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The quest for aspen management in eastern Canada

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THE QUEST FOR ASPEN MANAGEMENT IN EASTERN CANADA

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ABSTRACT.--In eastern Canada aspen represents 0.03 percent to nearly 20 percent of the individual provincial growing stock volumes. Regional and local differences in growing stock volume and markets influence the management view of the resource. A significant portion of the resource is located in Ontario and Quebec, and is in mature to over mature stands that may contain high levels of defect. Previous silvicultural efforts were directed at eliminating aspen in favor of softwoods. However, expanding markets and changing technologies are provoking serious thought about how to manage this resource. Precommercial and commercial thinning of aspen in pure and mixedwood stands may be key treatments in managing this increasingly important resource.

THE RESOURCE

Eastern Canada stretches approximately 3000 kilometers from the Manitoba-Ontario border to eastern tip of Newfoundland. Over such a broad expanse there are significant regional differences in forest ownership patterns, forest cover types, and the quantity and quality of the available aspen resource. Trembling aspen (Populus tremuloides Michx.) and largetooth aspen (P. grandidentata Michx.) both occur in eastern Canada, although trembling aspen is generally the most common. The total poplar growing stock volume in eastern Canada is approximately 1.3 billion cubic meters.

In Atlantic Canada, market opportunities for aspen are restricted either due to the limited quantities available or the lack of industry that uses aspen as a feedstock. The greatest portion of the poplar resource, in eastern Canada, is located in the provinces of Ontario and Quebec where market opportunities are better due to the size and diversity of the forest industry and the quantities of aspen available (Table 1).

NEWFOUNDLAND

Aspen is present on most of the island of Newfoundland, but it forms stands only in the north-central part of the province. These stands develop after fire (Damman 1983). Cull and decay are lower than in aspen of the same age situated elsewhere, and mean merchantable volume increment culminates at age 95 years (Page 1972). Aspen is much more productive than birch or any softwood species, but an increase of the acreage in aspen is needed before commercial utilization is feasible (Page 1972). Large stems may be used when encountered in normal softwood operations (e.g., for bridge building), but there is no industry using aspen commercially at present.[2]

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Table 1.--Aspen growing stock volume in eastern Canada by province.[1]

Province	Volume (m^3)	Percent of Provincial Growing Stock
New Brunswick	41,570,000	7.3
Newfoundland	3,000,000	0.03
Nova Scotia	7,400,000	3.0
Ontario[2]	1,011,200,056	19.8
Prince Edward Island	1,580,000	6.1
Quebec[2]	291,852,000	7.0

[1]Derived from Canadian Forestry Service (CFS) 1987a, 1987b, 1988a, and 1988b, Ontario Ministry of Natural Resources (OMNR) 1986a, and Parent 1987.
[2]Total of all Populus species.

NEW BRUNSWICK

Aspen represents 32 percent of the hardwood sustained yield and has a estimated gross total annual allowable cut (AAC) of 1,191,500 m^3, over half of which is on freehold land, and an estimated net AAC of 834,100 m^3, assuming 30 percent cull (Neill and Gunter Ltd. 1985). Utilization of the poplar resource is limited to one panelboard plant, less than 20 percent in pulp furnish, and practically none in sawlogs (Neill and Gunter Ltd. 1985). The aspen resource by grades is 36 percent sawlogs and 64 percent fiber (McFarlane 1982).

NOVA SCOTIA

Aspen is present primarily in the western and central parts of the province, and is divided into the following products or classes sawlogs 20 percent, bolt wood 17 percent, top wood 12 percent, pulpwood 50 percent, and cull 2 percent (Wellings 1982). Seventy-one percent of the forest land is in private ownership with more than two-thirds being in holdings of less than 400 ha (Wellings 1982).

PRINCE EDWARD ISLAND

While the aspen growing stock volume is too small to support an industry, nearly one-third of a million cubic meters of aspen and other species were used as fuel wood during the 1986 heating season. This represented 12.4 percent of the total energy consumed for heating resulting in a saving of 58.7 million liters of fuel oil (CFS 1987b). Private ownership accounts for 95 percent of the productive forest land (CFS 1987b).

