AN INVESTIGATION OF ANIMAL DAMAGE ASSOCIATED WITH MAPLE SYRUP PRODUCTION

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ABSTRACT

An increase in the use of plastic tubing systems to collect sap from sugar maples (Acer saccharum) has allowed syrup producers to boost production in recent years, but not without cost. Rodents gnawing on tubing, spouts, and fittings may cause damage in excess of $300,000 annually in Vermont, the largest maple producing state. Red squirrels (Tamiasciurus hudsonicus), gray squirrels (Sciurus carolinensis), and chipmunks (Tamias striatus) appear to be responsible for the majority of damage. Other species including flying squirrels (Glaucomys sabrinus), white-footed mice (Peromyscus leucopus), porcupines (Erethizon dorsatum), and woodpeckers (Picidae spp.) may also cause substantial damage.

Past attempts to control damage with zinc phosphide treated grain, shooting, and trapping have been costly, labor intensive, and generally unsuccessful. Control techniques including habitat manipulation, repellents and exclusion with electric polywire are being field tested. Mast crops are being monitored in an attempt to predict changes in rodent populations, and tooth mark patterns on tubing are being studied so that the species responsible for the damage can be properly identified.

INTRODUCTION

Vermont is the largest maple producing state in the U.S. with over 2,500 sugar makers that collect and process over 20 million gallons of sap per year. Average annual syrup production is over 500,000 gallons with an estimated value of $30 million when support industries (equipment, packaging, etc.) and hired labor are included.

In recent years maple syrup producers have turned to new technology to increase yields and stay competitive. The days of wood-fired evaporators and horse-drawn sleighs carrying gathering tanks from the woods to the sugar house are yielding to oil-fired evaporators, reverse osmosis machines, ultraviolet sap treatment, and plastic tubing gathering systems.

These tubing systems generally consist of 0.08 cm dia. (5/16 in.) plastic droplines connected to a spout that may be driven into the tree. A 0.08 cm. dia. lateral line connects 20 - 40 droplines before emptying into a 1.9 - 10.2 cm dia. (0.75 - 4 inch) mainline. Mainlines collect sap from several lateral lines and ultimately empty into collection tanks that may be located in or near the sugar house where sap is processed. Most large producers leave their tubing in place throughout the year because of labor costs associated with retrieving tubing and subsequently

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reinstalling it.

Collecting sap with tubing requires significantly less labor than using buckets. This allows producers to tap more trees and to tap trees in areas that would be considered inaccessible when using buckets to collect sap. The use of tubing may reduce the cost of syrup making by as much as 40% (Lancaster et al. 1982). A closed tubing system creates a natural vacuum that increases sap production. Artificial vacuum may also be added to further increase production by 100% or more (Morrow and Gibbs 1969).

While the adoption of this technology has led to increased maple syrup production, it has also led to an increase in wildlife damage problems. The purpose of this work is to identify the species responsible for damage and explore potential control methods that may be used to alleviate the damage. The work presented in this paper complements other technical assistance and direct control activities conducted by ADC in Vermont.

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SPECIES CAUSING DAMAGE

With increasing use of tubing systems by maple producers, wildlife damage has become a significant problem. A survey of maple producers by the Vermont Agricultural Experiment Station (VAES) revealed that animal damage to maple tubing systems may cost Vermont maple producers over $300,000 annually (Howard and Pelsue 1987). Several species may cause significant amounts of damage. Deer sometimes chew on tubing strung between trees, and moose may knock down tubing while moving through a sugar bush (A sugar bush is a stand of sugar maples managed for maple syrup production.). Bears and coyotes will gnaw on mainlines leaving canine punctures, and bobcats will chew on drop lines that hang within their reach. Porcupines may also cause heavy localized damage to all tubing within reach of a tree. Woodpeckers sometimes peck holes in mainlines or spouts and even insects such as wood bores or wasps are suspected of making tiny holes in tubing. Red squirrels, chipmunks, and gray squirrels were identified by the VAES survey as the three species most frequently responsible for damage. Damage caused by these species is usually the result of gnawing on tubing, connectors, and spouts. Most of this damage occurs within 30.5 cm (12 in.) of a tree, creating holes which can cause loss of vacuum and sap. Northern flying squirrels may also cause extensive damage in some areas. However, red squirrels appear to be the species responsible for the greatest amount of damage.

