Assessment of paper birch trees tapped for sap harvesting near Fairbanks, Alaska

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Summary

With increased growth in the birch sap extraction industry, the need for assessments of tree health and sustainability of birch tapping practices also grows. Site visits and evaluation of tapping practices were conducted at two commercial harvest locations in the Fairbanks area, Eva Creek in Ester and Cache Creek near Murphy Dome in 2007. In this evaluation we report on walk through observations and a pilot dissection study of tapped trees at each location. Numerous improper tapping practices are reported as well as breach of the Alaska Birch Syrupmakers’ Association (ABSA) “Best Practices Guidelines for Tree Tapping”.

There will be a companion biological evaluation to this site visit report produced in 2008 by the same authors that will review the “Best Practices” guidelines developed by the ABSA and evaluate impacts to paper birch trees tapped for sap harvesting in Alaska.

Introduction

Birch sap harvesting operations continue to expand across the vast birch forests in south-central and interior Alaska to meet market demand for birch sap derived products. Harvesters, land managers, and land owners are increasingly seeking information on the sustainability of the current sap harvesting practices and a review of the Best Practices Guidelines for Tree Tapping issued by the Alaska Birch Syrupmakers’ Association (ABSA) in the early 1990’s (Appendix A). The USFS has also received numerous inquiries recently by agency officials concerned about the long term health effects of tapping practices on birch. Unfortunately, there is scant literature on this subject and much of it is in a language other than English.

Simply stated, installation of sap collection taps is a practice that wounds birch trees. Tapping causes stain to develop, and it potentially introduces decay-causing organisms that impair tree function, weakens structural stability and may lead to premature tree death. The degree to which wounding affects tree health, however, depends on many factors including number of wounds, size, depth and location of wound, time of year, and health of the tree prior to this wounding. Healthy, vigorously growing birch may compartmentalize wounds, thus reducing future impairment.
Tree diameter dictates the suggested number of tap holes per tree. The best practices guidelines for tree tapping issued by the ABSA conservatively recommends only one tap per tree greater than 8” in diameter at 4.5 ft (dbh) (Appendix A). The ABSA recommends against tapping birch trees less than 8” dbh and recommend a shallow tap hole < 1.75” deep placed between 2 and 4 feet above ground.

Proper birch tree selection is essential to achieving high sap productivity, high sugar content, and maintaining tree health. The ABSA recommends that only healthy trees are tapped. Telishevskyj (1970) defines healthy trees as those that lack dead tops, fire damage, or evidence of fungi. He also recommends that only healthy birch trees are suitable for tapping.

To date, no comprehensive study investigating the sustainability of sap harvesting techniques in Alaska has been conducted. Thus, a pilot study was initiated by personnel from the US Forest Service, University of Alaska Fairbanks (UAF), and Alaska Department of Natural Resources, Division of Mining, Land and Water (DMLW). This study was intended to: 1) evaluate tapping practices at two specific sites, Cache Creek and Eva Creek, both tapped by Jeff Weltzin; and 2) evaluate pathogen introduction and internal decay associated with tap holes.

Pilot Study

Site selection and history

A pilot study was undertaken in summer 2007 to: 1) locate two accessible birch tapping sites in the Fairbanks area tapped at least 5 years ago, 2) fell and dissect a random representative sample of tapped trees at each site, and 3) assess tapped trees for signs and symptoms of internal and external pathogen introduction associated with the tapping.

Two sites were located and selected with the assistance of Alaska Department of Natural Resources DMLW and Mental Health Trust personnel, Cache Creek near Murphy Dome and Eva Creek in Ester. Both sites were tapped for sap collection by Jeff Weltzin with a permit from the respective land management agencies. DMLW and Mental Health Trust personnel maintain records of the permits associated with these two sites.

Records indicate that birch trees at Eva Creek were tapped only once, in 1990, while birch trees at Cache Creek was tapped at least two, perhaps three times between 2001 and 2007. Using these two sites for study and comparison had the advantages of tapping protocol consistency because both sites were tapped by Mr. Weltzin and provide a 17 year retrospective for assessing tree health after tapping.

Sap collection equipment at both sites involved the installation of a tap and plastic tubing system. (Figures 1 and 2). Proposed permitted activities for sap collection included:

- drill 7/16” holes no more than 2” deep into selected birch trees
- place a sap spout connected to 5/16” feeder tubes
- remove tree spouts, tubing, equipment within one week of the cease of sap flow

In each selected birch, one or more taps were installed. Tubing was connected to the tap and the sap ran downhill through the tubes to a central collection point.
Figures 1 and 2: Spout and tubing at an individual tree and multiple trees at the Cache Creek site.

