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The Occurrence and Growth of Trembling Aspen in Newfoundland

by G. Page

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THE OCCURRENCE AND GROWTH OF TREMBLING ASPEN IN NEWFOUNDLAND

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Résumé en français

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ABSTRACT

In Newfoundland, stands of trembling aspen (*Populus tremuloides* Michx.) are relatively common only in the north-central part of the Island, where the average annual rainfall is less than 50 inches and the mean July temperature exceeds 60 F. Most stands are found on fresh, sandy-loam till sites, where conditions are generally favorable to root sucker development. The average growth rate of aspen stands is excellent, exceeding that of other native species on similar sites by a considerable margin. Basal-area and volume growth is also better than that of most mainland stands beyond an age of about 50 years. Cull volumes are no higher than those of most other native species, and are lower than in comparable aspen stands from other parts of North America. Clonal variations in productivity seem to be present among the stands that were sampled. Trembling aspen is considered to have great potential for commercial utilization in view of the expected increases in the demand for wood on the Island. However, the acreage of aspen stands on suitable forest sites, of which there are estimated to be more than 1 million acres within the most favorable climatic zone, must be increased considerably through such techniques as clear-cutting, prescribed burning, and scarification before commercial operations can become feasible.

RÉSUMÉ

Dans l'île de Terre-Neuve, les peuplements de Tremble (*Populus tremuloides* Michx.) se rencontrent assez communément dans le secteur nord-central où la pluviosité moyenne annuelle est moins de 50 pouces et la température moyenne de juillet excède 60° F. On les trouve surtout sur des tills sableux-limoneux et frais dans lesquels les drageons se développent facilement. Leur taux de croissance moyen est excellent, très supérieur à celui des autres arbres indigènes poussant dans des stations semblables. Il en va de même pour la surface terrière et l'accroissement en volume de la plupart des peuplements quand on les compare avec ceux d'un âge de plus de 50 ans qui croissent sur le continent. Les volumes de mauvais bois ne sont pas supérieurs à ceux de la plupart des autres espèces indigènes; en fait ils sont inférieurs à la moyenne de l'espèce dans des peuplements similaires ailleurs en Amérique du Nord. Par ailleurs, la productivité des clones semble varier. Vu que l'on prévoit une utilisation accrue de bois dans cette île, le Tremble est susceptible de devenir en grande demande. On devra cependant augmenter considérablement la superficie totale dans les stations favorables, superficie estimée à actuellement 1 million d'acres, par la coupe rase, le brûlage dirigé, le scarifiage du sol, avant que puissent être entreprises des opérations commerciales.

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INTRODUCTION

Pulpwood operations on the Island of Newfoundland are geared to softwood species, and most hardwood stands, of both birch (*Betula papyrifera* Marsh.) and trembling aspen (*Populus tremuloides* Michx.), are left uncut during harvesting. The main reasons for this are the limited and somewhat localized occurrence of hardwood stands, in particular trembling aspen, and the present adequate supplies of softwoods.

An expansion of the Island's wood-using industries is planned, however, for the near future, and it is estimated that by the year 2000 the demand for wood in Newfoundland will exceed the total annual growth on all productive forest sites of the Island (Anon., 1970). Recent observations suggest that aspen may be more productive than any other species native to Newfoundland, that aspen cull volumes may be lower in Newfoundland than elsewhere in Canada, and that the presence of aspen may improve site fertility. Trembling aspen might thus in future assume a role in Newfoundland forestry far more important that its present occurrence and utilization may suggest.

Data from a series of aspen sample plots measured in 1971 have been combined in this paper with additional information collected during the preparation of the Newfoundland Forest Inventory and during a number of other related Canadian Forestry Service studies to form an account of the occurrence, growth, and yield of trembling aspen stands in Newfoundland and to permit a preliminary evaluation of the potential of the species on the Island.

STUDY METHODS

In 1971, 94 sample plots of 1/10 acre each were measured in fully stocked, even-aged trembling aspen stands in the north-central part of Newfoundland from Clarenville in the east to Deer Lake in the west. Stands were selected to obtain a representative sample by age class and geographical location; there was no selection for "best" stands on the basis of tree growth or site conditions. All stands sampled were between 19 and 116 years of age at breast height and between 26 and 98 feet dominant height, and consisted of more than 75% aspen by basal area.

On each sample plot all stems were tallied by species and 1-inch breast height diameter classes, and the heights, breast height ages, and exact breast height diameters of four dominant stems were recorded. Pertinent site data collected for each plot included elevation, aspect, topographic position, surficial geology, soil type, soil moisture regime, profile drainage class, depth of surface humus accumulation, and the texture of the upper mineral soil.

