Investigation of roadside brushing practices in Ontario

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INVESTIGATION OF ROADSIDE BRUSHING PRACTICES IN ONTARIO

Context

Forest road managers perform roadside brushing (vegetation management) as a key component of annual forest road maintenance operations. Roadside brushing operations are necessary to ensure safety for road users, reduce maintenance costs and to maintain roadside ditch management. Roadside brushing operations may be performed on continually active roads or on roads that are being reactivated to support planned forest operations. Despite the fact that roadside brushing is a key component of forest road maintenance, there is a lack of information on this activity to guide forest road managers in planning and managing this phase of their operations.

In response to this lack of information, FPInnovations launched a project in 2012, with funding support provided by the Ontario Ministry of Natural Resources, to take an initial look at this topic. The activities conducted in 2012-2014 were principally focused on conducting field visits to active and recently completed roadside brushing operations and to perform a survey of key Ontario forest industry contacts.

This project initiative was launched in early fall 2012 and FPInnovations was able to complete visits to seven companies. The objective of the visits was to gather information and observe equipment and strategies that are used to perform roadside brushing operations on forest access roads. Ongoing brushing activities, recently performed operations and operations completed within the last three years were visited.

In support of this project, FPInnovations performed a literature search as an initial phase to this initiative. The literature search was focused on documents that support the management, planning or operation of roadside brushing operations on forest roads. The literature search required the use of similar terms to describe roadside brushing such as roadside mowing and integrated vegetation management. The results of the literature search confirmed, as previously believed, that there does not currently exist a comprehensive guide for roadside brushing and maintenance operations for resource roads. However, there have been a few documents with indirect application that contain aspects of implementation to forest roads. This includes integrated roadside vegetation management documents that have been developed for highways. These documents have a primary focus on the establishment of grasses and the management of roadside mowing operations. This is also the case for right-of-way vegetation management for power transmission lines.

This document presents a summary of the observations made by FPInnovations during the field visits conducted throughout Ontario. The information for each operation represents that which was provided by the company and contractor or which was compiled through the short-term observations made by FPInnovations.
Field visit – Northeastern Ontario

**Tembec**

The field visit was conducted in October 2012 with Tembec-North East Ontario operations. Three roadside brushing operations were visited; two were active and one had been recently completed. There were two types of work methods being used, regular roadside brushing and roadside brushing paired with road maintenance. Regular roadside brushing was performed with a feller-buncher and a bulldozer whereas the combined operation (brushing and maintenance) was performed with an excavator only.

When there is no dedicated equipment available, such as a mower or brush cutter, roadside vegetation management is often performed with readily available equipment such as an excavator or feller-buncher. Equipment such as feller-bunchers may also be chosen in order to extend the operating season of the machine. Extending the operating season by performing roadside brushing provides for additional work hours for the machine operator which is an important factor when trying to attract and retain machine operators and contractors.
Table 1 presents a list of equipment and features that were observed during the field visit as well as information gathered on cost and productivity.

Table 1. Characteristics of observed equipment.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Productivity* (km/shift)</th>
<th>Estimated costs ($/km)</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excavator equipped with regular bucket and thumb (brushing)</td>
<td>1.5</td>
<td>1 100</td>
<td>Performs well on uneven terrain, soft ground and slopes.</td>
<td>Risk of damaging culvert ends that are not well identified or difficult to see.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Can be used to expose mineral soils.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Long reach.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Safe to operate.</td>
<td></td>
</tr>
<tr>
<td>Excavator equipped with regular bucket and thumb (brushing and ditch maintenance)</td>
<td>Not available</td>
<td>2 500</td>
<td>Can perform various road maintenance tasks (installing culverts, ditching, rock removal).</td>
<td>Risk of damaging culvert ends that are not well identified or difficult to see.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Performs well on uneven terrain, soft ground and slopes.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Can be used to expose mineral soils.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Long reach.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Safe to operate.</td>
<td></td>
</tr>
<tr>
<td>Bulldozer</td>
<td>1.5 to 2.0</td>
<td>1 100</td>
<td>Fast and productive on flat terrain.</td>
<td>May only flatten brush when density is high.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Can be used to expose mineral soils.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Safe to operate (no spinning attachments).</td>
<td></td>
</tr>
<tr>
<td>Feller-Buncher</td>
<td>1.3</td>
<td>1 500 to 1 800</td>
<td>Fast when cutting merchantable trees.</td>
<td>The saw may jam when brushing small vegetation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Varies depending on density</td>
<td>Good boom reach.</td>
<td>Doesn’t cut small brush.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>May hit rocks when the machine head is working in a sweeping motion.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Rapid wear of saw teeth.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Potential safety issues (flying debris).</td>
</tr>
</tbody>
</table>

