THE PLACE OF NORTH AMERICAN CONIFERS IN BRITISH FORESTRY

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MANAGEMENT PROBLEMS, GROWTH AND YIELD

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INTRODUCTION

Having given some of the reasons for the choice of North American conifers for introduction to the British Isles and having given instances of their use in certain situations, it remains to give a brief account of some of the management problems arising from their adoption and to elaborate on the preceding generalizations regarding growth and yield.

Not the least of these problems is the appearance of a new crop of diseases in the forest scene, some having come across the sea with their hosts, others being the result of a change or extension of diet on the part of pathological organisms already present in Britain. Slightly different climatic conditions from those to which the trees are accustomed have also produced troubles in the form of windthrow, windbreak, frost and snow damage and occasional belated wood-ripening. Natural regeneration of the introduced species is a problem embodying many of the factors which will be discussed.

Reliable data on growth and yield are scarce; the British Forestry Commission in 1946, however, brought out preliminary yield tables for Douglas-fir and Sitka spruce, giving total tree volumes in cubic feet per acre on four site qualities, assuming frequent moderate thinnings. These two trees have been planted more extensively than any others

from this area and yield tables for Hemlock, Pines and Cedars are not yet ready. Considerable use has been made of these tables in the preparation of this report in an attempt to give a tabulated comparison of yields in the two countries.

TREE ENEMIES: Fungi.

Two fungi have been responsible for the most serious cases of fungal damage. One of these is Fomes annosus, the Conifer Heart-Rot. Of the introduced species Douglas-fir might seem the least susceptible although by no means immune to this fungus. Sitka spruce, western hemlock, western red cedar and Port Orford cedar are frequently attacked. When the victim trees are over ten years old they are rarely killed but may become completely heart-rotted before the infection is obvious. Where young plantations are attacked, however, infection usually results in the death of the affected trees. Armillaria mellea, the Honey Fungus or Shoestring Fungus, is the other serious fungal pest of exotic conifers and the native Scots Pine. Again Douglas-fir appears to be less susceptible than the spruces, Chamaecyparis, Thuja or Tsuga. Where Fomes annosus may wipe out entire young plantations, Honey Fungus usually selects single trees or small groups within the plantation.

: Insects.

As yet no major epidemics of insect attack have occurred in plantations of exotics in Great Britain although they have broken out in other parts of Europe. Bark beetles, engraver beetles and ambrosia beetles have taken a small toll, sawflies and woodwasps have made a few isolated sorties and Aphids and Adelgids have made their slight inroads.

: Climatic Injuries.

One of the main factors in species selection and the principal reason for the low timberline (about 1600 feet in North Wales) is wind. The insular climate enjoyed by the Islands provides winds which frequently reach gale force. With this in mind, exotic trees must be sited and treated carefully if severe damage is to be avoided. Windthrow and windbreak are both combatted by frequent light thinning of the plantations. Although Sitka spruce is also susceptible to wind exposure it has been found to stand up fairly well under the autumn and spring frosts which may occur at unexpected times. Lodgepole pine from the Pacific Coast has been planted on the most exposed sites with considerable success and shows promise of being an excellent pioneer species in such areas. Douglas-fir, western hemlock, western red cedar and Port Orford cedar are usually planted on

the lower, more sheltered slopes.

: Rodents and Ground Game.

It is apparent that in the centuries since its importation into the British Isles, the cottontail rabbit has managed to retain its taste for the conifers of its native North America. The result is that the rabbit is the greatest single obstacle to the establishment of coniferous plantations. Few areas in Great Britain are free of this pest and new plantations with few exceptions must be fenced to exclude it. Fencing must of course be preceded by a complete and costly campaign of eradication within the area to be planted. The damage done by other mammals pales into insignificance beside that of the rabbit but browsing by deer is also serious in some parts, while mice, moles and squirrels account for hundreds of bushels of seed annually.

NATURAL REGENERATION.