Identifying species causing tubing damage is often a problem. Very few maple producers have actually seen animals gnawing on tubing. Therefore, tooth mark patterns on tubing are being compared to tubing damaged by live trapped animals to help identify the types of damage by species.

REPAIR COSTS

Equipment costs are a relatively minor portion of repair expenses. Tubing is about 26 cents/m (8 cents/ft.), connectors are 5 cents each, and spouts are 25 cents each. The biggest expense is the labor required to locate and repair damaged sections of tubing. Sixty-three man hours were spent repairing 356 droplines and 152 lateral lines at a field test site. At $6.00/hr., labor costs were $378.00. Tubing and connectors for the repairs cost approximately $75.00 bringing total repair costs to over $450.00. Assuming an average year, at least 12% of the potential profit in this 630 tap sugar bush was lost because of rodent damage. Poor production in recent years and tree health problems associated with drought, maple decline, acid deposition, and insect defoliation have magnified damage problems.

FACTORS CONTRIBUTING TO DAMAGE

There are undoubtedly several factors contributing to the causes of wildlife damage to tubing but there is some evidence to suggest that salt deposits left on tubing after it is washed with 5% chlorine solution may compound rodent damage problems. Tubing is washed to retard bacterial growth inside the tubing system during the summer months. Some producers who have alternatively used only water and air forced through the tubing under high pressure to clean their systems, report a decrease in the amount of damage. The scrubbing action created by the air/water mixture may allow producers to eliminate or reduce the use of chlorine solutions. Power washing equipment costs $3,000 to $5,000 and is impractical for all but the larger maple producers. More research is needed to identify alternative washing solutions which must be approved by the Food and Drug Administration.

Although salt deposits left after washing tubing seem to be a contributing factor to damage in many sugar bushes, significant amounts of damage also occur in sugar bushes where chlorine solutions have never been used to wash tubing.

Agonistic behavior associated with territoriality and rodent's general tendency to chew are among the other suspected causes of damage. Perhaps in the spring when tubing contains sap, there is a learned response by squirrels that they may obtain the sweet sap by biting the tubing. Ferron et al. (1986) noted that red squirrels spent 13.1% of their feeding time eating flowers, fruits, and sap of deciduous trees. However, damage is not limited to the spring sugaring season and appears to occur throughout the year.

CULTURAL CONTROLS

Habitat modification is one of several potential nonlethal controls currently being investigated. Plant communities in coniferous stands and sugar bushes with heavy rodent damage were sampled using a 10X prism at randomly chosen points.

Balsam fir (Abies balsama) comprised 58% of the total basal area in Groton A (Table 1). This site was relatively flat with little understory and active squirrel middens were rare. Live traps used to capture and estimate the squirrel population at this site were checked twice each day. No red squirrels were captured in the 180 day trapping period.

Spruce (Picea sp.) and sugar maple comprised 59% of the total basal area in Groton B (Table 2). A mark recapture estimate of the red squirrel population in this stand revealed approximately 6 squirrels on the

4.9 ha study site. Groton B was rocky, hilly, and contained numerous saplings and several active middens.

Hophornbeam (*Ostrya virginiana*) 3.2 m^2/ha, hemlock (*Tsuga canadensis*) 3.7 m^2/ha, and paper birch (*Betula papyrifera*) 5.0 m^2/ha, comprised 65% of the basal area in Graham C (Table 3). Distributed throughout this site were numerous young spruce in the 8 cm (3 in.) dbh class. This site is located adjacent to a sugar bush that has sustained heavy rodent damage for 3 consecutive years. Numerous active squirrel middens were observed at the Graham C. site. Four red squirrels were trapped here during the 285 day trapping period. There were no recaptures. It appears that relatively low densities of red squirrels may cause significant amounts of tubing damage.