*: Both sides of the road in a 10-hour (PMH) shift
Excavator

The excavator (John Deere 350D) was working on an old forest road (figure 1). The vegetation to remove was mainly small non-merchantable saplings with a low proportion of merchantable sized trees. The operator was rehabbing the ditches and removing boulders when needed. When none of these operations were required, the operator was removing brush and small trees using a back swing called “grubbing”, which exposed the mineral soil. The average width of the brushed area was approximately 4.5 m but varied depending on location, road class and on the need to maintain safe sight distances. The use of a “thumb” on the excavator’s bucket was useful for moving rocks and other material if needed. The main constraint reported with this work method is that old culverts can be damaged if they are not visible or well identified. The excavator can be used during any season, even if the operator’s visibility is reduced during the summer as a result of the heavy foliage. With no rotating attachment, as is the case for some alternative roadside brushing equipment, hitting rocks will not cause significant damage to the equipment.

Figure 1: Excavator performing grubbing manoeuvres with the bucket.
Bulldozer

The bulldozer (Caterpillar D5) also performed the work on an old forest road. The vegetation was mainly non-merchantable trees and vegetation. The bulldozer was travelling parallel to the roadway and on the side of the road and brushing in two passes with an average width of 4 meters. The required brushed width can vary depending on the road class. The brushing was done on a flat section of the road and safety for oncoming traffic was not an issue. The brushed areas did not expose as much mineral soil as compared to work performed by the excavator. This method is fast but does not always completely remove the vegetation (figure 2). The brush and saplings were flattened in some areas and were not completely stripped from the soil. This machine is not well adapted for slopes, winding roads and has a limited reach. This machine can be used in all seasons, even if the operator’s visibility is reduced during the summer as a result of the heavy foliage. With no rotating attachment, as is required for some alternative roadside brushing equipment, hitting rocks will not cause damage to the equipment.

Figure 2: Recent roadside brushing performed by a D5 bulldozer.
**Feller-Buncher**

The feller-buncher (John Deere 903G) was working on an old forest road in an area with a low proportion of merchantable trees (less than 20%) mixed with dense vegetation (figure 3). Cutting small stems (DBH less than 2 cm) was a challenge for the operator. The weight of the head would bend the smaller stems rather than cutting, so the head was used in a sweeping motion at a 45 degree angle. Because of the limited visibility from the cab of the machine, the operator was unable to cut brush lower than 20 to 30 cm. Heavy brush can cause the saw to jam which can result in up to an hour of unplanned maintenance in order to release jammed material from the sawhead. This machine should be used in the fall or winter (when snow height is low) when visibility is better which will help to prevent the saw from hitting rocks. If the road is almost closed-in by heavy vegetation, a grader is often required after the brushing operation is completed to form the road surface.

![Feller-buncher performing roadside brushing.](image)

**EACOM Timber Corp.**

The field visit was conducted in October 2012. No roadside brushing operations were on-going during FPInnovations’ visit but two recently completed sites were visited and a road section that had been brushed in 2010.

FPInnovations observed the results of two different work methods during the field visits. Regular road brushing was performed on some road sections and brushing paired with road maintenance in others. Regular road brushing was performed with a brush cutter, and the combined operation was performed with an excavator.

When there is no dedicated equipment like a mower or brush cutter, roadside vegetation management will be performed by readily available equipment, whether it’s an excavator or a feller-buncher. The excavator was the one machine mainly used to perform road maintenance and brushing at the same time.
Table 2 shows the equipment list and different characteristics that were observed or discussed during the field visit and presents the information gathered on cost and productivity.