For each plot, tally data were used to calculate average breast height diameter and total basal area; plot dominant height and breast height age were determined by averaging values from the four dominant stems; plot

total and merchantable (6-inch stump to 3-inch top diameter inside bark) cubic foot volumes were calculated from Newfoundland volume tables (Page et al., 1971). Curves showing height/age, height/diameter, number of stems, basal area, total volume, merchantable volume, and mean annual increment trends were then constructed.

Information on the distribution of aspen in Newfoundland was obtained from the randomly distributed ground-check plots of the Newfoundland Forest Inventory. Aspen stems tallied were summed by plots and map sheets to produce a map showing the occurrence of the species.

Cull and decay data were obtained from 19 aspen trees sampled during the Newfoundland cull survey[1] and from an additional 57 trees in two 1/20-acre plots measured in a current Canadian Forestry Service study.[2]

Data for 86 typical white birch plots were also collected during 1971 for use in comparison with the aspen plots; sampling methods were the same as for aspen. Comparative softwood growth figures, for balsam fir (*Abies balsamea* (L.) Mill.) and black spruce (*Picea mariana* (Mill.) B.S.P.), were obtained from data presented by Bajzak (1962),[3] Bajzak, Bouzane, and Page (1968), and Page (1970) for the four most productive softwood forest types of western and central Newfoundland as described by Damman (1964, 1967). These forest types occur on sites similar to those on which aspen is found. Appropriate curves for softwood height, basal area, and volume growth were obtained from reports by van Nostrand (1964) and Page (1968).

RESULTS

Occurrence of Aspen in Newfoundland

Scattered individual aspen stems or small groups of stems can be found in most parts of the Island of Newfoundland. No exact figures of the total acreage of forest land occupied by this species are available, but it is known that the total is small in comparison with that for spruce, fir, and birch. Only in the north-central part of the Island is the species of relatively frequent occurrence (Figure 1), and, with very few exceptions, it is only within this area that pure aspen stands (i.e. those of more than 75% aspen by basal area) of from ½ acre to perhaps 4 or 5 acres can be found.

The marked concentration of aspen in the north-central area, mainly within Forest Section B28a (Rowe, 1959), seems to be associated with certain

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[1]Hudak, J., J.P. Meades, and K.S. Richardson. 1971. Cull survey of the forests of Newfoundland. Can. Dep. Fish. Forest., Can. Forest. Serv. Intern. Rep. N-42. 52 p. and appendices.

[2]K.S. Richardson, personal communication.

[3]Bajzak, D. 1962. A study of the mensurational characteristics of some forest types of central Newfoundland. Can. Dep. Forest., Forest. Br. Mimeogr. Nfld. 62-2. 91 p.