At the Eva Creek site, Mr. Weltzin estimated 2,000-3,000 trees were tapped in 1990. Tapping was only allowed for one year on this site. Some taps and tubing were subsequently removed, but some remain on site as of winter 2007. Site clean up after harvest occurred several times since 1990 and included irrigating and corking any open wound created by removal of equipment, in keeping with ABSA standard practices. The harvester stated that he was following ABSA protocol by flushing tap holes with a hydrogen peroxide solution, then corking all holes. Removal of taps several years after harvest was reported as challenging at times and some could not be removed.

At the Cache Creek site, Mr. Weltzin estimated that 1,600 trees were tapped with approximately 4,000 taps in 2001, for an average of 2.5 taps per tree. An expansion of up to 10,000 taps was planned for 2002 but there is no report confirming this occurred. Removal of equipment from the site has not occurred. Most of the equipment remains in place and taps/tubing are still in trees. By Mr. Weltzin’s records, the site was last tapped in 2004. The permit on this site is presently open until 2009.

Methods

A walk through survey of both the Eva Creek and Cache Creek sites occurred in May 2007 by the authors and DMLW personnel. The survey provided an extensive look at the trees on the sites, equipment remaining on site, and helped determine criteria for felling.

Felling operations by the authors occurred at Cache Creek in late May and at Eva Creek in August 2007. At the Cache Creek site dozens of trees were assessed and 9 were randomly selected for felling. At the Eva Creek site, 44 trees were assessed and 12 were randomly selected for felling. At each site, different criteria was used to select trees for felling due to tapping frequency and tap hole treatment differences at each site. At Cache Creek three trees were randomly selected and felled in each category: untapped, less than 6 taps/tree, greater than 11 taps/tree. At Eva Creek there were only 1 or 2 taps/tree, thus three trees were randomly selected and felled in each category: untapped, tap hole closed naturally, tap hole corked, tap hole corked but cork now missing. Records are not clear on which year post–harvest the tap hole was corked. Tree selection was also based on a judgment of whether the tree could be safely felled.

Trees were assessed prior to felling. Tree diameter at 4.5 ft (dbh) was measured, number of taps were counted, height to lowest and highest tap was recorded, general crown and stem health was assessed, and external signs of pathogens such as presence of conks, mushrooms, or cankers were recorded. Post felling external assessment included height to live crown and total height. Each felled tree was bucked in 1 ft sections from the base to 10 ft. If internal decay or staining occurred, it was traced to determine if associated with the tap holes. Photographs were taken of
each tree prior to and post felling. Tree sections were cut near the tap hole and taken to the USFS lab in Anchorage for further analysis.

Results and Discussion

In the walk through surveys, spouts and tubing were commonly seen lying on the ground at the Eva Creek site, and some equipment remained in the trees after 17 years (Figures 3, 4, and 5).

Figures 3, 4, and 5. Examples of spouts and tubing in birch trees and on the ground at Eva Creek.

At the Cache Creek site spouts and tubing still remain in the trees. A maze of main line, secondary and tertiary tubing snakes through the forest making it difficult for humans to walk, and potentially difficult for large mammals to navigate. This tubing has been in place since 2004 (the last season tapped) or perhaps earlier (Figures 6, 7, and 8).

Figures 6, 7, and 8: Examples of spouts and tubing in trees and across the forest at Cache Creek.
While walking along the tubing lines to the processing facility, we observed that numerous sapling birch and spruce were cut and used as cross supports for the 2-4" plastic collection pipe (Figures 9 and 10). DMLW personnel is investigating whether this practice was outside of the permit stipulations.

Figures 9 and 10: Cut birch and spruce saplings used as support for the collection pipes.

A total of 21 birch trees were felled across two sites, 9 trees at Cache Creek and 12 trees at Eva Creek. Three untapped trees were included at each site for comparison. Data on trees from Cache Creek is in Table 1; data for Eva Creek trees is in Table 2.

At Cache Creek, trees were severely overtapped with up to 14 tap holes per tree (Table 1), despite records indicating 3 or fewer tapping seasons. ABSA Best Practices suggest only one tap per tree per tapping season. If this guideline was followed, trees at Cache Creek would have 3 or fewer total taps staggered across several years. Analysis of the tree cross-sections however revealed that trees with 6 or fewer taps had all tap holes placed in the tree in a single year which is considerably higher than recommended by ABSA. Similar trends were noted in the trees with > 11 taps.