QUEBEC

The annual allowable cut is estimated at 4.8 million m^3, half of which is on private land and represents less than 20 percent of the productive forest land area. The annual commitment is 2.9 million m^3, but the volume actually harvested in 1988 was estimated at 2.0 million m^3. This is a dramatic increase over the volume of 867,000 m^3 harvested in 1980 (Rinfret 1987), and projects in the planning stage suggest that the upward trend in utilization will continue. About two-thirds of the harvested volume is used for pulp and waferboard (figures not available separately) and one-third is used for sawlogs and veneer.

Theoretically, there is a considerable surplus of unused aspen. However, a large part is in mixedwood stands where availability depends on concurrent exploitation of other species, or in old stands where cull and decay become important factors. For example, when the allowable cut was calculated for a waferboard plant that went into production in 1988 in the Lac-Saint-Jean area 25 percent of the gross volume was deducted because of decay and other defects. When these factors are considered, the resource is entirely committed in some regions.

As in other areas, aspen is affected by a number of organisms. Nine different cankers have been reported on trembling aspen in Quebec (Laflamme 1982) with Hypoxylon canker being the most prevalent. A general survey of aspen stands (Benoit et al. 1982) showed that an average of 5 percent of all the stems and 4 percent of the merchantable volume were affected. Annual loss through mortality resulting from Hypoxylon canker was estimated at 1.2 million m^3. A more in-depth study of two management units (Archambault 1982) confirmed these figures, but infection was up to 26 percent in some stands.

ONTARIO

Of the eleven Ontario Forest Resources Inventory (FRI) species groupings, poplar is second only to spruce for total growing stock volume and is an aggregate of the two aspen species, balsam poplar (P. balsamifera L.), and eastern cottonwood (P. deltoides Bartr.) (OMNR 1986a). The major concentration of poplar within Ontario, as delineated by Fitzpatrick and Stewart (1968), occurs in the four northern administrative regions of the Ministry of Natural Resources and represents over 90 percent of the poplar resource, mostly trembling aspen which probably accounts for 80 percent or more of the poplar growing stock volume. The southern edge of this major poplar area coincides roughly with the boundary between the Great Lakes--St. Lawrence and the Boreal Forest Regions (Rowe 1972). Largetooth aspen occurs in commercial concentrations in the Great Lakes--St. Lawrence Forest Region in south-eastern Ontario (Davidson et al. 1988). The Crown holds title to most of the productive forest land and most of the aspen resource in Ontario.

During a recent ten year period the poplar harvest more than tripled from 0.793 million cubic meters in 1977 (OMNR 1981) to 2.768 million cubic meters in 1986 (OMNR 1986b). The harvest represents only a small portion of the volume available; however, other factors reduce the amount available for harvest. During the period 1977-1981 annual losses in growth due to forest tent caterpillar amounted to 933,000 m^3 while 155,000 m^3 of lost increment was attributed to other causes, and direct mortality resulting from Hypoxylon canker amounted to 6,184,000 m^3 (Smyth and Campbell 1987). In addition, total defect (stain and decay) can also be a factor in reducing the available volume. The age class distribution of the poplar resource is skewed to the older age classes with approximately 67 percent of the productive poplar land base, representing 75 percent of the poplar volume, in stands that are mature or over-mature (OMNR 1986a). Basham and Morawski (1964) reported high levels of defect in mature and over-mature stands (Table 2).

Table 2.--Stain and decay as a percentage of total merchantable volume in Ontario trembling aspen.[1]

Age Class (yrs)	Stain (%)	Incipient Decay (%)	Advanced Decay (%)	Total Defect (%)
21-40	5.2	2.4	0.2	7.8
41-60	7.0	5.3	1.0	13.3
61-80	8.2	6.5	2.7	17.4
81-100	10.8	8.1	4.8	23.7
101-120	11.4	12.3	8.8	32.5
121-140	17.3	9.3	10.6	37.2
141+	16.3	7.2	18.7	42.2

[1]Modified from Basham and Morawski 1964.

