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Canadian Forest Tree Seed Statistics: 1980-81 Survey Results

P.S. Janas and B.D. Haddon

Information Report PI-X-41
Petawawa National Forestry Institute

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PETAWAWA NATIONAL FORESTRY INSTITUTE

The Petawawa National Forestry Institute (PNFI) was formed on April 1, 1979, as the result of an amalgamation of the Petawawa Forest Experiment Station with the Ottawa-based Forest Management and Forest Fire Research Institutes. The Forestry Statistics and Systems Branch was established at PNFI in 1980.

In common with the rest of the Canadian Forestry Service, the Petawawa National Forestry Institute has as its objective the promotion of better management and wiser use of Canada's forest resource to the economic and social benefit of all Canadians. Because it is a national institute, particular emphasis is placed on problems that transcend regional boundaries or that require special expertise and expensive equipment that cannot be duplicated in CFS regional establishments. Such research is often performed in close cooperation with staff of the regional centres or provincial forest services.

Research at the Institute is in two main areas.

FIRE RESEARCH AND REMOTE SENSING. Every year in Canada large areas of productive forest are destroyed by fire. Research concentrates on studies of forest fire behaviour, the development of new methods of fire control, the evaluation of fire fighting equipment and retardants, and the development of computerized fire management systems that are rapidly finding applications with fire fighting agencies across the country. The environmental and economic impact of forest fires and the use of fire as a silvicultural tool for intensive forest management are also studied.

In remote sensing, investigations are made into the application of modern satellite and airborne remote sensing systems to forestry problems. In this respect, the ARIES digital image analysis system is proving invaluable.

INTENSIVE FOREST MANAGEMENT. As Canada moves into more intensive management of its forest to meet expected increases in demand for this vital resource, the role of this program will become increasingly important. An extensive reforestation program will require a steady supply of high-quality seed of the desired species. Improved growing stock, obtained through tree breeding and forest genetics research, is highly desirable. Increased emphasis is being placed on using the entire above-ground portion of the tree (biomass), but the effect on the environment of this and other forms of intensive management has to be carefully monitored. Biotechnological methods of improving yield while maintaining site productivity are being investigated.

In support of its research programs, the Institute has at its disposal a 98 km^2 area of forest in the western part of the Petawawa military reserve. Records of experiments and sample plots have been maintained since the 1920s. The forest also serves as a field laboratory for students from local schools, and a visitor centre is operated during the summer months.

The operations of PNFI also include THE FORESTRY STATISTICS AND SYSTEMS BRANCH (FSSB) which is responsible for the acquisition and publication of national information on the forests of Canada. Through the Canadian Forest Inventory Committee, which is comprised of provincial and federal forestry officials, the FSSB works in close cooperation with provincial forest agencies to improve and standardize the information available on Canada's forest resources.

Through the FORSTATS program, which involves all regional establishments of the Canadian Forestry Service, the FSSB coordinates the acquisition and publication within the CFS of national statistics on the forest of Canada.

Every five years, the FSSB publishes Canada's Forest Inventory, the official report on the location, extent, species, and condition of the forest resource. In addition, the FSSB is working closely with the provinces to expand the information available on changes to the forest from fire, harvesting, insects and disease, and from forest management activities. This information is essential to the development of sound policies for the improved management of this important and renewable natural resource.

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Abstract

Results of a 1980-81 national forest tree seed survey are presented. Jack pine, white spruce, and black spruce are by far the most important and widely used reforestation species in Canada, accounting for approximately 59, 22, and 6% of total seed used in reforestation, respectively. Based on the 5.7 billion seeds currently utilized in the nation's reforestation programs, seed usage needs to be increased by less than 4% per year to meet projected reforestation requirements up until 1987. Procurement programs on a Canadian scale are providing sufficient seed reserves for most major species. Over 88% of seed of major reforestation species originated from unimproved natural stands, slightly over 11% came from seed collection and production areas, and only 0.2% was collected from seed orchards.

Résumé

On présente les résultats d'un relevé national sur les semences d'arbres forestiers réalisé en 1980-1981. Le pin gris, l'épinette blanche et l'épinette noire sont de loin des espèces les plus importantes et les plus utilisées pour le reboisement au Canada, fournissant respectivement 59, 22 et 6 % approximativement du total des graines employées à cette fin. Les programmes de reboisement au pays utilisent actuellement 5,7 milliards de graines, de sorte qu'il sera nécessaire d'augmenter de moins de 4 % par année la quantité de graines utilisées pour répondre aux besoins prévus en 1987. Pour la plupart des espèces importantes, les programmes d'approvisionnement à l'échelle du Canada procurent des réserves suffisantes de graines. Les peuplements naturels non améliorés ont fourni plus de 88 % des graines utilisées des principales espèces servant au reboisement, les zones de récolte et de production de graines, un peu moins de 12 %, et les vergers à graines, seulement 0,2 %.

CANADIAN FOREST TREE SEED STATISTICS: 1980-81 SURVEY RESULTS

INTRODUCTION

This seed statistics summary has been prepared as part of the Canadian Forestry Service's Forest Resource Data Program. Established in 1976, the program endeavours to provide statistical information on Canada's forest resources, together with related economic, social, and environmental data. All provincial forestry agencies, other provincial and federal departments, as well as the forest industry cooperate in providing data for this program.