Table 1. Data for trees at the Cache Creek site, initially tapped in 2001.

<table>
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<tr>
<th>Tree #</th>
<th>DBH (in.)</th>
<th>Live Crwn Ht. (ft.)</th>
<th>Total Ht. (ft.)</th>
<th># of Taps</th>
<th>Tap Height (ft.)</th>
<th>Lowest</th>
<th>I</th>
<th>Highest</th>
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<tr>
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<td>30.3</td>
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<tr>
<td>5</td>
<td>8.7</td>
<td>34.7</td>
<td>54.6</td>
<td>6</td>
<td>3.7</td>
<td>4.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>13.2</td>
<td>33.7</td>
<td>57.5</td>
<td>3</td>
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<td>5.0</td>
<td></td>
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Table 2. Data for trees at the Eva Creek site; tapped one year, in 1990.

<table>
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<tr>
<th>Tree #</th>
<th>Category*</th>
<th>DBH (in.)</th>
<th>Live Crwn Ht. (ft.)</th>
<th>Total Ht. (ft.)</th>
<th># of Taps</th>
<th>Tap Height (ft.)</th>
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<td>45</td>
<td>C/no cork</td>
<td>11.9</td>
<td>33.0</td>
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<td>21</td>
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<td>cork (+)</td>
<td>8.2</td>
<td>19.5</td>
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<td>1</td>
<td>3.3</td>
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<td>32.0</td>
<td>69.0</td>
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<td>8.7</td>
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<td>69.0</td>
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<td>No tap</td>
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<td>73.0</td>
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<td>No tap</td>
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<td>29.0</td>
<td>80.0</td>
<td>0</td>
<td>n/a</td>
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</table>

*Categories were as follows: C/no cork = tap hole closed naturally, no cork was ever used; cork (+) = a cork was placed in the open tap hole post-harvest and remains in the tree; cork (-) = evidence that a cork was placed in the open tap hole post-harvest but as of 2007 cork is missing; No tap = tree was never tapped, control tree.

All tapped trees at both sites had red heart staining associated with the tap holes. This stain is an oxidation reaction to a wound and is common in mature birch. However, each tree at Cache Creek also has at least one or more tap holes with dark streaks and black staining within the red heart, indicative of decay organisms invading the tap hole (Figure 9).

![Figure 11. Cache Creek Tree 1 cross-section at dbh with red heart stain apparent at all 14 taps. White arrow indicates red heart stain at a tap that lacks decay organisms. Red arrows point toward tap holes with black staining, indicative of invasion by decay organisms.](image)

Furthermore, decayed wood was present in 33% (2 of 6) of tapped trees directly associated with tap holes (Figures 12 and 13). Stem analysis of the untapped trees indicated that none developed decay over the same time period. Thus all tapped trees sampled at Cache Creek appear to have decay organisms and/or decay directly associated with the tap holes and tapping practices.

Red heart stain associated with the tap holes was observed in the felled trees from 3 to 10 feet in length along the stem and averaged 6.3 feet in the Cache Creek trees. Decay columns associated with the tap holes did not exceed 1 foot.
Figures 12 and 13. Cross-sectional cookies cut at dbh for Trees 3 and 6 at Cache Creek, revealing red heart staining associated with every tap hole, and black streaks and black staining at one or more tap holes. All 11 taps on Tree 3 and all 3 taps on Tree 6 are clearly evident. Decay was also present at some tap holes (see red arrows) in each of these trees.

At Cache Creek, numerous examples of diseased trees being tapped and even some taps in dead trees were noted in walk-through surveys (Figures 14 and 15). ABSA tapping guidelines state that only healthy trees should be tapped.

Figures 14 and 15. Example of diseased birch trees that were tapped at the Cache Creek site. Pictured are conks of the common birch decay pathogens *Inonotus obliquus* (left), the cinder conk, and *Phellinus igniarius* (right, see arrow), the false tinder conk.
At Cache Creek, sap has flowed down the stem of many trees, evidenced by reddish brown streaks under both open and closed tap holes (Figure 16). Taps were frequently found in a direct vertical orientation from one another (Figure 16), which is an undesirable practice specifically stated in ABSA guidelines (Appendix A). Ants were observed crawling in open tap holes and along tubing, potentially vectoring bacteria and pathogens into open tap holes (Figure 17).