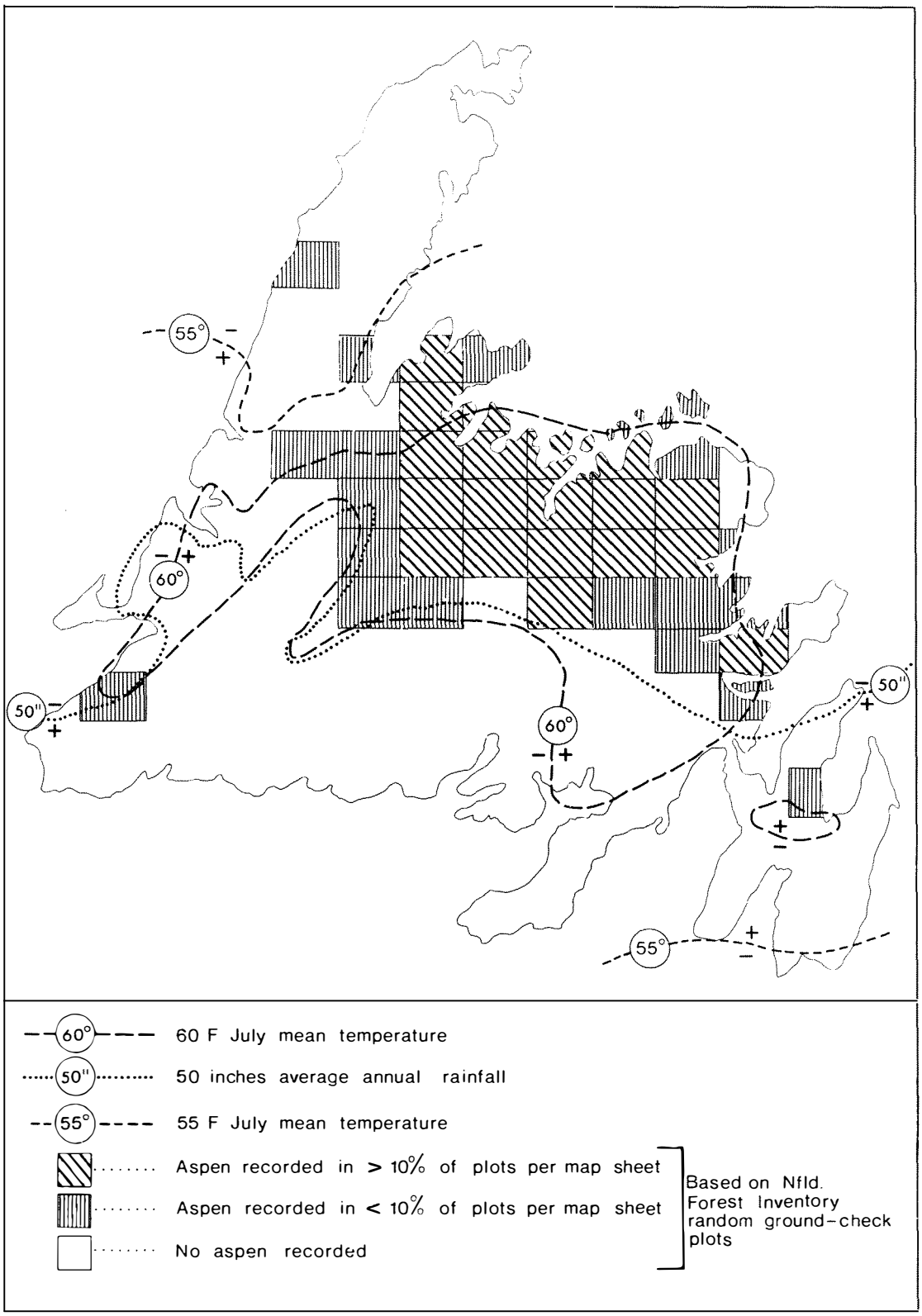

Figure 1. Distribution of aspen stands in Newfoundland.

moisture and temperature regimes. The main aspen zone is almost entirely within the 60 F mean July isotherm (Figure 1) and in areas having an annual precipitation of less than 50 inches (Hare, 1952). Aspen is virtually absent from the southern half of the Island, where annual precipitation exceeds 50 inches, and from the Great Northern Peninsula, where the mean July temperature is below 55 F.

Suckering is the main means of regeneration for trembling aspen throughout its natural range, and all young stands that were examined in Newfoundland were found to be of sucker origin (Figure 2). Direct evidence could not be obtained for older stands, but it is assumed that they also originated in this way. Maini (1968) has quoted results from several studies showing that soil temperature and aeration are major factors controlling root sucker formation: temperatures below 60 F and saturated soil are said to inhibit sucker formation. It seems probable that effects of this nature are the main factors limiting the spread of trembling aspen in Newfoundland and

Figure 2. Trembling aspen stand on fresh till site on Northwest Gander River watershed, central Newfoundland. Note aspen sucker growth among softwood slash in foreground and typically dense mature stand (about 75 feet high at 90 years) in background.

that they are the reason why this species is found mainly in that part of the Island where summer temperatures are above 60 F, rainfall is below 50 inches, and surface humus accumulation is minimal. The sandy-loam soils and the fairly frequent occurrence of forest fires (the latter being a result of the climate) also favor the spread of aspen in the north-central area.

The types of sites on which aspen stands have been recorded on the Island (Figure 3) reinforce this evidence. With very few exceptions, aspen stands were observed only where soil conditions appeared generally favorable to root sucker development and rapid early height growth of the stems. Stands were most common on freely drained, fresh, sandy-loam podzols developed in glacial till, at upper and middle slope positions and elevations of less than 600 feet. All but one of the sample plots had surface organic mantles less than 4 inches thick, but this was probably at least as much an effect as a cause of the presence of the aspen; Page (in press) has reported lesser accumulations of organic matter together with more favorable moisture and nutrient relations beneath hardwood stands than under softwood stands on most productive Newfoundland forest sites. No strong relation with aspect, such as that reported by Gregory and Haack (1965) for Alaska, was evident. There was, however, a complete absence of aspen sample plots on slopes exceeding 15% within a 110-degree arc centered on the northeast, the coldest aspect. Of the sample plots having other aspects nearly one-quarter (15 plots) were on slopes exceeding 15%. In general, the edaphic and topographic conditions of typical aspen sites in Newfoundland are very similar to those reported by Maini (1968) for the Prairie Provinces and other parts of Canada.

