Impact of the 1998 Ice Storm on the Eastern Ontario Maple Syrup Industry: A Case Study of Natural Disaster Policy in Canada

Jennifer Kidon,
Graduate Student, Department of Agricultural Economics and Business
University of Guelph, Guelph, Ontario N1G 2W1
Email: jkidon@uoguelph.ca

and
Dr. Glenn Fox
Professor, Department of Agricultural Economics and Business
University of Guelph, Guelph, Ontario N1G 2W1
Email: fox@agec.uoguelph.ca

Presented at the Canadian Agricultural Economics Society Annual Meeting
Vancouver, B.C., June 1-3, 2000

Funding for this project has been provided under the Canada-Ontario agreement for the Ice Storm Economic Recovery Assistance Program, Annex A, Assistance for the Agricultural Sector and Rural Communities in Eastern Ontario. This program is jointly funded by the Government of Canada and the Government of Ontario

Abstract

Under Canada's Disaster Financial Assistance Arrangements (DFAA), the federal government can provide provinces with funds for emergency response and recovery in the event of a natural disaster. This assistance has historically been provided on an ad hoc basis. In recent years, the amount of DFAA assistance has significantly increased without any auditing to determine how effective and efficient these expenditures are in offsetting economic losses due to natural disasters. The goal of this paper is to examine the implications of natural disaster compensation and assistance programs for economic efficiency. A framework is developed to determine if government assistance expenditures have offset economic losses to a specific industry using a case study of the 1998 ice storm and the eastern Ontario maple syrup industry. Projections of damage recovery are used to measure the economic impact of the storm, and a comparison is then drawn between the change in producers' welfare and government assistance. The implications of the findings for the case study and for future natural disaster assistance programs in Canada are discussed.

1.0 Introduction

1.1 The 1998 Ice Storm

Between January 4th and 10th of 1998, freezing rain, ice pellets and snow fell on over 600,000 hectares of land in eastern Ontario from the Quebec and United States borders west to Kingston (Lautenschlager and Nielsen, 1999). The hardest hit area in Ontario was within a 20-kilometer to 50-kilometer radius of the Kemptville-Winchester area, although damage was quite variable at a local scale (Irland, 1998). Freezing precipitation is caused by a relatively cool layer of atmosphere below a warm layer that supercools the liquid water in the warm layer above. This phenomenon is known as a temperature inversion. It does not usually last more than a few hours and therefore, the six days in January 1998 during which this inversion endured is considered a rare event (Kerry *et al.*, 1999). Eastern Canada is more prone to ice storm events because the arctic and maritime air masses tend to meet more frequently (Kerry *et al.*, 1999). The event in January 1998 was extraordinary in that it lasted for a number of days, created a thick accumulation of ice and affected a large area, including New York, New England, Ontario, Quebec and the Maritime provinces (Kerry *et al.*, 1999).

The freezing rain created an ice accumulation ranging from 40 mm to over 100 mm in the affected area in Ontario. Approximately 50% of this area is either broadleaf forest or mixed forest (Statistics Canada (c), 1998). The heavy ice accumulation caused branches and whole trees to snap and break under stress. The ice damage impacted a large number of maple bush owners in the area. Approximately 285,000 maple taps in Ontario were located in areas affected by the ice storm (Statistics Canada (c), 1998). Other agricultural industries that were impacted by this ice storm were livestock producers, orchard owners, greenhouse operators and dairy farmers (Statistics Canada (c), 1998).

1.2 The Maple Syrup Industry in Eastern Ontario

Pure maple syrup is a unique product and can only be produced in specific climates. Sugar maple (*Acer saccharum*) and Black Maple (*Acer nigrum*) are the preferred species for maple syrup production because they produce the sweetest sap, but sugar maples tend to be more abundant (Chapeskie, 1997). Sugar maples are found in eastern Canada from Manitoba to the Maritimes and in the northeastern United States.

Maple trees are tapped in late winter or early spring when temperatures fall at night, but increase significantly during the day (usually below and above freezing). Trees are fitted with spouts to draw out the sap and sap is collected either by buckets or a tubing system which converges at the sugarhouse. The collected sap is then put into an evaporator pan which heats the sap in order to evaporate off the water, leaving a thick, sweet syrup. Once the syrup has reached the desired sugar content, colour and flavour, it is ready to be packaged and sold.

Pure maple syrup is a unique product but has many close substitutes (imitation syrup, corn syrup, honey, etc.). Kolodinsky *et al.* (1994) found that syrup consumers are quite sensitive to price. Pure maple syrup is a normal good and is often much more expensive than its substitutes, thus it is often marketed as a luxury product to differentiate it from imitation syrup.[1] The marketing of pure maple syrup has also begun to focus on the natural aspects of the product and the potential for the rural tourism market. (Hinrichs, 1995; Agriculture and Agri-Food Canada, 1999).

In 1997, the province of Quebec produced 70% of the world's maple syrup, while the United States and Ontario accounted for 23% and 6% respectively (Quebec Maple Syrup Producers' Federation, 1999). The remaining 1% was produced by other Canadian provinces,

[1] It has been shown that an increase in income shifts the demand for pure maple syrup more so than for imitation syrup (Kolodinsky *et al.*, 1994)