The taps in the Cache Creek site trees presumably continue to flow sap in the spring regardless of whether tubing systems are intact. During the walk-through survey there appeared to be numerous breaks in the main line as well as in the secondary and tertiary connections. Thus sap that would normally contribute to tree vigor is diverted uselessly to the ground at the nearest break in the tubing line.

*Figures 16 and 17.* Sap streaming associated with tap holes causes bark discoloration and attracts ants and insects that may vector bacteria and pathogens.

All birch trees within the permit boundaries at the Cache Creek site appeared tapped, thus control trees were selected from an immediately adjacent birch stand of similar age and stature. No signs of red heart stain or decay occurred in the first 2 " of sapwood, the zone where tap holes would be placed by harvesters. Staining did occur in the heartwood of the trees (Figure 18 and 19) but the extent is considered typical for this age class.

*Figures 18 and 19.* Untapped trees 5 and 6 at Cache Creek lack stain or decay in the sapwood.
In contrast, Eva Creek trees were tapped once or twice 17 years ago (Table 2). Evidence of red heart stain was apparent at all taps and decay was associated with tap holes in 55% (5 of 9) of the trees (Figures 20 and 21). Red heart stain associated with the tap holes was observed in the felled trees from 2.5 to 10 feet in length along the stem, and averaged 6.6 feet.

Decay columns associated with the tap holes averaged 2.8 ft. Decay was present in both corked and uncorked tap holes and confined within the red heart stain. Several tapped trees on the site had a canker fungus, *Nectria galligena*, on the stem. This canker fungus appeared to infect the tree at the location of a cork (Figure 22) and at spouts remaining in the trees. This suggests that corking had no positive effect on tree health and may be detrimental to tree health. This also emphasizes the need to remove taps annually in a timely manner post harvest.

*Figures 20 and 21:* Stain and decay associated with tap holes in Trees 10 and 21, section cut at 4.5 ft.

*Figure 22:* The canker fungus *Nectria galligena* associated with a corked tap hole. Arrow points to the cork remnant. Dead flaring bark and concentric sapwood rings to the right of the cork are signs of invasion by this canker fungus.
Some trees at the Eva Creek site were corked, while others were not. Uncorked tap holes were difficult to locate 17 years post harvest because the trees had effectively closed the tap hole naturally (Figure 23). Trees that were corked at some time in the past 17 years were in various states of retaining or losing the cork (Figures 24 and 25).

The presence of corks inhibited the natural closing of the tap holes. Where corks had popped out, the wounds were re-opened to insects and decay organisms. There is a lack of evidence that corking prevents decay and in fact the presence of canker fungi at corked tap holes was observed. For these reasons, it appears that corking trees is unnecessary and likely harmful to birch trees.

*Figures 23, 24 and 25: From left to right, closed tap hole that was never corked, cork half way protruding from the tree, cork deeply imbedded in the tree.*

Untapped trees were located at the Eva Creek site, just east of the permit boundaries. Similar to the Cache Creek control trees, no signs of red heart stain or decay occurred in the first 2” of sapwood, the zone where tap holes would be placed by harvesters. Staining did occur in the heartwood of the tree (Figure 26 and 27) but the extent is considered typical for this age class.

*Figures 26 and 27: Untapped trees 52 and 53 at Eva Creek lack stain or decay in the sapwood. Sections were cut at 4.5ft.*
Synopsis

While the two sites are not directly comparable, some generalizations regarding tree health at both sites can be made. The proportion of stain and decay associated with tap holes was substantially higher at Cache Creek vs. Eva Creek. This is directly related to 1) considerably higher number of taps in the Cache Creek trees and 2) continued wounding inhibited wound compartmentalization. This strongly suggests reduced tree health for the birch trees tapped at Cache Creek. In the future, the Cache Creek will likely have limited use besides firewood due to the high proportion of stain and incidence of decay in the first 10 feet of the butt log. We believe that the Cache Creek tapped trees are well on their way to having substantially higher decay rates and a higher potential for premature death than untapped trees.

Except for timely equipment removal, the ABSA Best Practices Guidelines (Appendix A) seem to have been generally followed at Eva Creek. These protocols, however, were not practiced at Cache Creek. This study indicates a substantial increase in the magnitude of stain and decay in tapped trees at Cache Creek was due to improper tapping practices.