Sugar maple was a dominant

Table 1. Vegetative characteristics of Groton A.

	Trees/ha	Basal Area (m^2)	Frequency (%)
Balsam Fir	310.8	14.2	100
Red Maple	124.5	3.2	80
Sugar Maple	23.2	0.9	40
Big-Toothed Aspen	51.9	3.2	80
Spruce	52.9	2.3	80
Butternut	3.5	0.5	20
Total	566.8	24.3	

Table 2. Vegetative characteristics of Groton B.

	Trees/ha	Basal Area (m^2)	Frequency (%)
Balsam Fir	53.4	1.4	20
Sugar Maple	126.5	4.6	80
Big-Toothed Aspen	42.5	1.4	40
Spruce	122.6	4.6	100
Butternut	6.4	0.5	20
Paper Birch	75.6	1.4	40
Yellow Birch	73.6	1.8	40
Total	500.6	15.7	

species in or near areas where red squirrels were easily captured and would seem to be an important component of red squirrel habitat. Reichard (1976) concluded that maple trees were as important as mast producers for the survival of squirrel populations in Michigan. However, pure sugar maple stands alone probably do not provide adequate winter cover or diversity of food supply to support large numbers of red squirrels in Vermont. Sugar bushes where rodent damage to tubing is heavy usually contain small patches of spruce, fir, or hemlock, or these species are abundant adjacent to the sugar bush. Small deciduous woodlots may support several red squirrels as long as a few conifers are present (Wrigley 1969). Removing conifers from sugar bushes and from "buffer zones" around the sugar bushes may ultimately reduce the amount of tubing damage.

Another sugar bush, Morse Farm, contained few conifers (Table 4). The nearest coniferous stand was 203 m away and a plowed field separated the conifers from the sugar bush. A few conifers were present at this site, but as a function of random habitat sampling were not

Table 3. Vegetative characteristics of Graham C.

	Trees/ha	Basal Area (m^e)	Frequency (%)
Red Maple	17.8	0.9	40
Sugar Maple	24.2	1.4	60
Big-Toothed Aspen	25.2	0.5	20
Spruce	202.6	1.4	60
Butternut	7.9	0.9	60
Paper Birch	124.5	5.0	80
Hophornbeam	109.2	3.2	60
Ash	14.3	0.5	20
White Pine	5.9	0.9	40
Hemlock	124.0	3.7	40
Total	655.6	18.4	

Table 4. Vegetative characteristics of Morse Farm.

	Trees/ha	Basal Area (m^e)	Frequency (%)
Sugar Maple	149.2	24.3	100
Am. Beech	3.0	0.5	20
Total	152.2	24.8	

measured. This sugar bush has received heavy rodent damage in recent years. Snap traps set at this site yielded 5 red squirrels, and 2 Northern flying squirrels in the first 216 days of trapping.

Because damage seems to vary among years, mast and seed production are being monitored to determine if there is a correlation between mast production and the level of damage. Lair (1985) concluded that several aspects of female red squirrel reproduction appear to be regulated by the amount and quality of the food supply. Information regarding mast and seed crops may be helpful in predicting years when squirrel populations are high and heavy, wide-spread rodent damage is likely to occur. If so, simple monitoring procedures may be developed so that producers can increase prevention and control efforts accordingly.

Exclusion of squirrels from tubing using electric polywire is another potential nonlethal control being investigated. Polywire strung along lateral lines, held in place with wire bag ties, and powered by a flashlight battery operated charger is being tested. Twenty-three taps and 94.8 m of lateral lines covered by this system are being monitored on a weekly basis for damage. From late March to late August, 21 damage locations (7.6 cm of lateral lines and 86.4 cm of droplines) were recorded (Figs. 1 & 2). The polywire did not cover the droplines in this test but may in future tests.