Realizing the need for more intensive forest management to avoid predicted critical wood shortages by the next century, forest geneticists in cooperation with industry have made significant progress in developing superior genotypes which, by virtue of faster growth rates and improved stem form, yield larger wood volumes per unit area in far shorter time. This report will show, however, that the vast majority of seed currently used in reforestation is genetically unimproved, a situation expected to continue for several years.

Success of reforestation efforts are influenced not only by seed quantity, physical quality and sowing strategies, but also by the species used. In addition to presenting the nature, magnitude, and scope of seed procurement, processing, utilization, and storage programs in Canada, this report will aim to determine:

1) which species are used in regeneration activities and of these, which are the most important and widely used in Canada and which are of greatest significance in each province;

2) what agencies are involved in provincial cone and seed procurement programs; and

3) the degree to which seed requirements are satisfied by various types of seed production strategies.

Tree seeds collected and processed for export are not included because details are available elsewhere (Pollard 1982).

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METHODOLOGY

Data were gathered by means of a questionnaire (Appendix I) distributed to provincial forestry agencies. The provincial reporting period was fiscal year 1980/81 except for Manitoba and Saskatchewan (fiscal year 1979/80), and Quebec (calendar year 1981). Results were evaluted in light of commonly quoted reforestation targets for the 1980s so that the success and progress of seed collection, nursery sowing, direct seeding, storage, and seedling production strategies might be objectively assessed. An up-to-date directory of seed extraction facilities, production, and institutional affiliations is provided in Appendix II. Common names are used throughout the text; scientific names are provided in Table 1.

RESULTS AND DISCUSSION

National perspective

Of the 54 species collected throughout Canada for purposes of forest regeneration 34 are conifers and 20 hardwoods (Table 1). Despite representing 35% of the number of species, hardwoods represent an insignificant component of Canada's reforestation efforts, with only slightly over 10 million viable seeds sown in 1980/81, or less than 0.2% of total seed utilized. Although not a pure species, interior spruce has been included in Table 1 because this species group constitutes a major part of British Columbia's forestry program. According to the BC Ministry of Forests, precise taxonomic classification of engelmann and white spruce by cone collectors in most of that province is not usually possible because (1) these species have a very similar appearance and (2) they hybridize over a considerable portion of their range (J. Konishi, pers. comm.). Thus, "interior spruce" is the term applied to white spruce, engelmann spruce, and their hybrids in most of that province's interior and reference to this group will be made at several times in this report.

The 34 conifer species provided 7.6 billion seeds of which over 5.7 billion were used in direct seeding and planting programs. Some 28 billion seeds were in storage in 1981-82 (Table 2). Assuming no further collections, these seed reserves would provide an estimated 4.9 years of supply at the current usage rate for all species, or a 4.0 year supply if seed use of the eight major species (Table 3)* increased by 5% annually. This assumes approximately equal seed reserve:seed use ratios for all species, assuming no further collections. When years of seed supply are compared to seed crop periodicity, seed reserves of all species, except jack pine, appear satisfactory on a national scale. Jack pine's supply problem reflects the prodigious seed requirements of direct seeding programs particularly in Ontario and Quebec, and is not a result of insufficient cone crops, because this species is serotinous. That is, jack pine seeds are in effect stored on the tree between good crop years.

A 1978 national survey predicted that the area regenerated by seeding and planting must increase to 409 000 hectares by 1987 to fulfil national regeneration targets, which corresponds to a requirement of 7.3 billion

*major species in this report include those accounting for at least 1% of total seed used in Canada (Table 4).

Table 1. Species used for forest regeneration or establishment in Canada (excluding those such as poplars which are propagated vegetatively)

Scientific Name		Common Name
Genus	Species	
Abies	*amabilis*	amabilis fir
	balsamea	balsam fir
	grandis	grand fir
	lasiocarpa	alpine fir
Acer	*negundo*	Manitoba maple
	platanoides	Norway maple
	rubrum	red maple
	saccharinum	silver maple
	saccharum	sugar maple
Betula	*alleghaniensis*	yellow birch
	papyrifera	white birch
Carya	*cordiformis*	bitternut hickory
Chamaecyparis	*nootkatensis*	yellow cypress or cedar
Fraxinus	*americana*	white ash
	nigra	black ash
	pennsylvanica	red ash
	pennsylvanica var. *lanceolata*	green ash
Larix	*decidua*	European larch
	laricina	tamarack
	leptolepis	Japanese larch
	occidentalis	western larch
	sibirica	Siberian larch
Liriodendron	*tulipifera*	tulip-tree
Picea	*abies*	Norway spruce
	engelmannii	engelmann spruce
	general[1]	interior spruce
	glauca	white spruce
	mariana	black spruce
	rubens	red spruce
	sitchensis	sitka spruce
Pinus	*albicaulis*	whitebark pine
	banksiana	jack pine
	contorta	lodgepole pine
	flexilis	limber pine
	monticola	western white pine
	mugo	mugho pine
	nigra	Austrian pine
	ponderosa	ponderosa pine
	resinosa	red pine
	strobus	eastern white pine
	sylvestris	Scotch (Scots) pine

[1]British Columbia: defined as a "mixture of pure spruce seedlots and various *glauca* x *engelmannii* hybrids"

Table 1. (cont'd)

