTFP on the policy agenda. As Mitchell et al. (2010, p. 114) opine, " NTFPs, and those who use them for commercial, subsistence, recreational or cultural uses, rarely feature on the policy agenda in Canada."

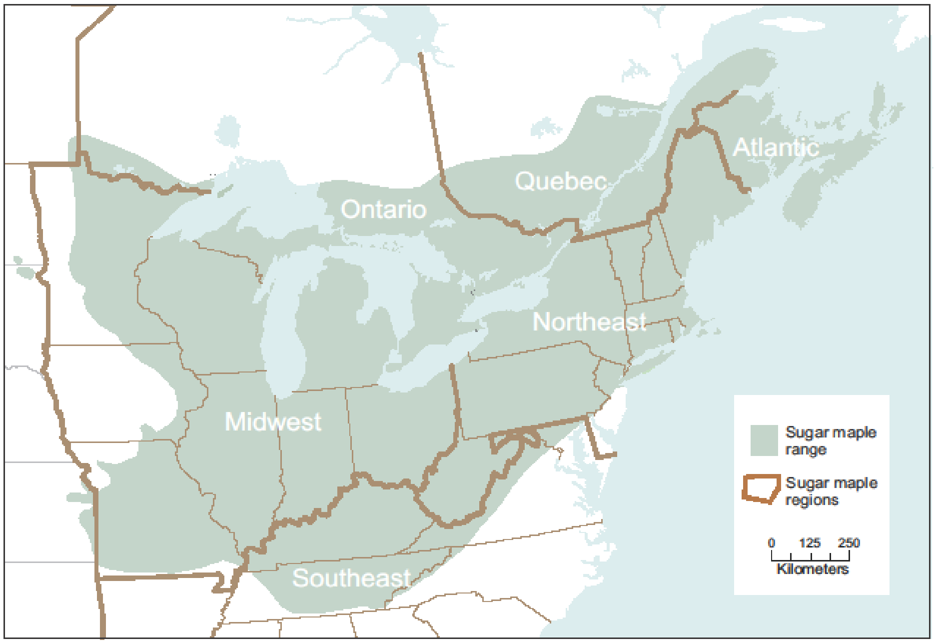
Policies affecting the NTFP sector are complicated by their positioning at the interface of multiple land tenure systems, siloed government departments and several problem/opportunity contexts (Mitchell et al., 2010). Maple sap is harvested on privately owned and/or rented land, on common property (e.g. on reserve) and on public lands (e.g. Crown Land); the sap is regulated as a food at both the federal and provincial level (in Ontario as an edible horticultural crop through the Ontario Ministry of Agriculture and Food) while woodlot production spaces are governed by natural resource agency policies (e.g. Ontario Ministry of Natural Resources); finally, issues associated with maple syrup include forest conservation, Indigenous culture, rural development, rural risk and resilience, and climate change, to name but a few. From interviews we know that these various contexts impact producer options, such as the installation of costly tubing systems (not appropriate on crown land) and the commitment to sugarbush management. However, more work needs to be undertaken to understand the opportunities and challenges imposed by these multiple contexts.

As previously mentioned, in contrast to many other NTFPs, the data on, and regulation of, maple syrup is relatively robust especially where production occurs on private lands (Mitchell et al., 2010). Regulation is more robust because in contrast to many other NTFPs, maple products are considered an agricultural product (Mohammed, 1999). Maple syrup is produced in the USA and in four Canadian provinces (82% of production)[8], with Quebec being the largest world-wide producer (see Figure 1). In Canada, 2010, 327.3 million litres of maple products were produced for a total value of $280.9 million (20% less than the previous year due to bad weather) (Statistics Canada, 2010). At the federal level, maple products are governed by the Canada Agricultural Products Act through the Maple Products Regulations.[9] Through these regulations, health and safety is governed by the Food and Drugs Act and thus subject

[8] http://www.omafra.gov.on.ca/english/crops/facts/info_maple_syrup.htm#quality
[9] http://laws-lois.justice.gc.ca/eng/regulations/C.R.C.,_c._289/page-1.html?term=products+canadian+product+maple#s-2.

to Canadian Food Inspection Agency rules and standards. Licensing to export across provincial lines and outside of Canada is also governed by these regulations.

Figure 1. Sugar Maple Range and Regions



There are also discretionary standards that may also guide industry members. These include organic[10] or/or woodlot certification[11] opportunities (Shanley et al., 2008). According to Pierce (2002), many maple syrup producers could quite easily obtain these certifications, but often chafe at the expense and intrusion of additional regulations. Moreover, sometimes these certification opportunities are not specifically geared to meet the needs of maple syrup producers. Hence, the uptake of certification remains marginal.

