A Profile of Lake States Maple Syrup Producers and Their Attitudes and Responses to Economic, Social, Ecological, and Climate Challenges

by

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INTRODUCTION

Maple syrup is an iconic as well as economically and culturally important non-timber forest product in North America. The economic benefits derived from maple syrup production are substantial. In 2016, the U.S. produced 4.2 million gallons of syrup worth an estimated $147 million (USDA, 2017b). In addition, sugaring provides many with a deep, personal connection to forestland, a means to develop social capital and support rural identity, and a way to keep a valued family or cultural tradition alive (Hinrichs 1998, Murphy et al. 2012). Yet, producers of maple syrup in the U.S. are currently facing a diversity of challenges, including potential range shifts in the maple resource; increasing variability in the timing, duration and yield of syruping operations; threats to the maple resource from invasive species, pests and diseases; intergenerational land and business transfer challenges; high equipment costs and lack of government subsidies; forestland tax burden; competition with Canadian syrup producers, and regulatory impacts (MacIver et al. 2006, Farrell 2009, Skinner et al. 2010, Mathews and Iverson 2017).

Given that maple syrup production is strongly tied to weather conditions, climate variability and related stressors are key concerns for the industry (MacIver et al. 2006, Duchesne et al. 2009, Farrell 2009, Mathews and Iverson 2017). Syrup is derived from the sap, which trees produce and store as starch in their roots during the winter months. Sap can be extracted in the spring when pressure differentials created by below-freezing night time temperatures followed by above-freezing day time temperatures cause sap to flow. Thus, changes in winter temperatures and conditions (e.g., snowfall) impact timing, continuity, and duration of sap production. In general, increases in average winter temperatures is anticipated to result in a reduction in the number of sap flow days and/or a needed shift in the sap collection season to adapt to altered conditions (Duchesne et al. 2009, Skinner et al. 2010). In addition to temperature, sap production is also influenced by soil moisture conditions, tree health, and snow pack (Skinner et al. 2010), factors which are influenced by climatic parameters. For example, decreased sap flow and quality has been associated with summer droughts (Foster et al. 1992). In addition to changes in sap flow, climate variability is also anticipated to have impacts on sap volume, sugar content, and quality, although research is needed to explore the specific nature of these relationships (Skinner et al. 2010). Geographical shifts in the distribution of the sugar maple resource northward due to changes in habitat suitability and/or contraction of the resource may occur under future climate scenarios (Iverson et al., 2008; Mathews and Iverson 2017). Taken together, climatic stressors may require maple syrup producers to actively adapt their operations through combinations of changing technology and management practices, as well as shifts in production timing (Mathews and Iverson 2017). Biological threats to the sugar maple resource are also emerging and/or intensifying. Examples include invasive pest species such as the Asian Longhorned beetle (*Anoplophora glabripennis*), which has been found to have particular affinity for sugar and red maples (Dodds and Orwig 2011), and the fungus *Ceratocystis coerulescens* which causes the fatal Sapstreak disease in sugar maples (Bal et al. 2013).

Commercial maple syrup producers in the U.S. face steep competition from Canadian producers. Approximately 75% of the world's maple syrup is produced in Quebec, Canada, in spite of a smaller sugar maple resource than the U.S. (Farrell 2009). The Canadian government has provided support for maple syrup production through cost-sharing programs for equipment purchase and attractive lease rates on public lands for tapping (Farrell 2009), competitive advantages that the U.S. government does not offer. In addition, the Canadian exchange rate influences profitability and production of syrup in the U.S, driving production down when the U.S. dollar is strong relative to the Canadian currency.

Finally, many of those who produce syrup, at least on the hobby scale, are also non-industrial private forest landowners (Whitney and Upmeyer 2004). As such, this segment of maple syrup producers faces a spate of challenges associated with being a private forest landowner (Butler et al. 2016). These include concerns about physical ability to continue operations given that the average age of family forest landowners in the U.S. is 63 years old, with more than 18% 75 years or older (Butler et al. 2016). Related to the aging landowner base, succession planning and concerns about whether heirs are interested in maintaining a syruping operation or even keeping forestland intact are issues that forest landowners are increasingly confronted with (Withrow-Robinson et al. 2013). Taxes on private forestland (Butler et al. 2012), as well as parcelization (Mehmood and Zhang 2001) and land development pressures (Stein et al. 2005) also exert influence over landowner decision-making for the use and future of private forestland.

Given this diversity of challenges, we were interested in exploring Lake States maple syrup producers' awareness, attitudes and concerns on how these factors may be affecting their sugar bush and syrup operations, as well as whether or how they may be responding and adapting their operations in the face of these pressures. We chose this region of the country given its extensive maple resource and the paucity of information on its maple syrup producers relative to those in the Northeastern states. Results are expected to provide insight into the information and assistance needs that maple syrup producers may have in order to maintain and grow their operations in the face of a diversity of ecological, economic and social challenges, as well as how receptive producers may be to information, outreach messages, and adaptation strategies focused around climate and other stressor topics.

BACKGROUND

While there is a substantial body of literature on the ecological aspects of maple syrup production and the sugar maple resource itself (e.g., Iverson and Prasad 2002, Skinner et al. 2010, Farrell 2013), much less is known about the producers of maple syrup and their attitudes, behaviors and intentions. The research on maple syrup producers has largely focused on two issues: 1) performance of and/or need for extension programming for maple syrup production, and 2) barriers and attitudes towards increased tapping and production by syrup producers. Maple syrup producers have been surveyed in Pennsylvania (Demchik et al. 2000) and Ohio (Graham et al. 2006, 2007) to gather information about needs for and attitudes towards information, assistance and outreach programs. For example, Demchik et al. (2000) surveyed maple producers in Pennsylvania to identify their technical assistance needs, concluding that production could be increased through targeted training on new sap collection and evaporation technologies, marketing of value-added maple products, and strategies for maintaining sugarbush health and productivity. Similarly, Graham et al. (2006, 2007) examined the effectiveness of extension programs for maple producers in Ohio and the influence of demographic characteristics on production practices, finding that participation in and the effectiveness of maple extension programs is influenced by operation size, age of landowner, and community traditions. In research on barriers to syrup production, Farrell and Stedman (2013) identified concerns about the impacts of tapping on the value of sugar maple sawtimber; lack of time, available labor, interest and knowledge in the sugaring process; and perceived lack of accessible maple trees among syrup producers in the Northeast. Other social-science research has focused on understanding the social and cultural elements of maple syrup production (Hinrichs 1998, Whitney and Upmeyer 2004).

A topic that is largely missing from studies of maple syrup production and producers is an examination of attitudes and behaviors relative to ecological and climate stressors and associated adaptation planning in response to such stressors. The scant research on this topic includes a small research study (n=33) on the impacts, adaptation opportunities, and adaptive capacity of syrup producers who attended the Ontario Maple Syrup Producer Association conference in 2010 (Murphy et al. 2012). Results of this analysis found that the majority of producers (70%) believed climate change had impacted their business or would affect it in the future, yet little direct action had been undertaken by producers specifically in response to climate change. When posed with a list of potential adaptation strategies, respondents reported favorable views on only two of activities: implementing new technology (57%) and active tree management (48%). The highest-rated barriers to adoption of adaptation strategies included uncertainty of impacts, long tree lifespan, cost, and lack of research.

The only other study that we are aware of on this topic examined knowledge and perceptions of climate change by commercial maple syrup producers in NY and VT, as well as their perceptions on their ability to adapt to climate-change related impacts (Kuehn, et al. 2016). In response to an open-ended question, the majority of respondents (58%) indicated they had at least one concern related to climate change and its potential impact on their syrup operation. Damage to their sugar bush from extreme weather events was the most commonly mentioned topic of concern (14% of respondents), followed by concerns for an earlier tapping season or change in timing for sap collection (13% of respondents). When asked about the types of changes they thought would be needed to their maple operation in the future or already undertaken in response to climate change, 70% of respondents indicated they had made or were planning to make modifications to their operations due to climate concerns. The most-highly cited adaptation activity already taken was tapping earlier (24%), followed by having added a vacuum tubing system to increase production (14%). All other adaptation activities that were mentioned were cited by 5% or less of respondents, including: improving tree health (5%), increasing number of taps (3%), and installing new technologies such as reverse osmosis (3%). Our research adds to this study by examining maple syrup producers' attitudes towards ecological, economic, social, and climate-related factors facing their operations and adaptation planning.

Maple syrup is produced in four Canadian provinces and approximately 15 U.S. states in the Northeast and Midwest, coinciding with the home range of the sugar maple resource (USDA NASS, 2016, Mathews and Iverson 2017). Canada produces the vast majority of the world's maple syrup (75%). The bulk of maple syrup production in the U.S. occurs in the northeastern states of Connecticut, Maine, Massachusetts, New Hampshire, New York, Pennsylvania and Vermont. Together, these states produced 3.78 million gallons of syrup, or 90%, of the national production in 2016 (USDA NASS, 2016). Of these, Vermont's production levels far exceeds any other state, with 1.99 million gallons (47.3% of U.S. total production) in 2016. However, some upper Midwestern states produce marketable quantities of maple syrup products, as well. Specifically, Wisconsin produced 235,000 gallons, Michigan 90,000 gallons, and Minnesota 14,000 gallons (USDA NASS, 2016). Up until 2016, the USDA National Agricultural Statistics Service collected annual statistics on the top 10 maple producing states (CT, ME, MA, MI, NH, NY, OH, PA, VT, WI), reporting the number of taps, yields, prices, and season start and end-dates (for those producers with at least 100 taps). In 2016, statistics for IN, MN, and WV were added. While the upper Midwest has not developed a maple syrup industry as large as those of states in the Northeast, research suggests that expansion opportunities exist in these states. Given the current condition of the sugar maple resource and maple syrup industry in these states, significant potential exists for increasing the percentage of sugar maple trees that could be tapped in this region, particularly in Michigan (Farrell 2009, Mathews and Iverson 2017). In addition, recent research on the potential impacts of future climate conditions on the sugar maple resource has suggested that Minnesota may see enhanced habitat suitability for sugar maple under future climate scenarios, also indicating expansion potential for the syrup industry in this region (Mathews and Iverson 2009).

Given these optimistic indicators for the maple syrup industry in the Lake States, we suggest that the maple syrup producers in the Lake States are an important segment of this industry. To our knowledge, there have been no studies focusing on understanding attitudes, behaviors, intentions and assistance needs of maple syrup producers in the Lake States. We anticipate that these Lake States producers are different from their New England counterparts in several important ways such as their scale of operation, production season, market opportunities, awareness and adoption of new production technologies, as well as tapping and production expansion potential. Thus, we believe that a study focused on the Lake States would provide new insights into the maple industry and maple producers in a region of the country and maple sugar range that has significant opportunities for enhanced production levels under current and potential future ranges of the sugar maple resource. Findings from this study will be important in contributing to the development of assistance, research, outreach and educational programs to help maple syrup producers understand, plan for and adapt to changing conditions and challenges. In addition, this study will add to the research literature on the social dimensions of maple syrup production and producers.

METHODS

Sample Population

The study population consisted of maple syrup producers in Minnesota, Wisconsin and Michigan. These three states share many similarities in terms of tree species and landowner characteristics. In addition, this area represents a segment of maple syrup producers that has not been as intensively studied as producers in the northeastern U.S. or Canada and also a region with potential for increased syrup production (Mathews and Iverson 2017). The sampling frame consisted of members of the Maple Syrup Producers Associations (MSPA) in each of these three states. The MSPAs are non-profit organizations focused on providing information and education, and are open to any individuals interested in learning about extracting, processing, and/or marketing maple syrup and associated products (http://www.mnmaple.org/about-us, http://www.wismaple.org/about-us/, http://www.mi-maplesyrup.com/). Members include both hobby and commercial producers. Minnesota and Wisconsin provided contact information for all of their current members. Michigan maintains two levels of membership: hobby producers (defined as those who produce syrup for use by family and friends, and/or sell a small amount, and/or simply have an interest in maple syrup production) and commercial producers (defined as those who produce, pack or prepare any maple product for profit). We were only able to obtain contact information for Michigan's commercial producer members via their MSPA webpage. By virtue of their membership in an MSPA, our population is not a random sampling of maple syrup producers, but rather one that could be characterized as a highly engaged and informed segment of producers.

Survey Development

A mail back questionnaire was developed through review of existing peer-review and Extension literature on maple syrup producers and production, the NASS Maple Syrup Producer reports (e.g., USDA NASS, 2016 and 2017), examination of blogs devoted to maple syrup production (e.g., http://mapletrader.com/community), and discussions with officers of the Minnesota MSPA. The survey sought to gather information about a respondent's: a) Sugaring operation, b) Motivations for and attitudes towards producing maple syrup, c) Observations and attitudes towards threats and changes they are experiencing in their operations, d) Actions they may be taking or willing to take in response to these threats and changes, e) Information needs, and f) Demographics. The survey was pre-tested in June 2016 by seven individuals who had experience tapping and/or producing maple syrup in Minnesota, Wisconsin or Iowa, but who were not members of an MSPA. Based upon their feedback, the questionnaire wording was slightly modified to enhance its clarity and elicit greater completeness of question responses. This revised version of the survey was reviewed by two of the same individuals for a second pre-testing in July 2016 to ensure that the modifications had successfully captured their suggestions.

Survey Deployment

Following the Dillman tailored design method (Dillman 2000); five contacts were made to survey recipients between August and October 2016: a pre-notice postcard, survey, reminder postcard, second survey, and a final email correspondence (when an email address was available through the membership list). Returned surveys were only identified by state and a random number assigned to each recipient. Of the 464 surveys that were mailed (183 to MN members, 85 to MI members, and 196 to WI members), six were returned as undeliverable, and 354 responses were received for an overall response rate of 77% (148 from MN, 59 from MI, and 146 from WI) (Table 1). Accounting for surveys returned blank, a couple of duplicate surveys from an individual respondent, and one respondent who only filled out the demographic questions, the usable response rate was 73%. In a few cases, multiple people involved with a specific maple syrup operation received the survey, and they elected to only have a single person fill out the survey on behalf of the operation; explaining many of the blank returned surveys.

Table 1: Survey Deployment Statistics by State

State	Number of (Deliverable) Surveys Sent	Number of Survey Responses Received	Percent Response
MI	84	59	70%
MN	179	148	83%
WI	195	146	75%
Total	458	353^	77%

^Note, one completed survey was returned with the identifying code removed and the state question left blank, thus it couldn't be used in computing state-level response rates.

Non-Response Bias Check

To check for nonresponse bias, we compared the initial quartile of respondents (based on when the completed survey was received) to the last quartile following Armstrong and Overton (1977) across many survey questions. T-tests and chi-square tests revealed that late responders were slightly more likely to be MI members, and early responders were slightly more likely to be MN members (p=0.05). However, no significant differences were found between early and late responders relative to equipment type, production levels, or operation size (e.g., number of taps, gallons produced, technology utilized (e.g., sap bags, sap buckets, vacuum pump, reverse osmosis, evaporator)), suggesting that late responders weren't necessarily larger producers or early responders smaller producers. No significant differences were found for methods by which their syrup was used/distributed (e.g., home consumption, retail, wholesaler), acres of forestland owned, future plans for their operation, or years of syrup operation. The only other significant variable found was year in which the respondent was born; late responders were slightly younger than early responders with an average birth year of 1960 for late responders versus 1955 for early responders (p=0.05). Thus, our data may be slightly more representative of MN than MI producers, and older rather than younger producers. Data aren't available to allow for a general comparison of our data to the population of all of those who produce maple syrup. The NASS only surveys those who have at least 100 taps, thus little information exists on small, hobby producers of maple syrup. Thus, we also suggest that our respondents, by virtue of their voluntary membership in a MSPA, may likely have a larger operation, be more knowledgeable, more production-oriented and/or more engaged than the population of people who produce maple syrup in the Lake States. The distribution of our respondents by producer size (e.g., small, medium, large) indicates that the bulk of our respondents utilized at least 100 taps in the 2016 season. Thus, we suggest that our results may be more representative of what we defined as mid-level and larger producers, as opposed to those syrup producers with fewer than 100 taps. Our results should be viewed with these caveats in mind.

Data Analysis

Descriptive statistics are provided for many of the survey questions segmented by state and/or producer size class. Comparative analyses by producer size class were computed for some of the survey questions using $\chi 2$, ANOVA with post-hoc Tukey tests, and cumulative logit models as appropriate to the data type; e.g., $\chi 2$ when the dependent variable was categorical, ANOVA for when the dependent variable was continuous, and cumulative logit when the dependent variable was discrete and ordered. A total of 175 individuals responded to open-ended questions and/or spontaneously offered comments by writing in the margins or at the end of the survey questionnaire. These qualitative data were analyzed using a modified conventional content analysis approach to identify themes in the comment text. A coding scheme was developed based on these emergent themes and *a priori* categories determined by the survey design (Hsieh and Shannon 2005). The coding scheme was then applied to a sample of the qualitative data by three members of the research team and further refined. The full narrative data set was coded and analyzed by a single member of the team using qualitative data analysis software (NVivo 10; QSR International 20). Results of this analysis are reported following quantitative analysis topics, illustrated by representative quotations.

RESULTS

General Respondent Characteristics by Producer Size Class

Given that the MSPA member list from Michigan was different in composition than the other two states, we provide only limited state-level reporting. Instead, the data are reported over all respondents and segmented by producer size class. To facilitate that analysis, the data were divided into three producer size categories based on the number of taps they reported for the 2016 season. While there are no specific industry-standards of what defines a producer size class, our intent was to create classes that approximate small, medium and large operations in the Lake States. We received advice from an officer in the Minnesota MSPA (Stephen Saupe, Personal Communication, 3/23/17) and examined the literature in helping us determine how to segment producer size class by number of taps. In a study of Ohio maple syrup producers, Graham et al. (2007) classified producer size by the number of taps with the following classification system: Hobby (<100 taps), Small Retail/Wholesale (101-250 taps), Medium Retail/Wholesale (251-500 taps), Large Retail/Wholesale (501-1000 taps) and Commercial (>1000 taps). Based on the information we collected about syrup producers in the upper Midwest, we parsed our data into the following three size categories: 1) Small producers were defined as those with less than 100 taps, 2) Medium size producers were defined as those having between 100 and 1000 taps, 3) Large producers were defined as those with greater than 1000 taps.