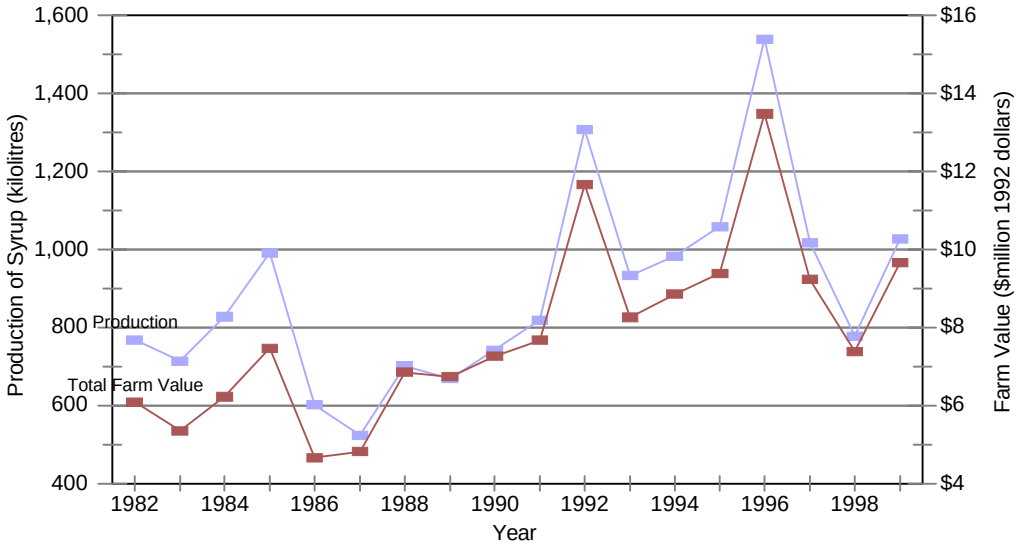
mainly New Brunswick and Nova Scotia. Over the last 10 years, these proportions have not varied significantly (Quebec Maple Syrup Producers' Federation, 1999).

Ontario's production of maple syrup accounts for approximately 8% of Canadian production (Agriculture and Agri-Food Canada, 1998). Figure 1 illustrates that the volume and value of maple syrup production in Ontario has been somewhat variable from year to year. This may partly be explained by the fact that maple syrup yield strongly depends on the weather conditions of the current and previous years (Bergeron and Sedjo, 1999). There are roughly 2,000 maple producers in Ontario who tap approximately 8,000 hectares of sugar bush per year (Chapeskie, 1997). Over the last ten years, the average operation in Ontario has consisted of only slightly more than 500 taps and most operations are in the range of 500 to 3,000 taps (Chapeskie, 1997).

In Ontario, approximately 90% of the maple syrup that is produced is sold by retail at the farm, while the rest is wholesaled in bulk to packers and distributers (McKibbon, 1989).

In 1996, the counties of eastern Ontario accounted for 19% of the total maple production

Figure 1: Production and Value of Maple Syrup Production
Province of Ontario, 1982-1999



in Ontario (Statistics Canada, 1996 Census data). Therefore, eastern Ontario accounts for a very small proportion (approximately 1%) of total North American maple syrup production. Within eastern Ontario, Lanark county and the united counties of Leeds and Grenville have continued to be the largest producers of maple products. In the past ten years, Lanark has accounted for approximately 30% of eastern Ontario maple production, while Leeds and Grenville united counties have produced just over 15% of the region's maple syrup.

1.3 1998 Ice Storm Damage and Maple Syrup Production in Eastern Ontario

Maple trees in sugar bushes are more vulnerable than their natural stand counterparts to ice storm damage because the crowns of sugar maples in managed forests tend to grow larger (Statistics Canada (c), 1998). The size of the tree crown, which is determined by the amount of branches and limbs on the tree, is positively related to total sap and sugar production (Moore *et al.*, 1952; Morrow, 1955; Blum, 1971).[2] Therefore, the loss of limbs caused by the ice storm will likely contribute to a reduction in sap production until the trees have recovered from the damage (Kerry *et al.*, 1999). In the 1998 maple season following the storm, maple syrup production was reduced by approximately 25% (Harris, 1998). Along with a reduction in the trees' ability to produce sap, the plastic tubing that is often used to collect sap from trees was damaged by ice accumulation. Because of safety concerns, many maple bushes were unaccessible when the sap began to flow in February. All of these factors significantly reduced maple syrup output in the spring of 1998 and the effects of the tree damage will continue to be a factor in the future (Kerry *et al.*, 1999).

Due to the uniqueness of the 1998 ice storm, there is little information on expected rates of recovery, mortality and biological responses of the trees to this type of damage. A number of

[2]Sap volume yield and total sugar production together determine the volume of syrup that can be produced.

forestry studies have examined the impact of ice storm damage on stem densities, canopy cover, basal area, and forest community structure (Seischab *et al*, 1993; De Steven *et al*, 1991; Melacon and Lechowicz, 1986), but none relate crown damage to syrup yield. Thus, there is considerable uncertainty regarding the anticipated biological effects of the storm damage on maple syrup production in eastern Ontario.

There is some literature which describes generally the effect of damage on maple trees which may be important for estimating the impacts of the 1998 ice storm. Kolb *et al.*(1992) found that an increased level of insect damage to maple trees reduced the yield of syrup per tree. Smith and Shortle (1998) estimate that maple trees which suffer more than 75% crown loss will not survive. Trees with 50-75% crown loss are expected to survive, but increased infection and growth suppression are likely (Smith and Shortle, 1998).

Following the 1998 ice storm, a few estimates regarding the recovery of maple trees were put forth, but these were not specific to any damage class or location. A representative of the Maple Syrup Producers' Federation in Quebec noted that would probably take 5 years to recover to the level of tapping before the storm (Ireland, 1998). Some maple operations may take15 to 20 years before fully recovering from the effects of the storm (Harris,1998). A representative from the Ontario Maple Syrup Producers' Association estimated that it could take 30 to 40 years before maple production in eastern Ontario returned to normal levels (Soulard *et al.*, 1998). These estimates indicate a wide range of expected recovery periods and may reflect variation in location or damage class. Dave Chapeskie, an agroforesty expert in eastern Ontario, estimates that full recovery for trees with 26-50% crown damage will take place in 5 to 15 years (personal communication, July 28,1999). It is important to emphasize that these projections are based on the assumption that recovery is taking place with favourable weather conditions and that the trees were relatively healthy at the time of the storm. The quality and quantity of sap produced by trees

depends not only on the weather during the year of harvest, but also on the weather of preceding years (Bergeron and Sedjo, 1999). Thus, accurately estimating the rate of recovery of syrup production for maple trees that were damaged by the ice storm becomes difficult in light of these complications.