In addition, each Canadian province has its own set of regulations and guidelines. Ontario is used here as an example. After Quebec and the USA, Ontario (followed closely by New Brunswick) is the third largest producer with most production concentrated in the areas of Waterloo-Wellington and Lanark County (See Figure 2). In Ontario, there are approximately 2,600 maple producers setting out 1.3 million taps each year.[12] In 2010, the Ontario gross value of maple products was $19.2 million (Statistics Canada, 2010, 2). Syrup offered for sale in Ontario must comply with Ontario Regulation 119/11 Produce, Honey and Maple Products under the Food Safety and Quality Act, 2001[13]. The regulation, in line with federal rules, includes grading and labelling requirements; minimum sugar densities; packaging guidelines; upon public request, Ontario Ministry of Agriculture and Food inspections; and maple product marketing guidelines. Beyond those regulations, quality assurance in the

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[10] http://www.canadianorganicmaple.com/index.php?option=com_content&view=article&id=18&Itemid=22

[11] http://www.eomf.on.ca/index.php?option=com_k2&view=item&layout=item&id=345&Itemid=353&lang=en

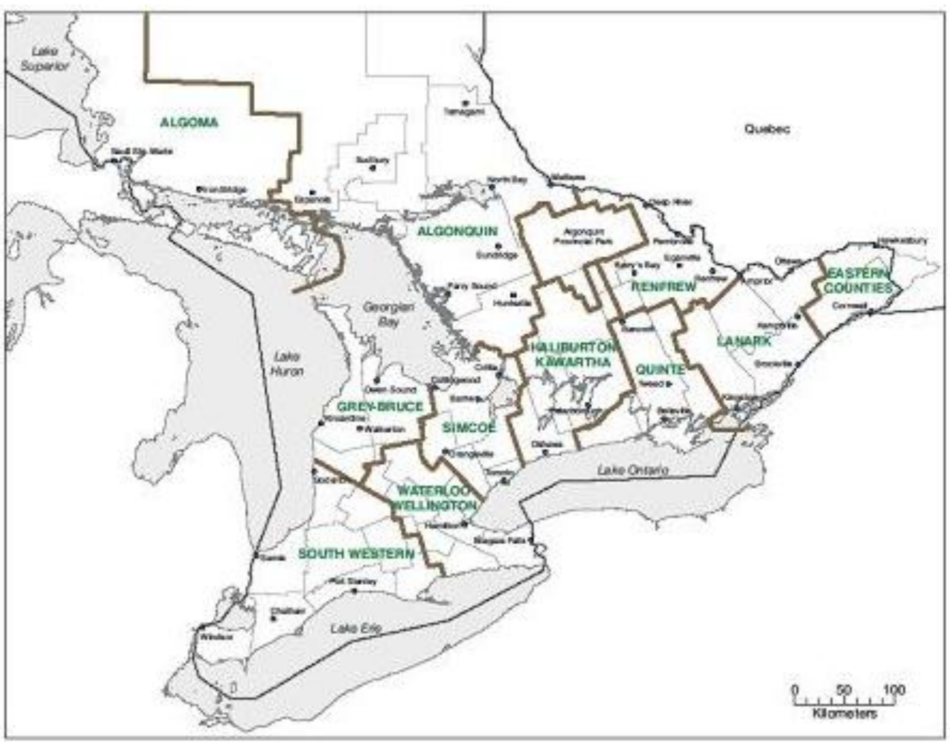
[12] http://www.omafra.gov.on.ca/english/crops/facts/info_maple_syrup.htm#quality

[13] http://www.omafra.gov.on.ca/english/food/inspection/maple/othr-mple-lbl-reg11911.htm

Ontario maple syrup industry is currently voluntary. The Ontario Maple Seal of Quality is a programme wherein producers rate their maple operation from woodlot to packaged maple syrup and identify areas of 'best practice' and improvements. To use the logo and ensure compliance, producers are monitored by the industry and government inspectors.[14] Two on-going quality assurance projects concern the reduction of lead in maple syrup (from old galvanized equipment)[15] and incoming rules implementing international, standardized grading.[16]

Beyond these formal regulations and voluntary standards and programs, governance of the maple syrup industry, including the dissemination of industry best practices and knowledges occurs through a variety of informal venues. These venues also foster the development of the social networking and social capital that are said to be vital for resilience in rural spaces (Hinrichs 1998; Sauchyn, Diaz, & Kulshreshtha, 2010). For instance, OMSPA and many other maple industry organizations provide annual conferences for producers to learn about new guidelines, products and technologies, to network with other producers and to visit state-of-the-art harvesting operations in the host region. Within regions, local workshops and other events are also held (e.g. pre-season workshops, first tap ceremonies). At the farm level, the on-going interaction amongst producers builds a network of resources and relationships that are used to share local knowledge, labour, and tools as well as camaraderie and a healthy dose of friendly competition.

Figure 2: Maple Syrup Producing Regions in Ontario



Source. (Murphy et al., 2009)

[14] http://www.ontariomaple.com/omspa/quality-assurance.html
[15] http://www.omafra.gov.on.ca/english/food/inspection/maple/pdf/maple_lead_fact.htm
[16] http://www.internationalmaplesyrupinstitute.com/maple_cards.pdf

In terms of other Ontario policies that may impact NTFPs including maple syrup, the Crown Forest Sustainability Act[17] specifically orients forest policy towards the triple bottom line, while Ontario's Policy Framework for Sustainable Forests requires the sustainable harvest of forest products while maintaining general forest sustainability (Mohammed, 1999).

Forest management in Ontario is also underpinned by differing land tenure regimes, demographic and ecological characteristics. While 90% of the forested area in Ontario is Crown land, in southern Ontario (the location of the most productive maple syrup stands), the opposite is true—87% of land is privately owned. Compared to the rest of the province, the southern landscape is characterized by much higher population and road densities, less overall forest cover and high levels of forest fragmentation and degradation. Simultaneously, the southern area boasts the highest species diversity, the best growing conditions and strong public support for non-extractive forest activities and non-commodity values (e.g. ecological, recreational, educational and aesthetic values) (Government of Ontario, 2000).