Birch trees at Cache Creek were repeatedly and unnecessarily exposed to decay organisms. Trees were subsequently infected by decay organisms at tap holes as a direct result of these practices, compromising the health of the tree. Examples include:

- Most trees were severely overtapped with many more than one tap hole per tapping year.
- Numerous examples of tapping diseased trees and even some dead trees.
- Taps were frequently located in a vertical plane from one another, compromising sap flow.
- Many taps were above 4 ft.
- Equipment remained in the trees long after the 2004 tapping season.

These practices are all discouraged in the ABSA Best Practice Guidelines (Appendix A).

Due to the above improper practices we believe the health of most tapped trees at Cache Creek is compromised. We therefore suggest that no further tapping occur at this site. Compliance with proper tapping procedures is essential to a) reduce tree wounding, b) reduce subsequent effects once a wound is made, and c) maintain tree health and resource sustainability.

Corking of tap holes appeared ineffective and perhaps harmful to the tree. Corks a) inhibited the natural closing of the tap holes b) did not prevent decay from forming, and c) were associated with the presence of canker fungi. Thus, we believe that corking trees is unnecessary and likely harmful to birch trees.

Although we do not recommend it, if birch sap harvesting is permitted at Cache Creek in 2008, we strongly suggest:

- Abandon trees with more than 3 tap holes for any further tapping
- In trees with fewer than 3 tap holes total:
  - Limit taps to one per tree per year for trees >8 inches in diameter.
  - Tree selection criteria to be approved by the permitter.
  - Only healthy trees are tapped – healthy trees are defined as those that lack dying or dead tops, fire damage, or evidence of fungi.
  - Follow current ABSA Best Practices Guidelines EXCEPT tap holes should not be corked, and tap as low on the tree as feasible.
  - Removal of taps occurs after every tapping season.
  - Monitoring inspections by the permitter are conducted annually prior to and post harvest to ensure compliance.

In contrast, some of the Eva Creek trees appear to have compartmentalized the stain and decay associated with tap holes. Wood compartmentalization has allowed some clear sapwood to develop post wounding. The Eva Creek trees may be considered for a variety of wood production purposes if markets allow for the low levels of stain and decay that have developed in these trees.

Stain and decay occurred at both sites in direct relationship to the tap holes emphasizing the fact that these practices are not harmless to the trees. We believe, however, that tree health can be maintained by sap harvesters if proper tapping practices are followed and the land owner and/or manager is willing to accept some degree of stain and decay in their trees. Although our sample sizes were small in this
pilot study, our findings were consistent within and between sites. We recommend more sampling to confirm our findings.

There will be a companion biological evaluation to this site visit report produced in 2008 by the same authors that will review the current “Best Practices” guidelines developed by the ABSA and further evaluate impacts to paper birch trees tapped for sap harvesting in Alaska.

References


Acknowledgements
We gratefully acknowledge Melissa Head, Alaska Department of Natural Resources DMLW for pictures and project permits, Megan Boldenow, formerly with Alaska Department of Natural Resources DMLW for pictures and site histories, and Marie Menefee, Mental Health Land Trust, for project permits. We also thank Kimberley Maher for translated literature, pictures, and field assistance at Eva Creek.

All pictures were taken by the authors except for Figures 1, 4, 9, and 10 taken by Melissa Head/Megan Boldenow and Figures 26 and 27 taken by Kimberley Maher.
APPENDIX A

Best Practices Guidelines and Recommendations for Tree Tapping
Developed by Alaska Birch Syrupmakers’ Association
(Excerpted from Agroborealis 2003)

Tree Tapping

1. Time to tap varies by locations; usually first part of April.

2. Tap holes: 1 ½ – 1 ¾ " deep, slightly upward angle, using a 5/16-7/16" bit depending on spout use.

3. Location of hole: 2-4 ft high, to the side of the previous holes.

4. Tap healthy trees; 8" diameter at breast height or larger.

5. Do not tap trees that have ever had pesticides sprayed on or around them.

6. Use one tap per tree.

7. Use plastic, nylon, or steel spouts or tubing supplies commercially available through local syrup equipment suppliers.

8. Do not drive taps too deep – wood can split, causing leakage.

9. Sterilize taps before use.

10. Tap trees when the sap flow is continuous.

11. Tap trees only where access is good and equipment will not compromise ground cover. Minimize damage to trails during break-up.

12. Remove spouts at end of season, may spray hole with pure water. Cork tap holes upon removal with appropriate sized cork (available through local suppliers).
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