Research: Forestry

Foresters' Approach to Sugarbush Management in the Northeast U.S.

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Maple sap is a non-timber forest product since it is the sap and not the tree itself being harvested. The harvesting of maple sap occurred for many centuries in North America beginning with Indigenous peoples in the region, although the methods with which sap is harvested has changed greatly over time.

The production of pure maple syrup relies on access to a "sugarbush" which is defined as "woodland or other group of maple trees tapped for maple sap" (Perkins et al. 2022). Sugarbush management (SBM) therefore represents the approaches (formal or informal) to maintaining a source of tapable maple trees and includes "manipulation of maple-dominated woodlands and the culturing of maple trees to ensure they remain vigorous and resilient to stress, produce abundant sap high in sugar content, and regenerate as needed." (Perkins et al. 2022).

The primary technique foresters use to satisfy objectives related to management of forest products is silviculture. The Society of American Foresters definition of silviculture states that it is the "art and science of controlling the establishment, growth, composition, health and quality of forests and woodlands to meet landowner/stakeholder goals." Silvicultural approaches generally fall into two categories; those that will tend to develop a single cohort of trees (even-aged management) and those that result in a stand of trees that include trees of many different ages (uneven-aged management). Silvicultural prescriptions relate to the number, size and distribution certain trees retained to reach certain goals and are related to the life history of the species being managed and the products desired.

The energy-intensive process of boiling sap requires an abundant source of fuel to feed maple evaporators. Wood was the primary source of fuel most of the history of maple production since sugarmakers have access to trees and will typically generate enough firewood during the process of tending to the sugarbush. Concerns have been raised that over time this process has tended to push a given sugarbush towards monoculture when only maples are retained during each harvest activity. Work by Parker et al. (2008) has identified the benefits to sugarbushes by retaining ≥25% non-sugar maple in reducing the amount of sugar maple-specific insect damage. This work has been widely adopted by most organic certifying organizations as well as some governmental agencies tasked with

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overseeing forest land use programs (FPR 2015).

Sap harvesting techniques have changed dramatically over time. For generations of sugarmakers and up until the early 1960's the only method for collecting sap relied on attaching a bucket to individual trees and gathering sap from each tree as needed. The strong positive relationship between tree size and sap yield (Isselhardt et al. 2018) combined with the high labor demand for collecting sap from individual trees encouraged producers to cultivate fewer but larger, widely-spaced crop trees. Early published recommendations support this point as the stocking recommendations (the area in a given stand covered in crop trees) was significantly lower and focused on maximizing crown size compared to similar stands managed for timber production (USDA 1922). Given that currently 98-99% of all maple taps use plastic tubing (UVM Extension *unpublished*) it stands to reason that management approaches for what constitutes an ideal sugarbush would differ depending on how sap is collected. It makes sense to better understand if forestry approaches to SBM have undergone similar changes or if new, more modern approaches are needed.

Professional foresters are licensed in many states to ensure the work they do on behalf of landowners meets industry standards and will not result in violations of state or federal environmental regulations. One document that has helped guide foresters and logging professionals in Vermont is titled

"Acceptable Management Practices (AMPs) for Maintaining Water Quality on Logging Jobs in Vermont." This publication was first adopted in 1987 and includes "the proper method for the control and dispersal of water collecting on logging roads, skid trails and log landings to minimize erosion and reduce sediment and temperature changes in streams." Harvesting sap is different than harvesting logs in many ways but both activities require a road system suitable to meet the demand. Regardless of the forest product being harvested, any activity that negatively impacts water quality can be subject to enforcement actions and penalties and for that reason many foresters employ AMPs in sugarbushes to ensure regulatory compliance.

This research is focused on a first of its kind survey of professional foresters with the goal of not only understanding the technical approaches foresters use when working in sugarbushes, but also how the surveyed foresters view SBM compared to managing stands for other forest products.

Methods

A twenty-one question, convenience survey was taken of professional foresters in the northeast United States between April and June 2020. The online-only survey consisted of twenty-one questions related to foresters' experience with SBM. The survey was shared within networks of professional foresters including the New England Chapter of the Society of American Foresters, various consulting forester networks, and foresters working on public land. The University of Vermont Institutional Review Board reviewed and approved the survey. Responses were received between April 13 and July 13, 2020.

