TRENDS IN ONTARIO'S FOREST NURSERIES

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ORGANIZATION AND PRODUCTION

Before proceeding into the theme of the meeting, let me first give a quick sketch of the Ontario nurseries.

There are ten bare root nurseries, seven of which are large-producing 5-18 million per year, and three small which produce 1.0-2.0 million per year (Figure 1). We have six container nurseries, each producing 60 thousand to 4.0 million annually. Administratively, there are 49 districts, 8 Regions and a Head Office. The large nurseries are administered from the Region, the container units are attached to nurseries or Districts Co-ordination and some technical direction is provided from Head Office.

For the past few seasons, the annual bare root seeding target for reforestation purposes for the province has ranged from 70 to 80 million and for containers 7-9 million annually. For reforestation use, bare root, 26 species are grown with 90% of the volume in 5 conifer species - white spruce, black spruce, red pine, jack pine and white pine. For containers, most production is concentrated in the north in jack pine, white and black spruce.

The most radical shift in bare root production was a recent move back to transplanting for spruce in the northern nurseries. Transplants now account for 35% of the total production, up from less than 10% some five years ago.

Approximately one-quarter of the production is sold to private land owners. A sliding scale of prices results in the first 50 trees costing $5.00 and a 1000 or more costing $10 per thousand. This will shortly be revised to more closely reflect actual production costs.

Ontario spends $3.5 million operating its nurseries and $8.0 million planting the seedlings. This high cost regeneration technique is being closely scrutinized, particularly as the costs of such labour intensive methods are escalating so rapidly. This is one of the primary reasons for using containers and for developing greenhousing to replace the open field seedbed system for some

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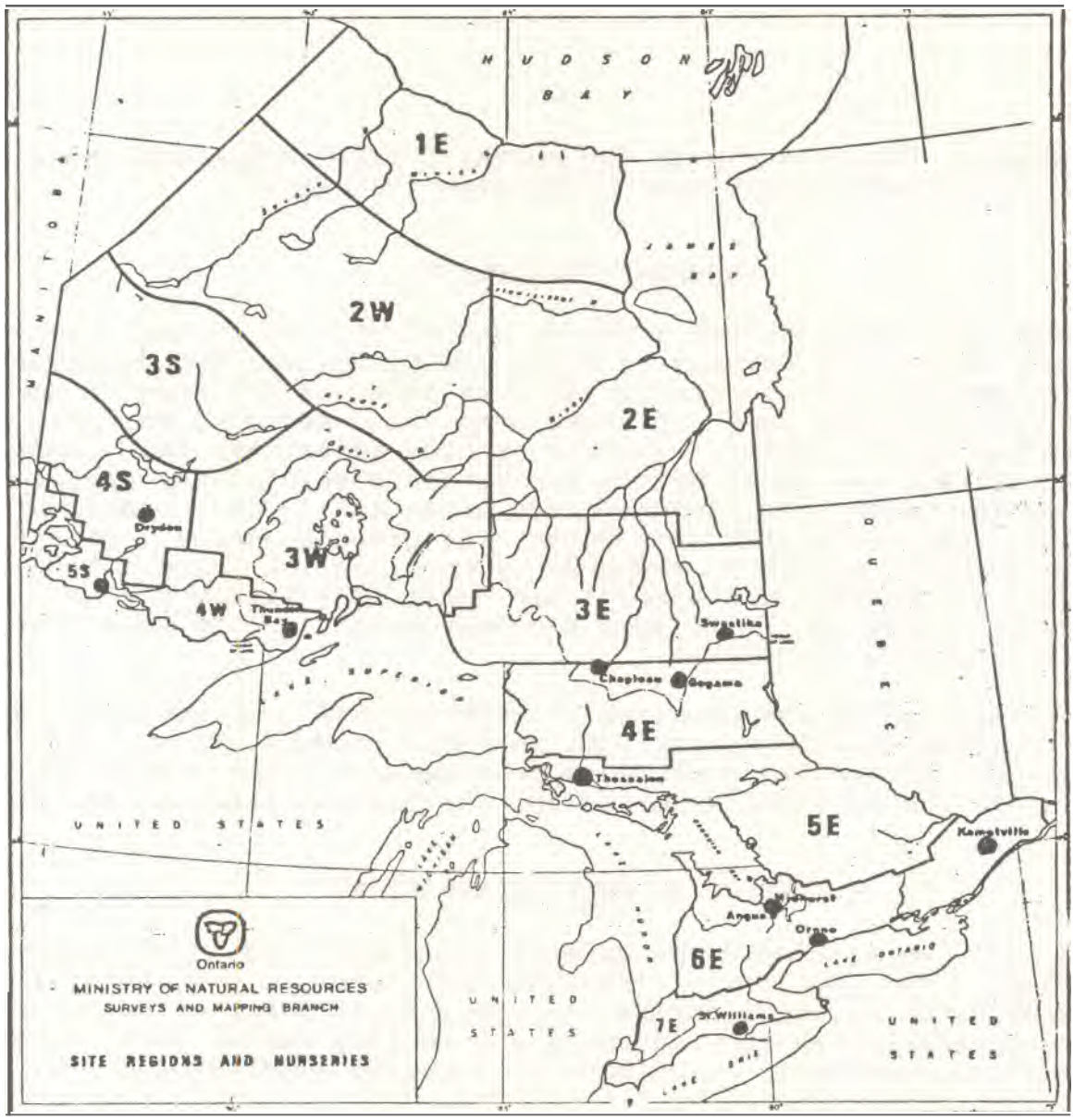
Figure 1