1.4 Government Response to the 1998 Ice Storm

The severity and scope of the 1998 ice storm resulted in provincial damage losses and recovery costs being eligible for Canadian Federal Disaster Financial Assistance Arrangements in which the federal government shares disaster costs with affected provinces (Emergency Preparedness Canada (a), 1998). A number of joint federal and provincial assistance programs were available to maple producers in eastern Ontario. In total, it is anticipated that the Government of Canada will contribute $582 million to ice storm recovery programs in Ontario, Quebec and the Maritimes (Emergency Preparedness Canada (a), 1998). A brief description of each of the assistance programs that were available to maple producers in Ontario are in Table 1. The government of Ontario has also provided technical assistance to farmers through the Ontario Ministry of Agriculture, Food and Rural Affairs and the Ontario Ministry of Natural Resources.

The Ontario Ministry of Agriculture, Food and Rural Affairs co-ordinated a damage assessment program in which trained technicians conducted damage assessments of individual maple bushes (Lake, 1999). These assessments were used to formulate post-storm management guidelines and to distribute government compensation for damages. Guidelines for the tapping and pruning of ice-damaged trees were made available to landowners. These guidelines included safety considerations and suggested conservative levels of tapping for different classes of damage (Ontario Ministry of Agriculture, Food and Rural Affairs, 1998).

Table 1: Government Ice Storm Assistance Programs Available to Maple Producers in Eastern Ontario

Ice Storm Assistance Program	Description
Eastern Ontario Disaster Relief Assistance	• funded by O.M.A.F.R.A and Agriculture and Agri-food Canada through the federal Disaster Financial Assistance Arrangements • financial assistance for clean-up, replacement of pipelines, damaged or lost maple trees
Canada-Ontario Business Recovery Assistance Program	• available to small and medium-sized businesses, including the agri-tourism business • financial assistance to restore economic activity
Human Resources Development Canada Clean-up Assistance	• clean-up crews were made available through Human Resources Development Canada for clean-up of debris in maple bushes
Forest Recovery Assistance Program	• governments of Canada and Ontario provided financial assistance to woodlot owners who were not compensated under the Disaster Financial Assistance Arrangements (Eastern Ontario Disaster Relief Assistance)
Farm Credit Corporation Loan	• funded by O.M.A.F.R.A. and Agriculture and Agri-Food Canada • first year-and-a-half interest on a two-year loan is paid by government to help producers make purchases to restore maple operations

1.5 Purpose and Outline of the Paper

In 1998 following the ice storm, Zachariah (1998) (O.M.A.F.R.A) developed a preliminary method for determining the net present value of production loss experienced by a maple producer because of the storm damage. The net present value of a productive maple tree was calculated in the absence of the ice storm and with three levels of ice storm damage (Light,

Moderate and Severe)[3]. The difference between the values with and without the ice storm damage multiplied by the number of trees was the estimated value of loss to a maple producer because of the storm. This analysis did not include maintenance costs or costs of replacement trees. Expert opinions and forecasts were used to estimate prices, the sap/syrup output from trees after the storm and the reduction in the number of taps and the number of lost trees (died or removed). The results of the analysis suggest that there is no net present value loss for trees with less than 10% crown loss, a $6.18 - $9.28 net present value loss per tree if crown loss is between 15-50%, and a $22.41 - $33.62 net present value loss per tree if crown loss is over 50%[4]. This analysis was not aggregated to the industry level.

The subject of this paper is a component of a project co-ordinated by the Ontario Ministry of Agriculture, Food and Rural Affairs, the Ontario Ministry of Natural Resources, the Canadian Forestry Service and the University of Guelph. The project is part of the Canada-Ontario Ice Storm Economic Recovery Assistance Program which is jointly funded by the Government of Canada and the Government of Ontario. The objectives of the maple production component of this project are to examine the economic feasibility of post-storm management options, to conduct a regional economic analysis of the ice storm impacts and to examine the policy implications of government responses to the ice storm.

The anticipated negative impacts of the ice storm damage on maple trees' ability to produce syrup implies that maple producers in eastern Ontario will experience economic losses. The purpose of this paper is to develop a preliminary analysis to characterize the losses

---

[3] The damage categories used were Light (<10% crown loss) Moderate (15-50% crown loss) and Severe (>50% crown loss). These categorizations differ from those used in the current analysis; Light (0-25%), Moderate (26-50%) and Severe (51-75%).

[4]The planning horizon for this analysis was 20 years (this was the estimated maximum period over which the ice storm is expected to affect maple production) and an 8% discount rate was used.

experienced by representative eastern Ontario maple producers. The average amount of financial assistance available to maple producers will be compared to the economic losses in order to determine if the assistance has offset these losses. This analysis will be important to examine the cost-effectiveness of different post-storm management options in response to the ice storm damage. The current analysis differs from that formulated by Zachariah (1998) in that it incorporates specific changes in revenues and costs incurred by producers, survey data on changes in production levels and activities since the storm and updated expert forecasts of recovery.

2.0 1998 Ice Storm Eastern Ontario Maple Syrup Producers Survey

2.1 Methods

A telephone survey questionnaire was conducted in order to investigate some of the consequences of the 1998 ice storm damage for maple producers in eastern Ontario. The questionnaire included questions concerning size of the operation and production techniques used. Producers were asked to report their pre- and post-storm production levels, their participation in government assistance programs and remedial actions and changes made to maple operations following the ice storm. Maple producers were also asked to report the percent crown damage rating for their maple bush which was assessed by O.M.A.F.R.A technicians. The last three questions of the questionnaire asked producers to comment on any other important impacts of the ice storm, the implementation of assistance programs and the role of the Ontario Maple Syrup Producers' Association in ice storm projects.