**Table 2. Characteristics of observed equipment.**

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Productivity* (km/shift)</th>
<th>Estimated costs ($/km)</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brush Cutter</td>
<td>1.5 to 3.0</td>
<td>1 000</td>
<td>Long reach.</td>
<td>Potential safety issues (flying debris).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Good productivity.</td>
<td>May require herbicides for longer-term effectiveness.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Low cost.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Potential safety issues (flying debris).</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>May require herbicides for longer-term effectiveness.</td>
<td></td>
</tr>
<tr>
<td>Excavator equipped with regular bucket and thumb (brushing)</td>
<td>1.5</td>
<td>1 500</td>
<td>Performs well on uneven terrain, soft ground and slopes.</td>
<td>Risk of damaging culvert ends that are not well identified or difficult to see.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Can be used to expose mineral soils.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Long reach.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Safe to operate.</td>
<td></td>
</tr>
<tr>
<td>Excavator equipped with regular bucket and thumb (brushing and ditch maintenance)</td>
<td>1.0</td>
<td>3 000</td>
<td>Can perform various road maintenance tasks (installing culverts, ditching, rock removal)</td>
<td>Risk of damaging culvert ends that are not well identified or difficult to see.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Performs well on uneven terrain, soft ground and slopes.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Can be used to expose mineral soils.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Long reach.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Safe to operate.</td>
<td></td>
</tr>
</tbody>
</table>

*: Brushed both sides of the road in a 10-hour (PMH) shift
**Brush cutter**

A section of road that had been completed in 2011 by a brush cutter (Denis-Cimaf DAH150) mounted on an excavator was visited (figure 4). The vegetation removed was mainly non-merchantable trees and saplings. This attachment is normally used in a sweeping motion, except when small trees are encountered, at which time the head is moved to a vertical position. This type of unit can cut trees with a DBH of 10 cm and less, but will perform better if the brush is smaller. The brushed area had an average width of 4 m on each side of the road, and the remaining brush was less than one meter tall. Premature wearing of the knives and possible knife breakage can occur if the head is operated too close to the ground (rocks). The best season to operate this kind of equipment is during the fall when operator visibility is good.

![Figure 4: Denis-Cimaf DAH150 horizontal-shaft cutting head.](image)
**Excavator**

The excavator had worked on an old forest road where vegetation comprised mainly non-merchantable saplings with a low proportion of merchantable-size trees. The operator had also rehabilitated the ditches and removed boulders (figure 5). When neither of these operations was required, the operator removed brush and small trees using a back swing of the excavator bucket called “grubbing”, which exposed the mineral soil. The average width of the brushed area was around 6 m but could have been reduced to an average of 4.5 m. The main issue reported with this work method is that culverts can be damaged if they are not visible or well identified. An excavator can be efficient in all seasons, even if the operator’s visibility is diminished during summer because of the heavy foliage. With no rotating attachment, hitting rocks will not cause damage to the equipment.

![Figure 5: Road section brushed by an excavator.](image)

**Old road**

The section of road shown on figure 6 was completed in 2010 with an excavator using the grubbing technique. No herbicides were sprayed after the initial treatment. Mineral soil exposure was still visible in some places and the vegetation that was growing was mainly grasses and non-woody species. The height of the vegetation was less than a meter so the line of sight was still clear.

![Figure 6: Road section brushed by an excavator after two years.](image)
Field visit - Northwestern Ontario

Resolute Forest Products

FPInnovations conducted a field visit during the last week of November 2012 with Resolute Forest Products. An ongoing brushing operation performed by a feller-buncher was observed. An active roadside brushing operation on a municipal road was also visited.

In the forest operation that was visited, most of the road brushing is done with a feller-buncher, except when road maintenance issue needs to be addressed, at which time an excavator may be used. The company was satisfied with the productivity and vegetation control results from the feller-buncher. It was observed that even after 4 years, the brush height was less than 1.5 meters and the line-of-sight was still clear.

Table 3 shows different characteristics that were observed during the field visit and presents the information on costs and productivity.