The distribution of respondents by the three producer size class reveals that 18% of respondents were small producers, 48% were medium, and 33% were large size operations (Figure 1).

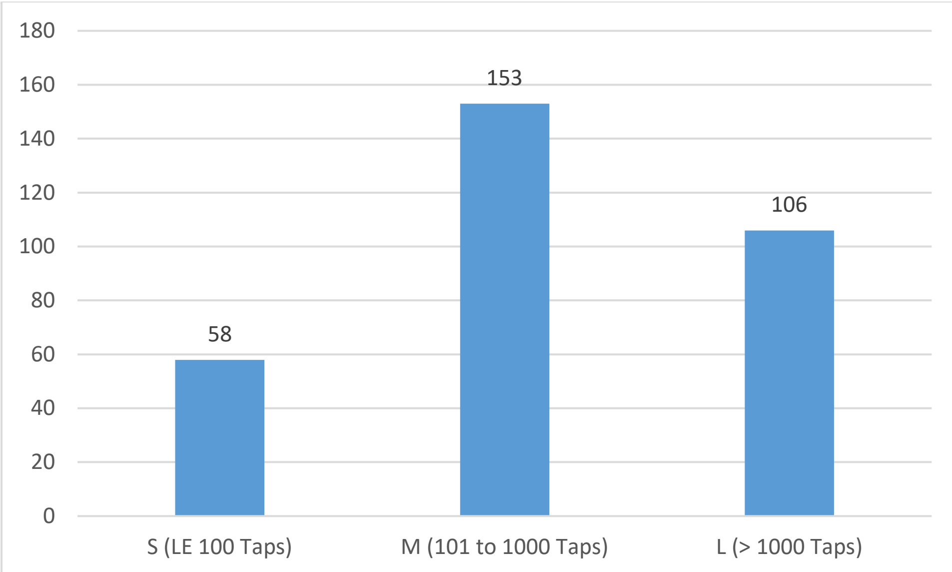

Figure 1: Distribution of Respondents by Producer Size Class (average number of taps).

General Respondent Characteristics by State

Examining the data by the three states (Figure 2) reveals that the number of responses received from Wisconsin and Minnesota were fairly similar, constituting 43% (136) and 40% (126) of total responses respectively, with 17% (55) of responses received from Michigan. Given the smaller population of members in Michigan, it is not surprising that the number of returned responses in our sample from Michigan was considerably smaller. However, it is somewhat surprising that not all of the MI respondents were in the large producer size class category since we were sampling specifically from that state maple syrup association's 'commercial' list. Thus, our findings should be viewed with these distributional issues in mind.

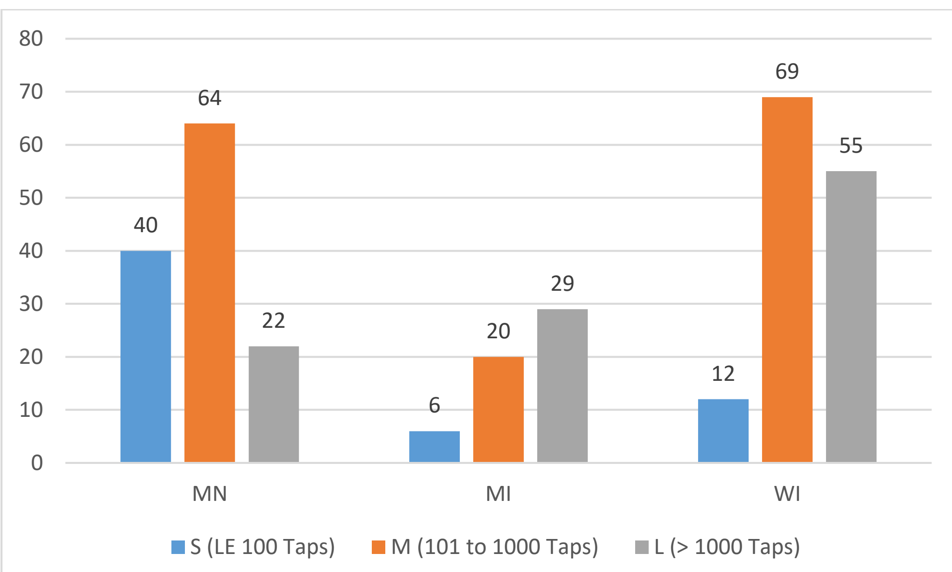

Figure 2: Distribution of Respondents by State and Producer Size Class.

General Respondent Characteristics by Size of Operation

The average number of taps used by respondents in 2016 was 2,062 (Table 2). When viewed by producer size class, however, the number of taps varied significantly, with average values for small, medium and larger producers at 59, 443, and 5,306 taps, respectively. A one-way ANOVA test was run and a significant effect was found for number of taps at the $p<0.05$ level for the three producer levels [$F(2, 306) = 63.10$, $p<0.0001$]. The average number of gallons of syrup produced in 2016 across all respondents was 830, ranging from an average of 35 gallons for small producers, to 175 for medium, and 2,113 for large producers in 2016 [$F(2, 302) = 32.05$, $p<0.0001$]. Respondents owned an average of 87 wooded acres, with no significant difference found between producer size classes [$F(2, 305) = 2.87$, $p=0.0582$]. Respondents have substantial experience and history with maple syrup operations. The number of years that the respondents' maple syrup operation had been in business, regardless of who owned the operation in the past, ranged from 1 to 166 years, with an average of 31 years. Years of experience was found to vary significantly by producer size class [$F(2,300) = 9.26$, $p=0.001$], with large operations having substantially longer tenures than the other two producer size classes (42 years versus 28 and 22 years for medium and small producers, respectively).

Table 2: General Producer Characteristics by Producer Class Size (Std Dev in parentheses).

	Average # of Taps	**Average # of Gallons**	**Average # of Wooded Acres Owned**	**Average Years in Operation**
Small	59 (29)	35 (151)	66 (138)	22 (23)
Medium	443 (266)	175 (832)	78 (128)	28 (28)
Large	5306 (6249)	2113 (3210)	117 (173)	42 (39)
Overall	2062 (4369)	830 (2190)	87 (143)	31 (32)

State-Level Characteristics

The size of a respondent's operation was statistically different by state in terms of both number of taps [$F(2, 302) = 4.92$, $p = 0.0079$] and number of gallons produced in 2016 [$F(2, 300) = 2.42$, $p = 0.0092$] (Table 3). On average, MN respondents had the smallest operations of the three states, in terms of taps and gallons, while MI was the largest. The average number of taps used by MN respondents was 1,253, followed by 2,286 in WI and 3,442 in MI. Both MI and WI respondents produced, on average, about twice as many gallons as MN producers (1,163 and 1,013 versus 503). The number of years in operation also varied statistically by state [$F(2, 300) = 2.42$, $p = 0.0092$], with MN respondents having 13 fewer years of experience, on average, than either MI or WI respondents. Age of respondents did not vary by state [$F(2, 321) = 2.49$, $p = 0.0847$], with the average age across respondents of all states of 60.

Table 3: General Producer Characteristics by State (Std Dev in parentheses).

	Average # Taps	**Average # of Gallons**	**Average # of Wooded Acres**	**Average Years in Operation**
MN	1253 (4126)	503 (1876)	91 (154)	23 (21)
MI	3442 (4638)	1163 (1809)	81 (201)	36 (39)
WI	2286 (4371)	1013 (2550)	85 (98)	36 (35)

Maple Syrup Production

Sources of Sap

The primary source of sap for processing across all producer size classes is from taps on forest land that the respondent owns (Figure 4). For small producers, the remaining 29% of the sap they process is derived from taps that they set on other's land. These might be taps set on lands of neighboring landowners who have no interest and/or capacity to engage in syrup production, but are willing and interested in allowing others to do so without a rental or lease fee. Sap from others' land is also the second greatest source of sap for medium producers (17%), but they also derive sap from forest lands that they lease (7%) and a very small percentage of sap received from others for processing (2%). Although large producers derive the bulk of their sap from lands they own (57%), sap from leased land makes up a much larger share of their supply (23%) than the other two producer groups as does sap received from others for processing (13%).

Qualitative data provide additional insights into the dynamics of securing access to land for tapping beyond fee simple ownership. Several small and medium producers tap on land to which they have connections through personal social networks, including on land belonging to relatives, neighbors, and, in one case, an employer. At least one respondent in each size class taps on public lands. Among these are non-profit organizations with educational missions and a large commercial operation, which is required to offer some educational opportunities as part of its concession. In addition to rural, remote, and farmlands, public and private lands in urban and residential areas also provide sources of sap.

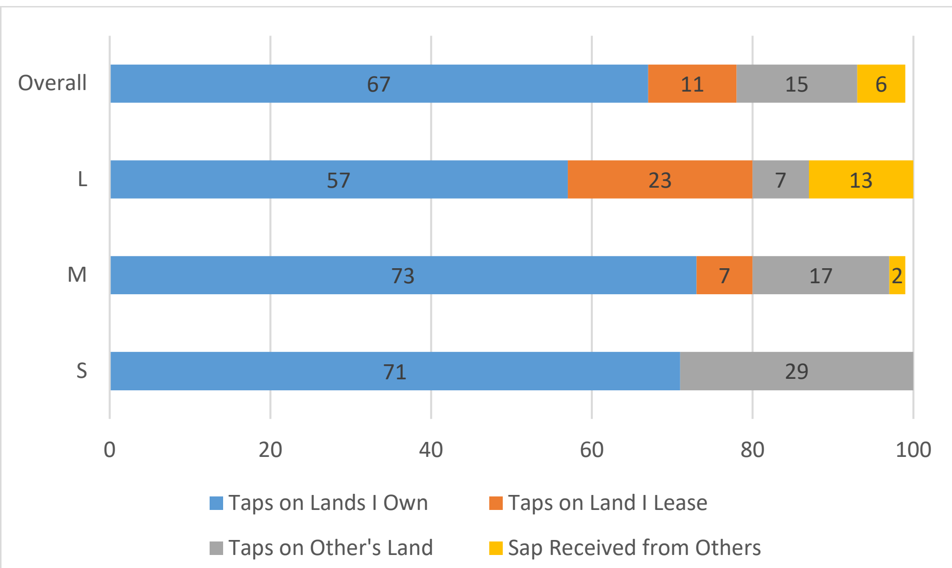

Figure 3: Sources of Sap by Producer Size Class (percentages).

Fuel Type

The primary source of fuel for sap processing across all producer size classes is wood (79%, 90%, and 58% for small, medium and large producers, respective). For small producers, gas makes up the bulk of the remaining fuel use (19%) with minor use of oil (Figure 5). For medium producers, the remaining 10% of fuel usage is split between oil and gas. Large producers have a much greater reliance on oil than the other two produce size classes (33%), and small amounts of gas use (6%). Among the other sources of fuel, comments indicate that one medium producer uses solar and wind power in addition to wood to power various aspects of their operation, suggesting possible future directions for the mix of fuel types used in sugaring.

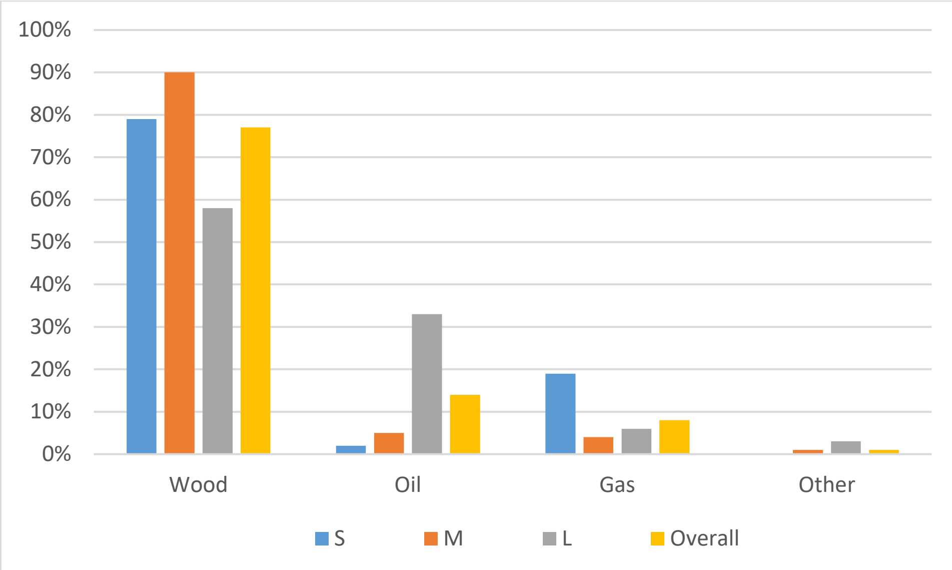

Figure 4: Percent of Fuel Usage by Producer Size Class.

Sap Extraction and Production Equipment and Technologies

Respondents were asked to report on their sap collection and processing equipment used in 2016.[1] Use of all but one sap collection equipment type differed statistically by producer size class (Table 4). No statistically significant differences were found in the use of gravity tubing [F(2, 184) = 5.29, p = 0.07] among the producer groups. Small producers are much more likely to use sap buckets for collection than medium or large producers (85%, 52%, and 46% respectively), and more likely than large producers to use sap bags (69% versus 47%). Further, small producers report much lower usage of gravity tubing and tubing with vacuum pumps (22% and 0% respectively) than the other two size classes. Large producer respondents reported usage of tubing with vacuum pumps at much higher percentages (91%) than medium producers (44%), and similar utilization of gravity tubing (43%) as medium producers (47%).

Differences are again seen among all three producer size classes when it comes to utilization of sap processing equipment. Use of all but one sap processing technology differed statistically by producer size class (Table 4). No statistically significant differences were found in the use of UV sanitizers [F(2, 218) = 4.15, p = 0.13] among the three producer groups. Use of much of what would be considered advanced sap processing equipment is uncommon among small producers, with 5% of respondents utilizing reverse osmosis, 3% a UV sanitizer, 3% air injection and 5% automatic draw-off. While percentages of use for UV sanitizer are slightly higher for medium (4%) and large (9%) producers, it was the least used sap processing equipment that we queried respondents about. High percentages of respondents across all producer size classes reported utilizing both evaporators and hydrometers, with average percentages across all producer size classes of 92% and 93% respectively. For nearly all of the processing equipment

[1] Respondents were asked to select either yes or no to their use of the list of sap collection and processing equipment. Many respondents selected neither response option for some equipment. For example, 30% of respondents didn't select either response when queried about the use of sap sacks/bag, 40% left the gravity tubing question blank, etc. Thus, the question pertaining to collection and processing equipment has a high percentage of missing values; results in Table 2 should be viewed with this point in mind. The associated N values for each type of equipment over all producer size classes are reported in Table 2.

examined, the percentage of respondents that reported utilizing each increased from small to large producers. Large producers reported utilization rates of at least 88% for reverse osmosis, automatic draw-off, filter press, hydrometer, and evaporators.

The qualitative data reflect this differentiation in processing technology by producer size. Comments offered by small producers with a primary goal of connections to Nature, social interaction, and/or education confirm they are more likely to use less automated equipment and see value in more hands on engagement, although there may be aspects of the process for which these types of operations would welcome a tool at a price point that suits them. The words of three small Minnesota producers are illustrative:

> "We are primitive in our operation. Because it is a hobby I'm not going to spend too much money on the operation." (MN054)
>
> "We keep our methods hands on and simple because the trees are tapped by school children and sap is collected by children and volunteers." (MN158)
>
> "[There are] Few choices for small production [hobbyist] filter system. (MN118)

Table 4: Use of Sap Collection and Processing Equipment by Producer Size Class and Percentage of Respondents (Mean values with standard deviations in parentheses). Results from $\chi 2$ tests of Difference by Producer Size Class (DF=2).

Sap Collection Equipment	**Small**	**Medium**	**Large**	**N**	**F Value**	**p**
Sap Sacks/Bags	69% (0.47)	71% (0.46)	47% (0.50)	221	10.87	0.0044
Buckets	85% (0.36)	52% (0.50)	46% (0.50)	216	17.93	0.0001
Tubing – Vacuum Pump	0% (0.0)	44% (0.50)	91% (0.29)	214	81.82	<0.0001
Tubing Gravity	22% (0.42)	47% (0.50)	43% (0.50)	184	5.29	0.0700
Sap Processing Equipment						
Reverse Osmosis	3% (0.17)	38% (0.49)	88% (0.33)	257	95.55	<0.0001
UV Sanitizer	3% (0.17)	4% (0.29)	9% (0.16)	218	4.15	0.1258
Filter Press	19% (0.40)	66% (0.47)	96% (0.20)	266	79.62	<0.0001
Hydrometer	84% (0.37)	98% (0.14)	97% (0.17)	286	15.02	0.1258

Automatic Draw-off	6% (0.23)	44% (0.50)	89% (0.31)	255	89.12	<0.0001
Pre-Heater	42% (0.50)	49% (0.50)	78% (0.42)	254	23.68	0.0005
Air Injection	3% (0.17)	6% (0.23)	25% (0.43)	225	19.00	<0.0001
Evaporator	82% (0.40)	95% (0.22)	99% (0.10)	295	19.02	<0.0001

Distribution of Maple Product

Respondents were asked to estimate how their 2016 maple product was distributed from among a variety of different outlets. ANOVA models and the Tukey HSD test were run to test for differences among distribution channels by producer size classes. Post-hoc comparisons revealed many statistically significant differences among the producer groups by each method of distribution. The percentage of maple product that was distributed by the nine different methods varied widely among the three producer size groups (Table 5). Except for Trading/Bartering [F(2, 304) = 1.44, p= 0.2387] and 'Other' [F(2, 304) = 0.76, p= 0.4680], the average percentage distribution by all other channels differed significantly by producer size class. Specifically, small producers distributed the bulk of their product (75%) among two channels: 44% given as gifts and 31% used for home consumption. No small producer respondents reported selling any of their 2016 produce via wholesale or retail distribution outlets. Distribution outlets were more retail-focused for medium and large producers, reflecting the larger scale of production and greater economic emphasis of these producers. For medium producers, the highest percentage of their product was sold at the sugar bush (27%), followed by similar percentage distributions through sale at farmers' markets (14%), gift-giving (14%) and home consumption (13%). For large producers, owing to the scale of their operations, the highest percentage of their product is sold to wholesalers (38%), followed by sale in retail stores (22%) and sales at the sugar bush (15%).