Over a 22 week test period, the voltage on the polywire averaged 6.1 kilovolts. The batteries in the charger failed once between weeks 11 and 12 of the survey period. During that time 10 of the 19 damaged droplines were recorded. Of the 94.0 cm of damage measured during the study period, 53.3 cm or 56.7% of the damage occurred during the week that the batteries failed. In the 2 weeks following the battery failure 4 more damage locations totalling 10.2 cm were noted.

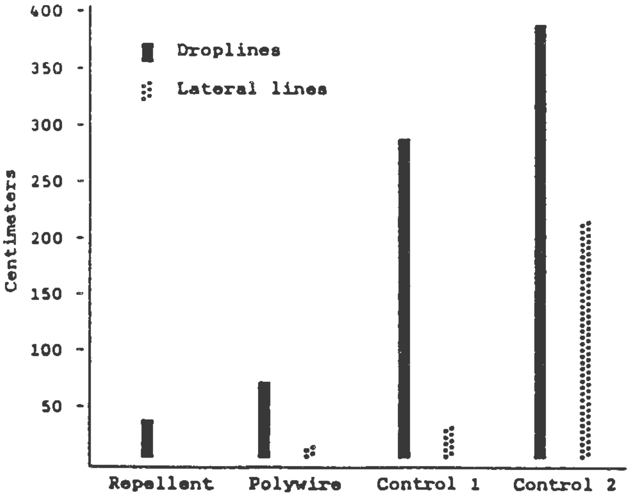

Figure 1. Cumulative amount of damage in centimeters for repellent and polywire field tests.

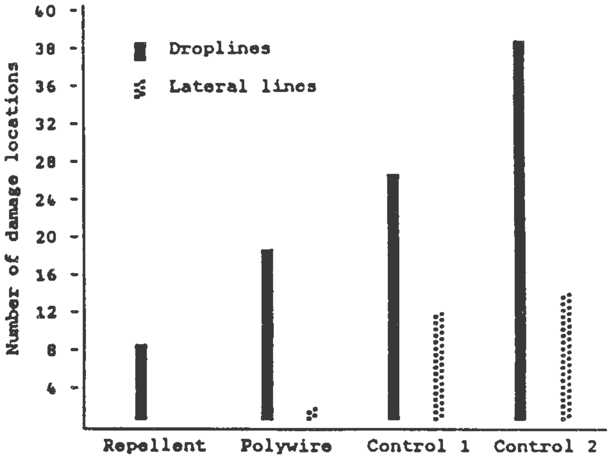

Figure 2. Cumulative number of damage locations for repellent and polywire field tests.

Control 1, consisting of 24 taps and 94.5 m of lateral lines, located adjacent to the polywire test, sustained damage to 38.1 cm of lateral lines and 289.6 cm of droplines.

Control 2, with 20 taps and 94.5 m of tubing, located 41.1 m away from the nearest polywire sustained 52 damage locations with 221 cm of lateral lines and 378.5 cm of droplines gnawed upon.

Electric polywire may be a useful tool in reducing damage in areas that receive persistent heavy damage. However, the cost of such a system may make it impractical for smaller maple producers. A 500 m roll of polywire costs approximately $38.00 and a small battery operated charger costs about $90.00. Such a system is installed easily without major changes to the existing tubing setup. A larger, more powerful charger may be needed to cover several hundred taps which could drive the cost of an electric polywire exclusion system higher.

There are currently no repellents registered for use on maple tubing in Vermont. However, several producers have tried home-made concoctions including mentholatum muscle rub and various mixtures of petroleum jelly and naphthalene flakes or hot sauce. A 24/C registration was recently obtained in Wisconsin by a maple producer for a petroleum jelly based repellent, and a similar repellent is being field tested on maple tubing not being used for sap collection Vermont. This material was spread over all droplines and lateral lines within 30.5 cm (12 in.) of each tree. This test, covering 27 droplines and 109.4 m of lateral lines, was initiated in March 1989 and to date only 9 damaged locations totaling 40.6 cm of tubing have been recorded. While this product appears to produce some repellency, it makes the tubing particularly messy to handle during tapping or repairs. In addition, there are some concerns about the repellent potentially entering the sap due to the porosity of the tubing. The repellent may then be concentrated during the boiling process and possibly taint the flavor or alter the color of the syrup.