Table 3. Characteristics of observed equipment.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Productivity* (km/shift)</th>
<th>Estimated costs ($/km)</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feller-Buncher</td>
<td>1.0</td>
<td>1 100 to 1 300</td>
<td>Fast when cutting merchantable trees.</td>
<td>The saw may jam when brushing small vegetation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Varies depending on density</td>
<td>Doesn’t cut small brush.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Rocks may be hit when the machine head is working in a sweeping motion.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Rapid wear of saw teeth.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Potential safety issues (flying debris).</td>
</tr>
</tbody>
</table>

*: Brushed both sides of the road in a 10-hour (PMH) shift
**Feller-Buncher**

This machine (Timberjack 618) was working on an old forest road and the area to be brushed had a small proportion of nearly merchantable trees (around 20 %) mixed with heavily dense brush (figure 7). The road was almost closed by the heavy brush and only the center line of the road was still visible. Cutting small stems (DBH less than 2 cm) was a challenge for the operator. The weight of the head would bend the smaller stems so the head was used in a sweeping motion. When larger brush required cutting, the operator was using the head as if he was harvesting merchantable trees and was bunching them on the ground. Because of the limited visibility, caused by the snow, of the felling head from the cab of the machine the operator couldn’t cut the brush lower than 10 to 20 cm.

Heavy brush can cause the saw to jam which can result in up to an hour of unplanned maintenance in order to release jammed material from the sawhead. This machine should be used in the fall or winter (when snow height is low) when visibility is better which will help to prevent the saw from hitting rocks. If the road is almost closed-in by heavy vegetation, a grader is often required after the brushing operation is completed to form the road surface.

![Figure 7: Brushed road (left) and the feller-buncher bunching small trees (right).](image-url)
Figure 8 shows the piece of equipment that was performing roadside brushing on a municipal road north of Thunder Bay that is used to access forest operations. The excavator attachment was a customized horizontal-shaft cutting head mounted on a small Link-Belt LX excavator. The operator stated productivity between 1 and 2 kilometers a day on one side of the road, depending on the terrain. He also stated that this type of attachment was more efficient with stiff stems, otherwise they would bend. Even with chains protecting the brush cutting head, a fair amount of debris was found on the road.

![Figure 8: Brush cutter mounted on a small excavator.](image)

**Domtar**

FPInnovations conducted a field visit with Domtar during the last week of November 2012 where an active roadside brushing operation using a Hydro-Ax brush cutter was observed.

Regular road brushing was performed on an old road with the Hydro-Ax. On main roads, after the brushing operation is completed, herbicides are also applied. Almost 90% of brushing on these operations is performed with the Hydro-Ax. When there is a high-density of small merchantable trees, a feller-buncher will be used. If road maintenance issues have to be addressed at the time when roadside brushing is required, an excavator will be used.

Table 4 presents the characteristics of the Hydro-Ax observed during the field visit.

**Table 4. Characteristics of observed equipment.**

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Productivity* (km/shift)</th>
<th>Estimated costs ($/km)</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydro-Ax</td>
<td>0.75</td>
<td>2 500</td>
<td>Strong and powerful. Works best on flat ground.</td>
<td>Dedicated machine. Potential safety issues (flying debris). Limited movement ability on uneven ground. High operating cost.</td>
</tr>
</tbody>
</table>

*: Brushed both sides of the road in a 10-hour (PMH) shift
**Hydro-Ax**

The vegetation to remove on the side of the road was mainly brush and saplings. The Hydro-Ax was travelling on the side of the road and brushing in two passes on with an average completed width of 5 meters on flat ground. Brushed width can vary depending on the road class and terrain. If the brushed areas were on a slope the Hydro-Ax must move perpendicular to the road which limits its reach to 3 to 4 meters. This machine is susceptible to getting stuck in part due to its heavy weight. As a result, this machine is often paired (with another Hydro-Ax) to limit loss time if they do get stuck. This machine is very heavy and fairly slow when brushing. There is an auxiliary hydraulic system and motor that drives the attachment. This machine is not efficient on slopes, winding roads and has a limited reach. This machine can be used in all seasons, even if the operator's visibility is reduced during the summer because of the heavy foliage. The brush cutting attachment weighs over 1000 kg and maintenance can be very costly. A safety perimeter around the machine is important as debris can be projected when the machine is working.

