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Contents

Trials of variable-retention harvesting in eastern Canada

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Abstract

Variable-retention harvesting will likely be increasingly used in eastern Canada because of new legislations regulating harvesting activities. In the fall of 2002, FERIC studied five variants of this harvesting approach, adapted to the forests of eastern Canada, and assessed the stand characteristics retained, the operational considerations, and the direct costs. The additional costs associated with variable retention arise primarily from the volumes of fiber that are left unharvested in the forest and depend on the nature and quantity of the elements retained. Our trials confirmed that variable-retention harvesting is a viable approach in eastern Canada.

Keywords:

Variable retention, Partial cut, Shelterwood cut, Harvesting with the protection of small merchantable stems, Cut-to-length harvesting system.

Introduction

Variable-retention harvesting is an approach that has been gaining rapid popularity in recent years in western Canada, particularly for forestry operations in old-growth forests on the western coast of Vancouver Island (Phillips 1996). However, the concept is relatively new in eastern Canada. This form of ecosystem management aims to harvest wood fiber while preserving the biological heritage associated with mature forests. Variable-retention harvesting simulates natural disturbances such as forest fires, disease epidemics, or windthrow. This approach will be used increasingly because of new legislations regulating harvesting activities in several provinces.

Variable-retention harvesting aims to ensure that after harvesting, at least 50% of the treated area will still be close to elements retained from the original stand (Franklin et al. 1997). These elements may be wooded patches of trees, living trees, snags, woody debris, or even understory species. Variable-retention harvesting should be practiced in mature stands. Two types of variable retention are possible: the retention of dispersed elements or of patches.

Retention of dispersed elements

The retention of dispersed elements maintains certain features throughout the treated area in a relatively uniform manner. Its main advantage is that it ensures a greater degree of structural complexity throughout the site. One current application consists of retaining a certain number of trees per hectare that will have good resistance to wind and other stresses. The dispersed retention can resemble seed-tree harvesting or harvesting with the protection of small merchantable stems (HPSMS) (Hillman 2003), but the objectives of the treatment vary. Variable retention harvesting with dispersed elements helps conserve the biological heritage of the harvested area.

Retention of patches

This form of retention conserves undisturbed islets of forest, of various sizes and shapes, distributed throughout the harvested area. This approach permits the conservation of all the components and several of the characteristics of the former stand. Elements that are very important to wildlife and biodiversity, such as snags or unstable standing trees, can thus be maintained more safely than using the dispersed-element approach. This approach also reduces the risks of windthrow or mortality due to weather-related stress.

Applications in eastern Canada

Variable-retention harvesting must account for the peculiarities of operations in eastern Canada, such as short turnover and the relatively brief lifespan of the different species. The great flexibility of this approach offers many possibilities for the management of biological resources.

Application of variable retention harvesting can have different objectives, depending on the type of forest (softwood, mixedwood, or hardwood). With low retention rates, the silvicultural regime is predominantly even-aged; in contrast, repeated interventions with high retention of the original forest lead to uneven-aged management and can preserve numerous wildlife and floristic habitats. Variable-retention harvesting can thus be realized by means of traditional silvicultural treatments such as shelterwood cuts, commercial thinning, or single-tree selection. If significant elements of the original stand are retained (even with a low retention rate), then clearcutting, harvesting with seed-tree reserves, and harvesting with the protection of small merchantable stems (HPSMS) can all meet the objective of preserving biodiversity while still permitting harvesting of the wood fiber.

Results of FERIC's trials

FERIC conducted five case studies in the fall of 2002 in two cut-to-length harvesting operations: a shelterwood cut (Stora Enso Port Hawkesbury Limited, Cape Breton, NS) and a harvesting operation with the protection of regeneration and of soils (Tembec Industries Inc., Témiscamingue, QC). In Nova Scotia (cases 1 and 2), the operations used an Enviro single-grip harvester equipped with a Logmax 3000 felling head and a Rottne Rapid shortwood forwarder. In Quebec (cases 3, 4, and 5), the operations used a Valmet 921 single-grip harvester and Valmet 860 shortwood forwarder.

Case 1: Shelterwood harvesting with 50% retention of the forest cover

This treatment targeted a total removal of around 50% of the basal area so as to permit the establishment of fir regeneration under the residual cover. The single-grip harvester felled and processed all the trees in a 5-m-wide strip to create the extraction trail (Figure 1). For 5 metres on each side of the trail, the operator then harvested

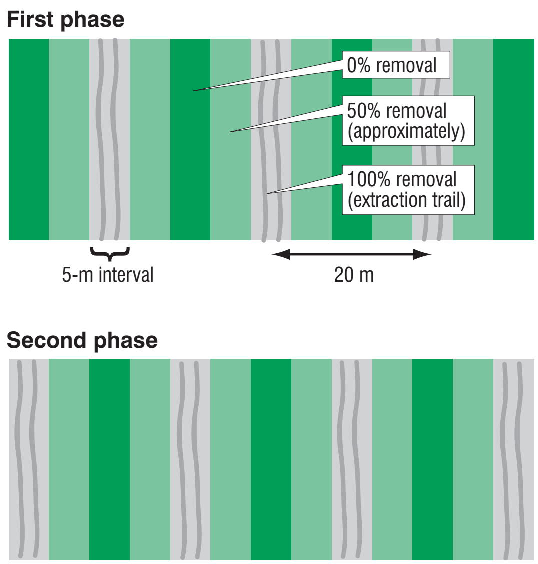

Figure 1. Layout recommended by FERIC for shelterwood harvesting with retention of 50% of the original forest cover and a 20-m trail spacing.