Scientific Name		Common Name
Genus	Species	
Platanus	occidentalis	sycamore
Prunus	serotina	black cherry
Pseudotsuga	menziesii	douglas-fir
Quercus	rubra	red oak
	velutina	black oak
Robinia	pseudoacacia	black locust
Thuja	plicata	western red cedar
Tilia	americana	basswood
Tsuga	canadensis	eastern hemlock
	heterophylla	western hemlock
	mertensiana	mountain hemlock

Table 2. Quantities of cones and seeds of coniferous species collected, processed, utilized, and stored in Canada for reforestation purposes in 1980/81

Province	Number of conifer species	Volume of cones collected (hl)	Seed yield from cones processed		Seed utilized		Seed in storage	
			kg	viable seed $x10^6$	kg	viable seed $x10^6$	kg	viable seed $x10^6$
Alberta	2	8 456	4 490	1 013	4 741	1 137	40 470	9 785.8
British Columbia	19	5 283	2 471	524	2 277	320.2	36 956	7 590.0
Manitoba	6	746	541	199	59	16.4	946	314.8
New Brunswick	8	945	856	410	612	123.3	1 602	560.3
Newfoundland	2	687	25	21	50	41.1	126	99.9
Nova Scotia	10	644	718	145	355	77.1	1 044	179.0
Ontario	14	21 325	11 920	3 431	14 226	3 230.8	21 496	5 127.3
Prince Edward Is.	4	108	179	20	12	0.3	168	19.3
Quebec	8	10 839	5 147	1 207	4 812	623.2	16 538	2 970.7
Saskatchewan	2	947	1 448	653	374	135.8	3 013	1 262.8
Totals (Canada)	34	49 980	27 795	7 623	27 518	5 705.2	122 359	27 909.9

Table 3. Seed supply for major reforestation species based on 5% annual increase in seed utilization and 1980/81 seed statistics

Species	Amount of seed utilized as % of seed in storage	[1]Years of supply	[2]Seed crop periodicity (years)	[3]Surplus (+) deficit (-)
douglas-fir	5.8	12.7	6	+
jack pine*	86.0	1.2	3	-
lodgepole pine*	10.0	8.3	2	+
red pine	14.4	6.1	5	+
white pine	13.9	6.3	4	+
black spruce	18.4	4.9	4	+
interior spruce	4.0	16.6	N/A	+
white spruce	16.2	5.5	4	+

*serotinous species: cones can be collected year-round.

[1]using 5% annual increase and $b = \frac{a(1-1.05^n)}{1-1.05}$

where a = current seed use
b = total seed in storage
n = no. of years

[2]from: Wang 1974.

[3]arrived at by comparing years of supply to seed crop periodicity assuming no further seed collection.

Table 4. Ten most important forestry species in Canada based on total viable seed used in reforestation in 1980/81

Species	% of total conifer seed utilized
jack pine	59.2
white spruce	21.8
black spruce	5.6
lodgepole pine	3.8
interior spruce	2.8
douglas-fir	1.1
white pine	1.0
red pine	1.0
red spruce	0.4
western hemlock	0.4

seeds by that time (Morgenstern 1978). Using these terms of reference, an absolute increase of 28% in the seed utilization reported in 1980/81 is required to meet this target, corresponding to a modest annual increase of 3.6% in each of the seven years up to and including 1987. Comparing the results of the present survey and the 4.6 billion seeds reportedly used in the 1978 survey, seed utilization has increased by over 23% over a three year period. Thus, projected sowing targets should be exceeded if the current annual rate of increase is sustained. Much of the increase will be obtained by year-to-year improvements in cone processing and seed cleaning technology as well as better-trained cone collection crews, which together result in higher yields of germinable seed from a given quantity of cones (B. Swaile, OMNR, pers. comm.). A 5% increase in seed procured annually up to 1987 should easily meet anticipated seed requirements.

The intensive regeneration approach of planting in British Columbia uses far less seed to obtain satisfactory restocking than the direct seeding programs in Alberta, Ontario, and Quebec. While Alberta used 3.6 times the number of seed in reforestation as British Columbia (most of it in direct seeding of white spruce), British Columbia produced 4.2 times as much bare root and container stock in 1979/80, and while Quebec used 1.9 times as much seed as British Columbia, it produced 3.3 times less planting stock (Smyth 1980). Ontario's massive jack pine direct seeding program helps explain why it used 10 times as much seed as British Columbia in its 1980/81 regeneration program because, as Brown (1973) reports, an average of 10 jack pine seeds is required to produce one germinant in direct seeding. Owing to the success achieved with direct seeding of jack pine and the fact that it is of lower cost than planting on a per hectare basis, 90% of all jack pine seed may be used for direct seeding in Ontario by the year 2000 (Rauter 1973).

Adequate seed reserves exist for most species (Table 3), so the number of seed utilized reflects current regeneration requirements. Based on this criterion, the 10 most important reforestation species are listed in Table 4. In the case of jack pine, the high percentage of seed used does not fairly reflect total area regenerated because a large proportion of the seed was used in direct seeding. While the number of seeds extracted from cones is also a function of reforestation needs, it is strongly influenced by periodicity of good crop years and, thus, would not necessarily be a rational indicator of species importance.