1975-76 Seeding Targets

Centre	STR		WLF	**OLA**
	Bare Root	Container*		
Dryden	8,119,000	-	-	-
Fort Frances	-	600,000	-	-
Thunder Bay	14,060,000	1,000,000	-	1,400
Chapleau	2,055,000	-	-	-
Gogama	1,500,000	1,200,000	-	-
Swastika	18,748,000	4,000,000	-	5,500
Thessalon	1,245,000	1,500,000	-	-
Kemptville	10,241,000	60,000	30,000	16,000
Orono	8,381,000	-	57,600	39,200
Midhurst	11,017,000	-	109,100	71,700
St. Williams	7,817,000	-	611,000	67,100
Total	83,183,000	8,360,000	807,700	200,900

* Planned Production. Fort Frances will not seed until 1976-77

species. Particularly in the north, initial steps are being taken to change some traditional production techniques.

NURSERY MANAGEMENT

Since 1959, we have had a fairly uniform system of soil management, influenced largely by Wilde and by Britain and directed by Ken Armson. Organic matter has been added in the form of decomposed peat or black muck and green crops are used only for soil protection during fallow. Sulphur or lime adjust the pH. Chemical fertilizers are added before sowing and several times during the growing season. No fumigants are used, but a small number of herbicides are relied upon during the growing season. Each fall the season's growth is assessed by sampling the trees. Each spring prior to seeding soil samples are taken from fallow fields. These results guide the fertilizer recommendations and to some degree the intensity of culture.

This soil and plant sampling program of bare root and containers is co-ordinated by a full time forester in Main Office. The annual cost of the lab analyses approximates $32,000 and is done by the Glendon Hall Soils Lab of the Faculty of Forestry, Toronto.

TRENDS IN ONTARIO NURSERIES

In 1974, we published the updated version of the 1961 Nursery Soil Manual. This new manual included the trends in soil fertility and seedling development during the previous 15 years of management and reestablished the standards and working ranges for the various physical parameters being used to describe seedling quality.