These north-south differences are mirrored by sugar maple woodlots and also subject to further nuances that impact maple syrup production, management and policies. Sugar maple tapping on Crown land is more common in the northern part of the range, whilst virtually non-existent in southern Ontario. In Waterloo-Wellington, maple sap is harvested from small woodlots, with larger operations needing to rent nearby sugarbush stands to meet their needs. In eastern Ontario (Lanark County), woodlots tend to be larger with less need for land rentals. Throughout the province, tapping on First Nations reserve land usually occurs in community forests, with producers viewed as caretakers of the land acting on behalf of the band members. Further, in all cases, larger producers may purchase unprocessed sap from nearby operations to augment their supplies.

2.2 Climate Change Policies and Impacts

In recent years, climate change research has shifted from focusing solely on mitigation—that is the reduction of greenhouse gases (GHGs) in the atmosphere—to also involving adaptation to the impacts of climate change, defined as both changes to seasonal averages and the increase of extreme events (Ford et al., 2010; Smit & Wandel, 2006; Wall & Marzall, 2006). It is understood that, regardless of the mitigation measures taken, some climate change is inevitable and that research must identify and address the vulnerability, adaptive opportunities and the adaptive capacities to muster a resilient response to those changes. Adaptive capacity is defined as the ability to implement strategies that deal with negative effects and capitalize on opportunities (Wandel, Pittman, & Prado, 2010). Adaptive capacity should be understood to be multi-dimensional. For the agricultural sector, key factors are thought to include: the capacity for self analysis, financial resources, training and education, awareness and concern, biophysical conditions, and farm-level capacities (Bryant et al., 2004).

Due to their dependence on the natural environment, resource-based sectors, including agriculture and NTFPs, are especially sensitive to climate change and weather variability (Belliveau, Bradshaw, & Smit, 2007; Parkins, 2008. To optimize adaptive capacity and resilience, policy development and decision-

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[17] http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_94c25_e.htm

making within resource-based sectors must take into consideration the long-term investments required by the industry. Investments made today (e.g. planting a sugar maple orchard) will be exposed to changed future conditions (Ford et al., 2010). Policies must also be oriented towards mainstreaming or a 'no regrets' agenda (Wandel et al., 2010), since farm-level adaption to climate change is often secondary to more immediate risk considerations (Bryant et al., 2004). In other words, policies that meet immediate needs as well as long-term climate change management goals will be produce a double benefit and do not require the sacrifice of short-term viability. Sauchyn et al. (2010, p. 360) provide the following advice in regards to policy development:

1. Leverage existing policy instruments and management initiatives oriented towards sustainable development goals,
2. Decision-making about climate change must be imbedded into local planning and management processes since adaptation is "largely achieved by municipalities and individuals working collectively in social networks and as informal institutions",
3. Participation of higher levels of government is necessary for providing appropriate policy frameworks and to facilitate local adaptation,
4. Sustainable growth requires the development of best management practices, including the integration of both adaptation and mitigation strategies, and
5. Local autonomy and flexibility will become increasingly important to deal with a rapidly changing local environment.

Only limited research has been undertaken to understand the impact of climate change on sugar maple ecosystems and maple syrup production. Changing precipitation patterns (both rain and snow); warming temperatures and increased evapotranspiration and/or drought; and increased susceptibility to pest infestations or other stressors (e.g. acid rain) are all likely to increase the stress on sugar maple ecosystems and lead to their decline, especially in the southern portion of their range (Carlson, 2009; Murphy et al., 2009). For instance, the ice storm in 1998 caused extensive maple tree crown damage across Eastern Ontario and Quebec (Noland, McVey, & Chapeskie, 2006) and during the 1990s sugar maple decline was noted throughout its range (Horsely & Long, 1998). In the USA, climate change scenarios project that sugar maple is likely to be extirpated throughout its range over the next 50-100 years (Carlson, 2009; Perkins, 2007). Using three projections (low, moderate and high GHG scenarios) from the Canadian Global Circulation Models and data about sugar maple ecosystem requirements, Lamhonwah (2011) demonstrated that the prime maple producing areas of Ontario are likely to be in jeopardy by 2070 and that suitable growing conditions may develop for sugar maples to migrate northwards (see also Goldblum & Rigg, 2005). However, this northward tree movement will be hampered by the less favourable conditions on the Canadian Shield, including lack of topsoil, steep slopes and acidic soils (Lamhonwah, 2011). Other species-related characteristics may also hinder potential migration. For instance, McCarragher (2009) found that northern seed germination and seedling establishment was significantly reduced under higher temperatures calling into question the regeneration viability of sugar maples under projected anthropogenic climate change.

Most of the current research focuses on the impact of climate change on sugar maple ecosystems. Another important question is the impact of climate change on maple syrup production. To date, this is an under-studied question. Pilot interviews and extensive participant observations have helped our research program develop a set of weather factors that are likely to become more variable and may be indicators of climate change. These factors are incorporated into the survey reported on below.