Comments related to the distribution of respondents' syrup permit further unpacking of complementary economic and social functions of maple sugaring. As noted above, small producers appear to prioritize supplying gifts and household consumption, with sales reserved for what is regarded as excess production. Although not offered as a category in the structured survey, charitable giving was mentioned by one or more producers in all size categories and likely is more widespread than is captured by these comments. Charitable giving takes the form of both donation of syrup itself and earmarking of profits from sales of syrup for donation to charitable and non-profit organizations such as churches, educational and community institutions, and public parks. In addition, non-profits that sugar as part of their programming may compensate volunteers who provide labor in the form of syrup.

> "All sales are donated to First Lutheran Church..." (Minnesota, Large producer)

> "We are an educational facility and our syrup is used for programming purposes and gifted to our volunteers." (Minnesota, Small producer)

Table 5: Distribution Methods of Syrup (Percentages of Respondents, Standard Deviation in parentheses, ANOVA test results).

DISTRIBUTION METHOD	Small	Medium	Large	Total	F value	p value
Home Consumption	30.65 (0.2524)	12.93 (0.1953)	2.24 (0.035)	12.3 (0.2005)	47.44	<0.0001
Given to Helpers	6.71 (0.1865)	6.64 (0.1521)	1.56 (0.033)	4.8 (0.1320)	5.11	0.0065
Sold Wholesale	0.0 (0.00)	7.45 (0.1908)	38.25 (0.377)	16.2 (0.2984)	56.87	<0.0001
Sold at Sugar Bush	7.65 (0.2028)	27.26 (0.3186)	15.31 (0.213)	19.9 (0.2776)	12.49	<0.0001
Sold at Farmer's Market	4.90 (0.1764)	14.13 (0.2783)	12.22 (0.223)	12.2 (0.2485)	2.74	0.0663
Sold at Retail	0.0 (0.00)	8.41 (0.1996)	21.50 (0.271)	11.6 (0.2260)	21.02	<0.0001
Given as Gifts	44.02 (0.356)	13.46 (0.2054)	2.70 (0.111)	14.8 (0.2456)	74.09	<0.0001
Traded/Bartered	2.90 (0.1351)	2.82 (0.0845)	1.12 (0.038)	2.2 (0.0828)	1.44	0.2387
Other (e.g., sold at Orchard)	3.28 (0.2349)	6.40 (0.1915)	5.18 (0.143)	5.4 (0.1635)	0.76	0.4680

Importance of Different Aspects of Maple Syrup Production

Respondents were asked to consider ten factors associated with sugaring and rank their importance on a 5-point Likert scale (1 = not important; 5 = very important). Average Likert-scale ratings were computed for each producer size class and over all respondents (Figure 6). In addition, cumulative ordered logit models were computed to identify statistically significant differences in ratings by producer size classes.

Respondents, regardless of producer size class, rated many factors associated with the production of maple syrup as important to them. Small producers rated five aspects with an average score of four or higher, with home consumption being the highest rated (4.59), followed, in order, by syrup to give away (4.51), getting outdoors in the spring (4.50), learning/preserving a craft (4.23), and feeling connected to the land (4.14) (Figure 6). Only one attribute rated less than a value of two, and that was selling syrup for income or bartering (1.73). Medium-sized producers also rated five attributes with an average value of four or greater, with getting outdoors in the spring the top-rated aspect of sugaring (4.24), followed by syrup for home consumption (4.19), bringing together family and friends (4.17), learning/preserving a craft (4.12), and feeling connected to the land (4.11). The least important aspect of sugaring to medium producers was spiritual significance, although it still rated higher than a value of two (2.29). For large producers, three aspects rated a value of four or higher. Not surprisingly, selling syrup for income was the top-rated aspect (4.48), followed by bringing together family and friends (4.01) and maintaining a family/cultural tradition (4.00). The two bottom-rated aspects for large producers were spiritual significance (2.31) and having syrup to give away (2.66).

Cumulative ordered logit models were run for each of the 10 importance factors to test for statistical significance differences in ratings by the producer size classes (Appendix A). Interpretation of the cumulative ordered logits reveal that producer size does matter for some of the importance rating factors, primarily between small and large producers. For the factor related to producing syrup for income/bartering, small producers have 56.317 times higher odds of rating this factor as less important than large producers. Conversely, for the factor syrup for home consumption, large producers have 3.228 times higher odds of rating this factor as less important than small producers. For the factor Syrup to Give Away, large producers have 13.21 times higher odds of rating this factor as less important than small producers. For the factor bringing together family and friends, medium producers have 0.473 lower odds of rating this factor as less important than small producers; e.g., it is more important to medium than small producers. Moreover, medium producers have 0.797 lower odds of rating this factor as less important than large producers. Thus, taken together, medium producers rate this factor as more important than the other 2 producer groups. For the factor related to maintaining a family or cultural tradition, small producers have 2.544 times higher odds of rating this factor less important than large producers. Finally, on the importance of getting outdoors in the spring, large producers have 2.338 times higher odds of rating this less important than small producers. Producer size was not significant for importance ratings related to feeling connected to the land, learning/preserving a craft, youth/community learning opportunities, and spiritual significance. Overall, factors of importance are largely reflective of the vocation versus avocation divided between large and small producers.

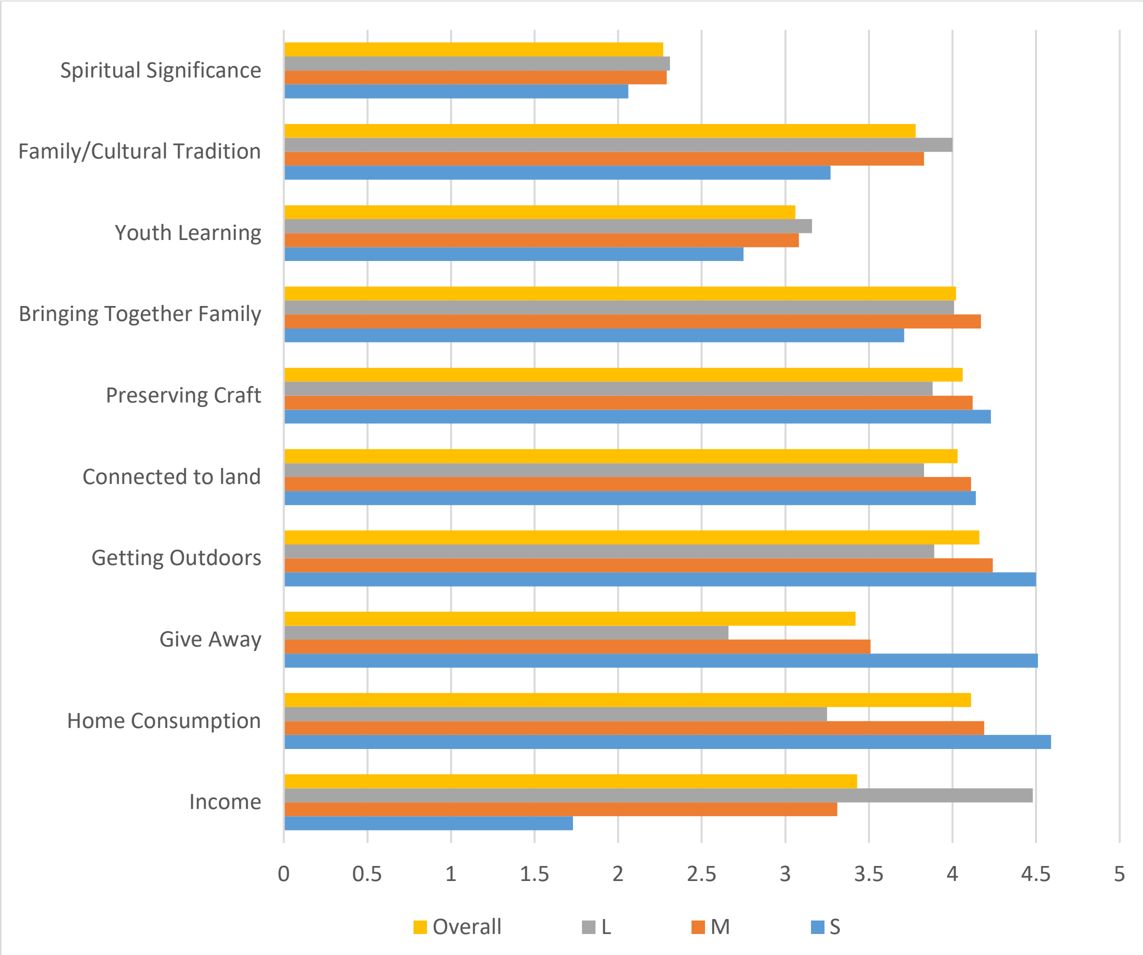

Figure 5: Average Likert-Scale Importance Rating of Attributes Associated with Maple Syrup Production by Producer Size Class.

Producers' comments are useful to further probe these values. Aside from the technology employed for collection and processing, the greatest number of comments (96) offered by respondents relates to social and affective dimensions of sugaring, reflecting the significance of these factors to them. A majority of these comments (75) were offered by small and medium producers, whose comments suggest the shared experience with kinship and social networks, as well as spending time in the woods, are particularly meaningful and joyful for them.

> "It brings family and friends together…The sap season is just a great time of year for us. I love the people coming and going. I love to see the changes taking place in the woods." (Wisconsin, Medium producer)

> "I enjoy being out in the woods in the spring. I love the sounds of migrating birds, the first signs of new life in spring. I love bringing my grandchildren and friends to the woods to enjoy the great outdoors". (Minnesota, Small producer)

Frequently, these producers use the word "fun" to describe their sugaring operations, sometimes noting that this objective outweighs income as a consideration.

> "I see no possibility of profitability for our operation. Therefore the goal is fun for family and friends of family members." (Minnesota, Medium producer)

In contrast, when large producers' comments mention social dynamics of their sugaring operations, it is more likely to be in the context of challenges or concerns:

> "We face challenges of parents helping collect 2200 buckets, and we always get enough people for each sap run." (Minnesota, Large producer)

> "We are concerned with keeping the family operation going. Our children are not close by…we would like to keep the operation family owned in the future." (Minnesota, Large producer)

The qualitative data also help elucidate other socio-economic functions of sugaring operations. Education is part of the mission for six respondents who provided comments (3 small, 2 medium, and 1 large). The words of one medium producer shed light on the kinds of non-profit organizations in which sugaring plays a mission-drive role:

> "We are an environmental education organization. Maple Sugar is one of our classes." (Wisconsin, Medium producer)

Comments also indicate the relative mix of socio-economic functions can be dynamic through time. Two respondents who had commercial operations for several years reported scaling back and ceasing to sell syrup, while another scaled up from producing strictly for personal use and non-market exchange to selling syrup.

> "I have significantly increased my operation in the past 2 years. It has just recently become a major source of income." (Michigan, Large producer)

> "I had a commercial maple operation until 1980. Since then, I've continued to make maple for fun." (Minnesota, Medium producer)

<u>Observed Trends in Syrup Production and Economic/Market/Regulatory Conditions</u>

Trends in Syrup Production

Respondents were asked their perceptions of trends in factors associated with syrup production over the past 10 years. Respondents who reported owning their syrup operation less than 10 years were not included in the analysis of this question, resulting in 78 responses being dropped for this section of the analysis. For the questions in this section, the specific wording of the response scales varied, but were designed to gauge perspectives on whether the respondent perceived directionality of a trend, no trend, or uncertainty about a trend (Tables 6-11). Respondents were queried about potential trends related to the sap season and economic aspects of syrup production. When examining the data across all producer size classes for the sap season factors, for five of the six factors, the response option with the highest percentage of responses was No Change. For example, when queried about the end of the boil season, 52% of respondents indicated no change in this factor over the past 10 years, with 28% indicating an earlier end, 17% a later end, and 3% were uncertain. The exception was the question related to potential trends in the start of the boil season where 47% indicated the trend was toward an earlier start date and

44% indicated no change. Thus, when viewed over the past 10 years, respondents, in general haven't perceived dominant trends across a variety of factors related to syrup season and production characteristics.

Chi-square tests were undertaken to determine whether perceptions of production trends varied by producer size class. For three of the syrup production trends, perceptions about boil start date ($\chi^2(6, 224) = 5.2733, p=0.5093$), boil end date ($\chi^2(6, N=219) = 8.3879, p=0.2110$), and boil season length ($\chi^2(6, 221) = 8.1082, p=0.2303$) were not found to vary as a function of producer size class. Differences in responses towards the other three factors did vary by size class. Perceptions in trends of sap production per tap varied by producer size class ($\chi^2(6, N=222) = 42.7644, p<0.0001$), with large producers more likely to report higher sap production per tap over time (61%), while medium (47%) and small (65%) more likely to report no change. For the sugar content trend, the response option with the highest percentage of responses for each producer size class was No Change. However, differences were seen were in the percentages of respondents by size class who selected one of the other response options ($\chi^2(6, N=224) = 19.9513, p=0.0028$). Specifically, large owners were more likely to report lower sugar content per tap (29%) relative to M (14%) and small (13%) producers. Finally, differences were also seen in perceptions about boil season continuity as a function of producer size class ($\chi^2(6, N=216) = 13.1014, p=0.0415$). Again, the response option selected by the greatest number of respondents among the three classes was no change (66%, 55%, and 42% for large, medium and small producers respectively). However, percentage of responses to the other choices varied by size class, with large producers fairly split on boil season continuity being less (20%) or more (19%), while medium and small producers were more likely to report less continuity (26 and 39%) than more (12 and 3%) for medium and small, respectively.

Table 6: Perceptions of Trend in Sap Production Per Tap (Percentage of Respondents by Producer Size Class. N=222).

Producer Size Class	**LOWER (N=26)**	**NO CHANGE (N=96)**	**HIGHER (N=80)**	**DON'T KNOW (N=20)**
Small (N=37)	11%	65%	14%	11%
Medium (N=101)	15%	47%	24%	15%
Large (N=84)	8%	30%	61%	1%
Overall	12%	43%	36%	9%

Table 7: Perceptions of Trends in Sugar Content (Percentage of Respondents by Producer Size Class. N=224).

Producer Size Class	**LOWER (N=43)**	**NO CHANGE (N=136)**	**HIGHER (N=21)**	**DON'T KNOW (N=24)**
Small (N=38)	13%	55%	13%	18%
Medium (N=102)	14%	60%	11%	16%
Large (N=84)	29%	64%	6%	1%
Overall	19%	61%	9%	11%

Table 8: Perceptions of Trends in Start of Boil Season (Percentage of Respondents by Producer Size Class. N=224).

Producer Size Class	**EARLIER (N=103)**	**NO CHANGE (N=96)**	**LATER (N=15)**	**DON'T KNOW (N=4)**
Small (N=38)	47%	39%	8%	5%
Medium (N=100)	48%	42%	8%	2%
Large (N=80)	46%	49%	5%	0%
Overall	47%	44%	7%	2%

Table 9: Perceptions of Trends in End of Boil Season (Percentage of Respondents by Producer Size Class. N=219).

Producer Size Class	**EARLIER (N=62)**	**NO CHANGE (N=113)**	**LATER (N=37)**	**DON'T KNOW (N=7)**
Small (N=38)	39%	37%	16%	5%
Medium (N=100)	26%	52%	19%	3%
Large (N=81)	26%	58%	15%	1%
Overall	28%	52%	17%	3%

Table 10: Perceptions of Trends in Length of Boil Season (Percentage of Respondents by Producer Size Class. N=219).

Producer Size Class	**SHORTER (N=46)**	**NO CHANGE (N=121)**	**LONGER (N=43)**	**DON'T KNOW (N=9)**
Small (N=38)	29%	45%	18%	8%
Medium (N=98)	24%	52%	19%	4%
Large (N=83)	13%	64%	21%	2%
Overall	21%	55%	20%	4%

Table 11: Perceptions of Trends in Continuity of Sap Run Over the Season (Percentage of Respondents by Producer Size Class. N=216).

Producer Size Class	**LESS (N=56)**	**NO CHANGE (N=114)**	**MORE (N=28)**	**DON'T KNOW (N=18)**
Small (N=38)	39%	42%	3%	16%
Medium (N=97)	26%	55%	12%	7%
Large (N=81)	20%	56%	19%	6%
Overall	26%	53%	13%	8%

Comments allowed producers to share more nuance about their observations of sugaring season start times. Regardless of length of time in operation, there was broad consensus among respondents that the trend is toward an earlier start to the sugaring season. However, this observation was not mutually exclusive of statements that, like the weather, their season remains highly variable from year to year and, in some cases, producers are challenged to be ready to tap when the sap run begins. A sample statement from a respondent in each operation age category illustrates the nuance and conviction in respondents' observations of sugaring seasonality through time:

> "Has usually been in March, this year was end of January." (Michigan, Large producer)
>
> "Difficult to answer, all depends on weather. Trend is toward warmer, earlier seasons." (Minnesota, Small Producer)
>
> "Make sure we are ready for early seasons" (Wisconsin; 26-50 years)
>
> "The one thing I have learned doing this is that every year is different" (Minnesota; 52-75 years)
>
> "syrup seasons are extremely variable…Sugarmakers ten miles apart can have different seasons due to weather conditions." (Michigan; 76-100 years)

> “We will plan on being ready to tap at the beginning of February. Years past we were not ready to tap until March. Note that we've produced syrup since 1901 and have records back to 1947, which indicate little change in the average start date at March 20.” (Michigan; $\geq$100 years)

Taken as a whole, comments on volumes of sap and syrup confirm perceptions of variability, with no discernible perception of trends in production from year to year. Three respondents report increased or steady sap volume but attribute it to vacuum technology, two report reduced volumes, and another variable volumes.