Growth of Aspen Stands in Newfoundland

The average height growth of the 94 aspen stands sampled is rapid (Table 1): a mean height of 55 feet is reached at a breast height age of 50 years (about 54 years total age) and a mean height of 76 feet at a breast height age of 90 years (94 years total age). Aspen stands exceed the height of comparable birch and softwood stands by an average of 8 and 12 feet respectively at 50 years, and by 14 and 23 feet at 90 years (Figure 4). Height/diameter ratios are also greater for aspen than for other species at all stages of development.

Fully stocked aspen stands typically carry a high basal area, surpassing an average of 100 square feet per acre in 30 years and reaching almost 280 square feet per acre in 90 years (Table 1). Average basal areas of comparable birch and softwood stands are at least 40 square feet per acre less than those of the aspen at all ages from 40 onwards (Figure 5). The high basal-area figures are a result of the moderately high average diameter of the aspen stems combined with the relatively high number of stems per acre (Table 1; Figures 2, 8, and 9), which, while not as high as in typical Newfoundland softwood stands (Page, 1970), are much higher than those of average birch stands.

The volume growth of the aspen stands is exceptionally good. The average total volume reaches 3,750 cubic feet per acre at 50 years and 8,200 cubic feet per acre at 90 years (Table 1). Merchantable volume reaches

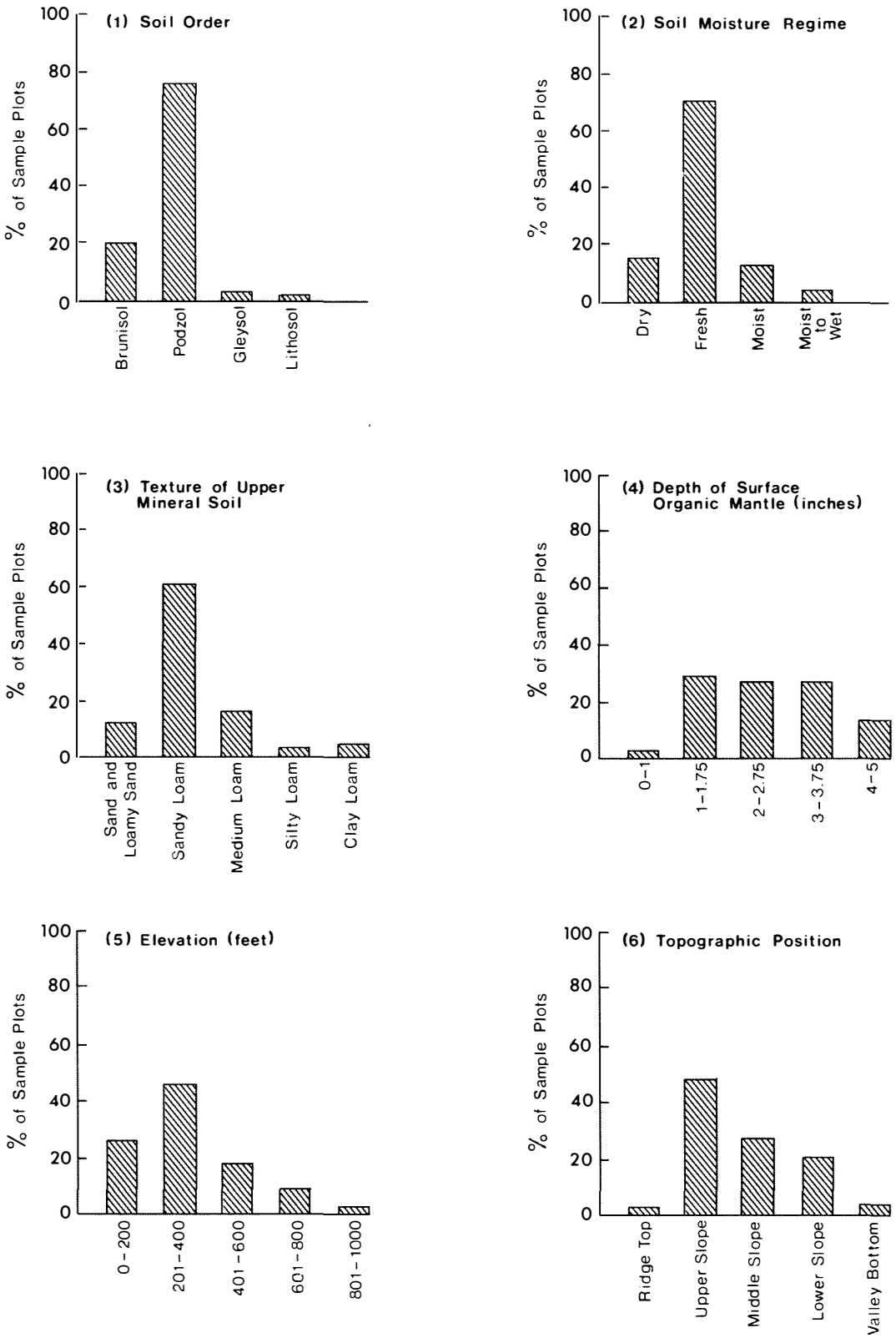

Figure 3. Occurrence of aspen stands in relation to major site characteristics.