In general, soil fertility levels have increased.. Organic matter levels have increased except at Midhurst where due to the relatively high cost of peat, only small quantities have been used. At most nurseries yet peat applications are a general practice and only in a few fields have the organic carbon levels fallen within the working range. Some sulphur is still used if the pH rises above 6.0, particularly for red pine land. Once the optimum pH range is established, acid peat and acid forms of fertilizer can usually maintain the desired level. In a few cases, these acid amendments were modified as pH began to drop below 5.0 and the sulphate nitrogen was replaced by the nitrate form and 20% phosphate replaced the 45% triple superphosphate. In extreme cases dolomitic lime is applied to those fields where the pH is below 5.0 (except for white spruce land where 5.5 is the minimum).

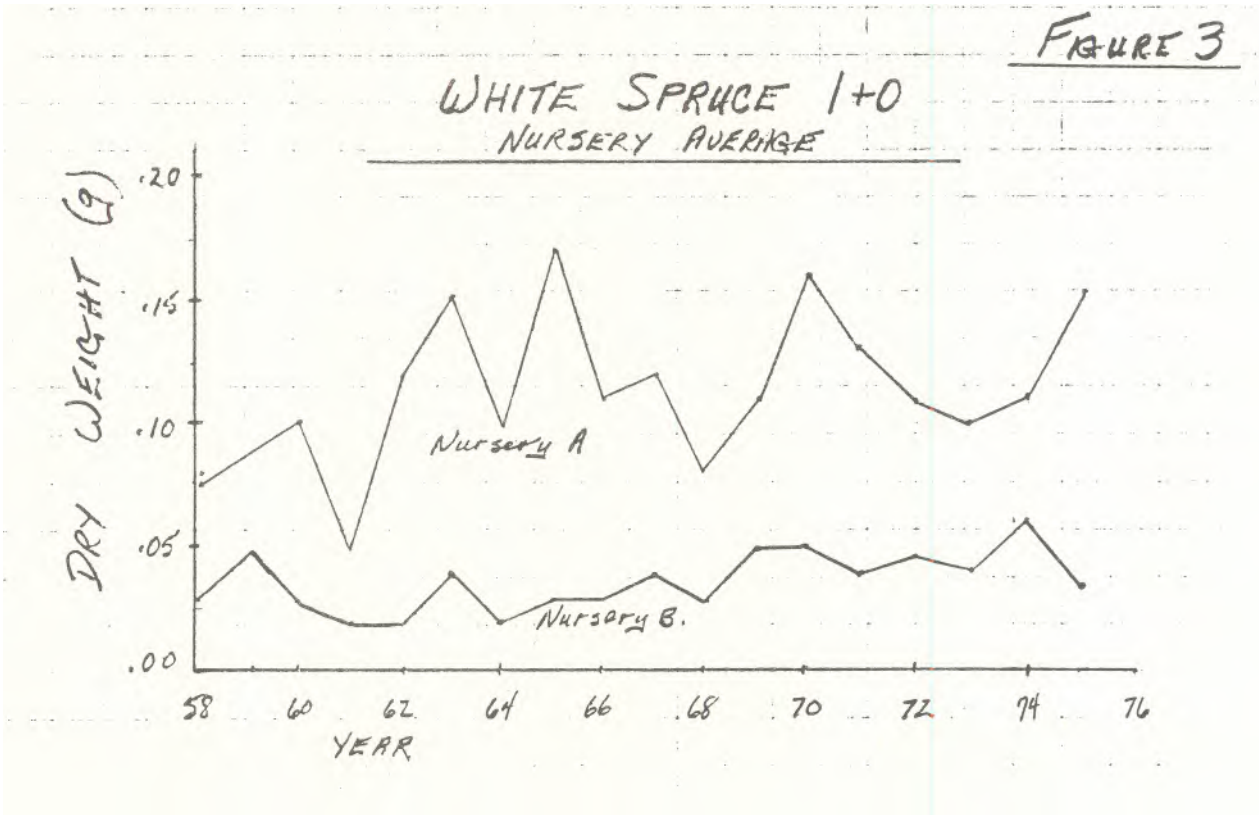
While phosphorus levels have increased and in a few cases are