> “Our enhancements to the sap collection methods (tubing/vacuum) have led to significant increases in the amount of sap collected and maple syrup made. This technology improvement will skew the numbers (and may not really show the impact of climate change.)” (Minnesota, Large producer)

> “Production is less variable with vacuum.” (Wisconsin)

> “Sometimes you invest a lot of time and energy to get a good amount, other times you have 120 taps out and the weather doesn't cooperate and you end up with two quarts of syrup, but that's life.” (Minnesota, Small producer)

Two comments note variability in sap sugar content. Reported syrup volumes also were variable. In contrast, there is a clear trend in the number of taps set by respondents who took the time to comment. Eight reported having increased their number of taps, with an additional two planning to do so. Notwithstanding, two report having decreased their number of taps and four simply report a number, suggesting this may be steady for them, with one stating that he does not want to set more taps than he has in the past. Three comments about numbers of trees tapped suggest many respondents may have access to significantly more trees than they currently tap.

Trends in Market and Regulatory Conditions

Respondents were also asked their perceptions about trends in five economic or regulatory factors associated with syrup production (Tables 12-16). Regulatory factors relate to issues with licensing, taxes, and inspections. When viewed across all producer size classes, the answer with the highest percentage of respondents to two of the factors, ability to find workers (64%) and profitability (41%), was no change. For the other three factors, the majority response was an increasing trend; e.g., higher production costs (61%), greater complexity of sugaring regulations (56%), and higher marketability of maple products (52%).

Chi-square tests were undertaken to determine whether perceptions of market condition trends varied by producer size class. All five of the trends were found to have statistically significant differences by producer size class. For production costs, large and medium respondents were most likely to indicate higher production costs (71% and 63%, respectively), while the majority of small producers (58%) indicated no change in costs ($\chi^2(6, N=219) = 38.0729, p<0.0001$). For the ability to find workers trend, the majority response for each producer size class was no change. Thus, the significant differences that were seen were in the percentages of respondents by size class who selected one of the other response options ($\chi^2(6, N=170) = 19.6259, p=0.0032$). Specifically, large producers were more likely to report less ability to find workers (28%) relative to M (8%) and small (6%) producers. For the marketability of maple products trend, the majority response for each producer size class was increased marketability.

Thus, the differences that were seen were in the percentages of respondents by size class who selected one of the other response options ($\chi^2(6, N=201) = 15.0162, p=0.0201$). Specifically, small producers were more likely to report a lack of certainty about marketability of products (29%) relative to medium (10%) and large (5%) producers. Medium and large producers were more likely to report perceptions of greater complexity in sugaring operations (65% for large and 44% for medium) versus small producers who were largely split on whether they thought regulatory complexity was staying the same (38%) or were uncertain (33%) ($\chi^2(6, N=206) = 19.2776, p=0.0037$). Finally, wide differences were seen in perceptions about profitability as a function of producer size class ($\chi^2(6, N=201) = 32.5888, p<0.001$). Medium producers were most likely to report no change in profitability, while 56% of small producers perceived profitability to be greater. However, large producers were nearly evenly split between reduced profitability, increased profitability, and no change in profitability.

Table 12: Perceptions of Trends in Costs of Production (Percentage of Respondents by Producer Size Class. N=219).

Producer Size Class	**LOWER (N=19)**	**NO CHANGE (N=59)**	**HIGHER (N=134)**	**DON'T KNOW (N=7)**
Small (N=31)	3%	58%	29%	10%
Medium (N=105)	5%	29%	63%	4%
Large (N=83)	16%	13%	71%	0%
Overall	9%	27%	61%	3%

Table 13: Perceptions of Trends in Ability to Find Workers (Percentage of Respondents by Producer Size Class. N=170).

Producer Size Class	**LESS (N=28)**	**NO CHANGE (N=108)**	**GREATER (N=21)**	**DON'T KNOW (N=13)**
Small (N=17)	6%	58%	6%	18%
Medium (N=77)	8%	68%	13%	12%
Large (N=76)	28%	71%	13%	1%
Overall	16%	64%	12%	8%

Table 14: Perceptions of Trends in Marketability of Maple Products (Percentage of Respondents by Producer Size Class. N=201).

Producer Size Class	**LESS (N=15)**	**NO CHANGE (N=62)**	**GREATER (N=105)**	**DON'T KNOW (N=19)**
Small (N=17)	6%	24%	41%	29%
Medium (N=99)	6%	37%	47%	10%
Large (N=85)	9%	25%	61	5%
Overall	7%	31%	52%	9%

Table 15: Perceptions of Trends in Complexity of Sugaring Regulations (Percentage of Respondents by Producer Size Class. N=206).

Producer Size Class	**LESS (N=1)**	**NO CHANGE (N=63)**	**HIGHER (N=116)**	**DON'T KNOW (N=26)**
Small (N=21)	0%	38%	29%	33%
Medium (N=100)	1%	28%	55%	16%
Large (N=85)	0%	32%	65%	4%
Overall	1%	31%	56%	13%

Table 16: Perceptions of Trends in Profitability of Sugaring Operation (Percentage of Respondents by Producer Size Class. N=201).

Producer Size Class	**LESS (N=63)**	**NO CHANGE (N=83)**	**GREATER (N=43)**	**DON'T KNOW (N=12)**
Small (N=38)	28%	11%	56%	6%
Medium (N=98)	33%	45%	15%	7%
Large (N=85)	34%	34%	32%	0%
Overall	31%	41%	21%	6%

Comments about market and regulatory conditions were most frequently offered by respondents with medium and large operations (69 comments). Collectively, costs listed by these respondents include those associated with real estate (leasing land, taxes on forest land, and buildings), upgrading equipment (sometimes in relation to compliance with regulations), liability insurance (for an educational operation) and non-equipment inputs (energy, labor, and purchase of raw sap). In particular, the cost of updating equipment was a concern, with two individuals indicating it is a factor in their considerations as to whether to continue sugaring.

> “The biggest challenge is the affordability of maple syrup equipment.” (Minnesota)

> “Would need evaporator, then building for it and so on. When penciling out the cost versus the profit, looks like a losing deal.” (Minnesota)

Comments about income were roughly divided between those indicating profit was not a goal of their operation and those discussing challenges to profitability. In the case of the former, as described above, respondents report proceeds from their sales support charitable or educational endeavors (e.g., a nature center, village recreational programs) or help to offset expenses such as property taxes and sugaring costs. In the case of the latter, challenges noted were falling prices for bulk syrup, lack of success in “cutting out the middle man,” marketing, and competition.

> “Revenue from syrup helps the nature center operations.” (Michigan)

> “Maple production along with the SFIA program and Golden winged Warbler program helps offset insurance and property taxes.” (Minnesota)

> “We will be challenged by falling syrup prices.” (Minnesota)

Of comments on marketing, half were upbeat to neutral; focusing on their marketing approach, including one respondent who feels organic certification has been helpful to their sales. The other five comments addressed challenges to marketing their syrup, with implications of four of these comments that some sort of marketing support organization is needed or would be valuable. Here, however, it is worth noting that one respondents feels existing marketing that emphasizes light syrup as the best quality is a problem for their business.

> “We have been certified organic since about 2003 and this has been helpful with different market/business opportunities.” (Minnesota)

> “Marketing of syrup and getting a good price is the most challenging part of the business.” (Wisconsin)

> “I am concerned that the maple industry is becoming "Big Business" with an unstated goal or unthoughtout [sic] goal to force the small producers out. I would like to find a way to address the needs and concerns of both in a cooperative and beneficial way. The two have little in common. Even the syrup is different: Large producers: pale, tasteless syrup made cheaply (RO) that must be blended to get a good flavor. Marketing that says only light syrup is good. Small producers: lower volume syrup with rich traditional (darker) flavor (and higher costs to produce.)” (Michigan)

Additional comments speak to the competitive pressure some commercial producers feel. Four comments about competition from the Canadian maple syrup industry highlight U.S. Lake States producers’ understanding of the specific challenges this poses for them: volumes, prices, and purchase of bulk U.S. syrup; currency exchange rates; and subsidies provided to Canadian farmers. Several one-off comments suggest the range of domestic competitors that may be felt by commercial syrup producers: bulk buyers (functioning as middle men who capture profit between the producer and food producers), excess production resulting from industry-wide adoption of vacuum technology, appropriation of a state branding label by an out-of-state packer, and local effects of “recreational” producers.

> “Why is all of our Bulk syrup going up to Canada? Why doesn't the Midwest have the power to keep our syrup here and market it?” (Wisconsins)

> “Competition from small-scale "recreational" producers can cause marketing difficulties on the local scale.” (Wisconsin)

Financing is another key element of the economics of maple sugaring for many producers. Challenges of financing sugaring operations was the topic of comments by four large and two medium producers, who noted difficulty obtaining loans, lack of grants or other programs to assist producers with equipment costs, and the burden of loan payments on cash flow.

> “We were happy to continue the operation, but struggle to reinvest and expand the operation. We hope to grow in order to make maple syrup a larger part of our livelihood.” (Minnesota)

Tensions are evident in comments regarding regulations. One or more respondents in each state believe regulations will drive small producers out of business. However, two Minnesota sugars suggest regulations in that state are not uniformly enforced and bemoan competition from operations whose equipment and practices are not in compliance. In contrast, two respondents report foregoing sale of their syrup because of challenges complying with regulations and/or uncertainty that their operations are in compliance. Lack of knowledge on both sides of the regulator/regulated equation was noted, suggesting opportunities for organizations representing sugarers to work with their members and regulatory organizations.

> “They are putting on too many regulations; that the small family operations are having a hard time complying with, or cannot afford to comply with.” (Wisconsin)

> “Due to Minnesota’s restrictive laws I used the syrup myself or gave it away.” (Minnesota)

> “The Wisconsin inspectors don't know anything about making syrup so don't understand why we do the things the way we do.” (Wisconsin)

An additional point of tension appears to exist in respondent opinion as to whether sugaring should be regulated as an agricultural enterprise like other farming activities.

> “Not recognized as farming by county without state license.” (Minnesota)

> “State regulations that are not in line with making syrup lumping us together with other kinds of farming.” (Wisconsin)

Adaptation Activities – Already Undertaken

Respondents were asked to think about the future of their maple syrup operation and specify the likelihood that they would undertake eight different activities for their sugaring operation in the next ten years, as well as if they had already undertaken these activities. Although the question did not specifically identify these activities as adaptation strategies, they could be viewed as such.

Overall, the activity already undertaken by the greatest percentage of respondents was adopting new technology (26%), followed by managing for healthier trees (18%), product diversification (18%), and managing for more productive trees (17%). The activities with the lowest percentage of implementation across all respondents were product diversification (1%), product simplification, or reducing the number of maple sugar-related products they produce (1%), and tapping non-sugar maples (4%) (Figure 7).

Chi-square tests were undertaken to examine whether implementation of these activities differed statistically by producer size class. For three of the activities, no statistically significant differences were found (planting climate change resilient maple trees, maple product simplification, tapping trees besides sugar maple). For the other five activities, levels of implementation did statistically differ by producer size class: adopting different sugaring technology ($\chi^2(2, N=304) = 28.8320$, $p<0.001$), active management for more productive trees ($\chi^2(2, N=305) = 6.9166$, $p=0.0315$), active management for healthier trees ($\chi^2(2, N=305) = 7.7039$, $p=0.0212$), product diversification ($\chi^2(2, N=305) = 25.400$, $p<0.0001$), and increasing number of taps ($\chi^2(2, N=304) = 6.2433$, $p=0.0441$).

Small producers reported low levels of implementation across all of the queried activities. The most-commonly implemented activity among small producers was active management for healthier trees (8% of respondents), followed by active management for more productive trees (6%), and product diversification (4%) and increasing the number of taps (4%) (Figure 7). None of the small producer respondents reported planting climate change resilient maple cultivars or undertaking maple product simplification.

In general, medium producers were more likely to have undertaken the queried activities than small producers (Figure 7). The highest-implemented activity was adopting different sugaring technology or equipment (28%), followed by management for more productive trees (19%) and management for healthier trees (17%). Just as with the small producers, planting climate change resilient maple cultivars and undertaking maple product simplification were the least-implemented activities for medium producers (1%). For the large producers, adopting different sugaring technology/equipment was the most commonly undertaken activity (39%), followed by product diversification (33%), and managing for healthier (26%) or more productive trees (23%). As with the other producer size classes, planting climate change resilient maple trees and product simplification were the least-undertaken activities for large producers at 3% and 2% respectively**.**

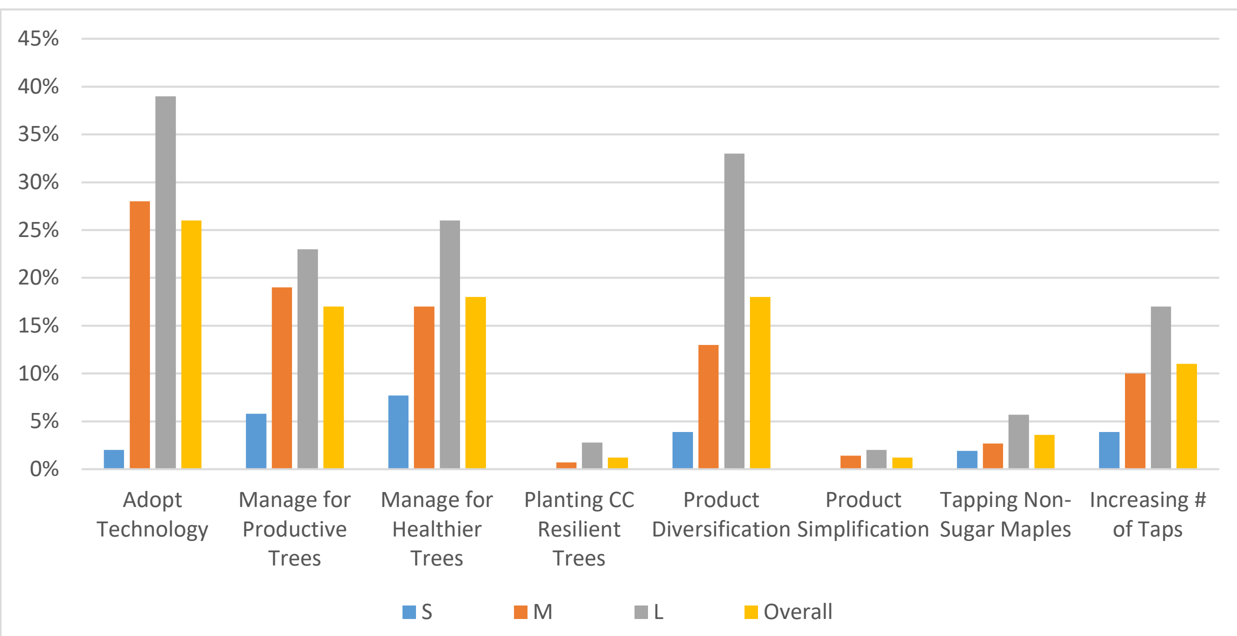

Figure 6: Adaptation Activities Already Undertaken by Producer Size (Percentage of Respondents).

Comments regarding sap collection technology were offered by 32 respondents at the end of the survey. Of these, nearly half (14) mentioned vacuum technology, in particular obtaining more steady, increased flow over yield from older approaches. While the adoption of vacuum technology generally is regarded as a positive measure by most of these respondents', some note actual or potential problems resulting from their operation's switch to vacuum or the larger trend to adoption of this technology. Two individuals express concern about flooding the market with sap as a result of increased production, while another two reports damage to their lines and costs associated with restoring them following large wind storms.

> "One thing that greatly increased our sap yield was the addition of vacuum. 2015 yield on buckets was 12.6 gal per tap; vacuum was 26.9 gal/tap sap. Even with weather warmer for extended periods we overcame that with vacuum, has very steady day to day yields without the freeze/thaw cycles." (Wisconsin)

> "Now that we have vacuum lines, we are flooding the market." (Wisconsin, Large producer)

Of the 19 respondents who provided comments about their forest management, eleven describe actions they have taken to enhance their sugar bushes and/or the health of their maple trees. These actions include removing other species, planting sugar maples, removing invasives, and using small spigots. Three individuals also report 'resting' trees in some years, either as part of a rotation scheme or in response to environmental stress such as drought. One or more respondents in each producer size category also report tapping species other than sugar maple, with three tapping red or silver maple and one each tapping yellow birch and black walnut.

> "I have increased harvest of non-maple species to benefit crown and tree growth." (Minnesota)

> "More selective in tapping trees to ensure only healthy trees are tapped and to rotate trees on and off from year to year" (Minnesota, Small producer)

<u>Adaptation Activities – Likelihood of Future Actions</u>

Respondents were also asked to indicate their likelihood of undertaking the same eight adaptation activities in the next ten years. The question was asked on a 5-point Likert scale from 1 (very unlikely) to 5 (very likely). For analysis purposes, a binary variable was created if a respondent selected a value of 4 or 5 on the response scale, indicating they had some likelihood of undertaking the activity (1= likely to undertake the activity, and 0 otherwise). Figure 8 displays the percentage of respondents likely to undertake each activity by producer size class and over all respondents. Across all producer size classes, three of the adaptation activities are likely to be undertaken by at least half of the respondents: adopting different technology (57%), increasing number of taps (56%), and managing for healthier trees (54%). Slightly less than one-half of respondents indicate they plan to manage for more productive trees in the future (46%). The activities least likely to be undertaken include: tapping non-sugar maples (7%), product simplification (4%), and planting climate change resilient maple trees (3%).

Chi-square tests were undertaken to examine whether the likelihood of implementation of adaptation activities varied by producer size class. For three of the activities, no statistically significant differences were found (planting climate change resilient maple trees, maple product simplification, tapping trees besides sugar maple). For the other five activities, levels of implementation did statistically differ by producer size class: adopting different sugaring technology ($\chi^2(2, N=257) = 17.0206, p=0.0002$), active management for more productive trees ($\chi^2(2, N=267) = 23.6470, p<0.0001$), active management for healthier trees ($\chi^2(2, N=257) = 13.1908, p=0.0014$), product diversification ($\chi^2(2, N=260) = 23.7684, p<0.0001$), and increasing number of taps ($\chi^2(2, N=293) = 13.6655, p=0.0011$). For all of activities in which statistically significant differences were found among producer size classes, small producers were always the least likely to undertake the activity, large producers the most likely, and medium producers were in-between.