TABLE 1. EMPIRICAL GROWTH DATA FOR NEWFOUNDLAND ASPEN STANDS (AVERAGE OF 94 PLOTS)

Breast height age (years)	Dominant height (ft)	Total number stems/ acre	Number merchantable stems/ acre	Average dbh merchantable stems (inches)	Total basal area (ft^2 acre)	Total volume (ft^3 acre)[a]	Gross merchantable volume (ft^3 acre)[b]	Mean annual merchantable volume increment (ft^3/acre/year)
20	30	3,120	230	4.0	70	750	200	7.5
30	40	2,260	440	4.8	106	1,500	900	27.0
40	48	1,550	620	5.6	142	2,500	1,900	43.5
50	55	1,170	760	6.4	178	3,750	3,150	57.0
60	61	1,050	810	7.2	214	5,000	4,400	68.0
70	67	990	780	8.0	244	6,200	5,600	75.5
80	72	860	680	8.8	265	7,300	6,700	80.0
90	76	700	550	9.6	279	8,200	7,700	81.5

[a]Total main-stem volume plus volume of 4-foot branch sections to minimum diameter inside bark of 3 inches.

[b]Main-stem volume to 6-inch stump and 3-inch top diameter inside bark, plus branch section volumes as for total volume.

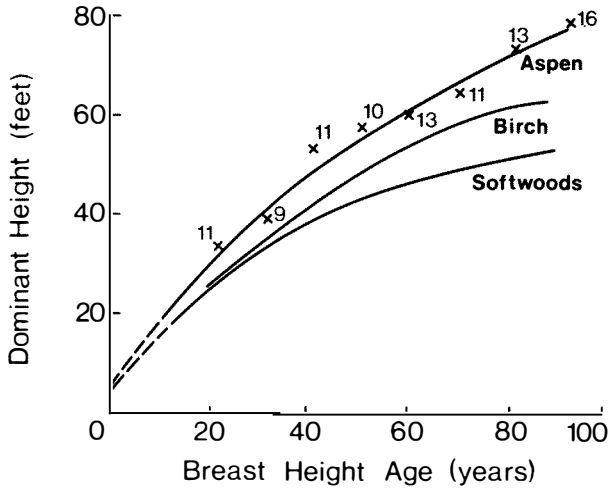

Figure 4. Height/age curves for aspen, birch, and softwood stands.

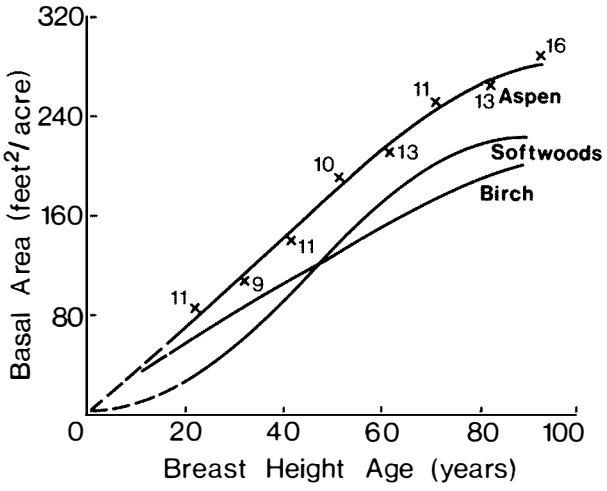

Figure 5. Basal area/age curves for aspen, birch, and softwood stands.