A list of producers' names and addresses was made available by the Ontario Maple Syrup Producers' Association. In order to interview producers equally from a range of damage levels, addresses were categorized into one of four damage classes; Light, Light-Moderate, Moderate and Moderate-Severe according to the Canadian Forestry Service map of ice storm damage to

hardwoods (http://www.mnr.gov.on.ca/mnr/csb/news/feb10fs98.html). Twenty-five producers from each of the four damage classes were randomly chosen and contacted by phone by a research associate during August 1999. Due to the nature of the ice storm, damage was locally variable, and the percent crown damage assessments reported by individual producers often did not correspond to the damage category based on the Canadian Forestry Service map and the geographic location of the bush. Therefore, each producer was re-categorized according to his or her reported crown damage assessment into one of three classes; Light (0-25% crown damage), Moderate (26-50% damage) and Severe (51-75%)[5]. Three responses were removed from the data set because producers were unable to provide complete information. The data were analyzed over all damage classes and for each damage class.

2.2 Results

2.2.1 Aggregate Results

In total, 56% of the 97 producers that were interviewed used buckets to collect sap, while the remaining 44% used a pipeline system. Of the 97 producers interviewed, 16% reported damage assessments in the Light category, 39% were in the Moderate category and 41% were in the Severe category. These results are similar to the proportions found by the Ice Storm Tree Assessment Program in Ontario in which 10% of producers were in the Light category, 40% in the Moderate category, and 51% in the Severe category (Lake, 1998)[6]. Only 3 producers in the

[5]These damage categories were chosen to be consistent with other ice storm research projects.

[6]277 maple bushes in total were assessed for ice storm damage by this program.

survey reported a damage rating greater than 75% (the Very Severe category), so this category was not analysed.

With respect to participation in the government assistance programs, 86% of all producers had O.M.A.F.R.A. tree assessments conducted, while 65% received Eastern Ontario Disaster Relief Assistance. 29% of producers took part in either the Farm Credit Corporation Loan program, the Canada Ontario Business Recovery Assistance program, or the Forest Recovery Assistance Program. 70% of the producers surveyed used Human Resources Development Canada crews to assist in the post-storm cleanup of their bushes. A summary of these results is presented in Table 2.

Table 2: Survey Producer Participation Rates in Government Assistance Programs Available to Maple Producers

Government Assistance Program	**Producer Participation [1]**
O.M.A.F.R.A. Tree Assessments	87%
Human Resources Development Canada clean-up	70%
Eastern Ontario Disaster Relief Assistance	65%
Forest Recovery Assistance Program	13%
Canada-Ontario Business Recovery Assistance	10%
Farm Credit Corporation loan	6%

Note: [1]Percentage of the 97 producers that reported participating in each program.

26% of the producers interviewed reported that the assistance programs and government

funding were essential to the recovery of their operation. 26% indicated that the assistance was helpful and that cleanup would have taken significantly longer without it, but that they could have managed without. The remaining 48% either reported that the assistance was not necessary, or had no comment.

The main responses of maple producers in the two seasons following the ice storm were to use fewer taps per tree, which 64% of producers did, and to tap fewer trees, which 46% of producers did. 32% of producers responded to the damage by tapping new trees, mainly younger trees or trees on other plots of land which had not been tapped before the ice storm. 16% of the producers that were surveyed leased additional land for tapping in order to make up for the decrease in production in their own bush. A few operators reported arranging a casual agreement with other land owners to exchange syrup for the use of their trees.

2.2.2 Damage Class Results

Production data were separated into each of the three damage classes and averaged. The results are presented in Table 3. The changes in production cannot be wholly attributed to the biological effects of the ice storm because pre- and post-storm management techniques play an important role in determining production levels (D. Chapeskie, personal communication, 1999). These results suggest that there was a substantial decrease in syrup yield per tap in 1998, but also that there was also a significant recovery in 1999.

Table 3: Average Annual Yield of Syrup per Tap for each Damage Class in a Normal Production Year, 1998 and 1999.

Damage Class	No. of producers	Average no. of taps/ operation[1]	Syrup Yield Levels				
			Normal Year	1998		1999	
			Yield (L/tap)	Yield (L/tap)	% reduction in yield	Yield (L/tap)	% reduction in yield
Light (0-25%)	16	880	0.53	0.38	28%	0.48	9%
Moderate (26-50%)	38	1,225	0.74	0.40	46%	0.63	15%
Severe (51-75%)	40	1,605	0.92	0.36	61%	0.61	34%

Note: Improvements in efficiency with larger operations tends to improve the yield, which may explain why the average yield for a normal year increases with damage class (Dave Chapeskie, Personal communication, 1999). In addition, smaller operations use bucket systems more often than larger operations, which also results in lower average yields (North American Maple Syrup Producers Council, 1996)

It is not known why the average operation size increases with the damage class. It may be that trees were better managed and therefore developed larger crowns in larger operations, making the trees more susceptible to ice storm damage.

[1] The operation sizes in the survey results fall within the average size of an Ontario maple operation which is 500-3,000 taps (Chapeskie, 1997)

3.0 Ice Storm Capital Budget Analysis

3.1 Methods

3.1.1 Structure of the Capital Budget Analysis

A capital budget analysis was developed to measure the economic losses to representative maple producers due to the 1998 ice storm damage. Budgets for six representative producers

were formulated; two sizes of maple operations (1,000 taps and 3,000 taps)[7] with each of the three damage classes (Light, Moderate and Severe). A comparison of two corresponding budgets, with and without the ice storm impacts, allows for a calculation of the net present value of losses due to the storm. Cost of establishment and operating cost data collected by the Ontario Ministry of Agriculture, Food and Rural Affairs, the Canadian Farm Business Council and the Ontario Maple Syrup Producers Association were used to develop and calibrate the baseline budget.