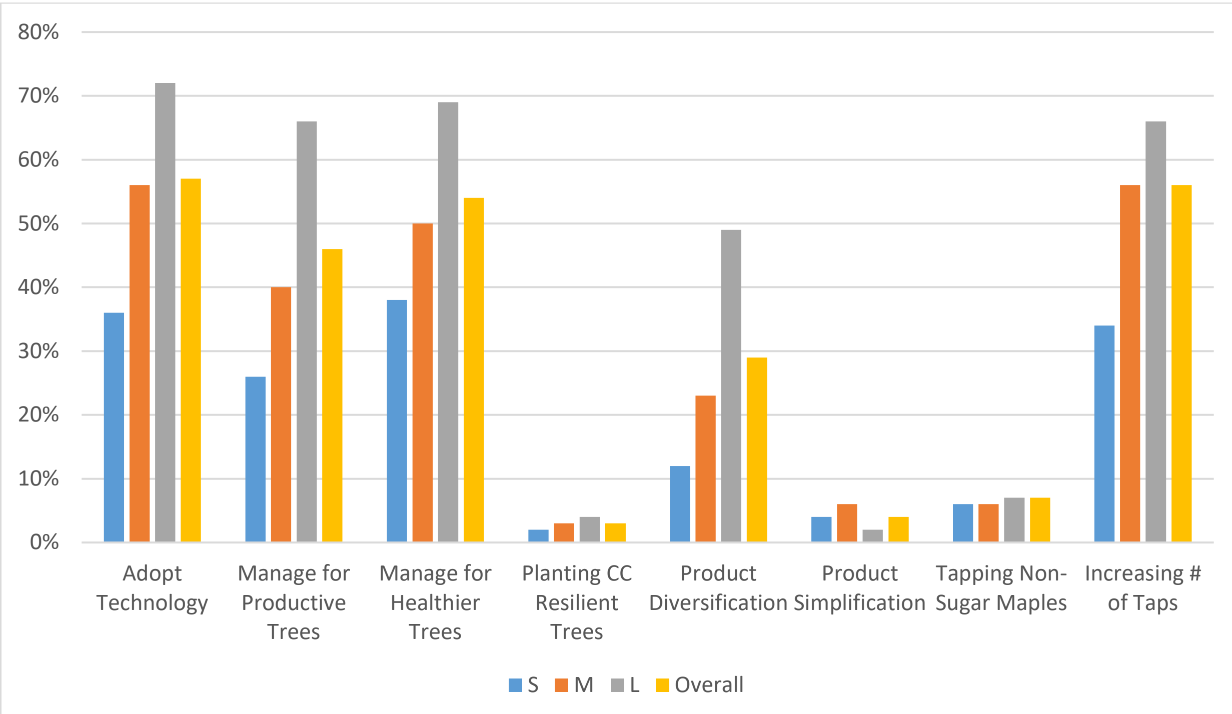

Figure 7: Likelihood of Undertaking Adaptation Activities in the Next Ten Years by Producer Size (Percentage of Respondents).

Across all producer levels, respondents indicated varying levels of interest in undertaking the eight activities (Figure 8). The top three activities that respondents were most likely to undertake were the same across the three producer size classes, but in different order and percentage of respondents likely to undertake them. For small producers, the three activities they expressed the greatest likelihood of undertaking were managing for healthier trees (38%), adopting different sugaring technology and equipment (36%), and increasing the number of taps (34%). These same three activities were also in the top three activities likely to be undertaken by medium producers, but a greater percentage of M producers expressed interest in adopting technology (56%), increasing the number of taps (56%), and managing for healthier trees (50%) than did small producers. Even higher percentages of large producers intend to undertake the same three activities in the future than the other two producer size classes; e.g., 72% intend to adopt different technology, 69% intend to manage for healthier trees, and 66% intend to add more taps. Respondents expressed low likelihood of planting climate resilient trees, tapping trees other than sugar maples, and product simplification, with less than 7% of respondents across each of the producer size classes expressing a likelihood of undertaking each of these activities.

Comparing rates of implementation of past activities to likelihood of future implementation of the same activities, all three of the producer size classes indicate enhanced interest or willingness to undertake many of the adaptation activities. For example, 8% of small producers had managed for healthier trees in the past, whereas 38% intend to do so in the future. Twenty-eight percent of medium producers had adopted different technology in the past, while 56% intend to do so in the future. Finally, 39% of large producers had reported adopting different technology in the past, while 72% report an intention to do so in the next ten years of their operation.

Another important comparison to note between rates of past and future adaptation activities is increasing the number of taps. Whereas increasing tap numbers is an activity that respondents had reported doing in the past, it was not one of the higher implemented activities among any of the producer size classes. Specifically, only 4% of small producers, 10% of medium producers and 17% of large producers had undertaken this step in the past. However, when considering rates of implementation of future activities, increasing the number of taps was one of the top three most likely activities for each of the producer size classes (34% for small, 56% for medium, 66% for large producers), suggesting potential interest in operation expansion among many producers.

Actions Taken Specifically Out of Concern for Changing Climate Conditions

Respondents were asked whether they had undertaken any actions or plan to take any actions in the next 10 years specifically out of concern for changing climate conditions. Overall, 11% of respondents indicated they had (6% of small, 10% of medium, 15% of large producers). An open-ended question followed this one asking respondents to write-in specific actions they have taken or plan to take out of concern for changing climate conditions.

Preparations to tap early and changes in technology were the most commonly mentioned (five people, each) action they have taken to adapt to changing climate.

> "[It is] Less of an action but more of a mindset. We make sure our schedules accommodate earlier sugaring seasons. And have planned less sugarbush work prior to the season to be sure to be ready for an early season." (Minnesota)

Comments that explicitly or implicitly addressed whether respondents believe anthropogenic climate change is occurring (15 comments) were roughly evenly divided between those who believe it and those who do not:

> "Don't believe in it (climate change)." (Wisconsin, Medium producer)

> "Climate change will pose new challenges." (Michigan, Large producer)

Concerns Related to the Future of Their Sugaring Operation

Respondents were provided a list of thirteen factors related to the future of their sugaring operation, and asked to rate their level of concern for these factors on a 5-point Likert scale that ranged from 1 (no concern) to 5 (significant concern). Average Likert scale ratings were computed for each producer size class and over all respondents (Table 17). When examining responses over all producer size classes, six factors averaged three or higher on the concern scale, with tree health rated the highest factor of concern (3.42). The six top-rated factors largely focused on sugar bush health issues and factors related to succession planning; e.g., physical ability to continue sugaring, and having family members interested in continuing the operation. Sugaring profitability and threats related to weather conditions and variability registered less concern. Little concern was expressed about having adequate information and training on sugaring technologies and syruping workforce availability.

Table 17 indicates that concerns varied somewhat by producer size class. In general, average concern ratings increase as producer size increases for most of the concern topics. For all of the concern factors but one (boil season length), average concern is lower for small than large producers. For all but three factors, average concern is lower for medium versus large producers (boil season start and stop dates, boil season length, physical ability to sugar).

The top three concerns for small producers were: tree health (3.12), weather threats (2.92), and physical ability to continue sugaring (2.89) (Table 17). Medium producers' greatest concerns were a bit different than small producers, with a focus on their physical ability to continue sugaring (3.55), stringency of sugaring rules and regulations (3.45), and having family members interested in continuing the operation (3.32). Large producers were most concerned about sugaring profitability (4.00), pest threats (3.84), and tree health (3.82). Syruping workforce availability was the least concerning factor among small and M producers, while boil season-length registered the least concern among large producers. Only one topic averaged an average Likert-scale value of four among any of the producer size classes, which was concern over sugaring profitability by large producers. Only one topic rated an average Likert-scale value over three for small producers (tree health). Six topics rated average concern scores between three and four for medium producers. Taken together, these average scores suggest that respondents, across all size classes, may only be registering moderate levels of concern over most of the topics they were asked to consider.

Cumulative ordered logit models were run for each of the 13 potential factors of concern to test for statistical significance differences in ratings by the producer size classes (Appendix B). Interpretation of the cumulative ordered logits reveal that producer size matters for all but two of the concern factor ratings. That is, statistically significant differences are found in concern ratings by producer size class for all factors except for 'threats from invasive plant species' and 'weather threats.' For four of the factors, significant differences are only found between small and large producers with small producers always more likely to rate concerns lower than large producers (sap production per tap, tree health, syruping work force availability, having family members interested in continuing the operation). For example, small producers have 2.726 times higher odds of rating tree health as lower concern than large producers.

For seven of the factors, significant differences were found between both small and large and medium and large producer size classes (Appendix B). For four of these, both small and medium producers registered less concern than large producers (available information and training, sugaring rules and regulations, pest threats, sugaring profitability). For example, small producers have 25.872 times higher odds of rating sugaring profitability as less of a concern than large producers, while medium producers have 3.134 times higher odds of rating this factor of lower concern than large producers. Finally, for the remaining three factors (physical ability to continue sugaring, boil season length, boil season timing), significant differences were found between small and large and medium and large producer groups, with higher concern ratings for medium versus the other two producer size classes. In none of the cumulative ordered logits were small producers more likely to rate higher concern levels for any of the factors. Considering both the average Likert scale values (Table 17) and the cumulative ordered logit results (Appendix B), concern for factors affecting one's sugaring operation increase with producer size class. However, overall, respondents tended to rate most of the factors with only moderate levels of concern, be it ecological, weather-related, or production-related issues.

Table 17: Concern for Factors Related to the Future of Their Sugaring Operation by Producer Size (Average Likert-scale Rating with 1=No Concern and 5=Significant Concern, standard deviation in parentheses).

Sugaring Operation Factor	Small	Medium	Large	Overall
Sap Production Per Tap	2.58 (1.11)	2.92 (1.38)	3.22 (1.37)	2.94 (1.36)
Sugaring Profitability	1.60 (0.98)	3.17 (1.47)	4.00 (1.29)	3.16 (1.56)
Boil Season Start and Stop Dates	2.21 (1.30)	2.81 (1.39)	2.60 (1.35)	2.62 (1.38)
Boil Season Length	2.33 (1.26)	2.89 (1.36)	2.10 (1.35)	2.71 (1.36)
Weather Threats	2.92 (1.27)	2.91 (1.39)	3.09 (1.30)	2.96 (1.35)
Pest Threats	2.79 (1.39)	3.00 (1.44)	3.84 (1.24)	3.28 (1.42)
Invasive Plant Species Threats	2.75 (1.40)	2.73 (1.36)	3.25 (1.34)	2.90 (1.40)
Tree Health	3.12 (1.31)	3.27 (1.26)	3.82 (1.06)	3.42 (1.26)
Syruping Workforce Availability	1.60 (0.93)	2.24 (1.34)	2.76 (1.35)	2.29 (1.32)
Physical Ability to Continue Sugaring	2.89 (1.53)	3.55 (1.33)	3.14 (1.49)	3.26 (1.44)
Family Members Interested in Continuing the Operation	2.84 (1.63)	3.32 (1.38)	3.32 (1.26)	3.23 (1.47)
Sugaring Rules and Regulations	1.90 (1.29)	3.45 (1.45)	3.61 (1.31)	3.21 (1.49)
Information/Training on Sugaring Technologies	1.89 (1.11)	2.75 (1.31)	2.86 (1.39)	2.61 (1.34)

The qualitative data provide additional insights into factors that affect the future of some producers' operations. Three individuals look forward to increased involvement in sugaring when they retire. Given the family significance of many operations, it is not surprising that some respondents express hope their children will continue sugaring, although three state they do not expect theirs to do so. Personal obstacles to sugaring include the demands of other work (four respondents), declining health and injury (six respondents), sometimes explicitly associated with aging. This suggests there may be a life cycle pattern in which the scale of small operations increases following sugarers' retirement from other work, followed by diminished production with advanced age and/or health challenges, at which point the survival of the operations in all producer size categories is in question where younger family members are not interested in taking over.

> "I expect to retire in 3 years and will be able to devote more time to my syrup operation." (Minnesota, size unknown)

> "We are concerned with keeping the family operation going. Our children are not close by. One is in Alaska and we would like to keep the operation family owned in the future." (Wisconsin, Large producer)

"Because of physical limitations (mainly arthritis) we could no longer continue." (Minnesota, Small producer)

Expectations for Their Operation

Respondents were asked how they expect their syrup production levels to change in the next ten years on a 5-point Likert scale ranging from a value of 1 (decrease greatly) to a 5 (increase greatly). Respondents could also select a 'don't know' response. In general, respondents expressed optimism about their future production levels. Overall, the average Likert-scale score was 3.68 (with the 'don't know' responses removed), indicating expectations for increasing future levels of production (Table 18). Average Likert-scale scores indicated stable to increasing levels of production in the future by all producer size classes (3.32, 3.62, and 3.95 for small, medium and large producers, respectively).

The majority of respondents (85%) anticipate either stable or increasing levels of production (Table 18). A higher percentage of small producers anticipated stable production levels as compared to medium or large producers (43% versus 30% and 13%). Alternatively, higher percentages of medium and large producers reported some level of production increase in the next 10 years than small producers (37%, 56%, and 76% for small, medium and large producers, respectively). Overall, only 10% of respondents anticipated a decline in production levels and only 8% were uncertain. Thus, respondents irrespective of producer size class were generally optimistic about the future of their operations and production levels.

Table 18: Expectations for Syrup Production Levels in the Next 10 Years (Percentages of Respondents).

Change to Syrup Production Level	Small	Medium	Large	Overall
Decrease Greatly	1.96	2.03	1.89	2.11
Decrease Somewhat	9.80	7.43	6.60	8.14
Stay the Same	43.14	29.73	13.21	25.90
Increase Somewhat	31.37	41.89	49.06	41.87
Increase Greatly	5.88	14.19	27.36	17.47
Don't Know	7.84	4.73	1.89	4.52
Overall[1]	3.32	3.62	3.95	3.68

[1] average Likert Scale rating

Confidence in Ability to Adapt

Respondents were asked to indicate their level of agreement with two statements related to the future of their sugaring operation and their confidence in adapting to both changing ecological and market conditions. Specifically, the questions posed were: 1) "I can adapt to changing ecological and/or weather-related conditions in the next 10 years," and 2) "I can adapt to changing market conditions in the next 10 years." Five-point Likert scale response options were offered and ranged from 1 (strongly disagree) to 5 (strongly agree), along with an N/A response. Average Likert-scale ratings were computed for each producer size class and overall.

Respondents were generally optimistic, or at least more optimistic than pessimistic, that they can adapt to future conditions (both ecological and market). Specifically, almost half of respondents (48%) answered a

4 or 5 in their ability to adapt to ecological conditions while 56% answered a 4 or 5 to the market adaptation question (Figures 9 and 10). Only 10% and 7% answered a 1 or 2 to the ecological adaptation and market adaptation questions, respectively. In addition, the average Likert-scale response for the ecological adaptation question was 3.60 overall, and 3.63, 3.58 and 3.61 for small, medium and large respondents, respectively. Average Likert-scale responses were similar for the market adaptation question, with an overall score of 3.71, and producer size class scores of 3.65, 3.65 and 3.29 for small, medium, and large respondents. Overall, these data suggest neutral to optimistic views on adaptation for both types of factors.

Cumulative ordered logit models were run for the two adaptation questions individually to test for statistical significance differences in ratings by the producer size classes (Appendix C). Results of the cumulative ordered logits found no statically significant difference by producer size class in responses to either adaptation question (Appendix C).

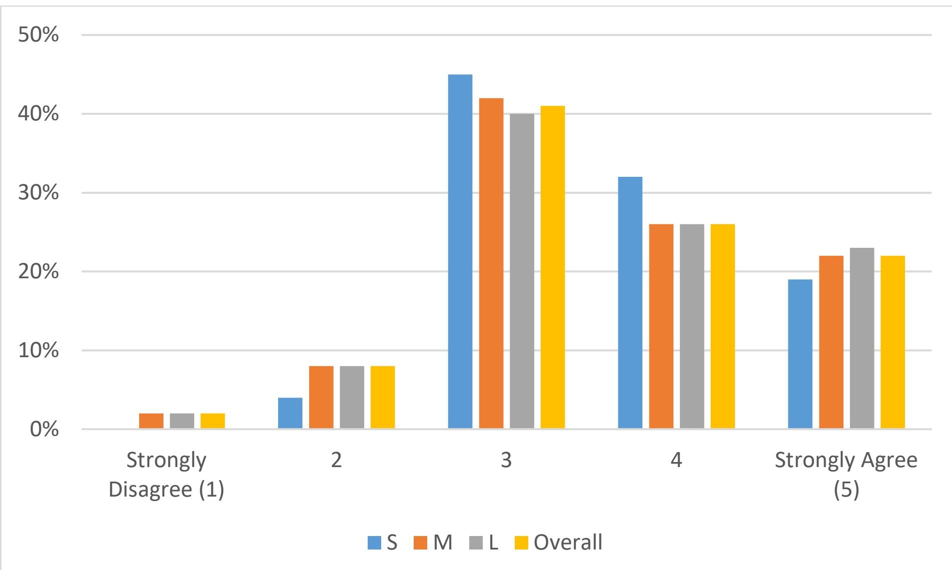

Figure 8: Confidence in Ability to Adapt to Ecological Conditions in the Next Ten Years by Producer Size (Percentage of Respondents).

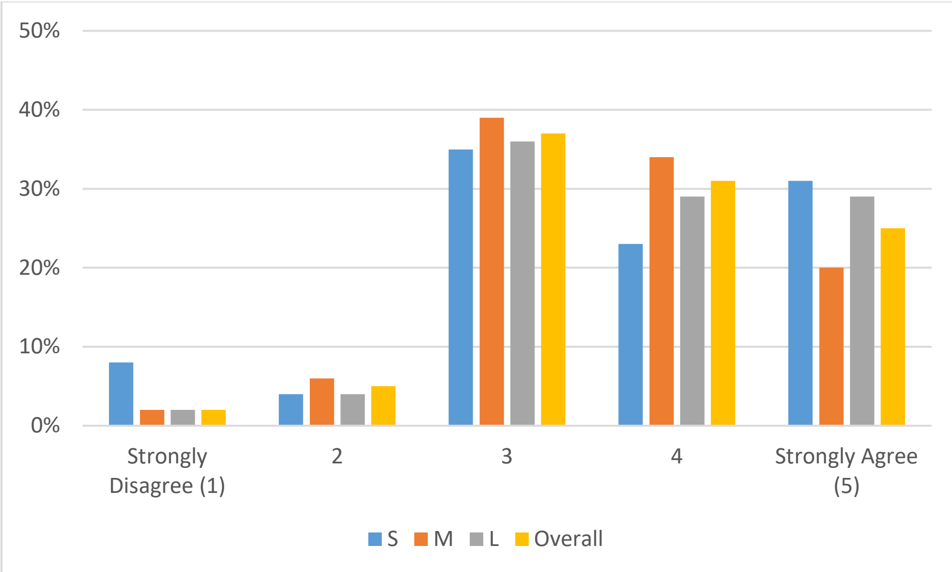

Figure 9: Confidence in Ability to Adapt to Market Conditions in the Next Ten Years by Producer Size (Percentage of Respondents).