3.0 Survey of Maple Syrup Industry Members: Methods

In the fall of 2010 the International Maple Syrup Institute, the North American Maple Syrup Council and the Ontario Maple Syrup Producers' Association held their annual conference in Stratford, Ontario. The conference population involved approximately 200 people from across the Canadian and American maple production regions. The attendees represented the various parts of the industry including producers, packers, equipment manufacturers, distributors, wholesalers and retailers. This event was seen as an opportunity to poll attendees about the variety of changes currently thought to be impacting maple syrup operations and sugar maple ecosystems including changes to regulations, technologies and climate. The survey sought to document industry members' experiences of these changes and to identify opportunities to adapt to these challenges. The survey utilized insights drawn from earlier work and was pre-tested with several members of the conference committee. The survey also drew insights from a survey undertaken by Ford et al. (2010) about climate change perceptions administered at a Canadian mining conference. One senior undergraduate student (Amy Hluchyh) and two members of the team administered the survey. To minimize bias and access as many participants as possible, the survey, lasting about 15-20 minutes, was administered randomly during the conference at coffee breaks, on field trips and at the trade show. The survey met the ethical protocols for working with human subjects. A total of 33 respondents completed the survey, virtually every person approached agreed to fill in the survey.[18] Although this is a small pool of respondents (16.5%), it actually represents a somewhat larger percentage of the views of attendees since participants often attended the conference with family members and/or business partners and it was always the case that one member filled in the survey on behalf of the entire group. One caveat to keep in mind is that the individuals who attend these conferences are likely to be the more motivated members of the industry; it can be surmised that these attendees may be more engaged and active than other members of the industry. Thus, these results probably represent the 'best case' scenario. Further, although Quebec produces the most maple syrup, this sample under-represents their views since few Quebec producers attended the event.

The survey was divided into three sections: 1) Characteristics of the survey population; 2) The nature of involvement in the maple industry; and 3) Changes in the maple industry. The first section asked about business location; type of business; and length of involvement in the industry. The second section inquired about level of involvement with and benefit of maple industry organizations; and the reasons for involvement in the industry. The third part asked questions about some of the broad rules and policies currently impacting the industry; whether key business factors were changing; the extent changing weather patterns affected their maple business; perceptions of weather variability and climate change; adaptation measures and barriers; and general views on

[18] In the Ford et al. 2010 survey 42 people completed the survey, from a conference population of 5000.

the robustness of the maple industry. We purposely did not focus solely on climate change since this is just one of many pressures facing rural communities. We were interested in the issue of climate change within the context of these broader pressures. Survey questions were closed-ended with several opportunities to add extra comments. The closed-ended responses included several types: likert scale questions; opposite pole answers such as decreasing-no change-increasing; queries where either one answer or multiple answers could be chosen; and simple yes or no questions.

Given the small sample size, most of the results are reported using basic descriptive statistics. A limited analysis was also undertaken using non-parametric, Chi-square contingency analysis. Two key respondent factors, location and levels of optimism, were hypothesized to influence responses. The results are provided below.

4.0 Survey Results

4.1 Survey Population

As can be seen by Table 1, the respondents were almost evenly split between Canada and the USA, with representatives from each producer region (See Figure 1). Most respondents (29/33; 88%) were involved with the actual production of maple syrup, in addition to other activities. Only three respondents had been involved with the industry for less than ten years, 91% had at least a ten year involvement. The modal level of involvement level was 20-50 years (13/33, 39%). Fifty eight percent (19/33) of respondents indicated that they currently had medium or high formal involvement with maple syrup organizations such as those sponsoring the conference. Given these respondent characteristics, knowledge about the industry and weather-related changes is most likely quite robust and the responses reflective of the range of maple production regions.

Table 1. *Respondent's Business Location*

Location of Respondent	# of Respondents
Ontario	12
Quebec	2
Atlantic Canada	3
USA-Northeast	8
USA-Southeast	1
USA-Midwest	6
Other	1

Contingency analysis was undertaken to assess if location was associated with differences in responses. It was hypothesized that the different policy contexts and different physical locations might impact responses. To facilitate this analysis, respondent locations were collapsed to Canada (17 respondents) and USA (16 respondents). The results of this analysis are included where appropriate.

4.2 Nature of Involvement With the Maple Syrup Industry

Respondents were asked about the benefits of maple syrup organizations (respondents could choose all categories that applied). As indicated by Table 2, respondents found the services provided by existing organizations as quite valuable with networking, learning new skills, conducting research and lobbying government all considered important. When asked to rate the reasons for their involvement in the maple syrup industry (on a scale from not at all, somewhat to quite important), 'learning new skills' was chosen by 70% (23/33) of respondents as quite important. Three choices, ranked second in the quite important category, were chosen by 55% (18/33) of respondents: financial profit, income diversification and meeting new members. In third position was the 'opportunity to get outside in early spring'. Other choices, suggested by the literature or earlier interviewees, such as connections to national heritage, Aboriginal heritage and history, legacy for their children, and spiritual relationships with the land were indicated as only somewhat important or not important by most respondents. As outlined in the final section, in terms of climate change adaptation, these existing benefits, social networks and learning opportunities can all serve as a basis for 'no-regrets' policies that meet both immediate and long-term term needs.