Techniques for obtaining natural regeneration of exotic conifers are still in the embryo stage, many of the trees having been imported in the last hundred years and therefore still awaiting the end of their first rotation on foreign soil. In the case of Douglas-fir, however, some evidence is available to show that natural regeneration may soon be expected in abundance on favourable sites and after

careful harvesting. This evidence includes the appearance of prolific seedling growth under adjacent Scots pine plantations and several instances of good regeneration under parent trees cut on a light shelterwood system. It is possible that Douglas-fir exhibits slightly more shade-tolerance in Great Britain than in its native habitat, but whether or not this is true great sensitivity to light conditions is shown. An interesting phenomenon in the New Forest in Southern England is the appearance of dense regeneration in a bomb crater surrounded by an area quite bare of seedlings but with considerable duff and herbaceous and low shrubby growth. This shows the marked preference of this tree for mineral soil for seed germination.

GROWTH AND YIELD.

Since in Great Britain four quality classes are recognized for both Douglas-fir and Sitka spruce, the figures for quality classes I, II, III and IV as determined by the British Forestry Commission were compared with Site Indices 200, 160, 120 and 80 respectively. The quality classes fixed for these species were based on the height attained at age fifty, the classes being separated by intervals of ten feet as shown in the accompanying age-height curves. Figures for the United States were taken from the two publications "The Yield of Douglas-fir in the Pacific

Northwest" Technical Bulletin 201 and "Yield of Even-aged Stands of Sitka Spruce and Western Hemlock" Technical Bulletin 544. In the latter case the figures were adjusted by the correction for a nearly pure Sitka spruce stand.

The figures for volume are the cubic foot volumes for the total stand. Data for the volumes in the United Kingdom were obtained from "Forestry Commission Yield Tables for Scots Pine and Other Conifers" published in 1946. Quarter-girth figures were converted to diameters and Hoppus feet to cubic feet true measure[1]. It should be noted that the diameters given are not truly comparable since breast-height in Great Britain is considered as four feet three inches and in the United States as four feet six inches. In the absence of reliable taper tables, however, this discrepancy could not be corrected.

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[1]British timber cruisers usually measure tree circumference rather than diameter at breast height. The measurement taken is divided by four and recorded as quarter-girth. More commonly the tape used has graduations which give the quarter-girth result directly. The Hoppus foot volume of a tree is the product of its quarter-girth squared, its form factor (f) and its height (l), or

$$V_h = (g/4)^2 \times f \times l = (2\pi r/4)^2 \times f \times l = \pi^2 r^2/4 \times f \times l$$

$$\text{where } r = \frac{\text{d.b.h.}}{2}$$

$$\text{True Volume} = \pi r^2 \times f \times l = \pi^2 r^2/\pi \times f \times l$$

$$\text{Therefore } \frac{\text{Hoppus Volume}}{\text{True Volume}} = \frac{\pi}{4}$$

Thus the Hoppus measure is a considerable underestimate but is an approximation accepted both by foresters and lumber merchants.

It is apparent from the comparisons made that the range of quality in the United Kingdom is much smaller than in the United States. While the first two quality classes of both Douglas-fir and Sitka spruce have similar figures in the two countries, quality classes III and IV should properly be compared with higher site indices than 120 and 80 respectively. Plantations of Douglas-fir and Sitka spruce falling into quality class IV are comparatively rare in the British Isles and further measurements made since the compilation of the yield tables have revealed the presence of several areas of both species whose height at age fifty shows them to fall into a class above quality class I. These areas are known as Super-I. They were, however, ignored in the preparation of this report.

The figures calculated for periodic annual increment are entered opposite that age which is the midpoint of the ten-year period for which they were calculated.

It is noticeable that in Great Britain Douglas-fir gains less height growth but greater diameter growth in its first fifty years than in the Pacific Northwest. Yield tables show also that the volume at age fifty is slightly greater in the United Kingdom than in the United States although the periodic annual increment is lower in the highest quality class. The volumes obtained are, in all cases, from fewer trees per acre in Great Britain. There

also, up to an additional fifty percent of the volume at age fifty is removed in thinnings during the first fifty years of the rotation. Owing to the close utilization practices much of this produce from thinnings is marketable. Some significance could be attached to the greater rate of diminution of the periodic annual increment in Great Britain than in the United States. Diminishing rate of growth as expressed by increment is frequently taken as a criterion in the choice of a suitable rotation and, in fact, the usual rotation for Douglas-fir in the British Isles is in the region of eighty to ninety years, somewhat shorter than that likely to be adopted in the public forests of the Pacific Northwest.