CURRENT PRACTICES

QUEBEC

Until fairly recently, aspen utilization was localized and much of it was for veneer and sawlog production. Large trees were used in some areas, but for the most part aspen stands or trees in mixedwood stands were left standing. Doucet (1989) found that a partial cut resulted in a gradual reduction in the growth of newly produced aspen suckers with a concurrent increase in brush density. He suggested that this would result in the production of an irregularly stocked stand of aspen.

The only general restriction on harvesting is that clearcut size must not exceed 250 ha (Walsh 1989). Special sites may be identified for recreation, wildlife, or conservation purposes. On these sites the restriction may range from patch clearcutting with irregular boundaries for a reduction of visual impact to a complete ban on cutting (Ministère de l'Énergie et des Ressources 1986). The only specific reference to aspen is a prohibition on cutting closer than 40 m to an active beaver lodge.

Except for a few trials (Doucet 1979), regeneration so far has meant either accepting what was coming after cutting or conversion to conifers.

ONTARIO

Current harvest practice in Ontario is a clearcut in both mixedwood and pure aspen stands. Whether the clearcut is a silvicultural clearcut or a commercial clearcut is dependent upon the composition of the stand and available markets. If white birch (Betula papyrifera Marsh.) is a stand component it is usually left standing in harvesting operations. The practice of harvesting mixedwood stands only for the conifer component or aspen stands only for veneer logs is discouraged (Heikurinen 1981). It has also decreased due to better markets and coordination between those harvesting veneer and pulpwood. The size and shape of clearcuts vary from area to area. If roads do not exist in an area the harvest operation progresses as the road extends and results in extensive areas of even-aged forest. To some extent the impact of large clearcuts has been minimized by the provision of wildlife corridors. Areas having an established road system tend to have a better distribution of harvested areas, creating a greater diversity of habitats for wildlife.

When a decision is made to harvest a stand, an active or passive decision in wildlife management has also been made. In Ontario, there are a number of habitat management guidelines which have been introduced over the last decade, most within the last five years. The species for which guidelines have been prepared include moose, deer, furbearers, waterfowl, eagles, warblers, and others. Managers use the guidelines as warranted by their particular situation. For example, consider the effects of harvesting and regeneration on moose habitat. The primary moose range agrees closely with the major poplar area in Ontario. Moose inhabit the early successional stage of stand development up to about 20 years (Timmerman and McNichol 1988). McNichol and Timmerman (1981) suggested that clearcut mixedwood stands do not provide desirable moose habitat, and that scarification and planting fail to provide the advantages of advanced conifer regeneration and residual hardwood cover that existed when only the merchantable conifer was harvested. Areas having residual basal areas of 2.5 m^2/ha each of hardwood and conifer were preferred habitat during January and February due to the quantity and variety of browse species available (McNichol and Gilbert cited by McNichol and Timmerman 1981).

Site preparation for the regeneration of aspen is generally not practiced in Ontario. However, at least one management plan made allowance for the removal of non-merchantable stems by mechanical or chemical means following commercial clearcuts to assure adequate aspen sucker regeneration. The actual need or desirability of removing non-merchantable residuals is dependent upon the quantity of trees that remain following harvesting. Jones (1976) suggested that a residual basal area of 3.4 m^2/ha approached a clearcut, but recommended felling of residual stems if the basal area was as great as 2.3 m^2/ha to encourage regeneration. However, leaving patches of residual trees may be beneficial for moose habitat, particularly in mixedwoods having conifers (McNichol and Timmerman 1981).

Equipment utilized in preparing harvested stands for establishment of conifer regeneration has changed dramatically over the last decade. The use of heavy drags (e.g., shark-finned barrels developed in Ontario during the mid 1960s) has decreased for site preparation, and there has been an increase in the use of shear blades, and implements similar to Young's Teeth, but on mixedwood sites under-utilization of hardwoods is still a problem requiring heavy equipment (Smith 1987). The use of heavy drags significantly reduced the growth and internal stem and root quality of 3-year-old suckers (Basham 1988).