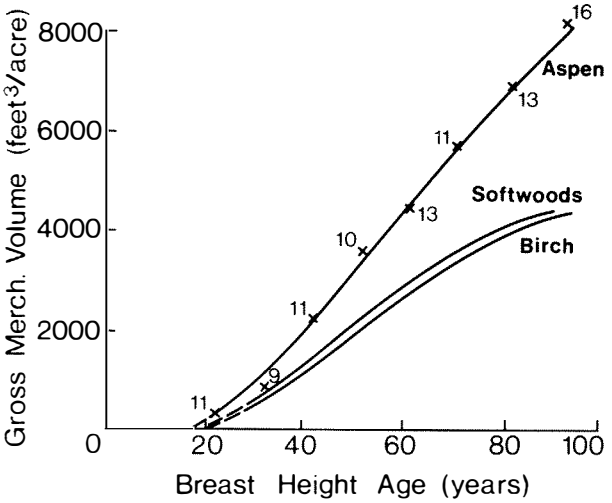

Figure 6. Gross merchantable volume/age curves for aspen, birch, and softwood stands.

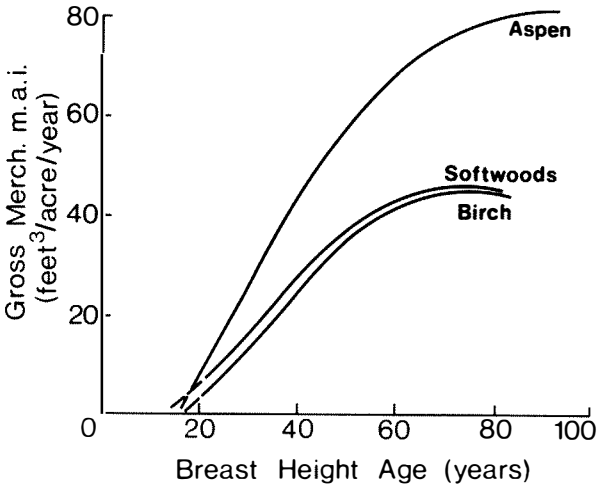

Figure 7. Mean annual merchantable volume increment curves for aspen, birch, and softwood stands.

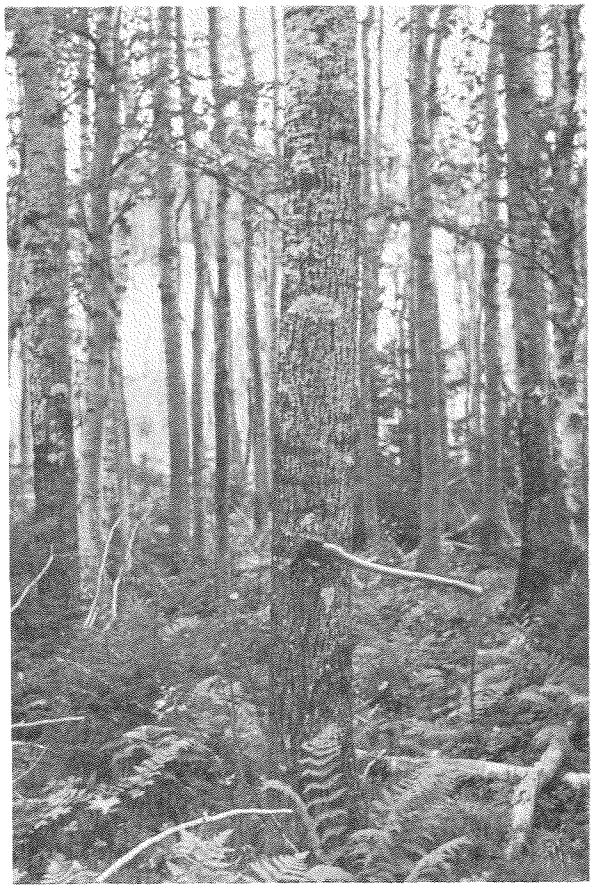

Figure 8

Figure 9

Figures 8 and 9. Interior views of two average aspen stands growing on brunisolic soils near Red Indian Lake, central Newfoundland. Heights are 50 to 60 feet at about 60 years of age.

3,150 cubic feet (37 cords[4]) per acre at 50 years and 7,700 cubic feet (91 cords) per acre at 90 years. Comparable birch and softwood stands produce only about 4,200 merchantable cubic feet (49 cords) per acre at 90 years (Figure 6).

Mean annual merchantable-volume increment culminates in aspen stands at 82 cubic feet (or almost 1 cord) per acre per year at a breast height age of about 95 years (Figure 7). In comparable birch and softwood stands increment reaches about 46 cubic feet per acre per year at 75 years of age. The late culmination of mean annual increment in Newfoundland aspen stands is a surprising feature for a species that elsewhere has a reputation for rapid early growth and relatively early culmination of volume increment (Jarvis, 1968). The continued rapid growth of the Newfoundland stands is, however,

[4]1 cord = 85 cubic feet.

apparent up to at least 90 years of age in terms of height, diameter, basal area, and gross volume, as well as mean annual increment.