Information and Assistance Needs

Respondents were asked to consider seven information/training topics and rate their importance on a scale of 1 (not important) to 5 (very important). Average Likert-scale ratings were computed for each producer size class and overall. Based on mean response ratings, the topic of greatest importance among all respondents was tree health, followed by information on improving profitability of one's sugaring operation (Table 19). Approximately two-thirds of all respondents rated the importance of information on increasing the health of their trees and information to improve marketability of maple products at a value of 4 or greater. The only topic that rated an average score less than three was information associated with product diversification.

When viewed by producer size classes, average importance ratings increased as producer size class increased (Table 19). Specifically, small producers had the lowest mean scores for all topics and large producers had the highest mean scores for all information topics. The highest-rated importance topic for small producers, and the only topic with a mean score greater than three, was tree health with a mean Likert rating of 3.61. Learning about processing methods and increasing production where the next two highest-rated topics for small producers. Average importance scores were higher for medium than small producers for all of the topics. As with small producers, tree health was the highest-rated information topic, followed by information on increasing profitability and learning about new processing methods. Large producers expressed the greatest interest in all of the information topics. Three of the topics were rated with an average importance score higher than four, information on profitability, marketing, and tree health. The remaining four topics also averaged importance scores higher than three.

The cumulative ordered logits reveal statistically significant differences among producer size classes for all seven of the information topics (Appendix D). Statistically significant differences were found between small and large producers for each of the information topics, with small producers more likely to rate each topic as less important than large producers. For example, small producers had 21.68 times higher odds of rating information on marketing as less important than large producers, and 21.59 times higher odds of rating information on improving profitability as less important the large owners. Small producers were only slightly more likely to rate information on tree health as less important than large producers (i.e., small producers had 1.446 times higher odds of rating this information topic as less important than large producers).

Table 19: Importance of Information/Training Topics by Producer Size Class (Average Likert-Scale Rating with 1 = Not Important and 5 = Very Important, standard deviation in parentheses).

Information Topic	Small	Medium	Large	Overall
Increasing Production	2.31 (1.10)	3.27 (1.40)	3.85 (1.26)	3.30 (1.39)
Tree Health	3.61 (1.02)	3.75 (1.06)	4.12 (1.00)	3.87 (1.04)
Collection and Processing Methods	2.78 (1.30)	3.46 (1.26)	3.79 (1.21)	3.45 (1.28)
Marketing	1.98 (1.33)	3.28 (1.36)	4.13 (1.18)	3.40 (1.46)
Profitability	2.08 (1.31)	3.52 (1.40)	4.31 (1.07)	3.63 (1.45)
Product Diversification	1.98 (1.35)	2.62 (1.49)	3.49 (1.38)	2.88 (1.54)
Succession Planning for Syrup Operation and/or Sugar Bush	2.29 (1.56)	3.06 (1.48)	3.40 (1.57)	3.07 (1.54)

Socio-Demographic Factors

Residence Status

The majority of respondents, regardless of producer size class, have a residence (either a primary or secondary home) at their sugar bush property (78%, 75%, and 74% for small, medium and large respondents, respectively). No statically significant differences were found between producer size classes $\chi 2$ (2, N=304) = 0.44, p = 0.80) (Figure 11). Of those with an on-site residence, the majority have their primary home located there (72%, 64% and 71% of small, medium, and large respondents, respectively) with no statically significant differences between producer size classes $\chi 2$ (2, N=304) = 1.95, p = 0.38). Secondary homes make up only a small fraction of the on-sugar bush residences, with medium producers having a slightly higher incidence of secondary homes (11%) than both small (6%) and large (3%) producers ($\chi 2$ (2, N=304) = 6.12, p = 0.05).

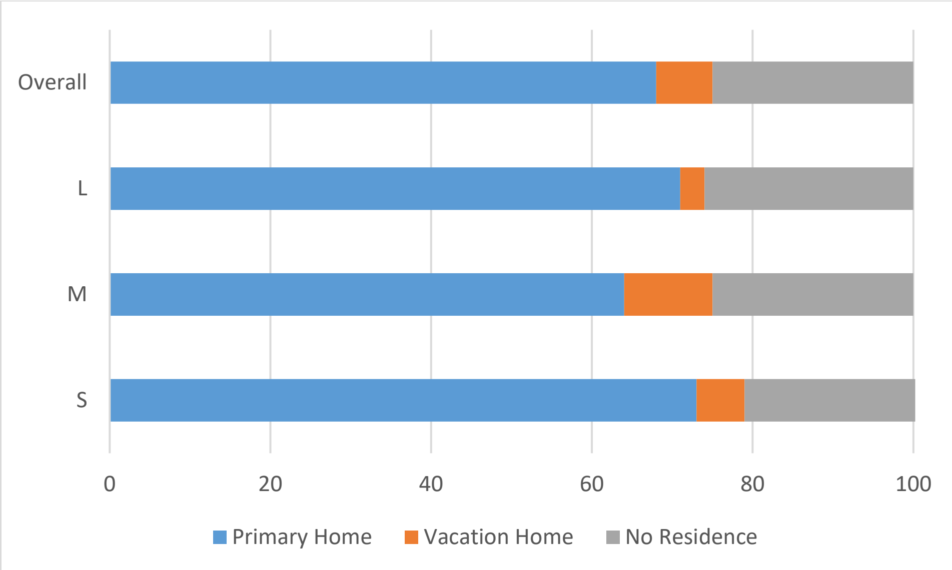

Figure 10: Residence Status by Producer Size Class (Percentage of Respondents).

Contribution of Sugaring Operation to Household Income

In general, respondents report little contribution from their sugaring operation to their household income (Table 20). Seventy-two percent of respondents report that sugaring revenue constitutes five percent or less of their household income, while only four percent report a contribution of more than 50%. When viewed by producer size class, however, not surprisingly, significant differences in the contribution of sugaring to the respondent's household income are found ($\chi2$ (8, N=302) = 112.85, p <0.0001). Small producers report little if any economic contribution from their operation, with 90% indicating less than one percent. The plurality of medium producers also report a less than 1% financial contribution from sugaring (50%), but 48% of respondents report up to a 25% contribution to household income. Finally, large producers report the greatest contribution to household income, although only ten percent derive more than 50% of their income from their operations.

Table 20: Percentage of Household Income Derived from Sugaring Option by Producer Size (Percentages of Respondents).

	Small	Medium	Large	Overall
Less than 1%	90	50	19	46
1 to 5%	8	34	24	26
6 to 25%	0	14	25	16
26 to 50%	2	2	22	9
Greater than 50%	0	0	10	4

Demographics

The age of respondents ranged from 19 to 89, with an average age of 60 for the full sample. The average age of the respondent varied significantly by producer size class [F(2, 296) = 9.52, p <0.001]. Large producers are somewhat younger than small and medium producers (64 years for small producers, 62 for medium producers and 56 for large producers). The majority of respondents were male (91%) and 99% were white, with no statistical differences among the producer size classes for these two attributes ($\chi2$ (2, N=299) = 0.3509, p = 0.8391 for sex) and ($\chi2$ (2, N=292) = 0.9365, p = 0.6261 for race). None of the respondents (N=286) indicated they were of Hispanic or Latino origin. One respondent identified as a Native American.

DISCUSSION

State-Level Characteristics

While we chose not to make many state-level comparisons among the three states in our study, our data indicate some state-level differences may exist in operation size and production efficiency. Although the average number of taps that were set in MI is almost 50% more than WI, the average number of gallons produced by both states is fairly similar. Several explanations might explain this disparity. Our sampling frame may be influencing these findings. However, other explanations for this finding could be that our WI respondents make greater use of advanced collection and processing equipment, and/or that differences may exist in the health, size, quantity, or quality of trees of the sugar bush among the Lake States. According to Oswalt et al. (2014), MI has almost double the volume of hard maple as WI, and an order of magnitude more than MN (4,464 million ft^3 in MI, 2,341 million ft^3 in WI, 484 million ft^3 in MN). In spite of the smaller hard maple resource, it is worth noting that Minnesota in particular may have great maple syrup production expansion potential. Levels of production and number of taps is considerably lower in MN than the other two states, and producers have fewer years of experience. Mathews and Iverson (2009) have suggested that Minnesota may see enhanced habitat suitability for the sugar maple resource under potential future climate scenarios. Thus, training and assistance efforts focused in Minnesota to attract new producers and/or assist existing producers in expansion efforts might be particularly fruitful in efforts designed to increase maple syrup production and capacity across the Lakes States.

Sources of Sap

While the majority of sap is derived from taps set on lands owned by the respondents, between 29% (small) and 43% (large) of sap processed in 2016 was derived from other's forested land. One implication of these findings is that forest land use and land ownership decisions made by others; e.g., those from whom supplemental sap is derived, have an influence on syrup production. If these forest lands that are currently providing supplemental sap change ownership or ownership goals, become parcelized or developed in the future, then this source of sap may decline. Kilgore and Snyder (2016) have found private forestland parcelization to a salient issue in the Lake States.

Equipment and Technologies

The equipment used in sap collection and processing is a fundamental element of a syrup operation, and one that is being used, in some ways, as a means to increase output and efficiency of maple syrup operations. Use of different sap extraction and production equipment varies by producer size class, as would be expected. Since respondents weren't asked why they used particular equipment, we don't know whether the choice of equipment is a function of the scale of their operation, preference for more/less traditional collection and processing ways, and/or cost factors associated with upgrading equipment, although the qualitative data suggest each of these can be a factor. The price of some of the more advanced equipment, like a reverse osmosis machine, can range between $3,000 and $35,000, depending upon the size. As was noted by some respondents in open-ended responses, cost share assistance is not available to producers in the region to make the purchase of equipment more feasible. Thus, equipment costs may represent a barrier for some producers to expand production and/or increase efficiency of their operations, as well as a potential barrier for new producers to develop an operation.

In addition, moving from traditional collection and processing equipment such as sap buckets to the use of more sophisticated equipment such as plastic tubing with vacuum collection systems and reverse osmosis is a way to increase efficiency of operations, reduce labor, and potentially reduce impacts of sap flow variability associated with weather conditions. While many respondents indicated that their method of adapting to earlier or more variable sap flows was simply being prepared to tap earlier, utilization of advanced technology was also reported by respondents as an adaptation mechanism. For example, when tubing is used instead of sap buckets or sap sacs, there is lower likelihood that producers may miss parts of the sap run as the tubing is installed and left up for the winter and spring and able to continuously capture sap whenever the flow occurs. In addition, use of tubing with vacuum can also extract more sap from trees than if gravity tubing or sap buckets are used (van den Berg 2016). Thus, when compared to more traditional sap collection methods, the use of more advanced technologies will typically increase output and efficiency, which may give producers an elevated perception and confidence that weather and climate vagaries can be overcome through adoption of new equipment. However, as noted by one respondent, the use of tubing makes one’s operation more vulnerable to damage from ice and wind storms, which may increase in frequency and/or severity under future climate scenarios.

Thus, if a producer is not able or interested in purchasing and utilizing these advanced technologies, their operations may be less resilient to change over time. Again, technology seems to offer producers confidence in their ability to face weather-related challenges, and thus may be one reason why respondents report being generally optimistic about the future of their operations and expressing little concern about climate impacts. The danger here is that while technology does allow producers to adapt to variability in timing and continuity of sap flows, these technologies are not as likely to compensate for secondary or associated impacts to the health and vigor of one’s sugar bush; e.g., impacts such as increased vulnerability to disease, pests, and extreme weather events. Thus, if producers seem to feel equipped and able to respond to sap season and flow variability through changes in technology, they may be less motivated to acknowledge or take actions to address other stressors associated with weather and climate variability. This reliance on technology advances as a climate adaptation strategy has also been documented within the context of farming systems and agriculture (e.g., Smithers and Blay-Palmer, 2001).

Perceived Trends in Seasonality/Market/Economic/Regulatory Aspects of Syrup Production

In general, respondents, regardless of producer size class, have not perceived trends in a variety of factors related to sap season conditions over the past 10 years; e.g., factors related to length, timing and continuity of sap flow. Thus, while many respondents indicated they have experienced *variability* in these factors over this time period in open-ended responses, they are not seeing strong, consistent trends. This lack of consistent trends, or perception of trends, in sap season factors may in part explain why so few of the respondents indicated undertaking actions specifically out of concern for climate issues. Without clear trends, it is hard to expect producers to be able to develop an effective or common approach to adapting to weather and climate-related factors.

In contrast to their low level of concern regarding climate, respondents expressed somewhat greater certainty in their perceptions of some of the trends related to market, economic and regulatory factors associated with syrup production. However, their perceptions of some of the trends were in tension with each other. That is, on one hand, respondents were generally perceiving greater complexity of regulations related to sugaring operations as well as higher production costs, yet also perceiving greater marketability of maple products. There was no clear consensus on whether profitability was increasing for maple products. Thus, it could be that regulations and production costs are impacting profitability which at some point may become a barrier to expansion and/or entry into commercial maple syrup production by new individuals.

Adaptation Activities Already Undertaken:

When queried about activities that could be viewed as adaptation strategies to various stressors, the activity that both medium and large producers are most likely to have already done is adopt different technology or equipment for extraction or processing. As mentioned previously, the adoption of more sophisticated collection and processing equipment, like tubing with vacuum pumps or reverse osmosis systems, are all things that, in some ways, help get around climate variability issues. These equipment items tend to increase efficiency, reduce processing costs, as well as moderate the uncertainty of variable sap flows. The adoption of new technologies tends to reflect the size and goals of producers increasing from small, hobby scale to more commercial, retail scale. Thus, in the case of commercial producers the adoption of new technologies could be viewed either as a means to moderate uncertainty in sap season conditions and/or a progression of adoption of more sophisticated equipment to expand the scale and profitability of operations, and as an ancillary benefit may provide buffering against sap season variability.

None of the three producer size groups have done much in the way of planting climate change resilient maple cultivars. Reasons for low levels of implementation for these activities could be lack of availability, knowledge, or interest in planting these climate resilient cultivars and/or associated costs. Regardless of the reason for low levels of implementation, producers big and small are not proactively or preemptively undertaking selective maple cultivar planting. Thus, if such activities are needed under potential future climate scenarios, this may be a big hurdle for syrup producers and/or sugar bush owners to overcome without targeted outreach and assistance efforts.

In general, small producers have not undertaken any of the queried activities to any great degree. Managing for healthier trees was the activity with the highest percentage of small producer participation, but that was only 8% of small respondents. Thus, these small, hobby producers may not view the queried activities as relevant or affordable for the scale of their operations, or they may be uncertain as to how to undertake some of the activities. While small producers may not be interested in making large or long-term investments in their operations through the purchase of new equipment, given the importance of making connections to nature and bringing together family and friends, management of their sugar bush for more productive and/or healthier trees may be a topic of greater resonance to these hobbyists.

Future Adaptation Activities

When considering the activities that respondents indicated they were likely to undertake in the next ten years, we find much higher percentages of respondents expressing an intent than had done so in the past. A number of factors might explain these intentions. These findings could signal a growth period in the industry in the region. It could also reflect a progression of increased investment as smaller producers move to expand operations; the ‘hobby out of control’ sentiment that was mentioned in open-ended comments. It could be a desire to increase efficiency of operations that often comes with adoption of advanced technologies and rising production costs. Finally, the interest in adopting technology and active management of the sugar bush could be a reaction to ecological conditions and challenges such as pest, disease or weather event issues that may be forcing producers and sugar bush owners to more actively consider activities such as enhanced sugar bush management. Our qualitative data offer evidence of lifecycles for sugaring operations that parallel respondents’ lifecycles, suggesting caution, however, in portraying enhanced future interest in sugaring activities as an inevitable, uni-directional process.

As with the question that focused on activities completed in the past, none of the three producer groups are likely to plant climate change resilient maple cultivars, tap non-sugar maples (e.g., box elder, birch, silver maple), or engage in product simplification. Thus, significant assistance and outreach would likely be needed for these activities to gain traction with producers in the future in the Lake States. At present, the only other tree syrup industry in the U.S. is that of birch syrup, which is primarily focused in Alaska (Cameron, 2001). While few of the respondents in our study expressed experience or interest in experimenting with tapping and processing of other trees, possibilities may exist or become more attractive in the future for development of fledging industries from other tree species. Farrell (2009) suggests potential for enhanced reliance on red maples in syruping operations, which may not suffer the same declines in abundance in eastern forests as sugar maples. Two respondent comments to this survey indicate they already are tapping red maples.

An activity that many respondents do intend to undertake in the next ten years in tap expansion. Approximately 65% of large producers and 55% of all respondents anticipate increasing the number of taps used in the next ten years. Thus, there is a desire for production expansion, which appears realistic for the Lake States. Mathews and Iverson (2017) suggest significant opportunity for increasing the number of taps for sap extraction throughout the range of the sugar maple, with Michigan having particular untapped capacity. Moreover, Mathews and Iverson (2017) also suggest that suitability of sugar maple habitat will change in the future under different climate scenarios, with Minnesota likely to experience an increase in habitat under many climate projections.

However, it will be important that producers follow best management practices regarding tapping guidelines. Installing too many taps in a given tree, or tapping trees that are too young or those impacted by drought, diseases or pests will serve to further stress a sugar bush and not result in gains to production (Houston et al. 1990). As noted by van den Berg et al. (2016), high yield sap removal practices associated with vacuum tubing and other modernizations can remove double the amount of sap from more traditional removal methods, and that care must be exercised in ensuring one's tapping and extraction system are sustainable for the conditions of one's sugar bush.