Questions were designed to elicit responses from foresters that would characterize their perspective of how sugarbush management fits with management for other forest products and required a variety of answers from simple yes/no to more open ended. When possible, answers that were not quantitative or binary were grouped together into broad categories.

Results

A total of sixty-six (66) professional foresters from around New England and New York responded to the survey. Not all respondents answered every question which resulted in slightly different numbers of responses for each question. Ninety-one percent of respondents reported working with landowners on SBM whereas 9% said they did not. Of the foresters who did report working on SBM, 53 % reported working with landowners in Vermont, 16% in New York, 12% in NH and 10% in Maine. Additional states/provinces reported included Connecticut, Massachusetts and Québec. Nearly 92% of respondents reported working with SBM on private land, compared to 5% of those who work on both private and public land or exclusively on public land (3%).

Collectively, the respondents reported working on a total of 184,834 acres of sugarbush. The mean number of total acres was 3,186, compared to the medi-

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an number of total acres of sugarbush each respondent worked on, which was 210. Figure 1 shows the distribution of total number of acres of sugarbush managed. The mean property size was 121 acres and the median was 75 acres (Figure 2).

Foresters were asked what type of land use maple sap production was. Sixty-five percent (39/60) responded that it was a mix of both an agricultural and forestry land use, 32% (19/60) said it was a purely forestry land use and only 3% (2/60) said it was purely an agricultural land use.

When asked what silvicultural technique best describes SBM strategy, foresters tended to favor approaches that would develop uneven age distribution of trees or a high proportion of large diameter trees. Fifty-eight percent of foresters use single-tree selection (34/59), 29% (17/59) use the "crop tree release" approach. The remaining responses were evenly spilt between small group selection (~7% or 4/59) and shelterwood (~7% or 4/59).

Respondents were asked if they view SBM as a short-term (<20 years) intermediate term (20-100 years) or long-term (+100 year) goal. 52% (31/60) of foresters' view SBM as a long-term goal and 47% (28/60) view it as an intermediate goal. Just one individual considered it as a short-term goal.

When asked which published guidelines for SBM are used when writing silvicultural proscriptions, the most common response from foresters, or 37% of those who answered, was "none." The next most common responses were not

specifically silvicultural guides, such as the *North American Maple Syrup Producers Manual* (27%), followed by several with less than 10% including those authored by Houston (1990), Lancaster (1974) and documents such as the State of Vermont Guidelines for sugarbushes enrolled in the Use Value Appraisal program (2015).

Foresters were asked when doing an inventory for a stand's potential as a sugarbush, what they consider to be the minimum diameter a tree can be to be tapped for sap collection. The most common response was 10" (58% of respondents, 35/60) followed by 9" (18%, 11/30) and 12" (15%, 9/60). Just over 8% of foresters indicated that 8" diameter trees would be considered as tappable when doing an inventory.

Survey recipients were asked if they incorporate an anticipated annual sap yield per tap or sap yield per acre in SBM planning. Of those who responded, 81% (41/51) answered "no" whereas 19% said "yes."

Ninety-eight percent of respondents answered "yes" to the question if they viewed SBM as a sustainable land use. Only one out of fifty-nine respondents answered "no" to this question.

The next section of the survey included the open ended question: "What are the greatest challenges to successfully implementing sugarbush management?" Foresters' most common responses related to communication with sugarmakers or landowners concerned the importance of a diverse forest, and the need to cut some maples to improve growth and regeneration of remaining crop trees. Another common response related to the impediments for implementing forestry activities once sap collection tubing was in place.