Establishment costs of maple production include sap collection equipment, sap and syrup tanks, evaporator equipment, packaging equipment, tools and structures/buildings. Annual operating costs include labour for sap collection, processing and maintenance, syrup processing materials, fuel, electricity and other expenses such as advertising and tap rental. Total revenues from a maple syrup operation are from the sale of maple syrup. It is assumed that the real price of maple syrup will be constant at $12.76 per litre during the recovery periods.[8]

Other inputs to the budget analysis include a capital depreciation rate, income tax rate(s), a discount rate and average age of equipment in the first year of the analysis (1998). The per unit operating and capital cost estimates used in this analysis are in real terms and are assumed to be constant over time.[9] Therefore the discount rate and tax rates are also in real terms. A 10% depreciation rate was used (O.M.A.F.R.A., Canadian Farm Business Council, 1999). The federal nominal income tax rates are 17% (for incomes less than $29,590) and 26% (for incomes less than $59,180). In addition, there are provincial taxes, so the marginal tax rates applied in this analysis

[7]These two operation sizes were chosen because they best describe the typical range of operation size in eastern Ontario (Dave Chapeskie, personal communication, April 2000)

[8]This price was the average price for retail syrup, wholesale and bulk syrup sold by maple producers in Ontario (Canadian Farm Business Management Council and O.M.A.F.R.A).

[9]Real terms in this paper refer to real 1998 dollars.

are 25% and 50%, respectively. For the purposes of this analysis, producers are categorized into tax brackets according to their maple income only.[10] A 5% real discount rate is used. Lastly, it is estimated that the average age of maple operation equipment in 1998 was 5 years. These inputs will be the same for each representative producer scenario, therefore it is unlikely that their value will significantly affect the difference between the net present value of cash flows with and without the ice storm, which is the focus of this analysis.

Appendix A contains a descriptive list of the inputs, establishment costs and operating costs for the capital budget analyses. The planning horizon for the capital budgets is the time period in which the trees are expected to fully recover from the ice storm damage.

3.1.2 Analysing the Impact of the Ice Storm

Ice storm damage will affect both the revenues and costs for a representative maple operation.

An important input into the capital budget analysis is the estimated annual yield of syrup per tap. The average yield of syrup for Ontario maple production is 1 litre per tap (Chapeskie, 1997). The yield of syrup per tap affects total revenue because it determines the total amount of syrup produced and sold per operation. Some operating costs such as evaporator fuel costs and packaging costs are dependant on total syrup production per operation. Because the yield of syrup per tap is expected to be adversely affected by the ice storm damage through a reduction in crown size and potentially an increase in decay, disease and mortality, total revenues and some operating costs for a given operation will also be affected.

The future yield of syrup per tap following the ice storm is difficult to predict given the

[10] This is probably not an accurate assumption since maple production is often used to supplement other farm income, or is done on a hobby basis. Nonetheless, the income tax rate is constant across all permutations of the capital budget analysis, so it will likely not significantly influence the comparison between the budgets with and without the ice storm impacts.

uniqueness of the 1998 ice storm and the lack of information specifically relating ice storm damage to maple syrup yield. Therefore, the annual syrup yield per tap during the recovery period was forecast using the results of the survey and estimates of recovery times for damaged maple trees. For this preliminary analysis, it is assumed that for each damage class, the yield of syrup per tap will recover from the 1999 value (from the survey data) in a linear projection up to the estimated full recovery time, at which point the yield returns to its pre-storm level (1 litre per tap). The estimates for these parameters are presented in Table 4.

Table 4: Estimates of Total Recovery Time and Percentage Reduction in Syrup Yield in 1999 for the Three Damage Classes

Parameter	**Light**	**Moderate**	**Severe**
	Estimate	**Estimate**	**Estimate**
Total Recovery Time[1]	5 years	10 years	20 years
Survey Estimate of % Reduction in Syrup Yield (L/tap) in 1999 [2]	9%	15%	34%

Notes: [1]These values were generalized from available literature, the survey results, and discussion with forestry and maple specialists. Estimated recovery time beginning in 1998.
[2] It is assumed that the pre-storm syrup yield is 1 litre per tap.

Maple producers in eastern Ontario may experience increases in operating costs following the ice storm because of the need for additional bush maintenance, equipment maintenance, thinning and pruning. Falling debris from damaged branches needs to be removed so that the sugarbush is accessible and safe for tapping activities. Damaged trees may require additional pruning to remove broken limbs or whole trees may need to be removed if the damage is severe enough. Some equipment may require additional repair because of breakage from the ice accumulation.

Some producers may also experience an increase in capital costs following the ice storm.

Damage to pipelines, buildings and equipment because of ice accumulation may require partial or complete replacement of these structures.

Estimated changes in operating and capital costs will influence maple producers' annual cash flows during the recovery period. These changes are described for each of the representative producers in Table 5. These costs were generalized from discussion with maple experts, representatives from the industry and from the results of the survey questionnaire.

Many producers who were interviewed in the survey reported reducing the number of taps in their operation in the 1998 and 1999 seasons. However, on average, producers in each of the damage classes planned to return to pre-storm tapping levels in the 2000 season. Most operating costs depend on the number of taps, therefore estimates of the reduction in the number of taps are also included in Table 5.