The three most widely used species among provincial forestry programs are white spruce, black spruce, and jack pine (Table 5). It is not surprising that these species are also the most important Canadian forestry species (Table 4), though in a different ranking. The fact that tamarack is used in 4 provinces and not listed in Table 4 as a major forestry species, may reflect the problems of low filled seed yields from its cones (Campbell 1982 reports a provincial average of only 3.3 viable seed/cone for Ontario) and the very infrequent occurrence of good crop years. Although tamarack could not be included in Table 3, it has the following values for that table's categories (all Canada):

1. seed utilized as % of seed stored: 52.5
2. years of supply: 1.9
3. seed crop periodicity: 3-6 years

Table 5. Species with most widespread use in Canada's reforestation programs

Species	Provinces reporting use in forestry program	Number of provinces
white spruce	ALTA, BC, MAN, NB, NS, ONT, QUE, SASK	8
black spruce	MAN, NB, NFLD, NS, ONT, PEI, QUE	7
jack pine	MAN, NB, NS, ONT, QUE, SASK	6
red pine	MAN, NFLD, NS, ONT, QUE	5
white pine	NB, NS, ONT, PEI, QUE	5
balsam fir	NB, NS, PEI, QUE	4
Scotch pine	MAN, NB, ONT, QUE	4
red spruce	NB, NS, ONT, QUE	4
tamarack	NB, NS, ONT, QUE	4
Japanese larch	NS, ONT, QUE	3
Norway spruce	NS, ONT, QUE	3

Even at the conservative 3 year crop interval, there is a clear deficit of seed in storage, comparing years of supply to seed crop periodicity. Tamarack (and other larches) can outgrow all native conifers in Eastern North America (Rauter and Graham 1982), and for this reason it has been described as among the best native species for reforestation in Eastern Canada (Vallée 1982). The seed supply problem must be rectified if the reforestation potential of native and exotic larches in this country is to be exploited.

Balsam fir and Scotch pine are both represented in Table 5 (extent of use) but not in Table 4 (major forestry species), which probably reflects their limited and specialized primary regeneration use in Christmas tree plantations. Balsam fir in particular is unpopular as a timber reforestation species because of its high susceptibility to spruce budworm (Choristoneura fumiferana Clem.).

Douglas-fir, western hemlock, interior spruce, and lodgepole pine, while among the 10 most important species, are not found in Table 5 because of their limited range. However, the fact that they are among Canada's major forestry species attests to the great importance of these species in

British Columbia's forestry program. Over 79% of the area planted in British Columbia consisted of douglas-fir, western hemlock, and spruce. Despite a 28% decline in planted area of douglas-fir in the next 15 years, counterbalanced by an expected 106% increase in use of engelmann spruce, the area planted with the above species will remain above 60% (Crown 1979).

Of the exotic species used in Canada's provincial reforestation efforts, Scotch pine is planted in 4 provinces, followed by Norway spruce and Japanese larch in 3 provinces (all in Eastern Canada). While Scotch pine is now planted primarily for Christmas tree production because of disasterous results obtained in widespread reforestation in the early 1900s, this species has potential as an important reforestation species if, as in the case of other successfully introduced exotics, appropriate provenances are selected (e.g. 'carpatica' strain from Eastern Europe).

Provincial statistics

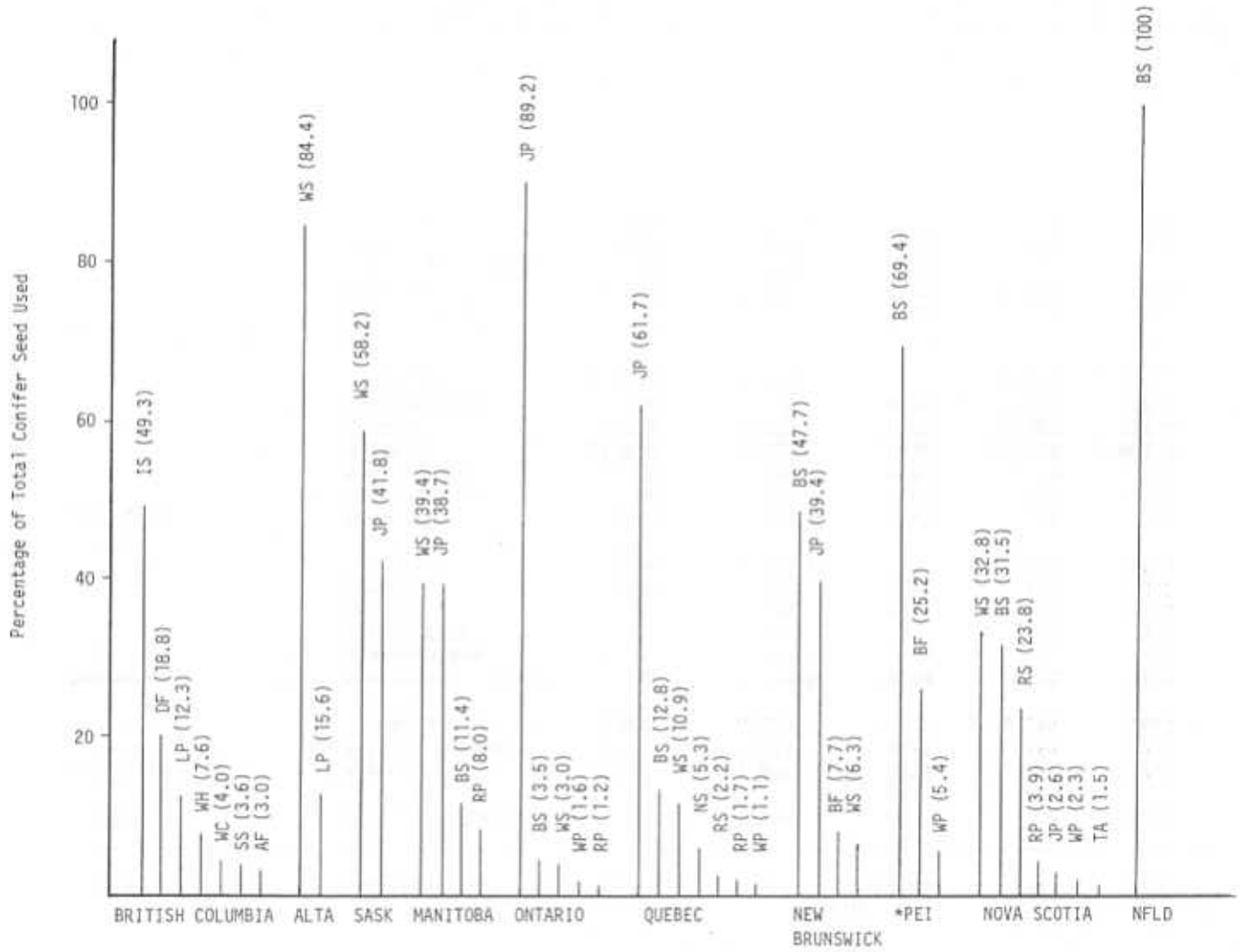
According to number of seeds used, jack pine, white spruce, and black spruce are the leading forestry species in most provinces (Fig. 1). White spruce is the main species in four provinces (ALTA, MAN, NS, SASK), black spruce is the most important in three (NB, NFLD, PEI), and jack pine in two provinces (ONT, QUE).