Table 2. *The Benefits of Maple Syrup Industry Organizations*

Benefits of Organizations	# of Respondents
Provide Opportunities to Meet/Network	28 (85%)
Provide Opportunities to Learn New Skills	27 (82%)
Conduct Research on Important Topics	26 (79%)
Lobby Government on Important Issues	21 (64%)

4.3 Changes to the Maple Industry

When asked to rate the impact of several current public discussions on their business as not at all, somewhat or quite important, respondents rated the following discourses as quite important: 1) Buying local is good for communities (23/33; 70%); 2) Health and environmental benefits of maple products (20/33; 61%); 3) 'Eat local' diet (100 mile diet) (19/33; 58%); and 4) Trees remove carbon from air, so they should be protected (13/33; 39%). When asked to rank the importance of several policy changes currently affecting the industry, new rules about food safety was most often ranked as quite important, followed by proposed new maple syrup grading rules, fiscal incentives and eroding support from government staff (Table 3).

Table 3. *The Importance of Changes and Opportunities in the Maple Industry*

Changes/Opportunities	Not at all Important	Somewhat Important	Quite Important	Don't Know/Not Applicable
New rules about food safety	0	11 (33%)	22 (67%)	0
Proposed new rules about maple syrup grading	2 (6%)	16 (49%)	15 (46%)	0
Fiscal incentives to modernize operations	4 (12%)	15 (46%)	13 (39%)	1 (3%)
Continued erosion of government staff	4 (12%)	14 (42%)	11 (33%)	1 (3%)

Ranking of business factors that have been changing, on a scale of decreasing, no change and increasing, yielded only one factor that was decreasing: Access to help (13/33; 39%). Factors listed as increasing by at least one third of respondents were: Level of technology (31/33; 94%), Costs (27/33; 82%), Number of taps (24/33: 73%), Level of bureaucracy (21/33; 64%), Participation in organizations (20/33; 61%), Market access (19/33; 58%), Health of trees (14/33; 42%), Impact of climate change (12/33; 36%) and Quality of sap (11/33; 33%). While not at the top of the list, it is important to note that climate change was deemed to be important as a business factor that was undergoing increasing change.

Two business factors yielded statistically significant relationships using contingency analysis. 14/17 (82%) of Canadians, but only 7/15 (47%) of Americans felt that the level of bureaucracy was increasing (p=.073) and 10/17 (59%) Canadians, but only 3/15 (20%) Americans felt that access to help was decreasing (P=.076).

In moving towards a more explicit discussion of weather and climate, respondents were first provided with a list of weather patterns and asked to assess whether a change to that pattern has a bad impact, no impact or good impact on their business. Bad impacts were associated with changes to day-time temperatures (19/33; 58%), night-time temperatures (17/33; 52%), more drought-like conditions (16/33; 49%), more violent storms (14/33; 42%), and changes in wind patterns (11/33; 33%). Only the category of more storms (13/33; 39%) was important in the 'no impact' category and none of the respondents indicated a positive impact from changing weather patterns. When asked about the timing of the season, a substantial percentage indicated that the syrup season was starting (18/21; 55%) and ending earlier (21/33; 64%) (Figure 3).

Figure 3. Change in Timing of the Season

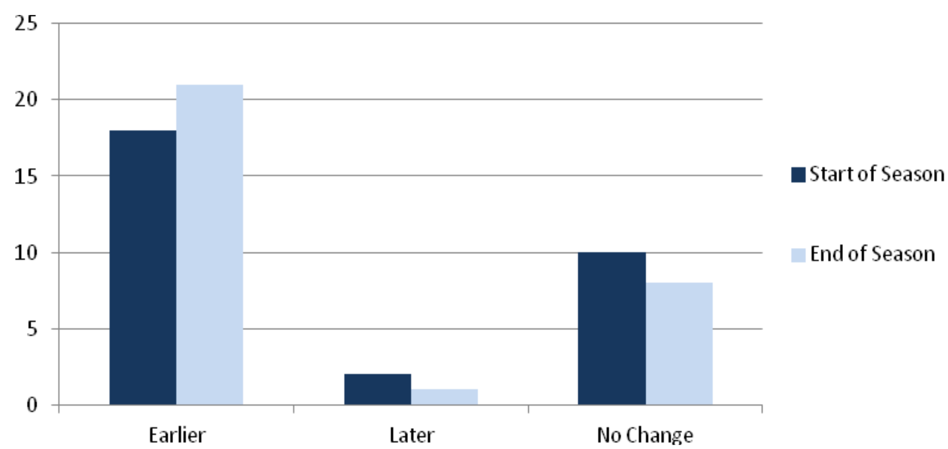


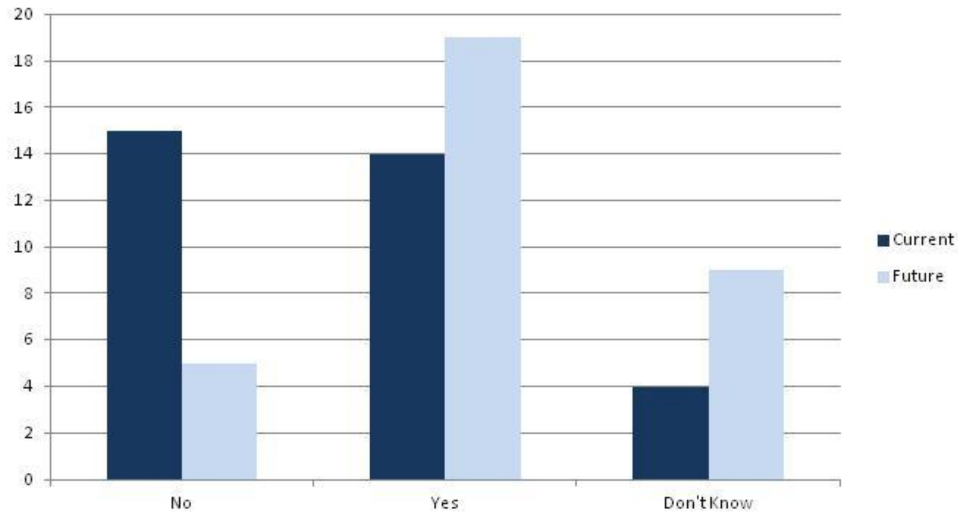
Table 4. *Weather Factors That Have Changed In Variability*