Table 5: Description of Capital Budget Cost Changes with the Effect of the Ice Storm Damage for each of the Six Eastern Ontario Representative Producers

Representative Producer		Changes in Operating Costs	Changes in Capital Costs
1,000-tap operation	Light	- additional bush maintenance[1] for 2 years (50 hours/year) - tap 900 taps in 1998, 920 in 1999 and 1,000 thereafter	
	Moderate	- additional bush maintenance for 4 years (100, 100, 50, 50 hours/year) - pipeline repair in 1998 and 1999 (an additional 18 hours) - tap 600 taps in 1998, 850 in 1999 and 1,000 thereafter	- replacement/expansion of pipelines in 1999 (additional 1200 ft; 50 taps)
	Severe	- additional bush maintenance for 6 years (150, 100, 100, 50, 50, 50 hours/year) - pipeline repair in 1998 and 1999 (an additional 18 hours) - tap 550 taps in 1998, 610 taps in 1999 and 1,000 thereafter	- replacement/expansion of pipelines in 1999 (additional 2400 ft; 100 taps) - expansion of roadways in 1999 ($200)
3,000-tap operation	Light	- additional bush maintenance[1] for 2 years (150 hours/year) - tap 2,700 taps in 1998 and 2,760 in 1999, 3,000 thereafter	
	Moderate	- additional bush maintenance for 4 years (300, 200, 100, 100 hours/year) - pipeline repair in 1998 and 1999 (an additional 54 hours) - tap 1,800 taps in 1998, 2,250 in 1999 and 3,000 thereafter	- replacement/expansion of pipelines in 1999 (additional 3600 ft; 150 taps)
	Severe	- additional bush maintenance for 6 years (500, 200, 150, 150, 100, 100 hours/year) - pipeline repair in 1998 and 1999 (an additional 54 hours) - tap 1,650 taps in 1998, 1,830 taps in 1999 and 3,000 thereafter	- replacement/expansion of pipelines in 1999 (additional 7200 ft; 300 taps) - expansion of roadways in 1999 ($200)

[1] Additional bush maintenance refers to sugarbush clean-up of debris, thinning and pruning, removal of trees, etc.

3.2 Ice Storm Capital Budget Analysis Results

The economic impact of the ice storm on a representative maple producer is measured by the difference in the net present value of cash flows under conditions without the ice storm damage compared to the estimated conditions with the storm. This measurement of economic impact is reported the third column of Table 6 for each representative producer.

Table 6: Net Present Value of Losses due to the Ice Storm Damage and the Average Financial Assistance Available for Each Representative Maple Producer

Representative Producer		**NPV of cash flows[1] without the ice storm**	**NPV of cash flows[1] with the ice storm**	**Loss in NPV of cash flows due to storm**	**Average Financial Assistance[2]**
1,000 tap operation	Light	$21,861	$16,282	$5,579	$8,640 - $9,890
	Moderate	$37,880	$24,085	$13,795	$13,068 - $14,268
	Severe	$59,111	$26,495	$32,616	$17,168 - $18,368
3,000 tap operation	Light	$83,584	$67,967	$15,617	$25,920- $37,096
	Moderate	$147,084	$107,122	$39,962	$46,927- $57,657
	Severe	$233,237	$140,232	$93,005	$66,654 - $77,383

Notes: [1] Net Present Value of cash flows during the estimated recovery period (Table 4, above) for each damage class, starting in 1998.

[2] The range of values for financial assistance corresponds to the range of percentage crown loss in each damage class (ie. 25-50% for the Moderate class). The C.O.B.R.A program and the Farm Credit Corporation Loan program are not included in this amount because information regarding this assistance to maple producers is unavailable. The survey results suggest that these two programs were used by a only small proportion of maple producers in eastern Ontario. It is assumed that each representative producer was eligible for the Eastern Ontario Disaster Relieve Assistance and therefore was not eligible for the F.R.A.P. assistance.

The last column of Table 6 reports the average potential direct financial assistance available to each of the representative producers (Appendix B). These were calculated from preliminary data regarding assistance programs and assuming representative producers receive the

maximum amount available for their size and damage class. Typically, producers received assistance sometime between 1998 and 1999.

4.0 Conclusions

The net present value of production loss is greater in this analysis than the preliminary results calculated by Zachariah (1998). Assuming on average there are 2 taps per tree[11], the loss per tree is approximately $10.80/tree for 0-25% crown damage, $27.10/tree for 26-50% crown damage and $63.60/tree for 50-75% crown damage. Conversely, Zachariah found net present value losses for similar damage classes around one-third of these values. Zachariah's analysis did not account for any changes in costs due to the ice storm, thus this could account for the difference in estimates of the economic impact on maple syrup production.

For the Light damage category, producers in either size class may have been given assistance in excess of their expected economic losses due to the ice storm. Conversely, for both of the representative producers in the Severe category, assistance may not have been sufficient to offset the expected impact of the ice storm damage, although not all assistance programs have been accounted for in this analysis. Producers in the Severe category may have received Canada-Ontario Business Recovery Assistance and/or Farm Credit Corporation loans which would have provided additional assistance. For representative producers in the moderate class, the assistance may have offset losses for producers with 1,000 taps, but may have been in excess of economic losses for producers with 3,000 taps.

These results suggest that the government financial assistance programs may not have exactly offset the expected economic losses experienced by maple producers in eastern Ontario due to the ice storm damage. The results indicate that producers in the Light category may have been overcompensated, while producers in the Severe category may have been under-

[11] This is a typical number for the average number of taps per tree (North American Maple Syrup Producers, 1996)

compensated.

This may have implications for the design of future compensation and assistance programs. It may be necessary to formulate assistance programs such that they are more dependant on the level of damage or are only applied above a certain threshold damage level, in order for assistance to more closely offset economic losses.

5.0 Further Research

The analysis of this paper is based on preliminary estimates of the biological recovery of maple trees and changes in costs following the ice storm. These forecasts will be updated as data from other ice storm research projects and expert opinions become available. A sensitivity analysis will also be conducted to examine the influence of varying estimates of recovery times, yields and post-storm costs on the results. The amount of direct financial assistance to representative maple producers may also be updated as this information is still being compiled.

The next step in the research project is to aggregate the producer-level budget analysis to the industry-level. The total impact of the ice storm damage on the eastern Ontario maple industry will be estimated and compared to total government expenditures on assistance to this industry. A literature review examining the economic problems related to natural disaster policies, compensation and assistance programs will also be conducted. The results of this study will help to guide efficient and cost-effective government disaster assistance programs in the future.