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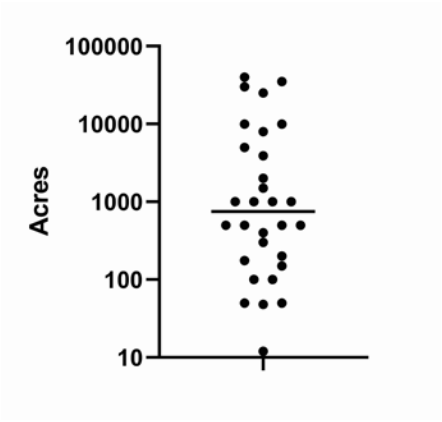

Figure 1: Individual responses from foresters to the question: "In total, how many acres of sugarbush do you assist with?" Black line represents the median value. n=29

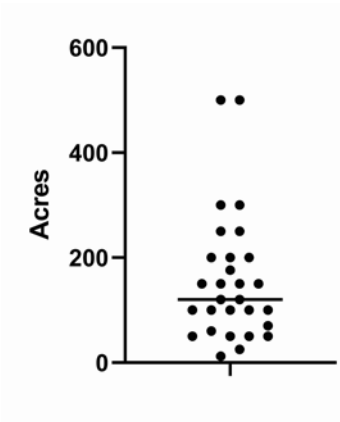

Figure 2: Individual responses from foresters to the question: "What is the average size property that you help manage for maple production?" Black line represents the median. n=30

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Foresters were asked if there were differences in how AMP's were implemented in sugarbushes compared to properties managed for other forest products. The response was almost an even split with 52% indicating "yes" there were differences and 48% saying "no." Responses from those foresters who said "yes" generally stated that road system design and the need to preserve access to the woods at all times of the year (especially during the sugaring season) made management more like managing a recreation area than a typical logging job that might only need access every 10-20 years. The number and durability of water bars was pointed to more than once as a difference, as well as quality of stream crossings, culverts and bridges.

Sixty-six percent of foresters recommend a 10-20 year interval between harvest entries in a managed sugarbush. This compared with 29% recommending intervals greater than 20 years. Just over 5% of respondents (3 individuals) recommended intervals of less than 10 years. Foresters were also asked how the harvest intervals in stands with installed tubing compared to properties managed for other forest products. Just under 52% responded that the interval was longer, compared to 42% who that said the interval was no different. Just under 7% (4 individuals) said that the interval was shorter.

Seventy percent of foresters indicated that they adjust their SBM approach on stands with below average site quality. Some foresters suggested that retaining more trees that would not make quality saw timber, others would retain species more well-suited to the site and others talked about reducing the number of taps or increasing minimum diameter for a tapable tree.

When asked if silvicultural prescriptions for dealing with invasive species differed for stands managed for sap production compared to those managed for other objectives, 70% of respondents answered "no." Of the remaining 30% who said "yes" the most common answer suggested that differences depended on if the sugarbush was certified organic or not (herbicides are prohibited in certified organic sugarbushes).

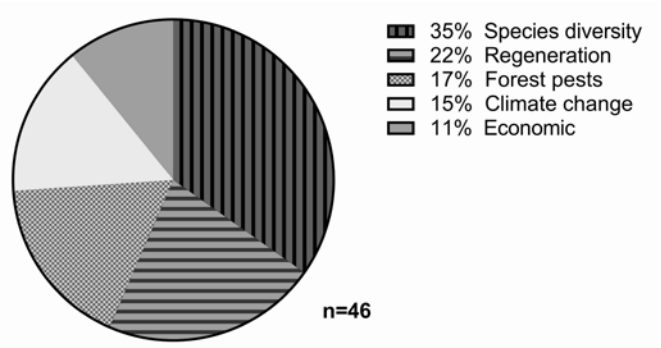

Figure 3: Answers from foresters to survey question: "What are your primary concerns with respect to forest lands managed for maple production?" (Individual responses grouped to summarize data). n=46

The final survey questions asked foresters about their primary concerns and what they view as the positive aspects or benefits of stands managed for maple production.

These open-ended questions elicited many detailed responses. Responses were coded into categories with similar themes. In response to the question "What are your primary concerns with respect to forest lands managed for maple production?" foresters' responses were grouped into five broad categories (Species Diversity/Forest Health, Regeneration/Forest Management, Forest Pests, Climate Change, and Economic). Thirty-five percent of those who expressed concerns about stands managed for maple production responded that their primary concern was related to species diversity or a general concern that sugarbushes tend to promote the development of monocultures (Figure 3). Concerns about regeneration (maple regeneration specifically) represented 22% of the responses. The remaining answers were roughly split between concerns about "Forest Pests" (17%), "Climate Change" and "Economic" (five individuals or 11%). Concerns about economic impacts of stands managed for maple production appear to be concerned with a perceived "bubble" in the growth of maple production. Some suggested that the relatively strong price for maple products will collapse if market demand does not keep pace with supply.