When provincial use of the eight most important species (Table 4) is considered, wide variations in kg of seeds/hl of cones are found (Table 6). This may be due to genetic variability between provincial ecotypes, site quality differences, annual variations in cone crop quality, or differences in cone extraction and cleaning techniques.

The frequency of good seed and cone crop years helps to explain the great disparities between quantities of seed procured and those used: 1.9 billion more seed was collected than used in 1980/81. Seeds must be collected during good crop years to ensure continuity of supply in intervening years. It is efficient and economic to collect seed in large quantities in good crop years because of higher seed yield and physiological quality resulting from increased flowering and cross pollination in such years.

The agencies procuring the seeds used in reforestation programs vary by province (Table 7). Manitoba relies solely on private contractors for collections of all major species, Quebec and British Columbia rely on contractors for some of their collections, and the remaining provinces depend mainly on provincial forestry staff (including seasonal employees) for Crown land planting and industry employees for private land reforestation. British Columbia, New Brunswick, and Nova Scotia, all of which have comparatively large private land holdings, rely on industry-funded cone and seed collections for many of their species. Newfoundland and Prince Edward Island are the only provinces depending solely on provincial forestry staff for seed procurement. It will be interesting to see whether the future tendency is towards a greater emphasis on contracted collections, if provincial forestry agencies continue experiencing increasing fiscal constraints and with the recent trend to forest management agreements in some provinces.

Figure 1. Most important reforestation species in each province based on % of total viable conifer seed used in 1980-81.



Species Key

WC - western red cedar
AF - amabilis fir
BF - balsam fir
DF - Douglas-fir
WH - western hemlock
JP - jack pine
LP - lodgepole pine
RP - red pine
WP - eastern white pine
BS - black spruce
IS - interior spruce (BC)
NS - Norway spruce
RS - red spruce
SS - sitka spruce
WS - white spruce
TA - tamarack

* no seed used in 1980/81; % is based on seed in storage

Table 6. Volumes collected, seed yields, seed utilized and seed in storage for major commercial species during 1980/81.

Species	Province	Volume collected (hl)	[1]Yield kg	[1]Yield kg/hl	Seed utilized kg	Seed utilized viable seed x10^6	Seed in storage kg	Seed in storage viable seed x10^6
douglas-fir	British Columbia	1 921	1 198	0.62	682	60.0	11 686	964.4
lodgepole pine	Alberta	6 321	1 647	0.26	1 187	177.2	9 449	1 410.9
	British Columbia	2 681	643	0.24	159	39.5	3 994	1 029.4
	Totals	9 002	2 290		1 346	216.7	13 443	2 440.3
red pine	Manitoba	12	9.5	0.79	12	1.3	-	-
	Newfoundland	-	-	-	-	-	5	0.4
	Nova Scotia	-	-	-	38	3.0	121	9.5
	Ontario	74	38	0.51	295	40.6	2 415	262.3
	Quebec	650	143	0.22	106	10.7	558	59.3
	Totals	736	190.5		451	55.6	3 129	331.5
jack pine	Manitoba	377	152	0.40	25	6.4	497	126.6
	New Brunswick	58	36	0.62	183	44.8	514	125.9
	Nova Scotia	20	28	0.43	9	2.0	70	15.0
	Ontario	17 670	8 329	0.50	12 188	2 882.4	9 379	2 364.5
	Quebec	7 959	3 983	0.51	1 369	384.4	5 187	1 456.9
	Saskatchewan	12	6	0.50	199	56.7	593	169
	Totals	26 096	12 534		13 973	3 376.7	16 240	4 257.9
eastern white pine	New Brunswick	5	1.5	0.27	-	-	4	0.21
	Nova Scotia	52	52	1.01	31	1.8	117	6.6
	Ontario	1 035	1 075	1.04	1 170	50.2	5 034	190.1
	Prince Edward Is.	34	28	0.82	-	-	28	1.0
	Quebec	683	604	0.88	134	7.1	4 388	232.6
	Totals	1 809	1 760.5		1 335	59.1	9 571	430.5