Appendix A: List of Capital Budget Inputs

Inputs

Number of taps in each year

Real annual syrup prices

Depreciation rate

Real Discount rate

Real Marginal Income tax rates

Average age of equipment

Estimated maple syrup yield per tap for each year during the recovery period

Establishment Costs

PIPELINE EQUIPMENT:
Posts
Wire
Pipe
Wire Ties
Manifolds
Tubing
Spiles
Fittings
Valves
Installation

BUCKET EQUIPMENT:
Buckets
Spiles
Lids
Gathering Pails
Gathering
Tank Trailers
Bucket Washer

VACUUM EQUIPMENT:
Pumps
Extractor
Valves
Misc Hardware
Installation

TANKS:
Sap Tanks
Pumps
Sap Filter
Valves
Misc Hardware
Installation

EVAPORATOR EQUIPMENT:
Reverse Osmosis (R.O.)
Evaporator
Finisher
Filter Tank
Filter Press
Level Arm
Controller
Refractometer

Establishment Costs continued

Refractometer

PACKAGING EQUIPMENT:
Canning Unit
Thermometer
Transfer pump
Barrels
Barrel Dolly
Installation

MISCELLANEOUS TOOLS:
Gas Tapper
Tubing Tools
Wire Tools
Bush Tools
Camp Tools
Tube Washer

STRUCTURES:
Evaporator & R.O. building
Tank House
Pump House
Storage Shed
Bucket Storage Shed
Bucket Washing Facility
Services- Hydro
Washrooms, Etc.
Well
Roadways, Signs
Snowmobile
All Terrain Vehicle

Operating Costs

LABOUR PIPELINE:
Tapping
Pulling Spiles
Leak Test Pipeline
Washing Bush Pipes
MAINTENANCE LABOUR:
Pipeline Maintenance
Equipment Maintenance
Building Maintenance
Bush Maintenance
LABOUR BUCKETS:
Tapping
Hanging Buckets
Pulling Taps
Washing/Storing Buckets
Sap Collection
PROCESSING COSTS & LABOUR:
R.O.Operation
Boiling Time without R.O.
Boiling Time with R.O.
Cleaning During Season
Canning
Washing Evaporator
Sales Retail
FUEL AND MATERIALS:
Oil
Propane
Wood
R.O. Electricity
Electricity(Other)
Syrup Filters
R.O. Chemicals
Pipleline Cleaner
Pan Cleaner
Packaging
OTHER EXPENSES:
Pipe Repair materials
Machine Repair materials
Building Repair materials
Custom Work
O.M.S.P.A. Fees
Truck Sap Pickup
Trucking Syrup
Advertising
Tap Rental

Appendix B - Preliminary Estimates of Direct Financial Assistance to Representative Maple Producers

1. Eastern Ontario Disaster Relief Assistance (Disaster Financial Assistance Arrangements):

a) Reimbursement for clean-up costs are up to $8/tap if work is done by the operator, or up to $12/tap if work is contracted out, with a maximum of 55 taps/acre. Reimbursement is based on actual receipts or estimates for work completed. The suggested guideline for clean-up costs are $3.64/tap for Light damage, $6.36/tap for Moderate damage and $9.09/tap for Severe damage.

b) Reimbursement for damaged equipment is based on actual receipts of replacement costs and labour up to a maximum of $8.50/tap for material and labour. There is a 10% depreciation rate applied to equipment and labour when the equipment is 100% replaced (ie. there is no depreciation on the repair of equipment and associated labour)

c) Reimbursement for tree loss is based on the formula:
(declared maple income in 1996/97÷$8.50) × $25 × (% crown loss) = Assistance ($)

(Estimated before-tax maple income is $1,700 {1,000 taps} & $15,200 {3,000 taps})

For a 1,000-tap operation:

a) Light ($3,640), Moderate ($6,360), Severe ($9,090)
b) Light ($0), Moderate ($408), Severe ($528)
c) Light ($1,700÷8.50 ×$25 ×0-25%) = $ 0 - 1,250
Moderate ($1,700÷8.50 ×$25 × 26-50%) = $1,300 - 2,500
Severe ($1,700÷8.50 ×$25 × 51-75%) = $ 2,550 - 3,750

For a 3,000-tap operation

a) Light ($10,920), Moderate ($19,080), Severe ($27,270)
b) Light ($0), Moderate ($1,224), Severe ($1,584)
c) Light ($15,200÷8.50 ×$25 × 0-25 %) = $ 0 - 11,176
Moderate ($15,200÷8.50 ×$25 × 26-50%) = $ 11,623 - 22,353
Severe ($15,200÷8.50 ×$25 × 51-75%) = $ 22,800 - 33,529

2. Canada-Ontario Business Recovery Assistance (C.O.B.R.A):

The average assistance provided to businesses under the C.O.B.R.A. program was $4,335 per business. There is no information currently available describing the amount of C.O.B.R.A. assistance that went to maple producers.

3. Farm Credit Corporation Loan:

The government pays for the first 1.5 years of interest on a 2-year loan. Minimum loan amount is $5,000 and the maximum loan amount is $50,000. There is no information currently available regarding loans or interest payments to maple

producers.

4. Human Resources Development Canada (H.R.D.C) clean-up crews:
   An estimated $1.5 million was spent on clean-up crews in maple syrup bushes. Approximately 300,000 taps were affected by the ice storm damage and therefore could potentially be eligible for clean-up crews. This averages $5/tap of paid labour for sugarbush clean-up activities.

   For a 1,000 tap operation: maximum $5,000 paid labour
   For a 3,000 tap operation: maximum $15,000 paid labour

5. Forest Recovery Assistance Program (F.R.A.P.)
   Maple producers who were not eligible for Eastern Ontario Disaster Relief Assistance could be eligible for F.R.A.P. assistance. No information is currently available regarding the amount of F.R.A.P. assistance that went to maple producers.

References

Blum, B. 1971. Some Correlations Between Sugar Maple Tree Characteristics and Sap and Sugar Yields. Northeastern Forest Experiment Station. USDA Forest Service Research Note NE-143. Pa.