Actions Taken Out of Specific Concern for Climate Change

While many respondents indicated they have undertaken or plan to undertake activities that could be viewed as adaptation activities (e.g., adopting new collection or processing technologies, active management for healthier or more productive trees), only 11% had done so out of specific concern over climate conditions. The lack of action out of concerns about climate related impacts could be attributed to myriad factors. One, as noted by some of the respondents, weather variability and associated variability in sap season timing and conditions have always been part of the syrup production. Thus, either significant enough changes or trends have not been observed to necessitate changes and/or changes that have been observed aren't viewed as attributable to long term climate changes. These findings are generally consistent with studies of maple syrup producers in Vermont (Kuehn et al. 2016) and Ontario (Murphy et al. 2012), both of which found producers didn't hold wide-spread concerns related to climate change and weren't often undertaking adaptation strategies out of specific concern for climate change.

Given that Mathews and Iverson (2017) and the Landscape Change Research Group (2014) report that future climate conditions are likely to reduce the amount of suitable habitat for maple trees, as well as adversely impact sugar bush health and productivity through droughts and increased insect infestations in the coming century, this lack of concern and action on the part of maple syrup producers may be cause for concern. One implication of producers' attitudes and actions towards climate change is that messaging, outreach and management strategies specifically invoking climate change or variability isn't likely to be an effective way to reach or motivate current syrup producers in the Lake States, at least at the present time. Messaging and management strategies more centrally focused on the impacts to the health and productivity of sugar bush and how to address them might resonate more.

Concerns

While respondents expressed moderate levels of concern about a variety of factors associated with the future of their sugaring operation, higher average concern ratings were expressed for factors such as profitability and impacts of rules and regulations than sap season variability and weather threats, particularly among medium and large producers. One implication of this concern about profitability, particularly among large producers, is that they may be reluctant to embrace any adaptation, sugar bush management, and/or production strategy that is seen as negatively impacting profitability. Tree health was the highest-rated concern among all producer size classes, suggesting opportunities and needs to engage with sugar bush owners on management strategies to enhance sugar bush health. While we did not query respondents about whether they had a forest management plan, this expressed concern over sugar bush health might represent an opportunity to focus forest management plans on strategies that enhance sugar bush health and productivity. Finally, this lack of significant concern about most of the factors queried may also underlie the overall optimism respondents largely expressed about the future of their operations.

Expectations for Operations

The majority of respondents indicated expectations for stable to increasing levels of production over the next ten years. While this is an optimistic sign for the industry in the Lake States, one must wonder if this expectation is more aspirational than realistic? Specifically, the average age of respondents was 60 and respondents indicated concern over their future physical ability to continue their operations and the potential for continued family involvement. Moreover, respondents also indicated a lack of financial cost-share assistance available to them which might allow them to upgrade their equipment and production facilities. Thus, while this expectation of increased production is a positive indicator, it should be tracked over time to determine whether increasing production is indeed possible and occurring among existing producers in the region, as well as whether new operations are being established in the Lake States.

Confidence in Ability to Adapt

Respondents expressed confidence in their ability to adapt to both changing ecological or weather/related conditions and changing market conditions. While respondents weren't specifically asked what influenced their response, a number of factors are likely at play. Respondents could feel that conditions aren't changing or changing enough to warrant adaptation approaches to their operations. Alternatively, they may agree that conditions are or could change, but feel that they possess the requisite knowledge, tools, skills, capital and resources to overcome conditions. Regardless of the reasons, underlying responses to this question, this attitude or belief that they can readily adapt to conditions could potentially present itself as a barrier or blinder to being open to considering new strategies or open to the possibility that changes are occurring that are or may eventually require new strategies.

Information Needs

Information on tree health is of interest to all three producer size classes. This suggests an opportunity and a need for extension and consulting foresters to develop education and outreach materials, training, messaging that specifically targets stewardship and management efforts to enhance sugar bush health and productivity. Given low or conflicting belief or concern in climate change issues, outreach and messaging to enhance tree health will likely be more effective if it isn't necessarily tied to messaging relative to climate change.

Interest in other information topics was more differentiated by size. Overall, small producers expressed low level of importance for the other information topics. We don't know whether that is a function of these topics not being relevant to them, or if they feel they have adequate information and assistance provided to them, or if they learn what they need to through other channels or are content with their operation as is. Across all of the topics, large producers rated importance factors the highest among all producer groups. This is consistent with sugaring generally being a greater part of large producers' livelihoods than small or medium producers. In structured survey responses, succession planning was one of the lowest rated topics among all producer size classes. This could indicate that they already have succession plans worked out, or that they haven't yet thought about it. However, several comments indicate anxiety about succession planning, suggesting it may be a fertile area for information programming.

Social Dynamics

Consistent with national research on family forest landowners, the majority of our respondents have a residence on or near their sugarbush. Respondents to our study were also fairly similar in socio-demographic characteristics to research family forest landowners in the upper Midwest (Butler et al. 2016). In general, syrup operations do not constitute the major source of household income for many producers in our study.

The quantitative and qualitative data indicate that the social structures and goals of maple sugaring operations are diverse and dynamic. This is true both through time and across size classes. Individual sugaring operations may experience cycles of expansion and contraction that parallel the discretionary time and physical capacity of the individuals who are their prime movers. Where family or others do not take over, operations may end when that person ceases to sugar.

Our results show that sugaring operations are constituted as hobbies, non-profit organizations, and profit-making enterprises. While small producers are less likely to see income from their operations and large producers often do, there does not appear to be a simple relationship between size and sugaring-related economic practices. Some small producers sell syrup they regard as surplus after supplying their households and gifts, while some or all of medium and large producers' proceeds may be dedicated to charitable giving. Some producers need or desire to make a profit. For others, connections to nature, as well as social and affective factors are their primary motivations. We note, however, that profit and social and affective values are not mutually exclusive. Much as Hinrichs (1998) showed for maple sugaring in Vermont, the connection of these values may be precisely the point for many producers.

CONCLUSIONS

It is clear that sugaring is important to maple syrup producers for myriad reasons beyond economic gain; even our large producer respondents indicated they valued the role that syrup production played as a means to bring family together, in maintaining a family or cultural tradition, and in the opportunities that syrup production offers to connect to forests and nature. These are important attachments and benefits to emphasize and cultivate, particularly when considering succession planning for maple syrup operations and associated sugarbushes. While maple syrup production will not be a venture that appeals to or is feasible to all forest landowners in the Lake States, for that segment of landowners for which it does, it is an important cultural, social, and economic facet of the northwoods landscape that contributes to rural livelihoods and sustainability. Intergenerational involvement in syrup production may be one important hook that can help foster engagement and stewardship of private forestlands among younger generations who may ultimately inherit private forestland and associated syrup operations.

While the production of maple syrup is directly tied to weather and climate conditions, few producers in our study expressed specific concern about how climate variability has or may impact their syrup operations. As a consequence, only a small percentage of our respondents report having taken actions specifically out of concern for or in response to climate change. Utilizing new sap collection and processing equipment and altering their syrup production schedule have largely been viewed as adequate strategies to circumvent any *direct* impacts that may be stemming from climate variability and climate trends; e.g., changes in sap season timing. However, other impacts that may be associated with climate stressors, such as threats to sugar bush health from drought, pests, invasives, and disease will call for additional management or adaptation strategies, regardless of whether these actions are motivated by or associated with climate conditions.

It is clear that sugar bush health is a topic of considerable interest and concern to current producers in the Lake States. Among all three producer size groups, tree health was both the highest rated information need and the highest rated factor of concern impacting the future of one's operations. Moreover, more than half of all respondents intend to actively manage their sugar bush in the future for healthier trees. These facts underscore needs and opportunities for extension agents, service forests, and Maple Syrup Producers Associations (MSPA) to promote forest management practices that not only contribute to productivity and longevity of sugaring operations, but can also contribute to overall forest health. It is important to emphasize, though, that respondents do not appear to be linking this concern about forest health with climate stressors. Given this, climate variability may not be the right messaging frame to use at this point when talking with owners about strategies for enhancing sugar bush health. This interest by producers in information and assistance related to tree health might also represent an opportunity for enhanced interactions with professional foresters and other services they can provide. For example, research suggests that sugar bush management can be practiced in ways that emphasize ecological benefits such as biodiversity conservation and habitat protection (Clark and McLeman, 2012). However, in their study, Clark and McLeman (2012) found that few sugar bush operators in their study in Ontario had a forest management plan with specified forest management goals for sugar bush health, let alone biodiversity and conservation practices.

A theme among some respondents in open-ended comments, notably large producers, was the impact of regulations and competition with Canadian producers. Approximately 75% of the world's maple syrup is produced in Quebec, Canada, this in spite of a smaller sugar maple resource than the U.S. (Farrell 2009). The Canadian government provides support for maple syrup production through cost-sharing programs for equipment purchase and attractive lease rates on public lands for tapping (Farrell 2009). In some open ended comments, respondents in our study lamented the lack of similar government assistance for operations in the U.S. Farrell (2009) also noted a lack of government-assisted marketing and promotion of maple products in the U.S. as compared to the Canada. Producers in our study are keenly aware of the competitive advantage that Canadian producers enjoy and point to this as a constraining factor in growing their operations in the Lake States.

There are many indications in our survey results that current producers in the Lake States are optimistic about the future of their operations and planning to undertake activities that could serve to expand their operations, from increasing the number of taps they plan to set, adopting new technology, and management for a healthier sugar bush. While sugar maple habitat suitability projections suggest that the maple resource in the Lake States may be stable to increasing in the future under different climate models (Mathews and Iverson, 2017), that is not to say that maple syrup producers in this region will not be immune to stressors associated with climate and weather variability, market forces and sugar bush health. Thus, the optimism expressed by our respondents may at some point need to be tempered by the reality that active planning, management and adaptation to ecological, weather, and market-related factors may be increasingly needed in the future. For the time being, producers in the Lake States feel like they have largely been able to adapt to variability in sap season conditions by being prepared to tap trees earlier and through adoption of new sap collection and processing equipment. If future climate scenarios play out, then additional planning and adaptation strategies may be called for, particularly as they relate to forest health and productivity issues.

It is also important to underscore that our analysis focused on current producers at a single point in time, who voluntarily belong to a MSPA. Given this, they probably are a more engaged, motivated group of syrup producers than those who are not members. Moreover, our research does not lend insight into what barriers or information needs might exist for sugar bush owners who aren't currently engaged in tapping and/or syrup production, but might have the potential to do so. Additional research is needed to increase our understanding of the types of information, outreach, assistance, and mentoring that might be needed to facilitate the entry of new syrup producers in the Lake States.

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APPENDIX A: Cumulative Ordered Logits for Question Related to Reasons for Producing Maple Syrup

<u>1. Importance of Syrup to Give Away</u>

a. Reference Conditions: Small Producer

Score test for Proportional Odds Assumption (N=299)

Chi-Square	DF	Pr > ChiSquare
4.32	6	0.6335

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Intercept_1	1	-1.9719	0.1760	125.59	<0.0001	
Intercept_2	1	-1.3588	0.1561	75.79	<0.0001	
Intercept_3	1	-0.4075	0.1412	8.33	0.0039	
Intercept_4	1	0.6620	0.1444	21.03	<0.0001	
Producer Size_Large	1	1.2210	0.1686	52.44	<0.0001	13.206
Producer Size_Medium	1	0.1386	0.1507	0.85	0.3576	4.474

b. Reference Condition: Large Producer

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Producer Size_Medium	1	0.1386	0.1507	0.85	0.3576	0.339

<u>2. Feeling Connected to My Land</u>

a. Reference Conditions: Small Producer

Score test for Proportional Odds Assumption (N=300)

Chi-Square	DF	Pr > ChiSquare
6.6286	6	0.3566

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Intercept_1	1	-2.8759	0.2612	121.2235	<0.0001	
Intercept_2	1	-2.1939	0.1982	122.4858	<0.0001	

Intercept_3	1	-1.0019	0.1392	51.8152	<0.0001	
Intercept_4	1	0.2576	0.1263	4.1578	0.0414	
Producer Size_Large	1	0.2218	0.1563	2.0144	0.1558	1.338
Producer Size_Medium	1	-0.1526	0.1469	1.0781	0.2991	0.920

b. Reference Condition: Large Producer

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Producer Size_Medium	1	-0.1526	0.1469	1.0781	0.2991	0.688

3. Learning/Preserving a Craft

a. Reference Conditions: Small Producer

Score test for Proportional Odds Assumption (N=303)

Chi-Square	DF	Pr > ChiSquare
6.2473	6	0.3961

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Intercept_1	1	-2.9085	0.2617	123.5363	<0.0001	
Intercept_2	1	-2.2637	0.2015	126.2181	<0.0001	
Intercept_3	1	-1.2720	0.1471	74.7931	<0.0001	
Intercept_4	1	0.2784	0.1259	4.8926	0.0270	
Producer Size_Large	1	0.2318	0.1566	2.1918	0.1387	1.460
Producer Size_Medium	1	-0.0850	0.1468	0.3355	0.5624	1.064

b. Reference Condition: Large Producer

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Producer Size_Medium	1	-0.0850	0.1468	0.3355	0.5624	0.728

4. Bringing Together Family and Friends

a. Reference Conditions: Small Producer

Score test for Proportional Odds Assumption (N=298)

Chi-Square	**DF**	**Pr > ChiSquare**
9.0325	6	0.1718

Analysis of Maximum Likelihood Estimates

Parameter	**DF**	**Estimate**	**Std Error**	**Wald Chi-Square**	**Pr > ChiSq**	**Odds Ratio**
Intercept_1	1	-2.6610	0.2454	117.6088	<0.0001	
Intercept_2	1	-2.1416	0.1984	116.4760	<0.0001	
Intercept_3	1	-0.8771	0.1363	41.3910	<0.0001	
Intercept_4	1	0.2789	0.1268	4.8381	0.0278	
Producer Size_Large	1	-0.0981	0.1566	0.3921	0.5312	0.594
Producer Size_Medium	1	-0.3252	0.1479	4.8362	0.0279	0.473

b. Reference Condition: Large Producer

Parameter	**DF**	**Estimate**	**Std Error**	**Wald Chi-Square**	**Pr > ChiSq**	**Odds Ratio**
Producer Size_Medium	1	-0.3252	0.1479	4.8362	0.0279	0.797

5. Youth/Community/Environmental Learning Opportunities

a. Reference Conditions: Small Producer

Score test for Proportional Odds Assumption (N=299)

Chi-Square	**DF**	**Pr > ChiSquare**
3.7550	6	0.7098

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Intercept_1	1	-1.4731	0.1563	88.8644	<0.0001	
Intercept_2	1	-0.4536	0.1273	12.6933	0.0004	
Intercept_3	1	0.4987	0.1279	15.2130	<0.0001	
Intercept_4	1	1.4714	0.1538	91.5118	<0.0001	
Producer Size_Large	1	-0.2202	0.1505	2.1404	0.1435	0.575
Producer Size_Medium	1	-0.1131	0.1408	0.6461	0.4215	0.640

b. Reference Condition: Large Producer

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Producer Size_Medium	1	-0.1131	0.1408	0.6461	0.4215	1.113

<u>6. Maintaining a Family or Cultural Tradition</u>

a. Reference Conditions: Large Producer

Score test for Proportional Odds Assumption (N=300)

Chi-Square	DF	Pr > ChiSquare
1.8886	6	0.9296

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Intercept_1	1	-1.9418	0.1839	111.4648	<0.0001	
Intercept_2	1	-1.3120	0.1511	75.3863	<0.0001	
Intercept_3	1	-0.6112	0.1317	21.5306	<0.0001	
Intercept_4	1	0.3870	0.1287	9.0477	0.0026	
Producer Size_Medium	1	-0.1331	0.1450	0.8419	0.3588	1.306
Producer Size_Small	1	0.5334	0.1883	8.0231	0.0046	2.544

b. Reference Condition: Small Producer

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Producer Size_Medium	1	-0.1331	0.1450	0.8419	0.3588	0.514

<u>7. Spiritual Significance</u>

a. Reference Conditions: Small Producer

Score test for Proportional Odds Assumption (N=285)

Chi-Square	DF	Pr > ChiSquare
8.2360	6	0.2213

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Intercept_1	1	-0.0894	0.1293	0.4778	0.4894	
Intercept_2	1	0.5701	0.1336	18.2088	<0.0001	
Intercept_3	1	1.3169	0.1530	74.0456	<0.0001	
Intercept_4	1	2.1464	0.1968	118.990	<0.0001	
Producer Size_Large	1	-0.1066	0.1605	0.4412	0.5065	0.689
Producer Size_Medium	1	-0.1596	0.1509	1.1180	0.2903	0.653

b. Reference Condition: Large Producer

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Producer Size_Medium	1	-0.1596	0.1509	1.1180	0.2903	0.948

<u>8. Selling Syrup for Income/Bartering</u>

a. Reference Conditions: Large Producer

Score test for Proportional Odds Assumption (N=299)

Chi-Square	DF	Pr > ChiSquare
128.1269	6	<0.0001

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Intercept_1	1	-1.1723	0.1674	49.0415	<0.0001	
Intercept_2	1	-0.8022	0.1607	24.9057	<0.0001	
Intercept_3	1	0.0405	0.1551	0.0681	0.7941	
Intercept_4	1	1.0438	0.1611	41.9719	<0.0001	
Producer Size_Medium	1	-0.1150	0.1592	0.5218	0.4701	6.316
Producer Size_Small	1	2.0730	0.2232	79.0227	<0.0001	56.317

b. Reference Condition: Small Producer

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Producer Size_Medium	1	-0.1150	0.1592	0.5218	0.4701	0.112

9. Income for Home Consumption

a. Reference Conditions: Small Producer

Score test for Proportional Odds Assumption (N=301)

Chi-Square	DF	Pr > ChiSquare
42.9940	6	<0.0001

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Intercept_1	1	-2.9097	0.2514	133.645	<0.0001	
Intercept_2	1	-2.1639	0.1937	124.8442	<0.0001	
Intercept_3	1	-1.1761	0.1515	60.2479	<0.0001	
Intercept_4	1	-0.3544	0.1367	6.7169	0.0096	
Producer Size_Large	1	0.6818	0.1692	16.2485	<0.0001	3.928
Producer Size_Medium	1	0.00433	0.1614	0.0007	0.9786	1.995

b. Reference Condition: Large Producer

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Producer Size_Medium	1	0.00433	0.1614	0.0007	0.9786	0.508