FIGURE 2
RED PINE 3+0
PROVINCIAL AVERAGE
DRY WEIGHT (g)
10
9
8
7
6
5
4
3
59
61
63
65
67
69
71
73
75
R.A.I. (cm²)
60
40
20
0
SHOOT/ROOT RATIO
6
5
4
3
YEAR

within the working range, some phosphorus is applied to all land being prepared for seeding or transplanting. Potassium levels seem related to soil pH,with problems developing in the more acid soils. Applications of potassium sulphate are made in the land preparation stage and if required as top dressings. In the later stages of the crop rotation,white spruce in particular usually requires these potassium top-dressings. Calcium levels are supplemented at most nurseries with dolomitic limestone, again white spruce being particularly critical. Almost all white spruce land receives magnesium sulphate and at some nurseries, this is a general recommendation for any species.

Plant growth has responded to this soil amendment program, with seedling weights almost doubling since 1959, except for white pine where the increase has been somewhat less.

These trends are illustrated for red pine 3+0 in Figure 2. This increased growth has not been without its problems. Many traditional rotations, particularly in the southern nurseries, are no longer possible. Red pine 2+2, norway spruce 2+2 and some white spruce 2+2 are no longer produced because of the difficulty in planting this very large stock. At two nurseries, red pine 3+0 has approached 15-20 grams in dry weight in the last two years and this approximates the size of the discontinued 2+2 stock. While the 3+0 rotation will not be adjusted, attempts must now be made to hold growth back to approximately 8 grams in order to keep a respectable shoot/root ratio.



Other conclusions were apparent as the 15 year data was tabulated. Although the provincial average weight had increased, some nurseries had not responded to the same degree as others. Figure 3 illustrates this difference for 1+0 white spruce. Considerable differences occur in the size of stock from year to year as can be seen from Figure 2 for shipping stock and in Figure 3 for 1+0 stock. There is an overlap in the size of stock from one age-class to another (Table 1), so that reference to age-class can only conger some vague representation of a product to be produced or planted. The data in this Table 1 is an average of nine years production so that the extremes in size are masked.

Table 1. Size ranges by age-class for black spruce

Age Class	Nursery	Weight	Diam	Height cm	Root Area Index cm^2
2-2	KN	12.9	-	-	-
	MI	8.4	5.0	22	70
	SW	12.9	6.2	34	-
	TB	11.5	5.6	30	94
	DR	8.9	5.1	31	62
3-0	KN	5.8	3.3	30	66
	MI	4.5	2.7	32	38
	SW	4.9	4.4	28	45
	TB	2.6	2.6	24	21
	DR	3.5	2.8	30	36
1-2	KN	10.8	8.0	38	96
	SW	6.4	4.5	25	45
	DR	7.2	4.8	25	-

Source
Sadreika, 1973. Averages for nine years of production (1964-1972).

SPECIFICATIONS FOR PLANTING STOCK

The question to be asked is - What size of stock should we grow? What dimensions should be ascribed to the parameters we are currently using? We felt it important to answer this question because first, we should quantify or put dimensions on some of

the factors we deal with in the growing of trees. It has not been impossible in other husbandry sciences. This description of stock provides an objective for the nurseryman and tells the customer what he will receive. We often have two nurseries supplying trees to the same district. Often one of these nurseries is 200 miles or more distant and some standardization in production is necessary to help bridge the communication gap. In Ontario we deal with a wide range of sites, from agricultural fields to new cut overs and no one grade of stock will satisfy all these sites. We also are developing a wide range of new products from greenhouses for which some common base for comparison is required.

Table 2: General specifications for planting products in Ontario.