A recently developed connector allows lengths of droplines and lateral lines to be easily taken apart and reattached. This permits droplines to be removed from the sugar bush in areas where heavy damage is likely. The droplines may then be reinstalled during tapping for the next sugaring season. These connectors currently cost 25 cents each. Tubing for a 45 cm long drop line costs about 13 cents. These connectors may pay for themselves in one year because of labor costs to repair damage. A disadvantage to using these connectors is that they do not hold pressure well when artificial vacuum is used (S. Williams, UVM Proctor Maples Res. Cen., pers. commun.). This design flaw may eventually be remedied.

The color of the tubing and the manufacturer of the tubing do not appear to effect its likelihood of receiving rodent damage. However, other factors such as the chemical composition of the tubing may be important. Therefore, manufacturers are being urged to develop new types of tubing which may be less susceptible to rodent damage.

LETHAL CONTROLS

Potential lethal controls for rodent damage in sugar bushes include trapping, shooting, and toxicants. Snap traps baited with peanut butter or apple slices may be used to remove squirrels from areas of localized heavy damage but are not practical for covering large areas. Careful placement of traps near areas of squirrel activity such as middens or nests may improve success.

Small caliber rifles or shotguns may be used to control damage caused by squirrels in sugar bushes; however, shooting is often labor intensive and effective control is difficult in large sugar bushes.

A 24/C registration for zinc phosphide on cracked corn for control of red squirrels, chipmunks, and mice in Vermont sugar bushes has existed since the 1960's. However, few maple producers currently use this product because of poor success in the past. Current labeling does not suggest prebaiting with untreated grain prior to application. This would likely increase acceptance by red squirrels. The manufacturer is currently considering a label change to emphasize the importance of prebating. Poor success with zinc phosphide in the past decreased the demand for this pesticide and subsequently, it is not readily available in local stores and must be special ordered at an increased cost to the producer.

An experimental use permit is being sought to test the use of cholecalciferol, a rodenticide that causes hypercalcemia. This product has no odor, thus bait shyness is not likely to be a problem as it is with zinc phosphide. Once a lethal dose is metabolized, the rodent stops feeding. This foraging behavior results in lower food consumption and, therefore decreases the potential for secondary hazards because the amount of rodenticide consumed is generally small.

Initial field work to identify species causing damage to tubing and potential prevention and control methods may lead to more formal research to be conducted by USDA/ADC or others.

RECOMMENDATIONS TO REDUCE DAMAGE

Maple producers experiencing heavy, persistent damage to their tubing systems should discontinue, at least temporarily, using chlorine solutions to wash their tubing. Large producers may consider purchasing a power washer which forces a mixture of air and water through tubing and may allow the producer to reduce or eliminate chlorine use.

Coniferous trees may be totally eliminated from sugar bushes and "buffer zones" established around sugar bushes to reduce the available nesting and foraging habitat for red squirrels. It may be possible to integrate these and other timber stand improvement practices with current sugar bush management.

Tubing connectors which allow droplines to be easily removed and reattached may be installed in areas that consistently experience damage. These connectors can potentially pay for themselves in one year because of labor costs to repair damage.

In specific problem areas, rat size snap traps wired to trees and baited with peanut butter or apple slices may be effective in reducing populations of squirrels. In larger sugar bushes, zinc phosphide treated corn may be used in weather proof bait containers to reduce damage caused by squirrels. Prebaiting may be necessary to achieve effective control.

Prevention of damage to tubing through habitat modification or exclusion devices should be the preferred approach; however, these methods must be practical and economical. If lethal control methods are used, treatment should be timed to address the existing rodent population and dispersing young. An integrated approach using several of the control methods mentioned above will likely achieve the best results.

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