Table 6. (cont'd)

Species	Province	Volume collected (hl)	[1]Yield kg	kg/hl	Seed utilized kg	Seed utilized viable seed x10^6	Seed in storage kg	Seed in storage viable seed x10^6
black spruce	British Columbia	-	-	-	-	-	0.3	0.2
	Manitoba	59	20	0.33	2	1.9	28	23.5
	New Brunswick	710	623	0.88	107	58.8	550	302.5
	Newfoundland	687	25	0.73	50	41.1	121	99.5
	Nova Scotia	29	12	0.44	43	24.3	18	10.1
	Ontario	1 245	1 018	0.89	116	113.9	1 084	1 025.2
	Prince Edward Is.	64	18	0.27	-	-	18	13.4
	Quebec	1 316	216	0.16	108	80.1	502	370.6
	Totals	4 110	1 932		426	320.1	2 321.3	1 845
interior spruce	British Columbia	303	244	0.80	491	157.7	12 292.6	44 776
white spruce	Alberta	2 135	2 843	1.33	3 555	959.8	31 020	8 374.9
	Manitoba	294	351	1.19	16	6.5	403	164.1
	New Brunswick	132	157	1.19	26	7.8	357	107.1
	Nova Scotia	164	190	1.16	94	25.3	202	54.6
	Ontario	1 117	1 286	1.15	257	97.6	2 997	1 150.9
	Quebec	77	71	0.54	2 227	68.2	1 679	503.4
	Saskatchewan	935	1 442	1.54	175	79.1	2 420	1 093.8
	Totals	4 854	6 340		6 350	1 244.3	39 078	11 499

[1]Calculation based on volume of cones processed in reporting year, not necessarily volume collected in that year.
- nil

Table 7. Number of species collected for reforestation purposes and agencies involved

Province	Reporting year	Number of species per collection agency: Provincial employees	Industrial employees	Contractors	Total
Alberta	80/81	2	2	0	2
British Columbia	80/81	12	10	5	19
Manitoba	79/80	0	0	6	6
New Brunswick	80/81	4	7	0	8
Newfoundland	80/81	1	0	0	2
Nova Scotia	80/81	6	6	0	10
Ontario	80/81	..	..	..	34
Prince Edward Island	1980	3	0	0	4
Quebec	79/80	2	0	8	8
Saskatchewan	79/80	2	1	0	2
All					54[1]

[1]Includes 8 exotic species.
.. not available.

Table 8. Seed yield of major reforestation species in Canada by production strategy for 1980/81

	Seed yield (viable seed x10)			% Yielded by:		
	[1]G/SZ	[2]SCA/SPA	[3]SO	G/SZ	SCA/SPA	SO
douglas-fir	102.7	-	3.0	97.2	-	2.8
jack pine	1 702.2	345.4	-	83.1	16.9	
lodgepole pine	460.3	-	-	100	-	-
red pine	2.6	2.3	0.2	0.5	45.1	3.9
white pine	47.1	-	0.6	98.7	-	1.3
black spruce	1 113.6	105.6	2.1	91.2	8.6	0.2
interior spruce	96.3	-	-	100	-	-
white spruce	1 943.6	253.8	6.5	88	11.5	0.3
Totals	5 468.4	707.1	12.3	88.4	11.4	0.2

- nil.
[1] general/seed zone collections.
[2] seed collection areas/seed production areas.
[3] seed orchards.

The large number of species (34) collected in Ontario reflects the relatively large hardwood planting program, made possible by conducive soil and climatic conditions in the southern fringe of that province. An annual target of 2.6 million trees, largely consisting of sugar maple, red maple, basswood, and black locust, is produced by Ontario's four southern provincial nurseries (Klapprat 1983). This figure is 57% higher than 1980/81 seed use statistics for these same species, assuming two viable seed per plantable seeding (Hall 1981), which may be in response to sharply declining supplies of high quality hardwoods in that region.

Main seed production strategies

Genetic tree improvement programs are contributing marginal amounts of seed to reforestation efforts, with only 0.2% of total seed originating from seed orchards of the major species (Table 8). Red pine and douglas-fir have the highest percentages of seed emanating from seed orchards, with 3.9 and 2.8%, respectively. Only 11.4% of the total quantity of seed for these major forestry species was obtained from seed production or collection areas; the vast majority of seed (88.4%) emanated from general or seed zone collection, consisting of natural, unrogued stands. One should note that seeds coming from general collections are often of a better than the average stand genetic quality from which they originated; collectors are usually instructed to make collections from trees of superior form and vigour.

The results of this survey indicate that dramatic increases in the amount of genetically improved seed used for regeneration are required if, as provincial agencies predict, 55% of all seed will originate from seed production areas and 3% from seed orchards by 1987 (Morgenstern 1978). It is anticipated that this increase will come about because of the many seed orchards and production areas established in the last decade in response to greater emphasis on intensive forest management. Currently, more than 140 hectares of seedling and clonal seed orchards have been established in the Maritime provinces (J.D. Simpson 1983), 129.5 ha in Quebec (Lamontagne 1982), 297 ha in Ontario (S. Ianetti, pers. comm.) and 77.9 ha in British Columbia (Pollard 1982). Recent computerization of seedlot origin information in many provinces should also result in a significant increase in the amount of seed reported from genetically improved stands in the next few years, because it will be far easier to determine origins of seed used in regeneration programs (B. Swaile, OMNR, pers. comm.). In the interim, however, it is clear that in most provinces, unimproved seed from natural stands will continue to provide the bulk of materials used in reforestation.