*Figure 9: The Hydro-Ax brush cutter.*
Field visit - Central Ontario

Algonquin Forestry Authority

Field visits were conducted in December 2012 and December 2013 with the Algonquin Forestry Authority. FPInnovations visited two operations, including one that utilized a brush cutter mounted on an excavator and a second operation that featured a cutting head mounted on a Gradall working as part of a team with a tractor equipped with a flail mower.

The characteristics of the equipment observed during the field visits are presented in Table 5.

Table 5. Characteristics of observed equipment.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Productivity* (km/shift)</th>
<th>Estimated costs ($/km)</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brush Cutter (Roanoke)</td>
<td>3.0</td>
<td>750 to 1 000</td>
<td>Extended reach. Good productivity. Low operating costs. Low maintenance. Brushing attachment can be removed and machine can work again as an excavator.</td>
<td>Potential safety issues (flying debris). Not effective on vegetation greater than 6 cm in diameter.</td>
</tr>
<tr>
<td>Promac Rotary cutting head mounted on a Gradall</td>
<td>2.0 to 4.0</td>
<td>750 to 1 000</td>
<td>Extended reach. Boom reach allows cutting of overhanging branches. Works best on flat ground.</td>
<td>High fuel consumption. Difficult to maneuver on narrow roads. Potential safety issues (flying debris).</td>
</tr>
<tr>
<td>Rhino flail mower mounted on a Massey-Ferguson</td>
<td>2.0 to 4.0</td>
<td>750 to 1 000</td>
<td>Effective in small vegetation. Boom reach allows cutting of overhanging branches.</td>
<td>Potential safety issues (flying debris).</td>
</tr>
</tbody>
</table>

*: Both sides of the road in a 10-hour (PMH) shift
**Roanoke head mounted on a Kobelco K909 LC excavator**

The equipment (Figure 10) was working on an active road where vegetation to remove was mainly small coniferous trees (DBH 2 to 6 cm) with a small proportion of merchantable trees. The operator was using a horizontal sweeping motion with the head at different heights, starting high and going lower stopping at about 25 cm from the ground. The area brushed had an average width of 3.5 m. As shown in figure 10 (on the left), the use of a brush cutter on an excavator requires an auxiliary motor to power the head (the hydraulics of an excavator are not built to power a rotary attachment). It takes 8 hours to retrofit the machine back to a regular excavator. This machine should be used in fall or winter (limited snow) to assure operator’s visibility and prevent the head from hitting rocks, which can cause damage to the rotary cutting knives.

![Roanoke head mounted on a Kobelco K909 LC excavator](image)

**Figure 10 : Roanoke vertical shaft cutting head mounted on a Kobelco K909 LC excavator.**

**Rhino flail mower mounted on a Massey Ferguson tractor**

FPInnovations observed a Rhino mulching head mounted on a Massey Ferguson Tractor working as part of a two machine team (Figure 11). The tractor was completing the first pass along the roadside removing smaller vegetation and a second pass to remove larger vegetation was completed by the Gradall with a Promac rotary cutting head. The operator was cutting vegetation to a maximum diameter of 10 – 12 cm. Due to the heavy snow present at the time of the operation the vegetation was cut just at the snow level. The operator was cutting vegetation 2.4 m from the road edge and any overhanging branches up to a height of 4.5 m.
**Promac rotary cutting head mounted on a Gradall**

At the time of the visit the equipment was working in winter conditions on an active haul road. The Promac rotary cutting head has a diameter of 1.5 m and was mounted on a 1993 Gradall 660E (Figure 12). The machine was removing vegetation with an average diameter of 15 – 20 cm with a maximum diameter of up to 25 cm. This machine was working in tandem with the tractor equipped with the Rhino mulching head. The Gradall would follow behind the tractor which was cutting the smaller vegetation. Vegetation was cut to a distance of 2.4 m from the road edge and any overhanging branches to a height of 4.5 m. Give the long reach of the extendable boom, the performance of the machine is best suited to wider roads where the machine is provided the area in which to suitably maneuver.