Prescribed burning increased sharply by the mid 1980s with the number of burns nearing 60 per year and area totals approximating 15 000 hectares per year (Gagnon 1987). However, the treatments are aimed at conifer regeneration and not aspen. Aspen sites may be too moist to burn during years with normal weather patterns and the fire situation may be too critical for burning the aspen sites during dry years. Another possible difficulty with burning aspen sites is proper fuel loading to carry the fire across the site. Perala (1974) described similar difficulties on a mixedwood site in Minnesota.

FUTURE DEVELOPMENTS

THINNING

There is interest in commercial thinning to increase yield by salvaging potential mortality and increasing growth of the residual trees, and in precommercial thinning to shorten rotation length. This interest stems from the results of the few experiments that have been done. Young dense stands on medium to good sites respond favorably. Maximum response was obtained four years after treatment (Doucet and Veilleux 1982), but differences were still evident after ten years. Thinning to 1500 stems/ha did not decrease total or merchantable volume increment for the first five-year period after thinning (Table 3) and volume increments increased during the second five-year period after thinning.

Table 3.--Growth response of aspen to thinning.

Stand Data After Thinning					Net Volume Increment (m^3/ha)			
Age (yrs)	Dominant Height (m)	Residual Density (stems/ha)	Volume Total[1] (m^3/ha)	Volume Merchantable[2] (m^3/ha)	First 5 Years		Second 5 Years	
					Total[1]	Merchantable[2]	Total[1]	Merchantable[2]
15	9.4	10,000[3]	81	6	41	10	25	30
		1,500	31	1	36	12	34	41
		750	22	1	27	15	33	41
23	12.5	7,375[3]	154	61	44	48	32	38
		1,500	73	25	48	45	55	55
		750	51	24	38	38	35	36
45	14.6	2,792[3]	210	122	27	34	27	43
		750	101	76	33	32	42	42

[1]DBH ≥ 1.0 cm.
[2]DBH ≥ 9.1 cm.
[3]Control: DBH ≥ 1.0 cm.

Thinning to 750 stems/ha slightly decreased volume increment for the first five-year period, but a recovery was evident in the second period. If this trend continues results will be similar to those in the Lake States (Perala 1978). Even a 45-year-old stand responded favorably to heavy thinning by maintaining net volume increment, and the 10-year DBH increment of the 250 largest trees/ha was 50 percent greater in the thinned plots at 4.8 cm compared to 3.2 cm in the unthinned portion of the stand. This suggests that stands in Quebec can maintain their growth potential longer than those in the Lake States (Schlaegel and Ringold 1971). This is consistent with observations that aspen longevity is inversely related to mean annual temperature (Shields and Bockheim 1981).

Much of the present logging is conducted in mature and over-mature stands 60 or more years of age, so that cull and defects represent a large percentage of the total volume. The main incentive of thinning would be to produce large diameters in a shorter time. Commercial thinning would be particularly attractive if logging methods can be adapted. Thinning could be done as soon as it pays for itself and up to about 40 years of age. In mixedwood stands or in aspen stands with a few scattered conifers, there is evidence that thinning could favor the establishment of softwood regeneration.

Managers might be more reluctant to use precommercial thinning as it requires an investment that would not be recovered until much later in the rotation. However, this treatment will likely have a place in the production of large logs while shortening the rotation, increasing browse production, and providing variety of habitat for game and non-game species. Another benefit of thinning is a possible reduction of defect in the harvested crop. The presence of higher amounts of defect in the lower crown class trees has been reported in several studies in Ontario (Kemperman et al. 1976, Kemperman et al. 1978, Weingartner and Basham 1985).

Economic application of precommercial thinning would require the development of markets for material smaller than the minimum pulpwood diameter, development of appropriate harvesting technologies, and favorable cost/benefit analysis of the treatment. A favorable analysis could result not only from immediate financial return or increased timber values in the future, but also, from improvements in wildlife habitat, and other features such as recreational value and aesthetics.

The response of five-year-old sucker regeneration to precommercial thinning is substantial and fairly immediate. Five years following treatment of three stands stem volumes of released trees were 29 percent to 45 percent greater than unreleased trees of the same volume prior to treatment (Weingartner 1987). A similar response to thinning for diameter growth was reported by Bella (1975).