Weather Factors	Less Variable	No Change	More Variable	Don't Know/ Not Applicable
Start of Season	0	5 (15%	24 (73%)	1 (3%)
End of Season	2 (6%)	7 (21%)	20 (61%)	1 (3%)
Day Temp	2 (6%)	7 (21%)	18 (55%)	3 (9%)
Sap Production	1 (3%)	8 (24%)	17 (52%)	3 (9%)
Night Temp	2 (6%)	9 (27%)	16 (49%)	3 (9%)
Snow Cover	1 (3%)	12 (36%)	14 (42%)	3 (9%)
Drought	0	15 (46%)	11 (33%)	4 (12%)
Violence, Storms	1 (3%)	15 (46%)	11 (33%)	3 (9%)
Wind	1 (3%)	17 (52%)	8 (24%)	4 (12%)
Rain	0	18 (55%)	7 (21%)	5 (15%)
Sap Quality	2 (6%)	19 (58%)	6 (18%)	3 (9%)
# of Storms	2 (6%)	18 (55%)	6 (18%)	4 (12%)

When the survey probed more specifically about noticed changes in weather variability, respondents noted a number of weather factors that were becoming more variable (Table 4). Notice in particular that even though respondents indicated that as an overall trend, the season start and end were occurring earlier, respondents also indicated quite strongly that the timing of the season was becoming more variable.

Contingency analysis yielded some striking results in this part of the survey. When assessed separately, six of the weather factors were found to be significantly more variable by Canadian respondents: Sap quality (p=.04), night time temperatures (p=.057), day time temperatures (p=.04), rain (p=.075), snow (p=.057), and violence of storms (p=.059). This prompted a further analysis wherein the responses were summed to create an index of variability that was then collapsed into two categories, high and low variability. When cross-tabbed against the location, overall assessed weather variability in the high category was 63% for Canadians and 15% for Americans (p=.01). These results, combined with the other differences noted above between Americans and Canadians, seem to suggest that there are likely spatial, socio-economic and political contexts influencing participant responses. This underscores the need to design climate change adaptation policies within a framework that is flexible enough to deal with multiple contexts and geographies.

Figure 4. Current and Future Impact of Climate Change on Business



The direct question about perceptions of climate change was not asked until near the end of the survey in order to contextualize climate change in relation to other pressures. Also, it had been found in previous interviews that producers often did not like to engage directly with the idea of climate change; the language of climate change was something scientists were trying to push—it was not the way they understood their lived experience (See also Bryant et al., 2004). Yet despite this tendency, when asked whether climate change was currently having an impact, or would impact their business in the future, the number of 'yes' responses was surprisingly high. Responses were evenly split between 'no' (15/33; 46%) and 'yes' (14/33; 42%) for the current time period. The 'yes' response increased to 19/33 (59%) of respondents for the future, with only 5/33 (15%) indicating that future climate change was not an issue and 9/33 (27%) choosing the 'don't know' category (Figure 4). A total of 23/33 (70%) respondents felt that climate change has already impacted their business or would affect it in the future. Those 23 respondents were then asked about the direction of the climate change impact on their business both now and in the future. The results were about evenly split between 'neutral impact' (now: 10/23; 43%), (future: 9/23; 39%) and 'bad for business' (now: 9/23; 39%), (future: 12/23; 52%) with only one individual choosing 'good for business'.

Again, interesting differences exist between the Canadian and American respondents. Ten of seventeen (59%) Canadians, but only 3/15 (20%) of Americans felt that climate change was currently impacting their business (p=.07). Similarly in the future, 12/17 (71%) of Canadians but only (40%) of Americans felt that climate change would be significant (p=.03). Moreover, the remaining Canadian respondents (29%) chose 'don't know', whereas Americans were almost evenly split between 'no impact' (33%) and 'don't know' (27%). It remains for future research to determine whether these contrasting perceptions are grounded in ecosystem variances or in differences in views towards climate change between Canadian and American political jurisdictions.

The survey then asked about actions to deal with these impacts and the barriers that existed. The survey listed a range of options that had been identified by the literature or through previous interviews. Among the 23 individuals who indicated that climate change was currently or would impact their business in the future, only new technology (13/23; 57%) and active tree management (11/23; 48%) resonated with the respondents; both of these are examples of current activities that can be leveraged for future sustainability (e.g. no regrets approach). The other options, including planting climate change resistant maple cultivars, planting on good quality sites for best health, insurance coverage, business diversification, reducing industry involvement, reducing carbon emissions and lobbying for the reduction of greenhouse gas reductions, were never chosen by more than 4 respondents. But when asked what barriers exist to adaptation, despite an extensive list, no dominant reasons for the lack of adaptive strategies were evident, although four answers garnered agreement from at least one-third (8/23) of respondents (Table 5). These answers were uncertainty of impact, long tree lifespan, cost and lack of research.