**Tembec**

A field visit was conducted in October 2013 with Tembec’s operations in the North Bay area where FPInnovations observed two operations performing roadside brushing. The first operation utilized a mower mounted on a New Holland tractor. The second operation was considered a trial and involved the spreading of biomass material along the ditch lines to prevent regeneration of vegetation.
The characteristics of the equipment observed during the field visits are presented in Table 6.

**Table 6. Characteristics of observed equipment.**

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Productivity* (km/shift)</th>
<th>Estimated costs ($/km)</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>US Mower rotary blade mounted on a New Holland tractor</td>
<td>1.0 to 3.0</td>
<td>400 for light brushing 1 000 for heavy brushing</td>
<td>Effective in small vegetation. Boom reach allows cutting of overhanging branches. Maneuverable.</td>
<td>Potential safety issues (flying debris).</td>
</tr>
<tr>
<td>Excavator spreading biomass</td>
<td>0.5</td>
<td>1 400</td>
<td>Offers disposable option for unused biomass.</td>
<td>Slow production. Unknown performance in controlling vegetation growth.</td>
</tr>
</tbody>
</table>

*: Both sides of the road in a 10-hour (PMH) shift

**US Mower rotary blade mounted on a New Holland tractor**

FPInnovations visited the operation in October 2013 at which time roadside brushing was being conducted on a primary and secondary road. The US Mower (Figure 13) was removing vegetation with an average diameter of 10 – 12 cm with a maximum diameter of 17 cm being cut. The mower has a cutting width of 1.5 m and a reach of approximately 4.5 m which facilitated the company objective of cutting 6.0 m from the roadside on primary roads and 2.5 – 3.0 m from the roadside for secondary roads. The machine was also able to lift the mower head to cut any overhanging branches that may have been present. The operator had performed some modifications to the machine in order to improve performance including an additional hydraulic pump, upgrading of hydraulic hoses and the installation of a joystick to control the mower.

![Figure 13. US Mower rotary blade mounted on a New Holland tractor.](image-url)
**Biomass application with excavator**

At the time of the visit by FPInnovations Tembec was performing a biomass spreading trial. The objective of this trial was to evaluate an alternate method of controlling roadside vegetation while providing for an alternate use of biomass material that was evaluated as unfit for other uses. In this operation two excavators and two gravel trucks were employed (Figure 14). One excavator would load the trucks while the other would prepare the roadside by removing any larger vegetation followed by spreading of the biomass material. The material was spread with a thickness of 0.3 – 0.6 m and a width of 4 – 7 m from the edge of the road. The areas in which the biomass was permitted to be applied were restricted to distances of at least 30 m from a watercourse and in areas where ditch water was not present.

![Excavator spreading biomass](image)

**Figure 14. Excavator spreading biomass to control vegetation establishment.**

**Phone survey**

In addition to the field visits, FPInnovations conducted a phone survey, where 10 forest road managers in Ontario were contacted, to gather additional information on brushing practices in the province. The main questions asked were:

- Are you performing roadside brushing and how many kilometers on average are completed annually?
- What types of machines and/or attachments are being used?
- What are the average productivities and costs of the machines?
- When is the best time of the year to conduct roadside brushing operations?
- Is herbicide spraying applications considered part of your roadside brushing operation?
Table 7 presents a summary of the information gathered from the survey.

Table 7. Summary of roadside brushing information collected during the phone survey.

<table>
<thead>
<tr>
<th>Type of machines used</th>
<th>Productivity *(km/shift)</th>
<th>Costs ($/km)</th>
<th>Best time of the year</th>
<th>Optimum vegetation size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excavator with a shredder attachment</td>
<td>1.5</td>
<td>450 to 1 500</td>
<td>Fall</td>
<td>Vegetation less than 6 cm in diameter.</td>
</tr>
<tr>
<td>Feller-Buncher</td>
<td>2.0</td>
<td>2 000 to 4 000</td>
<td>Summer and fall</td>
<td>Merchantable trees (DBH &gt; 6cm).</td>
</tr>
<tr>
<td>Bulldozer</td>
<td>1.5 to 2.0</td>
<td>1 500</td>
<td>End of summer and fall</td>
<td>Young regeneration.</td>
</tr>
<tr>
<td>Backhoe with a mowing head</td>
<td>1.0</td>
<td>2 200</td>
<td>Fall</td>
<td>Vegetation less than 6 cm in diameter.</td>
</tr>
<tr>
<td>Excavator</td>
<td>1.5</td>
<td>1 500 to 1 800</td>
<td>End of summer</td>
<td>Vegetation less than 6 cm in diameter.</td>
</tr>
</tbody>
</table>

*: Both sides of the road in a 10-hour (PMH) shift

All of the companies contacted were performing annual roadside brushing. Funding-dependent, most of them were doing an average of 30 to 50 km (both sides) each year.