In the case of Sitka spruce the rapidly diminishing periodic annual increment is even more noticeable when compared with figures from the United States which actually increase up to the age of fifty. Tree volumes in the higher quality classes at this age are also considerably lower than those in the Pacific Northwest, probably due to the lower height growth and smaller number of trees per acre. With this species too, British foresters usually calculate in terms of rotations of about eighty years.

DOUGLAS FIR

Quality Class I compared with Site Index 200

AGE (Years)	MEAN HEIGHT (Feet)		D.B.H. (Inches)		NO. OF TREES		VOLUME (Cubic feet)				INCREMENT (Cubic feet per year)			
							Main Crop	Thinnings	Total		Mean Annual		Periodic Annual	
	U.K.	U.S.	4'3" U.K.	4'6" U.S.	U.K.	U.S.	U.K.	U.K.	U.K.	U.S.	U.K.	U.S.	U.K.	U.S.
15	38		4.5		1330		2140	-	2140		143			
20	53½	53	7	5.7	715	571	3840	550	4390	1830	219	91		
25	67		9.3		470		5320	750	6070		241		350	292
30	78	90	11.5	9.0	335	350	6540	800	7340	4750	244	158		
35	87		13.7		255		7550	820	8370		239		267	275
40	95½	120	15.6	12.2	205	340	8450	760	9210	7500	232	187		
45	103		17.5		170		9280	730	10010		224		230	265
50	110	140	19.4	15.3	140	176	10060	690	1o750	1o150	215	203		

Quality Class II compared with Site Index 160

15	33		3.8		1605		1670	-	1670		111			
20	46½	43	6.1	4.2	850	1o12	3200	290	3490	1490	174	74		
25	58½		8.3		560		4520	550	5070		203		324	239
30	69	70	10.5	6.5	395	640	5780	660	6440	3880	213	129		
35	78		12.7		295		6670	690	7360		210		247	228
40	86	90	14.6	8.7	230	445	7560	690	8250	6160	206	154		
45	93½		16.5		185		8360	660	9020		200		218	214
50	100	115	18.4	10.9	150	331	9120	620	9740	8300	195	166		

Quality Class III compared with Site Index 120

20	39½	32	5.1	2.6	1115	2324	2520	-	2520	990	126	49		
25	51		7.3		650		3780	390	4170		167		288	164
30	60½	52	9.5	4.4.	445	1219	4870	530	5400	2630	180	88		
35	69		11.4		335		5820	560	6380		182		238	152
40	76½	66	13.4	6.1	265	798	6680	570	7250	4150	181	103		
45	83½		15.3		210		7440	620	8060		179		207	139
50	90	80	16.9	7.7	170	572	8170	580	8750	5540	175	111		

Quality Class IV compared with Site Index 80

20	33½	22	4.1	1.3	1530	6920	1910	-	1910	520	95	26		
25	43		6.0		860		3040	160	3200		130		256	83
30	52	34	8.3	2.6	570	2700	4080	390	4470	1330	149	44		
35	60		10.2		415		5010	450	5460		156		227	78
40	67½	45	12.1	3.8	310	1530	5850	500	6350	2110	159	53		
45	74		14.0		245		6620	520	7140		159		199	73
50	80	55	15.6	4.9	200	1050	7320	520	7840	2840	157	57		

SITKA SPRUCE

Quality Class I compared with Site Index 200

AGE (Years)	MEAN HEIGHT (Feet)		NO. OF TREES		VOLUME (Cubic Feet)		INCREMENT (Cubic feet per year) Mean Annual		INCREMENT (Cubic feet per year) Periodic Annual	
	U.K.	U.S.	U.K.	U.S.	U.K.	U.S.	U.K.	U.S.	U.K.	U.S.
20	49	43	850	1550	4330	2750	216	137		
25	59½		645		5970		238		305	401
30	69	75	505	810	7380	6760	246	225		
35	77½		395		8610		246		240	401
40	85½	103	305	395	9780	10770	244	269		
45	93		245		10880		242		212	402
50	100	126	190	2000	11900	14790	238	296		