In relation to barriers, only one statistically significant relationship was found using contingency analysis. Canadians were more likely (69%) to indicate that they had adopted new technology, compared to just 33% of Americans (p=.096).

Table 5. *Barriers to Actions*

Barriers	Yes	No
Uncertainty of Impacts	9 (39%)	14 (61%)
Long Lifespan of Trees makes Adaptation Hard	9 (39%)	14 (61%)
Too Expensive	8 (35%)	15 (65%)
Lack of Research	8 (35%)	15 (65%)
Don't Know What to Do	6 (26%)	17 (74%)
Too Busy	6 (26%)	17 (74%)
Lack of Government Policies	3 (13%)	20 (87%)
Nothing I Could do Would Make a Difference	2 (9%)	21 (91%)
Current Regulations Make it Hard to Adapt/Change	1 (4%)	22 (96%)
Market Uncertainty	0	23 (100%)

Finally, to assess their overall levels of optimism or pessimism about the industry both now and over the next ten years, respondents were asked to rate their agreement with six statements using a scale from very strongly disagree through to very strongly agree. As evident in Table 6, most respondents were optimistic about their industry and its future. However, note that 14/33 (42%) respondents strongly or very strongly agreed that they currently had some concerns about their tree health and 13/33 (39%) strongly or very strongly agreed that there may be some future impacts that they will not be able to handle.

Contingency analysis was also conducted on a range of survey variables to assess if perceptions of optimism influenced any of the results. It was hypothesized that higher optimism might be correlated with more adaptive behaviour. An index of the six responses was created by summing the responses from Table 5 (2 question responses were reversed) and then converting the scores to low, medium and high levels of optimism. However, in contrast to the above noted geographical differences, no logical or statistically significant relationships were found.

Table 6. *Optimism/Pessimism About the Maple Syrup Industry*

	Very Strongly Agree	Strongly Agree	Neither Disagree nor Agree	Strongly Agree	Very Strongly Agree*
Current:					
Currently business is thriving	1 (3%)	0	2 (6%)	16 (49%)	13 (39%)
Currently confident in dealing with weather changes	1 (3%)	4 (12%)	8 (24%)	14 (42%)	3 (9%)
Currently concerned about health of my trees	5 (15%)	2 (6%)	11 (33%)	9 (27%)	5(15%)
Future:					
In next 10 yrs, I'm optimistic my business will grow	0	0	2 (6%)	18 (55%)	11(33%)
In next 10 yrs, I can adapt to CC	0	1 (3%)	11 (33%)	15	2 (6%)
In next 10 yrs, may be negative CC impacts that I can't handle	4 (12%)	8 (24%)	5 (15%)	11 (33%)	2 (6%)

* The 'Don't know' category was dropped since it was rarely chosen.

5.0 Policy Recommendations and Principles

This final section draws from these survey results, the literature review and the broader research program findings to develop specific policy recommendations for the enhancement of adaptive capacity and resilience in the maple syrup industry and in the rural spaces within which it operates. In the final section, the adaptation policy principles that should underpin these recommendations are outlined.

5.1 Recommendations

#1. Maple syrup organizations should be provided with the long-term resources needed to support and educate producers.

The maple syrup industry contributes to the adaptive capacity and resilience of rural spaces and should be encouraged to flourish in a way that contributes to social, economic and ecological sustainability. As demonstrated by the respondent replies, and the broader research program, being part of the maple syrup industry and maple syrup organizations enhances adaptive capacity by: providing venues through which a dispersed rural population can synthesize and promote their views and needs; promoting and supporting social capital networking and opportunities for on-going learning; providing income diversification; and valuing woodlots.

#2. An international working group should be established to spearhead, champion and coordinate research into the impact of climate change on sugar maples and maple syrup.

More research is needed to reduce uncertainty and understand the impact of climate change on the maple industry and affected rural spaces. The survey results clearly support the previous interview data and pilot survey indicating that climate change is impacting the maple syrup industry. The timing of the season is generally earlier, with variability increasing. Key weather variability factors included daily temperature fluctuations, precipitation changes and storm violence.

Predominantly, climate change, especially in the future was expected to be 'bad for business'. As signalled by the last question on the survey, despite optimism amongst respondents, the impact of climate change is adding an additional level of uncertainty within the producer community. Respondents also noted that barriers to adaption included lack of research, the long lifespan of trees and the uncertainty of impacts. Thus, more research is needed regarding the impact of climate change on both sugar maple ecosystems and maple syrup production. This research should specifically consider the disconnection between human decision-making time scales and the longevity of maple ecosystems; here is a tangible example where planning for future generations is crucial. Further, as we have previously argued, research on regions dominated by woodlots and other rural spaces where maple syrup is an important activity often suffer from a dearth of climate and other data (Murphy et al., 2009). Research on maple syrup and maple ecosystems can be utilized to help Canadians understand the impacts of climate change on these under-studied spaces. The research program has also stressed the need to work across disciplinary knowledges and advocated for the use of interdisciplinary methodologies that actively 'tap into' local and traditional knowledges. As an additional benefit, the effective involvement of the local community in the research process can contribute to local resiliency by fostering knowledge transfer and social capital.

#3. One of the key objectives of the working group should be to find adaptation strategies that meet both immediate and long-term needs.