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around 50% of the available volume and left a 5-m-wide strip beyond that untouched. The majority of the residual cover would be harvested during a second pass once the regeneration has reached an acceptable height. By using the present leave strip as the future extraction trail, this two-phase approach would avoid damaging the regeneration established after the first pass.

The different removal intensity between strips creates a forest cover with more elaborate horizontal and vertical structures, even after the second intervention. This enrichment of the second-growth forest's structural elements meets, at least in part, the definition of variable-retention harvesting proposed by Franklin et al. (1997).

In the study area, good visibility and the low quantity of unmerchantable or dead stems permitted good productivity from the single-grip harvester. Because the larger trees were harvested, this offset the productivity losses typically observed in partial cutting. The felling and processing productivity in shelterwood cutting was only 6% less than that observed in clear cuts. In addition, there is no systematic volume loss associated with this form of retention since the residual cover will be harvested during the second pass. Nonetheless, there's still a risk of accidental losses to windthrow or wounding between the two interventions.

Case 2: Modified shelterwood harvesting with retention of coarse woody debris

This approach used the same layout as in Case 1, but in addition, operators felled 12 to 14 trees/ha within the thinned strips and left them unprocessed on the ground so as to improve the quality of pine marten habitat. Raised structures of coarse woody debris (Figure 2) create a favorable environment for hunting by the marten in winter by facilitating its entry under the snow to pursue its prey (small mammals that shelter under these structures).

The stems used for this purpose had an average merchantable volume of 0.127 m^3/stem and a mean DBH of 17.4 cm. These habitat trees represent a loss of merchantable fiber and thus an increase in both direct and indirect harvesting costs. The mean time required to create these structures was 0.71 min each. The productivity loss averaged 9% compared with clearcutting, but only 3% compared with the shelterwood cut that did not retain such woody debris. Some skill is required to create these raised structures, but as the operator selects the habitat trees, the approach is relatively simple to implement.

Figure 2. Raised structures of woody debris created by felling stems at a height of around 60 cm above the ground and resting the stem on its stump.

Case 3: Harvesting with the retention of patches

Studies 3, 4, and 5 took place in Quebec, in an area where harvesting methods had to be modified in order to accommodate local requirements. Harvesting with the retention of patches represents one of the options that were tested (Figure 3).

Figure 3. Clump of trees surrounding a white pine, a species that is relatively rare in this region.

The patches retained after the treatment represented 12% of the total pre-harvest volume. The patches were chosen for the specific elements that distinguished them from the original stand, in terms of volume and mean stem diameter, both for snags and merchantable stems. After harvesting, the quantity of woody debris on the ground was comparable within the patches and on the cutover, but most debris within the patches was more decayed than on the cutover.

We observed no productivity loss during felling and processing as a result of harvesting with retention of patches. However, slight productivity losses could be expected during forwarding because of the increased average extraction distances that result from having to weave around the patches. The volume loss was significant (12% of the total) in this case study. This factor must thus be considered when positioning the patches in order to reduce the value of these losses while still meeting the treatment's biological objectives.

Variable-retention harvesting with the retention of patches presents few operational constraints for the felling and processing because the need to exclude small patches of trees is already a common occurrence to bypass immature or inaccessible areas. The main additional task posed by variable retention is to clearly identify the location of the patches so as to avoid errors during harvesting. This may induce slightly higher planning costs.

Case 4: Harvesting with the retention of dispersed elements

This approach resembles the one described in the theoretical model of Franklin *et al.* (1997). In the present study, individual stems chosen for retention comprised red pine, white pine, larch, yellow birch, sugar maple, red maple, eastern white cedar, and black ash, as well as spruce less than 14 cm in DBH (Figure 4).

The retained stems had a residual density of 330 stems/ha, which represented a volume loss of 16.7 m^3/ha (nearly 12% of the total volume). These conditions were similar to those observed by Hillman (2003) in harvesting operations with the protection of small merchantable stems in eastern Quebec. The productivity of the single-grip harvester increased slightly since the trees harvested were larger, on average, as a result of leaving low-volume trees standing.

This form of variable-retention harvesting requires less additional planning than in the approach with residual patches since it requires no additional boundary marking. The additional costs are thus mostly related to the choice of which trees to leave standing, both because of the value of the fiber that isn't harvested and the increased indirect harvesting costs, since the total volume harvested per hectare decreases.

Figure 4. Harvesting with the retention of dispersed elements: species that are relatively rarer in this region are left standing, as are small spruce.