Equipment suitable for harvesting small dimension material has been proposed, and/or developed and tested in various throughout eastern Canada locations. In Ontario, the CFS produced a prototype brush harvester based on the Pallari rotary shear, integrated with a drum chipper (Sutherland 1985). An advantage of the design is the low speed (40 rpm maximum) of the hydraulically driven shear blades, reducing the danger of flying fragments if the implement contacts a rock. Another approach is to use a chipper-forwarder (Stokes and Sirois 1986) in conjunction with a feller buncher. A feller buncher developed in Ontario consisting of two counter rotating saws with an accumulating head achieved production rates close to 850 trees per hour and more than 17 green tonnes per hour in a sycamore plantation in Alabama (Frederick et al. 1986).

Interest in the 'greenhouse effect' or global warming is increasing steadily. The full impact of this warming process on North American forests is unknown, but it may have substantial impact on the aspen resource even during current rotations. If climatological predictions (temperature increase and precipitation decrease) prove correct what effect will it have on aspen production on those sites that are slightly drier than the best sites? Site quality and growth of aspen have been related to moisture availability in numerous studies over the years (Fralish and Loucks 1975, Strothmann 1960, Wilde and Pronin 1949). If slow growth is equated with increased defect these sites may need to be actively managed to produce suitable yields of quality material for industry. One method to achieve this end is by thinning which allows for the redistribution of water and nutrients to the crop trees.

GENETIC IMPROVEMENT

A program of genetic improvement of poplar in Quebec began during the mid-sixties (Comité de recherche en génétique forestière 1971). Aspen has attracted only minimal attention in this program, because other poplars are easier to reproduce vegetatively and their growth rate is usually better. A survey program has been started, mainly in the northern regions, to identify superior clones. These would either be used directly to produce improved seedlings, or as material for the development of hybrids with other native or exotic aspens and other poplars. Potential superior clones are tested for their resistance to Hypoxylon canker. The objective of the program is to develop planting material better adapted to somewhat less fertile sites or to heavy soils such as those of the Clay Belt in northwestern Quebec[3].

MANAGEMENT IN MIXEDWOOD STANDS

Increased use of aspen will mean that the mixedwood stands will have a larger proportion of aspen in the second rotation. This may not be entirely acceptable as softwoods are in great demand. Careful planning will be needed to decide which species is to be favored in each case. Although managers usually prefer pure stands, because they are easier to manage and harvest, they will have to deal more and more with mixedwood stands in the future, and they will have to act accordingly. Many questions on the management of aspen in mixedwood stands will have to be addressed. For example, would it

[3]Gilles Vallée, Service de l'amélioration des arbes, ministére de l'Énergie et des Ressources, Québec. Personal communication.

be practical, for example to cut aspen a few years before the softwood harvest to minimize suckering in areas where conifers are to be favored?

Information on the management of aspen in mixedwood stands is limited; however, articles dealing with extensive and intensive management of mixedwood provide some indication of management options.

In one scenario, aspen is present in spruce-aspen stands at low density after harvest of the merchantable trees. The next rotation is dominated by aspen with understory spruce as advanced regeneration or seedlings from seed trees forming the nucleus of a spruce stand in the following rotation (Schreiner 1959). Berry (1982) reported the results of establishing conifers by direct seeding in a mixedwood stand followed by removal of the aspen canopy, 28 years later, and the resultant mixedwood stand that developed during the next 30 years. The result was a stand of aspen and conifer of similar size.

A reference for intensive management in Sweden describes the gradual reduction of hardwood density via precommercial and commercial thinning in a conifer planted mixedwood. The method applies precommercial and commercial thinning to gradually remove the hardwood component and reduce the spruce component to approximately 2500 stems per hectare during the first 20 years of the rotation resulting in a pure conifer stand (Alriksson 1983).

The feasibility of silvicultural operations in pure aspen and mixedwood stands is dependent upon the continued and increasing market acceptance of aspen, development of appropriate silvicultural systems, and favorable economic cost and benefit of the treatments. The extensive areas covered by aspen in eastern Canada warrant thorough exploration of all the above aspects.

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