SUMMARY AND CONCLUSIONS

Highlights of the 1980/81 national seed survey are presented below:

(1) The ten top species used in reforestation in Canada in descending order of importance based on number of seed used are jack pine, white spruce, black spruce, lodgepole pine, interior spruce, douglas-fir, white pine, red pine, red spruce, and western hemlock (Table 4).

(2) Among Canadian provinces, the 11 most widely used species in descending order with number of provinces reporting use in

brackets are: white spruce (8), black spruce (7), jack pine (6), red pine (5) white pine (5), balsam fir (4), Scotch pine (4), red spruce (4), tamarack (4), Japanese larch (3), and Norway spruce (3) (Table 5).

(3) Scotch pine, Norway spruce, and Japanese larch are currently the most extensively used exotic forestry species in Canada (Table 5).

(4) The number of viable seed used in coniferous reforestation activities during 1980/81 in Canada was 5.7 billion, comprising 34 conifer species. Hardwoods accounted for less than 0.2% of total seed sown, with just over 10 million seeds utilized during the same reporting period.

(5) A per annum increase of approximately 4% in the amount of seed used in direct seeding and planting programs is needed to reach projected seed requirements by 1987.

(6) Cone collection efforts for major conifers have generally satisfied regeneration needs; 1980/81 collections totalled 7.6 billion seeds and significantly exceeded total seed utilized for the same period. Tamarack and some exotic larches, while being widely used and having good potential in eastern Canada, will continue to frustrate reforestation efforts because of difficulty in obtaining sufficient seed of adequate viability.

(7) Only 11.4% and 0.2% of seed originated from seed production/collection areas and seed orchards, respectively (Table 8). These figures are well below those anticipated for 1987. For the next several years, unimproved seed will continue to constitute the bulk of material used for reforestation in Canada.

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APPENDIX I: FOREST RESOURCE DATA PROGRAM - SEED PROCUREMENT AND PROCESSING QUESTIONNAIRE

FOREST RESOURCE DATA PROGRAM - SEED PROCUREMENT AND PROCESSING QUESTIONNAIRE

REPORTING YEAR[1]: _____ CFS REGION: _____

PROVINCE OR TERRITORY: _____ REPORTED BY: _____

List of Species Collected for Purposes of Forest Regeneration or Establishment:
(Please list by scientific names, using additional pages if more than four species are reported).

Volume of Cones Collected in Reporting Year

(A) Collection Agency:	(i)	Provincial/Territorial Government Staff	(hectolitres)				
	(ii)	Forest Industries	(hectolitres)				
	(iii)	Contractors or Dealers	(hectolitres)				
(B) Collection Type:	(i)	General/Seed Zone Collections[2]	(hectolitres)				
	(ii)	Seed Collection/Seed Production Areas[3]	(hectolitres)				
	(iii)	Seed Orchards[4]	(hectolitres)				

Volume of Cones Processed in Reporting Year

(A) Collection Type:	(i)	General/Seed Zone Collections	(hectolitres)				
	(ii)	Seed Collection/Seed Production Areas	(hectolitres)				
	(iii)	Seed Orchards	(hectolitres)				

Clean Seed Yield from Cones Processed in Reporting Year

(A) Collection Type:	(i)	General/Seed Zone Collections	(kilograms)				
			(number of viable seeds)				
	(ii)	Seed Collection/Seed Production Areas	(kilograms)				
			(number of viable seeds)				
	(iii)	Seed Orchards	(kilograms)				
			(number of viable seeds)				

[1] Please specify the summary time frame, i.e. calendar year, fiscal year, etc.
[2] Collections identified only as to administrative district or seed zone, i.e. parent trees are not identified.
[3] Seed collection area - a stand which, because of its better than average growth and form, has been identified, although not necessarily reserved, for seed collection.
Seed production area - a plus stand which is subjected to periodic removal of undesirable individuals (rogued) and to cultural treatments for early and abundant seed production.
[4] A plantation of seedlings or vegetatively propagated trees established primarily for the production of seed of proven genetic quality.

REPORTING YEAR: _____ CFS REGION: _____

PROVINCE OR TERRITORY: _____ REPORTED BY: _____

Seed Use in Reporting Year[5]

(A) Domestic Use:	(i)	General/Seed Zone Collections	(kilograms)				
			(number of viable seeds)				
	(ii)	Seed Collection/Seed Production Areas	(kilograms)				
			(number of viable seeds)				
	(iii)	Seed Orchards	(kilograms)				
			(number of viable seeds)				
(B) Exported:	(i)	General/Seed Zone Collections	(kilograms)				
			(number of viable seeds)				
	(ii)	Seed Collection/Seed Production Areas	(kilograms)				
			(number of viable seeds)				
	(iii)	Seed Orchards	(kilograms)				
			(number of viable seeds)				

Seed Inventory at End of Reporting Year[6]

(A) Collection Type:	(i)	General/Seed Zone Collections	(kilograms)				
			(number of viable seeds)				
	(ii)	Seed Collection/Seed Production Areas	(kilograms)				
			(number of viable seeds)				
	(iii)	Seed Orchards	(kilograms)				
			(number of viable seeds)				

Remarks:

[5] Amount of seed per species withdrawn from storage or current year's collection for nursery sowing, greenhouse sowing, direct seeding, etc.
[6] Amount of clean seed in storage at end of reporting year.