<u>10. Getting Outdoors in the Spring</u>

a. Reference Conditions: Small Producer

Score test for Proportional Odds Assumption (N=304)

Chi-Square	DF	Pr > ChiSquare
14.0429	6	0.0292

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Intercept_1	1	-3.0522	0.2729	125.1262	<0.0001	
Intercept_2	1	-2.3756	0.2083	130.0725	<0.0001	
Intercept_3	1	-1.4010	0.1534	83.4349	<0.0001	
Intercept_4	1	-0.0851	0.1275	0.4459	0.5043	
Producer Size_Large	1	0.5096	0.1606	10.0605	0.0015	2.338
Producer Size_Medium	1	-0.1700	0.1525	1.2435	0.2648	1.185

b. Reference Condition: Large Producer

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Producer Size_Medium	1	-0.1700	0.1525	1.2435	0.2648	0.507

APPENDIX B: Cumulative Ordered Logits for Question Related to Concerns about Factors Impacting Their Sugaring Operation

1. Sap Production per Tap

a. Reference Conditions: Large Producer

Score test for Proportional Odds Assumption (N=304)

Chi-Square	DF	Pr > ChiSquare
9.7058	6	0.1376

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Intercept_1	1	-1.2577	0.1465	73.6536	<0.0001	
Intercept_2	1	-0.6946	0.1309	28.1464	<0.0001	
Intercept_3	1	0.7828	0.1326	34.8298	<0.0001	
Intercept_4	1	1.6419	0.1607	104.4530	<0.0001	
Producer Size_Medium	1	-0.00089	0.1415	0.000	0.9950	1.493
Producer Size_Small	1	0.4023	0.1839	4.7880	0.0287	2.234

2. Sugaring Profitability

a. Reference Conditions: Large Producer

Score test for Proportional Odds Assumption (N=304)

Chi-Square	DF	Pr > ChiSquare
6.6117	6	0.3583

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Intercept_1	1	-0.9434	0.1559	36.6283	<.0001	
Intercept_2	1	-0.4389	0.1481	8.7875	0.0030	
Intercept_3	1	0.4191	0.1461	8.2307	0.0041	
Intercept_4	1	1.4848	0.1598	86.3114	<.0001	
ProducerSize_Medium	1	-0.3228	0.1528	4.4620	0.0347	3.134
ProducerSize_Small	1	1.7880	0.2241	63.6423	<.0001	25.872

3. Boil Season Beginning and End Dates

a. Reference Conditions: Large Producer

Score test for Proportional Odds Assumption (N=303)

Chi-Square	DF	Pr > ChiSquare
3.5051	6	0.7433

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Intercept_1	1	-0.7344	0.1325	30.7135	<.0001	
Intercept_2	1	0.0141	0.1252	0.0128	0.9100	
Intercept_3	1	1.0695	0.1397	58.6388	<.0001	
Intercept_4	1	2.1263	0.1859	130.7772	<.0001	
ProducerSize_Medium	1	-0.3553	0.1425	6.2166	0.0127	0.769
ProducerSize_Small	1	0.4475	0.1857	5.8114	0.0159	1.716

4. Boil Season Length

a. Reference Conditions: Large Producer

Score test for Proportional Odds Assumption (N=303)

Chi-Square	DF	Pr > ChiSquare
6.4883	6	0.3708

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Intercept_1	1	-0.8932	0.1362	43.0158	<.0001	
Intercept_2	1	-0.2393	0.1258	3.6208	0.0571	
Intercept_3	1	1.0681	0.1399	58.2787	<.0001	
Intercept_4	1	2.0329	0.1814	125.6333	<.0001	
ProducerSize_Medium	1	-0.3300	0.1432	5.3131	0.0212	0.776
ProducerSize_Small	1	0.4065	0.1846	4.8468	0.0277	1.621

5. Weather Threats (E.g., drought, low snow pack)

a. Reference Conditions: Large Producer

Score test for Proportional Odds Assumption (N=303)

Chi-Square	DF	Pr > ChiSquare
4.3963	6	0.6232

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Intercept_1	1	-1.4425	0.1529	88.9758	<.0001	
Intercept_2	1	-0.5618	0.1278	19.3175	<.0001	
Intercept_3	1	0.5214	0.1272	16.7937	<.0001	
Intercept_4	1	1.6982	0.1652	105.7150	<.0001	
ProducerSize_Medium	1	0.0844	0.1402	0.3628	0.5470	1.250
ProducerSize_Small	1	0.0547	0.1804	0.0918	0.7618	1.214

6. Pest Threats (e.g., Asian Longhorned Beetle, Earthworms)

a. Reference Conditions: Large Producer

Score test for Proportional Odds Assumption (N=303)

Chi-Square	DF	Pr > ChiSquare
1.1114	6	0.9810

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Intercept_1	1	-1.5850	0.1595	98.7052	<.0001	
Intercept_2	1	-0.7476	0.1335	31.3681	<.0001	
Intercept_3	1	0.0498	0.1269	0.1542	0.6945	
Intercept_4	1	1.2339	0.1463	71.1175	<.0001	
ProducerSize_Medium	1	0.2780	0.1413	3.8749	0.0490	3.003
ProducerSize_Small	1	0.5435	0.1827	8.8545	0.0029	3.916

7. Threats from Invasive Plant Species (e.g., Buckthorn)

a. Reference Conditions: Large Producer

Score test for Proportional Odds Assumption (N=302)

Chi-Square	DF	Pr > ChiSquare
2.1475	6	0.9056

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Intercept_1	1	-1.3902	0.1514	84.2642	<.0001	
Intercept_2	1	-0.3448	0.1265	7.4285	0.0064	
Intercept_3	1	0.6111	0.1300	22.1077	<.0001	
Intercept_4	1	1.6157	0.1613	100.3648	<.0001	
ProducerSize_Medium	1	0.2270	0.1410	2.5923	0.1074	1.947

ProducerSize_Small	1	0.2123	0.1821	1.3584	0.2438	1.919

8. Health of my Trees (e.g., Sapstreak Disease)

a. Reference Conditions: Large Producer

Score test for Proportional Odds Assumption (N=299)

Chi-Square	**DF**	**Pr > ChiSquare**
2.1094	6	0.9094

Analysis of Maximum Likelihood Estimates

Parameter	**DF**	**Estimate**	**Std Error**	**Wald Chi-Square**	**Pr > ChiSq**	**Odds Ratio**
Intercept_1	1	-2.2434	0.2008	124.8041	<.0001	
Intercept_2	1	-1.2331	0.1467	70.6776	<.0001	
Intercept_3	1	-0.0952	0.1265	0.5665	0.4516	
Intercept_4	1	1.3776	0.1517	82.4815	<.0001	
ProducerSize_Medium	1	0.1913	0.1424	1.8045	0.1792	2.200
ProducerSize_Small	1	0.4058	0.1844	4.8446	0.0277	2.726

9. Syruping Workforce Availability

a. Reference Conditions: Large Producer

Score test for Proportional Odds Assumption (N=299)

Chi-Square	**DF**	**Pr > ChiSquare**
13.2172	6	0.0397

Analysis of Maximum Likelihood Estimates

Parameter	**DF**	**Estimate**	**Std Error**	**Wald Chi-Square**	**Pr > ChiSq**	**Odds Ratio**
Intercept_1	1	-0.3005	0.1341	5.0183	0.0251	
Intercept_2	1	0.6623	0.1380	23.0378	<.0001	
Intercept_3	1	1.5825	0.1609	96.7554	<.0001	
Intercept_4	1	2.5825	0.2148	144.5331	<.0001	
ProducerSize_Medium	1	-0.0975	0.1500	0.4218	0.5160	2.081
ProducerSize_Small	1	0.9278	0.2070	20.0926	<.0001	5.802

10. My Physical Ability to Continue the Sugaring Operation

a. Reference Conditions: Large Producer

Score test for Proportional Odds Assumption (N=303)

Chi-Square	DF	Pr > ChiSquare
4.3802	6	0.6254

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Intercept_1	1	-1.3606	0.1514	80.7702	<.0001	
Intercept_2	1	-0.7449	0.1321	31.7974	<.0001	
Intercept_3	1	0.0618	0.1246	0.2457	0.6202	
Intercept_4	1	1.1943	0.1429	69.8123	<.0001	
ProducerSize_Medium	1	-0.4218	0.1420	8.8183	0.0030	0.627
ProducerSize_Small	1	0.3766	0.1816	4.3022	0.0381	1.393

11. Having Family Members Interested in Continuing the Operation

a. Reference Conditions: Large Producer

Score test for Proportional Odds Assumption (N=301)

Chi-Square	DF	Pr > ChiSquare
6.9746	6	0.3232

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Intercept_1	1	-1.2069	0.1457	68.6458	<.0001	
Intercept_2	1	-0.7308	0.1322	30.5562	<.0001	
Intercept_3	1	0.0659	0.1250	0.2778	0.5981	
Intercept_4	1	1.1900	0.1434	68.8377	<.0001	
ProducerSize_Medium	1	-0.1591	0.1414	1.2666	0.2604	1.056
ProducerSize_Small	1	0.3730	0.1835	4.1326	0.0421	1.798

12. Stringency of Sugaring Rules and Regulations

a. Reference Conditions: Large Producer

Score test for Proportional Odds Assumption (N=302)

Chi-Square	DF	Pr > ChiSquare
6.0112	6	0.4219

Analysis of Maximum Likelihood Estimates

Parameter	**DF**	**Estimate**	**Std Error**	**Wald Chi-Square**	**Pr > ChiSq**	**Odds Ratio**
Intercept_1	1	-1.2631	0.1589	63.2149	<.0001	
Intercept_2	1	-0.3644	0.1386	6.9095	0.0086	
Intercept_3	1	0.5159	0.1375	14.0815	0.0002	
Intercept_4	1	1.4684	0.1523	92.9381	<.0001	
ProducerSize_Medium	1	-0.6614	0.1483	19.9004	<.0001	1.192
ProducerSize_Small	1	1.4982	0.2055	53.1720	<.0001	10.330

13. Availability of Information and Training on Sugaring Technologies

a. Reference Conditions: Large Producer

Score test for Proportional Odds Assumption (N=302)

Chi-Square	**DF**	**Pr > ChiSquare**
10.6015	6	0.1015

Analysis of Maximum Likelihood Estimates

Parameter	**DF**	**Estimate**	**Std Error**	**Wald Chi-Square**	**Pr > ChiSq**	**Odds Ratio**
Intercept_1	1	-0.7889	0.1374	32.9808	<.0001	
Intercept_2	1	0.1121	0.1291	0.7541	0.3852	
Intercept_3	1	1.2796	0.1468	75.9915	<.0001	
Intercept_4	1	2.2472	0.1891	141.2322	<.0001	
ProducerSize_Medium	1	-0.3649	0.1444	6.3881	0.0115	1.170
ProducerSize_Small	1	0.8871	0.1940	20.9061	<.0001	4.093

APPENDIX C: Cumulative Ordered Logits for Question Related to Their Confidence in Their Ability to Adapt Their Sugaring Operation to Future Conditions

1. Confidence in Ability to Adapt to Ecological and/or Weather-Related Conditions in the Next 10 Years

a. Reference Conditions: Large Producer

Score test for Proportional Odds Assumption (N=290)

Chi-Square	DF	Pr > ChiSquare
2.4885	6	0.8697

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Intercept_1	1	-4.0631	0.4543	79.9809	<.0001	
Intercept_2	1	-2.3371	0.2124	121.0451	<.0001	
Intercept_3	1	0.0235	0.1282	0.0335	0.8548	
Intercept_4	1	1.2438	0.1501	68.6719	<.0001	
ProducerSize_Medium	1	-0.00217	0.1581	0.0002	0.9890	1.059
ProducerSize_Small	1	0.0615	0.1489	0.1704	0.6797	1.128

2. Confidence in Ability to Adapt to Changing Market Conditions in the Next 10 Years

a. Reference Conditions: Large Producer

Score test for Proportional Odds Assumption (N=265)

Chi-Square	DF	Pr > ChiSquare
6.9295	6	0.3274

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Intercept_1	1	-3.7854	0.4230	80.0824	<.0001	
Intercept_2	1	-2.5806	0.2549	102.4660	<.0001	
Intercept_3	1	-0.2351	0.1525	2.3745	0.1233	
Intercept_4	1	1.1139	0.1681	43.9024	<.0001	
ProducerSize_Medium	1	-0.1430	0.1762	0.6593	0.4168	0.858
ProducerSize_Small	1	0.1333	0.1697	0.6171	0.4321	1.132

APPENDIX D: Cumulative Ordered Logits for Question Related to Importance of Information and Assistance Topics

Cumulative Ordered Logits from Question 15: "Rate the importance of the following information and assistance as it relates to your sugaring operation:"

a. Information and Training to Increase Your Production

Reference Conditions: Large Producer

Score test for Proportional Odds Assumption (N=300)

Chi-Square	DF	Pr > ChiSquare
13.8724	6	0.0316

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Intercept_1	1	-1.5776	0.1643	92.2436	<.0001	
Intercept_2	1	-0.8956	0.1411	40.3051	<.0001	
Intercept_3	1	0.1728	0.1315	1.7262	0.1889	
Intercept_4	1	1.4025	0.1513	85.9088	<.0001	
ProducerSize_Medium	1	-0.1300	0.1432	0.8241	0.3640	2.289
ProducerSize_Small	1	1.0882	0.1926	31.9219	<.0001	7.740

b. Information and Training to Increase the Health of Your Trees

Reference Conditions: Large Producer

Score test for Proportional Odds Assumption (N=301)

Chi-Square	DF	Pr > ChiSquare
4.5437	6	0.6035

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Intercept_1	1	-3.7475	0.3854	94.5674	<.0001	
Intercept_2	1	-2.0987	0.1907	121.1038	<.0001	
Intercept_3	1	-0.6284	0.1311	22.9621	<.0001	
Intercept_4	1	0.7759	0.1340	33.5044	<.0001	
ProducerSize_Medium	1	0.1474	0.1440	1.0485	0.3058	1.281
ProducerSize_Small	1	0.4173	0.1862	5.0202	0.0251	1.446

c. Information and Training to Learn about Different Sap Collection Technologies and Methods

Reference Conditions: Large Producer

Score test for Proportional Odds Assumption (N=297)

Chi-Square	DF	Pr > ChiSquare
1.7619	6	0.9402

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Intercept_1	1	-1.9434	0.1845	110.9526	<.0001	
Intercept_2	1	-1.1928	0.1477	65.1794	<.0001	
Intercept_3	1	-0.0127	0.1285	0.0098	0.9213	
Intercept_4	1	1.2801	0.1475	75.3029	<.0001	
ProducerSize_Medium	1	-0.1427	0.1434	0.9902	0.3197	1.644
ProducerSize_Small	1	0.7826	0.1889	17.1530	<.0001	4.147

d. Information and Training to Learn Market Maple Products

Reference Conditions: Large Producer

Score test for Proportional Odds Assumption (N=290)

Chi-Square	DF	Pr > ChiSquare
3.9070	6	0.6893

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Intercept_1	1	-1.4054	0.1709	67.6636	<.0001	
Intercept_2	1	-0.7294	0.1539	22.4568	<.0001	
Intercept_3	1	0.1908	0.1482	1.6572	0.1980	
Intercept_4	1	1.3441	0.1611	69.5707	<.0001	
ProducerSize_Medium	1	-0.1750	0.1544	1.2857	0.2568	3.581
ProducerSize_Small	1	1.6257	0.2271	51.2527	<.0001	21.680

e. Information and Training to Improve the Profitability of Sugaring Operation

Reference Conditions: Large Producer

Score test for Proportional Odds Assumption (N=289)

Chi-Square	DF	Pr > ChiSquare
4.8205	6	0.5670

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Intercept_1	1	-1.5532	0.1784	75.7916	<.0001	
Intercept_2	1	-0.9706	0.1600	36.7805	<.0001	
Intercept_3	1	-0.1763	0.1500	1.3822	0.2397	
Intercept_4	1	1.0076	0.1559	41.7906	<.0001	
ProducerSize_Medium	1	-0.2127	0.1565	1.8468	0.1742	3.377
ProducerSize_Small	1	1.6424	0.2299	51.0144	<.0001	21.585

f. Information and Training to Diversify Your Sugaring Operation

Reference Conditions: Large Producer

Score test for Proportional Odds Assumption (N=293)

Chi-Square	DF	Pr > ChiSquare
6.3839	6	0.3816

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Std Error	Wald Chi-Square	Pr > ChiSq	Odds Ratio
Intercept_1	1	-0.6407	0.1427	20.1532	<.0001	
Intercept_2	1	-0.1205	0.1383	0.7594	0.3835	
Intercept_3	1	0.6832	0.1433	22.7323	<.0001	
Intercept_4	1	1.8141	0.1741	108.5723	<.0001	
ProducerSize_Medium	1	0.0537	0.1515	0.1256	0.7230	2.856
ProducerSize_Small	1	0.9420	0.2141	19.3583	<.0001	6.942

g. Information and Training to Sell or Pass on Your Sugaring Operation and/or Sugar Bush

Reference Conditions: Large Producer

Score test for Proportional Odds Assumption (N=286)

Chi-Square	DF	Pr > ChiSquare
13.7107	6	0.0330

Analysis of Maximum Likelihood Estimates

Parameter	**DF**	**Estimate**	**Std Error**	**Wald Chi-Square**	**Pr > ChiSq**	**Odds Ratio**
Intercept_1	1	-0.8596	0.1459	34.7057	<.0001	
Intercept_2	1	-0.2355	0.1367	2.9665	0.0850	
Intercept_3	1	0.4422	0.1381	10.2517	0.0014	
Intercept_4	1	1.2208	0.1524	64.1507	<.0001	
ProducerSize_Medium	1	-0.2091	0.1502	1.9374	0.1640	1.505
ProducerSize_Small	1	0.8273	0.2087	15.7062	<.0001	4.244