	Planting stock grade		
	Heavy	Medium	Small[2]
Bare root stock			
Total dry weight (g)	10.0	5.0	1.5
R.A.I. (cm^2)[1]	50.0	30.0	15.0
Stem diameter (mm)	5.5	4.0	2.5
Shoot height (cm)	22	22	15
Shoot/root ratio	2.5	3.5	2.5
Containerized stock			
Total dry weight (g)		0.70	0.35
Stem diameter (mm)		1.5	0.75
Shoot height (cm)		15.0	7.5

[1] Root area index (cf. Armson & Sadreika 1974)

[2] 2+0 Black & White spruce bare root.

This situation brought about the establishment of three grades of stock - Heavy for the difficult, weedy areas, Medium for the average situation and Small for the easiest planting. Table 2 indicates the physical dimensions for these three grades, encompassing all species. The dimensions were determined partly on

Table 3: Production rotations for planting products in Ontario.

	Planting stock grade		
	Heavy	Medium	Small
Bare root stock			
Jack pine		2+0	1+0
Red pine		3+0	2+0
White pine (north)	2+2	2+2	
(south)	2+2/1+2	3+0	
Black spruce	1½ +1½	3+0	2+0
White spruce (north)	2+2	[illegible]	
(south)	1½ +1½	3+0	2+0
Containerized stock		(Type I container)	(Type II [2] container)
Jack pine		15-20 weeks (current) [3]	8-10 weeks (current)
Black spruce		30-34 weeks (overwintered)	16-18 wks (current)
White spruce		26-30 weeks (overwintered)	14-16 weeks (current)

[1] Type I container equivalent to size 408 paperpot or Ferdinand Rootrainer.

[2] Type II container equivalent to size 308 paperpot or 3/4 in (2 cm) plastic tube.

[3] Planted in same year as produced.

what was currently being produced by most nurseries and partly of what planters felt was too large or too small. Within these broad limits, some species have minor deviations. In some cases, a nursery will have to adjust its cultural practices to produce stock that conforms to the specifications. Clearly the bare root specifications are more reliably based than those for container stock; however it is presently felt that 350 mg dry weight seedlings might have an impact equivalent to Small grade stock and 700 mg to Medium grade. No containers currently produced are equivalent to Heavy grade. As feedback from the planting crews develops, some modifications will no doubt have to be made. The specifications listed here are for physical parameters only; ultimately we would want to indicate the physiological requirement of a seedling also, but this is still a remote objective. Impedance meters, and pressure bombs are two tools being developed.