A clear line of sight on the brushed roads were said to last between 5 and 8 years in hardwood regeneration and between 8 and 12 years for coniferous regeneration. One company contacted was brushing the same road every two years (hardwood).

Most of the brushing operations seem to be performed with the available equipment which may not always be the best machine for the type of vegetation being managed. Some brush cutter attachments (grinder, mower, etc.) are hard to find in some areas leaving feller-bunchers or regular road building or harvesting equipment to be used for brushing operations (bulldozer and excavator).

**Herbicide spraying**

The responses gathered regarding regulated herbicide spraying activities were very diverse. Sixty percent of the contacted companies stated that they are not using herbicides due to environmental reasons, such as forest certification requirements and pressures from environmental groups. The remaining respondents indicated that herbicides were sprayed after the brushing operation had been completed by a shredder, mower or other brush cutter. The operations that have implemented herbicide spraying stated that this practice helps extend the period between roadside brushing interventions up to a few years and was primarily performed on high-traffic primary access roads. The stated average cost of herbicide spraying was estimated between $150 and 300/km on the ground and approximately $50 to 90/ha when an aerial application was performed.
Summary

Roadside brushing operations are conducted across Ontario on an annual basis to ensure safety for road users and to maintain road infrastructure performance. There is a variety of equipment being used to perform roadside brushing, including purposely built mower or grinder attachments as well as excavators and bulldozers. FPInnovations observed that the purposely built attachments were primarily used when roadside brushing was required to re-establish appropriate line-of-sight for road users. When extensive road maintenance and upgrades to the road surface or ditches were required an excavator or bulldozer would be used.

The type of equipment being implemented for roadside brushing is primarily determined by the equipment availability of local contractors. A few forest operations indicated that multiple local contractors offer a selection of equipment however most operations were limited to one machine or purposely built attachment that is locally available. As a result, FPInnovations fielded many questions concerning the productivity as well as requests for recommendations of the most suitable roadside brushing equipment for given road conditions and maintenance objectives. The work performed by FPInnovations in 2012-14 was the first attempt at addressing these questions and concerns and highlighted that additional work and eventual availability of guidance documents would be beneficial to the Ontario forest industry.
Development of a Guide for Roadside Brushing on Forest Roads

The initial work performed in 2012-13 by FPInnovations, with funding support by the Ontario Ministry of Natural Resources, highlighted the need for continued work on identifying, evaluating and recommending equipment and management for roadside brushing on forest roads. Roadside brushing operations are performed on an annual basis by all forest road managers in Ontario. Despite this, there lacks even basic information on the equipment, planning and management components of roadside brushing operations to ensure effective operations. FPInnovations fielded many questions from the forest companies and contractors that were visited and interest was high on how each of these operations could most effectively manage their roadside brushing operations.

In response, FPInnovations has identified a need for a comprehensive review of roadside brushing operations with the objective of producing a management and planning guide for roadside brushing operations on forest roads. The management and planning guide for roadside brushing operations would focus on a few key aspects, such as:

1. Overview of equipment and practices
   a. Types of cutting heads available
   b. Review of the advantages, disadvantages and suggested conditions for use
   c. Review of prime movers
   d. Herbicide use
2. Operation considerations
   a. Time of the year to best conduct operations
   b. Frequency of operations
   c. Cutting heights for vegetation
   d. Diameter and size of vegetation
   e. Establishing desirable roadside vegetation
   f. Effectiveness
3. Productivity and cost
   a. Productivity and costs for available roadside brushing equipment
   b. Factors that influence productivity, costs and effectiveness
4. Equipment selection recommendations