REPORTING YEAR: _____ CFS REGION: _____

PROVINCE OR TERRITORY: _____ REPORTED BY: _____

LIST OF FOREST TREE SEED EXTRACTION PLANTS

Ownership[7] Category	Mailing Address[8] Phone Number Supervisor	Production Capacity (hectolitres)	Clean Seed Storage Capacity (kilograms)

SIGNATURE: _____ DATE: _____

[7] Four symbols are used to designate forest tree seed extraction plant ownership;
P - Provincial F - Federal I - Industry X - Private

[8] Including name of agency.

APPENDIX II

Reforestation-oriented tree seed extraction plants in Canada

Ownership category P=provincial I=industry(private)	Mailing address Supervisor	Phone number	Production capacity (hl) D=daily Y=yearly	Clean seed storage capacity (kg)
P	Ministry of Forests Duncan Seed Centre P.O. Box 816 Duncan, B.C. V9L 3Y2 Mr. R. Bowden-Green	(604)748-5133	45 (D)	(184.6 m^3)
P	Ministry of Forests Redrock Nursery R.R. 7, 15 Mile Road Prince George, B.C. V2N 2J5 Mr. D.C. Prideaux	(604)963-7282	3.5 (D)	
I	Reid, Collins and Associates Ltd. P.O. Box 430 Aldergrove, B.C. VOX 1AO Mr. L.M. Glen	(604)533-2212	16-30 (D)	2,760 (8.6 m^3)
I	Silva Enterprises Ltd. 1296 Freeman Street Prince George, B.C. V2M 2R8 Mr. R. Hellenius	(604)563-3250	16-18 (D)	120 (0.6 m^3)

Ownership category P=provincial I=industry(private)	Mailing address Supervisor	Phone number	Production capacity (hl) D=daily Y=yearly	Clean seed storage capacity (kg)
P	Pépinière forestière de Berthierville 1690 Grande Côte C.P. 540 Berthierville, P.Q. J0K 1A0 Mr. J.P. Campagna	(514)836-3788 (514)836-3787		
P	Maritime Forest Seed Centre R.R. 6 Fredericton, N.B. E3B 4X7 Mr. N.H. Kreiberg	(506)455-4055	8,000 (Y)	5,000
P	Provincial Forest Nursery Dept. Lands and Forests P.O. Box 219 Lawrenceton, N.S. B0S 1M0	(902)584-3400	400 (Y)	500
P	Tree Improvement Centre Dep. Lands and Forests Debert, N.S. B0M 1G0 Mr. T.J. Mullin	(902)662-3300		4,000
P	Provincial Tree Nursery Dep. Forest Resources and Lands P.O. Box 616 Grand Falls, Nfld. A2A 2K2 Mr. W.L. Burry	(709)489-3012	1,330 (Y)	1,100

Ownership category P=provincial I=industry(private)	Mailing address Supervisor	Phone number	Production capacity (hl) D=daily Y=yearly	Clean seed storage capacity (kg)
I	Western Tree Seeds Ltd. P.O. Box 144 Blind Bay, B.C. V0E 1H0 Mr. F.D. Barnard	(604)675-2463	35-45 (D)	(3.5 m^3)
P	Energy and Natural Resources Pine Ridge Forest Nursery P.O. Box 750 Smokey Lake, Alberta T0A 3C0 Ms. K. Yakimchuk	(403)656-4130	50,000 (Y)	62,000
P	Pineland Provincial Forest Nursery Dep. Natural Resources Box 45 Hadashville, Manitoba R0E 0X0 Mr. H.C. Tirschmann	(204)426-5235	5,400 (Y)	3,500
P	Ministry of Natural Resources Dryden Tree Nursery P.O. Box 90 Wabigoon, Ontario P0V 2W0 Mr. T. Myland	(807)938-6326	10,890 (Y)	10,000
P	Ministry of Natural Resources Ontario Tree Seed Plant Box 70 Angus, Ontario L0M 1B0 Mr. B. Swaile	(705)424-5311	18-20,000 (Y)	45,000

APPENDIX III

Glossary of Terms Used

GENERAL/SEED ZONE COLLECTION: identified only as to administrative district or seed zone; actual collection locations can occur within a wide area of seed zone.

OUTCROSSING: mating between several unrelated parent trees.

SEED COLLECTION AREA: is a visually superior stand, selected to provide an immediate supply of large amounts of source-identified seed. Management of such areas is absent or minimal and seed is obtained by destructive collection methods (i.e. felling).

SEED PRODUCTION AREA; consists of an above average quality natural or planted stand which is upgraded by removal ("roguing") of visually undesirable individuals and is cultured to provide better genetic quality and larger quantities of seed.

SEED ORCHARD: is a plantation of seedlings or vegetatively propagated individuals established for the production of proven and high genetic quality seed in substantial quantities.

SEROTINOUS: pertains to cones remaining closed on the tree for a year or more after maturity.

VIABLE SEED: seed which, based on results of germination tests, is capable of germinating.