When asked to describe the primary benefits of stands managed for maple production (Figure 4), responses were coded into four broad categories (Economic/Financial, Forest Retention, Carbon Sequestration/Carbon Storage, and None), 45% of respondents (23/51) cited economic benefits including the annual income generated from maple products or the payments from sugarmakers who lease the trees. The next highest-ranked benefit was "Forest Retention" (43% or 22/51). A smaller group of responses referenced "Carbon Sequestration/Storage" as a benefit (8% or 4/51). 2 out of 51 respondents answered "None" and

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suggested that there are no positives or benefits to forest lands managed for maple production).

Discussion

The technology and practices for harvesting maple sap have changed dramatically over time. Academic research and industry innovation have effectively doubled potential sap yields over the past 25-50 years. Far fewer innovations been made to update the instruction and practice of growing crop trees over the same period. Foresters are often hired to help forest landowners achieve specific goals including developing and maintaining productive and healthy sugarbushes, despite the fact that few if any college-level forestry courses expose students to the concept of sugarbush management. Professional foresters must therefore modify practices developed for other forest products such as timber production.

Concerns expressed by foresters about potential negative impacts of stands managed for maple production focused on loss of biodiversity, regeneration and forest health including invasive plants and insects. Few expressed concern about the direct impact of tapping on maple tree health and all but one of those responding (or 98% of foresters surveyed) consider maple sugarbush management a sustainable land use. Recent work by van den Berg et al. (2016) has highlighted the importance of growth rates, crown position and vigor in assessing the sustainability of sugarbush management. Whereas timber forest products management requires foresters to inventory stands and produce estimates for yield ahead of harvest activity, only 19% of foresters considered sap yield when assessing a stand for maple production. This is despite the strong relationship between tree size and yield (Isselhardt et al. 2018). Concepts that integrate this knowledge will provide an important foundation for future sugarbush management guidelines and help solidify foresters' perceptions of the sustainability of maple production long-term. Moreover, integrating regeneration and forest health goals more directly with sugarbush management guidelines will ensure the long-term sustainability of sugarbush management in an increasingly uncertain future.

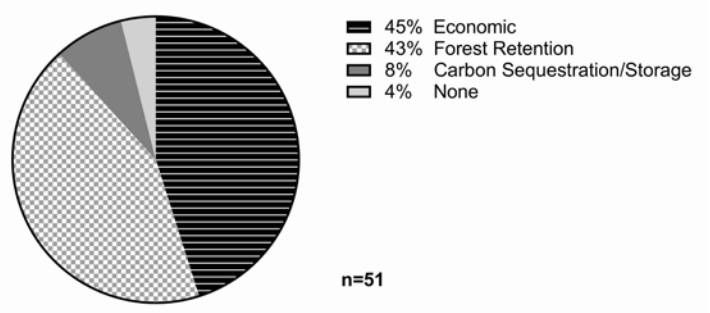

Figure 4: Answers from foresters to survey question: "What do you view as the positive aspects or benefits of forest lands managed for maple production?" (Individual responses grouped to summarize data). n=51

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Conclusion

The production of pure maple syrup requires harvesting a non-timber forest product (maple sap). While harvesting practices have changed dramatically over the history of maple production in North America, published guides to the management of maple trees for sap collection have not kept pace. Foresters are largely left to lean on practices used in cultivating other northern hardwoods forest products such as timber despite fundamental differences in the two products. Respondents overwhelmingly view SBM as a sustainable land use. Those responding to the survey expressed concerns about impacts on diversity (species and forest structure), regeneration, forest pests and climate change in relation to stands managed for maple production. Foresters focused on the economic (annual income) and ecological (forest retention) implications when asked about benefits of stands managed for maple. New recommendations for sugarbush management should seek to integrate sustainable, high yield practices and while addressing foresters near and long-term concerns.

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