Most of the aspen stands sampled diverge little from the average growth curves presented in Figures 4 to 7. For example, 56% of all stands measured are within ±10%, and 87% within ±20%, of the average height/age curve. The reason for this is believed to be the great similarity of the sites on which most of the stands are growing. There are, nevertheless, a number of stands with growth rates both much above and much below the overall average.

Less favorable climatic conditions near the eastern and western extremes of the main aspen distribution zone (Figure 1) are probably the reason for the below-average height growth observed on 86% of all sample plots in these two areas. Similarly, insufficient moisture is probably the main reason for the below-average growth observed on 70% of all plots on dry sites, and excess moisture probably accounts for the poor growth on 79% of all plots on moist and moist-to-wet sites.

There are, in addition, a number of stands with divergent growth rates that do not appear to be related to unfavorable site or climatic conditions. These stands, which occur on typical aspen sites within the main distribution zone, may differ from average stands as a result of genetic variation. Data for five of the most exceptional stands, all of which appear to be composed of genetically superior clones, are presented in Table 2.

TABLE 2. GROWTH FIGURES FOR FIVE EXCEPTIONAL STANDS

Plot no.	Location	Breast height age (years)	Dominant height (ft)	Site index (height in feet at breast height age 50)[a]	Average dbh of merchantable stems (inches)	Total basal area (ft^2/acre)	Merchantable volume (ft^3/acre)
71-73	Bishop's Falls	43	61	67	7.3	169	3,760 (44 cords)
71-64	Jumpers Brook	53	75	72	6.9	245	5,211 (61 cords)
71-94	Exploits River	78	82	64	8.6	302	8,008 (94 cords)
71-49	Northwest Gander River	94	80	57	10.2	345	9,918 (117 cords)
71-159	Sheffield Lake	108	98	67	11.1	428	12,345 (145 cords)

[a]Based on curves harmonized with average height/age curve presented in Figure 4.

Comparisons of Growth in Newfoundland and Mainland North America

Growth figures for average aspen stands in Newfoundland, northern Ontario (data for Site Class II stands of Plonski (1956)), Saskatchewan (Site Class II stands of Kirby, Bailey, and Gilmour (1957)), and interior Alaska (Site-Index Class 55 stands from Gregory and Haack (1965)) are presented in Table 3.

The height growth of average Newfoundland stands is a little slower than that of Saskatchewan and Alaskan stands and considerably slower than that of Ontario stands. The number of stems per acre is higher in Newfoundland stands than in any others, except Alaskan of less than 40 years of age. The large numbers of stems in Newfoundland stands more than 60

TABLE 3. GROWTH DATA FOR AVERAGE ASPEN STANDS IN NEWFOUNDLAND, ONTARIO,[a] SASKATCHEWAN,[b] AND ALASKAc

Area	Age	Dominant height (ft)	Number of trees per acre	Total basal area (ft^2/acre)	Merchantable volume (ft^3/acre)
	20[d]	25	3,540	55	0
N	40[d]	45	1,800	127	1,500
F	60[d]	59	1,080	199	3,870
L	80[d]	69	920	258	6,280
D	100[d]	78	590	286	8,180
O					
N	20	31	1,236	63	159
T	40	55	667	110	2,150
A	60	72	412	136	3,962
R	80	81	280	147	4,761
I	100	84	225	149	4,915
O					
	20	27	2,687	53	0
S	40	46	1,515	100	511[e]
A	60	61	646	120	2,256[e]
S	80	73	369	130	3,109[e]
K	100	81	252	137	3,451[e]
A					
L	20	28	5,840	81	0[f]
A	40	48	1,927	111	558[f]
S	60	61	951	133	2,002[f]
K	80	71[g]	565[g]	148[g]	3,447[g]
A	100				

[a] Data from Plonski (1956).
[b] Data from Kirby et al. (1957).
[c] Data from Gregory and Haack (1965).
[d] Breast height age plus 4 years.
[e] Trees of 6-inch dbh class and over.
[f] Trees of 5-inch dbh class and over.
[g] No data.

years of age are an especially noticeable feature. Despite these larger numbers, the diameter growth of Newfoundland stands is similar to that of Saskatchewan stands.

The basal-area growth of Newfoundland stands after about 40 years of age is much more rapid than that of those situated elsewhere; the average basal area of 90- to 100-year-old Newfoundland stands is about twice that found in other parts of North America. Similarly, the average stand volumes in Newfoundland exceed those in other areas from an age of 50 or 60 years onwards. The mean annual merchantable-volume increment of stands culminates at 66 cubic feet per acre at an age of about 60 years in Ontario, and at 40 cubic feet per acre at an age of about 75 years in Saskatchewan. In Newfoundland and Alaska, however, volume increment does not culminate until about 95 years of age, at 82 and 46 cubic feet per acre respectively.