Chapeskie, D. March 1997. The Maple Industry in Ontario: Answers to Commonly Asked Questions and References. Ontario Ministry of Agriculture Food and Rural Affairs. www.gov.on.ca/OMAFRA/english/crops/facts/maple.htm.

Chapeskie, D. Maple Orchards in Ontario. Maple-Erable CD ROM. 1998.

Chapeskie, D. Personal Communications. Agroforestry Specialist, Ontario Ministry of Agriculture, Food and Rural Affairs.

Coons, C.F. Sugar Bush Management for Maple Syrup Producers. 1992. Ontario Ministry of Natural Resources.

Emergency Preparedness Canada (a). Ice Storm 1998: Recovery Programs and Assistance to Victims. www.epc-pcc.gc.ca/epc/ice_storm.html. June 1999.

Emergency Preparedness Canada. Federal Disaster Assistance Arrangements. www.epc.ppc.gc.ca/epc/dfa.html. Oct. 1999.

Gray, F. The Maple Sweetener Situation- Trends and Prospects. August 1975. United States Department of Agriculture.

Harris, E. Struck Powerless. March/April, 1998. *Canadian Geographic*. 118(2): 38-43.

Hinrichs, C.C. Off The Treadmill? Technology and Tourism in the North American Maple Syrup Industry. 1995. *Agriculture and Human Values.* 12(1): 39-47.

Irland, L.C. Ice Storm 1998 and the Forests of the Northeast: A Preliminary Assessment. 1998. *Journal of Forestry*. 96(6): 32-40.

Iskow, J., Kolodinsky, J. and D. Russo. Summary of Research Results: An Economic Analysis of the Demand for Maple Syrup. February 1994. *Maple Syrup Digest.* Vol 6A (1)

Kerry, M., Kelk, G., Etkin, D., Burton, I., and S. Kalhok. January/February 1999. The Ice Storm of 1998. *Environment* 41(1): pg. 7-33.

Kolb, T.E., McCormick, L.H., Simons, E.E., and D.J. Jeffery. Impacts of Pear Thrips Damage on Root Carbohydrate, Sap, and Crown Characteristics of Sugar Maples in a Pennsylvania Sugarbush. 1992. *Forest Science.* 38(2): 381-392

Lake, Alison. June, 1999. Ontario's Tree Assessment Program. Facsimile transmission. Ontario Ministry of Agriculture, Food and Rural Affairs. Kemptville, Ontario.
Lautenschlager, R.A. Personal Communications. Forest Ecologist and Research Scientist. Ontario Forest Research Institute, Ontario Ministry of Natural Resources.

Lautenschlater, R.A. and Nielsen, Cathy. 1999. Ontario's forest science efforts following the 1998 ice storm. *The Forestry Chronicle*. 75(4): 633-641.

Lemon, P.C. 1961. Forest ecology of ice storms. *Bulletin of the Torrey Botanical Club.* 88(1): 21-29.

McKibbon, E.D. Maple Syrup Industry in Ontario- Factsheet. January 1989. Economics and Policy Coordination Branch, Ontario Ministry of Agriculture Food and Rural Affairs.

Melacon, S. and M.J. Lechowicz. 1986. Differences in the damage caused by glaze ice on codominant *Acer Saccharum* and *Fagus Grandifolia*. *Canadian Journal of Botany*. 65: 1157-1159.

Morrow, R.R. 1955. Influence of Tree Crowns on Maple Sap Production. Cornell University Agricultural Experiment Station, Ithaca Bulletin. 916.

North American Maple Syrup Council. Maple INFO Erable. Version 1.0, 1998. CD ROM. In cooperation with the Ontario Maple Syrup Producers Association and the Canadian Farm Business Management Council.

North American Maple Syrup Producers. North American Maple Syrup Producers Manual. Ohio State University Extension in Cooperation with the North American Maple Syrup Council. Edited by Melvin R. Koelling, and Randall B. Heiligmann. 1996.

Ontario Ministry of Agriculture Food and Rural Affairs. February 1998. Interim Guidelines for the Tapping and Restoration of Sugar Bushes Affected by the Ice Storm of January 1998. http://www.gov.on.ca/OMAFRA/english/crops/facts/infomapl.htm

Ontario Ministry of Agriculture Food and Rural Affairs. June 1999. Maple Syrup Economics Study: Draft. Produced under the auspices of the Canadian Farm Business Management Council and the Ontario Ministry of Agriculture Food and Rural Affairs.

Ontario Ministry of Natural Resources. Ice Storm 1998; Forest Health Monitoring Maps. http://www.mnr.gov.on.ca/mnr/csb/news/feb10fs98.html. February 1999.

Quebec Maple Syrup Producers' Federation. http://www.maple-erable.qc.ca/world.htm May, 1999.

Smith, K.T. and W.C. Shortle. 1998. Will winter storm injury affect hardwood quality and maple sap production? Ice storm 1998, Information Sheet #2. Northeastern Research Station, U.S.D.A. Forestry Service.

Statistics Canada. (a) Agricultural Profile of Ontario. Census of Canada. 1981.

Statistics Canada. (a) Agricultural Profile of Ontario. Census of Canada. 1986. Catalogue no. 96-108
Statistics Canada. (a) Agricultural Profile of Ontario. Census of Canada. 1991. Catalogue no. 95-356
Statistics Canada. (a) Agricultural Profile of Ontario. Census of Canada. 1996. Catalogue no. 95-177

Statistics Canada. (b) Production and Farm Value of Maple Products, 1982-1999. Catalogue No. 23-211 and Statistical Bulletin. www.gov.on.ca/omafra/english/stats/misc/maple.htm.

Statistics Canada. (c) The St. Lawrence River Valley 1998 Ice Storm: Maps and Facts. 1998. Catalogue no. 16F0081XIB.

Van Dyke, O. 1999. A Literature Review of Ice Storm Impacts on Forests in Eastern North America. Landmark Consulting.