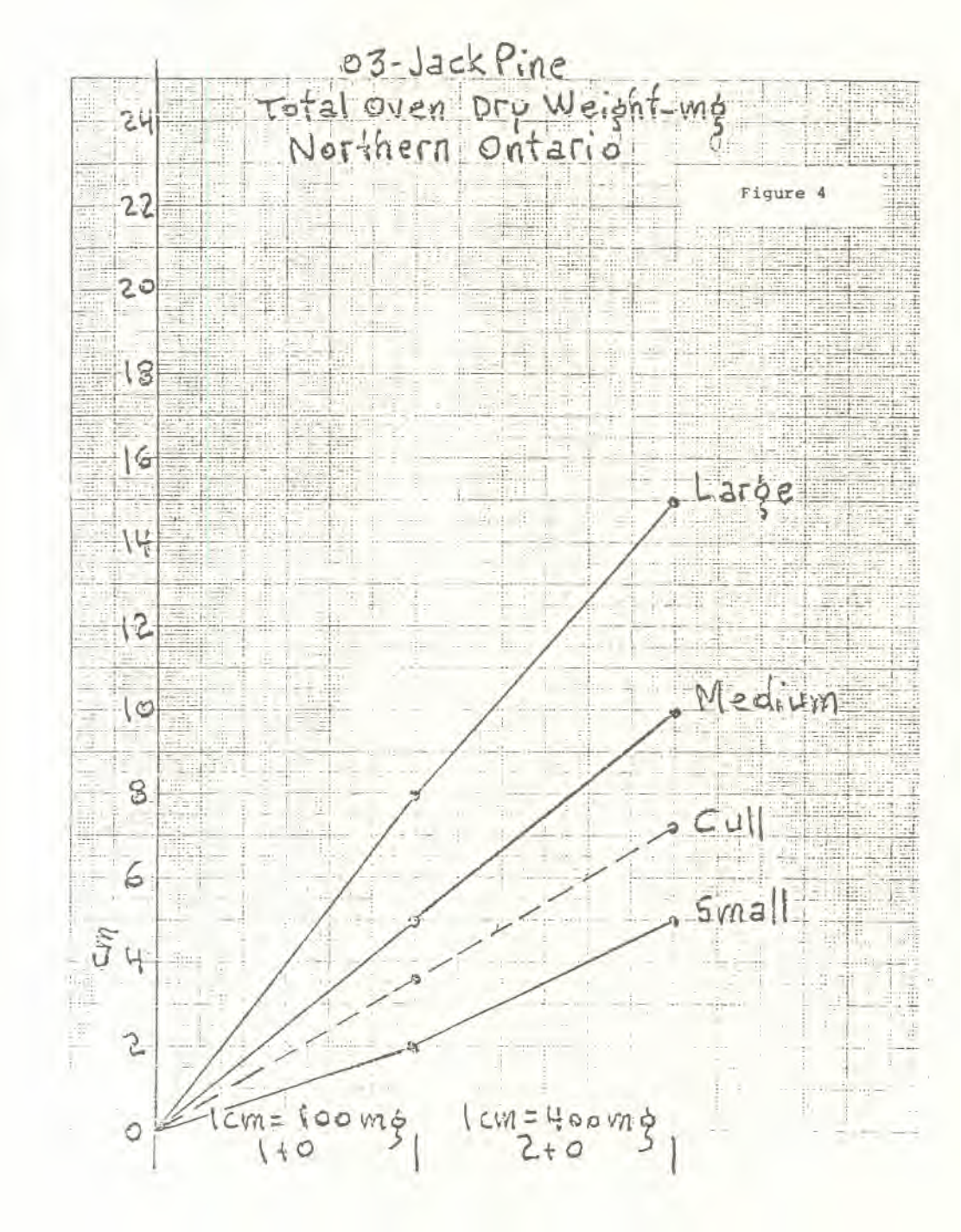
Rotation ages were prescribed for nurseries, selecting the system that came closest to producing the required planting stock. This is shown in Table 3. For some species, certain grades are not produced. For container stock the diameter of the container is included since this has a critical bearing on the size of stock that can be grown.

CONTROLLED GROWTH

We must now deal with the variation that occurs from one crop to another. Our approach has been to monitor the actual growth and by means of a flexible growing schedule, control the growth pattern. Let me hastily add that this is a new area, monitoring is on a pilot scale and growth control is certainly not routine. A standard growth curve is required with its end point tied into the particular specification being monitored. To this standard curve we compare the actual growth that is developing. Sampling is done regularly during the growing period, starting almost immediately after germination.

Figure 4 indicates the importance of starting early. A small 1+0 jack pine will ship as a small 2+0 jack pine and in this case the crop suffers heavily from culling. The relative growth rate of the seedling is higher in the first year than in the second. These jack pine grow at least 100 times their weight in the first year compared to 8 times in the second. It is during this early rapid growth period that growth modification is easiest.

Having recognized that growth is "off-line", what can be done? Here is where the skill of the grower is involved - the degree to which fertilizer and water are regulated, and undercutting timed. This is area in which we will gather information in the next few years so that in fact we can control growth to more


03-Jack Pine
Total Oven Dry Weight-mg
Northern Ontario
Figure 4
24
22
20
18
16
14
12
10
8
6
4
2
0
cm
Large
Medium
Cull
Small
1cm = 100 mg
1+0
1cm = 400 mg
2+0

closely meet the seedling specifications.

I hope this background will lay the framework against which the remaining speakers can provide more details.