According to the survey results, little direct action has been undertaken by producers to address climate change. Again, this corroborates the interview data. In the survey, producers chose only two responses, adopting new technology and active tree management; both of these activities are part of normal sugarbush management. As suggested by Bryant et al. (2004) climate change, per se, is often perceived as a secondary issue, with farmers concentrating on 'more pressing' management tasks. As an NTFP, this trend is even stronger, since maple syrup is typically a part-time, season-limited occupation. In the survey, the respondents noted that several industry issues were of immediate concern including new maple syrup food safety and grading guidelines. If new rules, technology choices and sugarbush management strategies can be oriented towards these immediate needs, but with an eye towards approaches that are likely to support long-term ecological, social and economic wellbeing, then adaptive capacity will be augmented.

5.2 Adaptation Policy Principles

At the broader level, the results of this paper suggest several principles that should inform all policies oriented towards helping the maple syrup industry adapt to the impacts of climate change.

#1. The identification and implementation of adaptation strategies, including knowledge transfer, should capitalize on existing policies, protocols, organizational structures and informal networks.

Respondents indicated on several occasions that the development of new skills, learning about new technologies and opportunities for meeting and networking were key reasons why they were involved in the maple industry and why they attended conferences and other events. The solicitation of collective wisdom regarding appropriate climate change strategies and the dissemination of new ideas could be integrated into these events. Beyond these structures, if voluntary certification processes (organic, woodlot, maple product) are assessed and found to contribute to sustainability within the maple industry, then incentives could be put into place to encourage participation. If not, then specific certification guidelines should be developed that meet the needs of the maple industry. In terms of formal policies, existing provincial and federal policies oriented towards sustainability and resilience should be leveraged whenever possible (e.g. Ontario's forest legislation).

#2. Governance policies should be oriented toward holistic frameworks that break down silos (academic, governmental, societal).

Respondents indicated that they had multiple roles in the industry from producer through to retailer; that their reasons for involvement spanned economic (income), social (networking) and ecological (get outside) values; and that in addition to weather variability and climate change, several other dimensions of their business were currently in flux. This is not an anomaly; change, diversity and complexity typify resource-based economies generally and the NTFP sector specifically (Laird et al., 2010). Whether developing new policies, or utilizing existing tools, stakeholders should be cognizant of the resultant short- and long-term triple bottom line implications and work towards frameworks that adopt systems-oriented approaches.

#3. Governance policies should be oriented to achieve both mitigation and adaption goals.

Part of acknowledging and working towards a holistic framework involves addressing both mitigation and adaptation to climate change, whenever possible and appropriate. For instance, since respondents indicated that both their levels of technology and their costs were increasing, developing more energy efficient equipment is a way of meeting immediate needs as well as mitigating climate change. In addition, there is increasing interest in the value of woodlot forests for carbon sequestration.[19] Participation in such an initiative could add both economic and ecological value to sugar maple ecosystems.

#4. Adaptive capacity will be increased by strategies that are robust enough to achieve sustainability while being flexible enough to meet the requirements of different regions and the farm-level needs of producers.

On the one hand, respondents indicated that the level of bureaucracy was increasing in the maple industry, yet it is known that harvesters find a heavy-handed approach offensive and untenable (Pierce, 2002). On the other hand, respondents indicated that they were increasingly becoming involved in their producer organizations and expect these organizations to lobby government and conduct research. There were also differences between Canadian and American responses (e.g. levels of bureaucracy, access to help, views on climate change). All of this suggests that 'a one size fits all' approach will not work (Smit & Pilifosova, 2003). To effectively straddle the fine line between insufficient oversight and a bureaucratic morass, producers and their organizations, both regional and international, should be actively involved in developing the rules and regulatory frameworks that guide the industry. Ultimately, formal policies initiated or

[19] http://www.eomf.on.ca/index.php?option=com_k2&view=item&id=295:carbon-offsets&Itemid=403&lang=en

managed by government agencies, should facilitate the local implementation of mitigation and adaptation strategies in rural spaces.

#5. Adaptive strategies should capitalize on existing or emerging public discourses, but should shape growth in the maple industry to meet sustainability goals.

As with other NTFPs, the respondents were clear that the maple industry has been enjoying a resurgence, partly based on the public's (re-)valuation of locally produced, sustainable foods. This provides a tremendous opportunity for industry development. However, increasing commercialization can increase pressure on the sector and lead to choices that are not sustainable in the long-term (Arnold, 2010). Sugarbush management and other aspects of the business should be evaluated in terms of increasing long-term adaptive capacity and resilience.

Finally, it is important to keep in mind that although maple syrup began as an Indigenous technology, today, very little is known about Indigenous producers, their location, methods, capacities, knowledges, etc. And, as outlined in our interviews and demonstrated by this survey, where only one respondent chose 'connection to my Aboriginal roots' as a reason for being involved in the maple industry, Indigenous peoples do not tend to participate actively in the settler organizations and venues. Further, settler governance structures, both formal and informal, are not always compatible with those prevalent in Indigenous cultures and do not acknowledge the distinct rights of Indigenous peoples within the Canadian Constitution. Thus, it cannot be assumed that strategies deemed to enhance sustainability within settler communities will necessarily meet Indigenous requirements. The development of appropriate strategies will necessarily require the active participation of Indigenous producers.

6.0 Acknowledgements

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