Case 5: Harvesting with the retention of dispersed elements and man-made snags

In forests undergoing management, the presence of large dead trees, whether standing or fallen to the ground, is a positive element in terms of biodiversity, since these snags represent essential wildlife habitat. In this case study, a number of snags were created artificially by felling trees as high as possible on the stem using the single-grip harvester (Figure 5).

The creation of such snags sacrifices the butt log, which usually contains most of the high-value fiber. This practice also slightly decreases felling and processing productivity. At a density of 10 man-made

Figure 5. A snag created artificially by cutting high up the stem.

snags/ha, the difference in cost is relatively low: around $0.04/m³ (<1%). Obviously, the greater the density of snags is, the greater the increase in cost. However, the main loss associated with this form of retention results from the volume loss of high-value fiber. For 10 snags/ha, FERIC estimated a loss of 1.23 m^3/ha (<1% of total volume). However, this fiber is often of saw log or veneer quality because the trees chosen for this purpose must generally be large so they can meet the needs of a wide variety of wildlife species. Thus, operators must take great care in choosing the trees destined to become snags in order to ensure that these big stems have little or no saw log or veneer potential, such as trees with fungi or major defects near the base. Clear instructions to the operators will help managers to avoid the costs of having to mark suitable trees.

Implementation

Variable-retention harvesting almost inevitably leads to additional costs, primarily due to fiber and value losses in the elements that are retained. Replacing the fiber left in the forest represents a direct cost, but there are also indirect cost increases for roads, planning, and monitoring that are incurred because of the reduction in the volume harvested. The additional costs associated with variable-retention harvesting depend on the choice and quantity of elements that will be retained. In every case, a site-specific analysis should be done. Managers must choose a compromise between the level of acceptable fiber losses and the ability to meet the harvesting objectives. In such context, the practice of uneven-aged management with variable-retention harvesting over parts of a forest may represent a cheaper alternative to the complete exclusion of forest stands from harvesting to permit their conservation. The main advantages of variable retention are the reduction of eventual losses of wood fiber by preserving the essential biological functions of forest ecosystems or by reducing the visual impact of harvesting.

To implement shelterwood cuts

Shelterwood cuts can be used in a program of variable retention wherever managers are willing to harvest a stand in two phases and want to establish abundant natural regeneration.

- The removal level, the stand characteristics, and the timing of the second phase of harvesting must be determined as a function of the local ecological characteristics for adequate regeneration to develop.
- To apply the system with 5-m strips described in Figure 1, navigation aids must be provided to the harvester operator. The use of GPS navigation or flagging of trails spaced 20 m apart is desirable to ensure a uniform harvesting treatment.
- Most cut-to-length harvesting equipment is suitable for treatment as described. It's even possible to use full-tree harvesting equipment.
- With the method proposed, removal intensity can range from 30 to 60% and the criteria for selecting which stems to fell can be simple: after having felled all stems in the extraction trail, the operator should choose one in three trees in the adjacent strips (typically the largest stems) and uniformly distribute the removal.
- Since shelterwood cuts are primarily intended to promote regeneration, avoid expensive efforts to protect the residual stand and don't try to develop sophisticated rules for selecting which stems to fell. Remember that the goal is not to significantly increase growth of the residual stems.

To implement the retention of coarse woody debris (wildlife trees or snags)

- Which coarse woody debris will be retained or be produced artificially must be defined as a function of the objectives of variable retention; for example, improving habitat for the pine marten or for nesting birds would require different approaches.
- Planning must guarantee the retention of a sufficient number of remnant trees with the desired characteristics to meet the biological objectives of the treatment. Several candidate trees will almost certainly need to be felled to permit maneuvering by harvesting equipment and the creation of extraction trails. Thus, roughly twice the required number of remnants should be identified before harvesting begins.
- The operator should select which trees to leave by looking for major visible defects that would indicate low potential value of the products extracted (e.g., saw logs, veneer).

Harvey (2003) suggests the following criteria for selecting elements to retain in variable-retention harvesting:

To implement the retention of patches

- Use the patches to protect the rarest attributes (habitats, species).
- Avoid straight lines, squares, and other regular shapes; instead, promote curved edges, as well as teardrop, kidney, oval, and other irregular shapes.
- The narrowest face of a patch should be oriented towards the direction of the prevailing wind.
- Create patches around wet zones, drainage channels or streams, breaks in the slope, and other difficult or sensitive sites.
- Consider creating "peninsulas" that extend out from corridors or other residual zones.
- Avoid patches of uniform forest, and instead choose those that contain a good degree of variety and vertical structure (e.g., a stratum of softwoods in the understory, saplings, mature trees and veterans, snags).
- Perform a partial cut along the edges of larger patches to remove some of the stems and improve wind firmness.
- Consider visual perspectives provided by variable retention as seen from the road, from scenic outlooks, and through open patches within buffer strips.

To implement the retention of dispersed elements

- Retain a range of stem sizes (large-diameter stems are important).
- Look for potential seed trees.
- Protect the veterans (very old trees).
- When you retain one or two individuals, you can include snags and the regeneration around them.
- Distribute the retained elements throughout the cutover.

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