Cull and Decay Factors

The available cull data for Newfoundland aspen are presented in Table 4. The overall average cull volume in aspen was calculated as 8.7% of gross merchantable volume at an average breast height age of 64 years. Of this total some 8.1% was due to decay and 0.6% to form defects. These figures compare with cull factors of 11.8% for balsam fir, 5.7% for black and white spruce, and 15.1% for white birch (Hudak, Meades, and Richardson, 1971: see footnote 1). It thus seems that, in general, aspen stands are no more defective than stands of the other major species of the Island.

Cull volumes in Newfoundland aspen appear to be less than those reported for comparable stands in other parts of North America. For example, 70-year-old stands are reported to have 12% cull in Ontario (Basham and Morawski, 1964), 14% in Saskatchewan (Kirby et al., 1957), 16% in Manitoba (Peacock, unpublished data quoted by Jarvis, 1968), and 20.5% in Minnesota (Schmitz and Jackson, 1927). In contrast, Gregory and Haack (1965) state that aspen stands seem to remain free of serious decay in Alaska longer than in more southerly regions.

TABLE 4. CULL AND DECAY DATA FOR NEWFOUNDLAND ASPEN

Plot	Breast height age	Dominant height (ft)	Number of trees	Gross merchantable volume (ft^3)	Cull volume (ft^3)		
					Decay	Form defects	Total
1[a]	64	51	40	121.6	15.5 (12.7%)	2.1 (1.8%)	17.6 (14.5%)
2[a]	77	59	17	131.3	2.3 (1.7%)	-	2.3 (1.7%)
Cull survey[b]	53	-	19	108.3	11.4 (10.6%)	-	11.4 (10.6%)
All data	64	-	76	361.2	29.2 (8.1%)	2.1 (0.6%)	31.3 (8.7%)

[a] See footnote 2.
[b] Trees from various locations. See footnote 1.

CONCLUSIONS

(1) The somewhat unusual distribution of trembling aspen stands in Newfoundland seems to be a result of strong climatic and edaphic controls on the process of root suckering, which is the principal method of regeneration for the species. Most aspen stands are found in areas where the average annual rainfall is less than 50 inches and the mean July temperature is above 60 F, and on fresh, sandy-loam sites at moderate to low elevations.

(2) The growth of aspen stands in Newfoundland is very good, especially in terms of basal area and volume. Average aspen stands are faster-growing and much more productive than comparable birch and softwood stands. Average Newfoundland stands are roughly equivalent in growth to the average on the mainland up to an age of about 50 years; beyond this age they mostly seem to be more productive.

(3) The incidence of cull and decay in stands appears to be no higher in 60- to 70-year-old aspen than in most other species on the Island and is generally lower than in aspen of the same age situated elsewhere.

(4) There is evidence of clonal differences in productivity among the aspen stands of the Island. Several of the most productive stands may be composed of genetically superior clones.

(5) The excellent growth observed suggests that trembling aspen has considerable commercial potential in Newfoundland. It seems that yields of moderate and good mineral soil sites might be markedly increased by encouraging the development of aspen stands. It will be necessary, however, to increase considerably the acreage under aspen before actual commercial utilization can become feasible. Estimates indicate that in the central part of the Island there are at least 1 million acres of productive or potentially productive sites[5] that could support vigorous aspen stands. All methods of encouraging aspen suckering involve treatment to remove the existing tree canopy and reduce or disturb the ground vegetation, the surface organic layers, and the upper mineral soil, so as to allow more light and warmth to reach the forest floor. Clear-cutting, controlled burning, and scarification have all been found effective for this purpose in other parts of Canada (e.g. Horton and Hopkins, 1965; Maini and Horton, 1966) and could probably be used with equal effectiveness in Newfoundland.

(6) Two important questions remain to be answered. Firstly, information is needed on the progress of decay in older stands, so that the most suitable commercial rotation can be determined. Secondly, the significance of clonal variation needs to be examined to determine whether genetically superior clones exist and are worth favoring by planting or other appropriate techniques. The performance of aspen clones and other

[5]All sites of Canada Land Inventory Capability Classes 2, 3, and 4, in which excess moisture is not the most important limiting factor (K. Beanlands, personal communication).

poplar species and hybrids from outside Newfoundland should also be evaluated alongside that of the native aspen (Zufa, 1970[6]). Studies to answer both these questions are either under way or planned for the near future.

ACKNOWLEDGMENTS

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