Quality Class II compared with Site Index 160

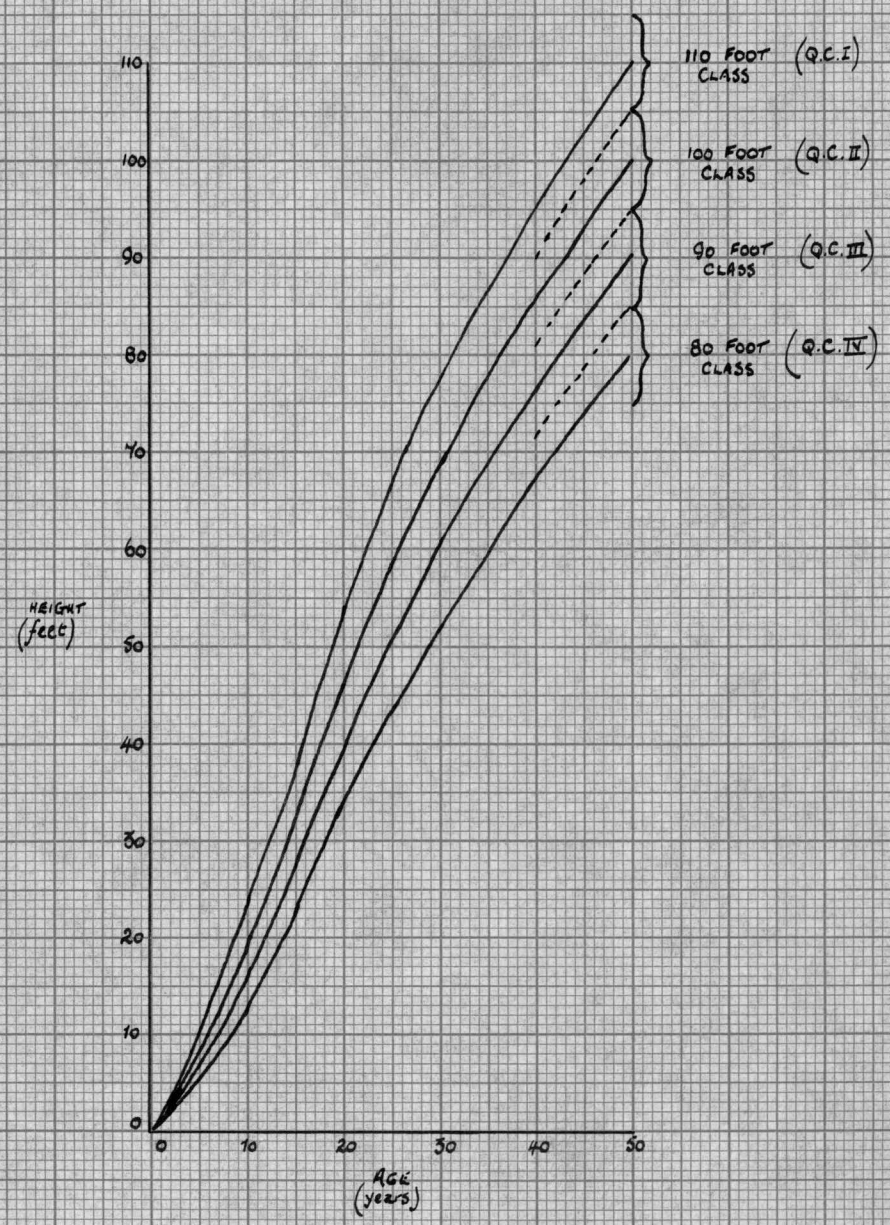
15	29½		1785		1340		89			
20	41½	34	980	1800	3130	2110	156	105		
25	52		695		4780		191		306	316
30	61	60	545	1130	6190	5280	206	143		
35	69		440		7380		210		229	327
40	76½	82	350	640	8480	8550	212	214		
45	83½		280		9500		211		196	328
50	90	101	225	382	10440	11830	209	237		

Quality Class III compared with Site Index 120

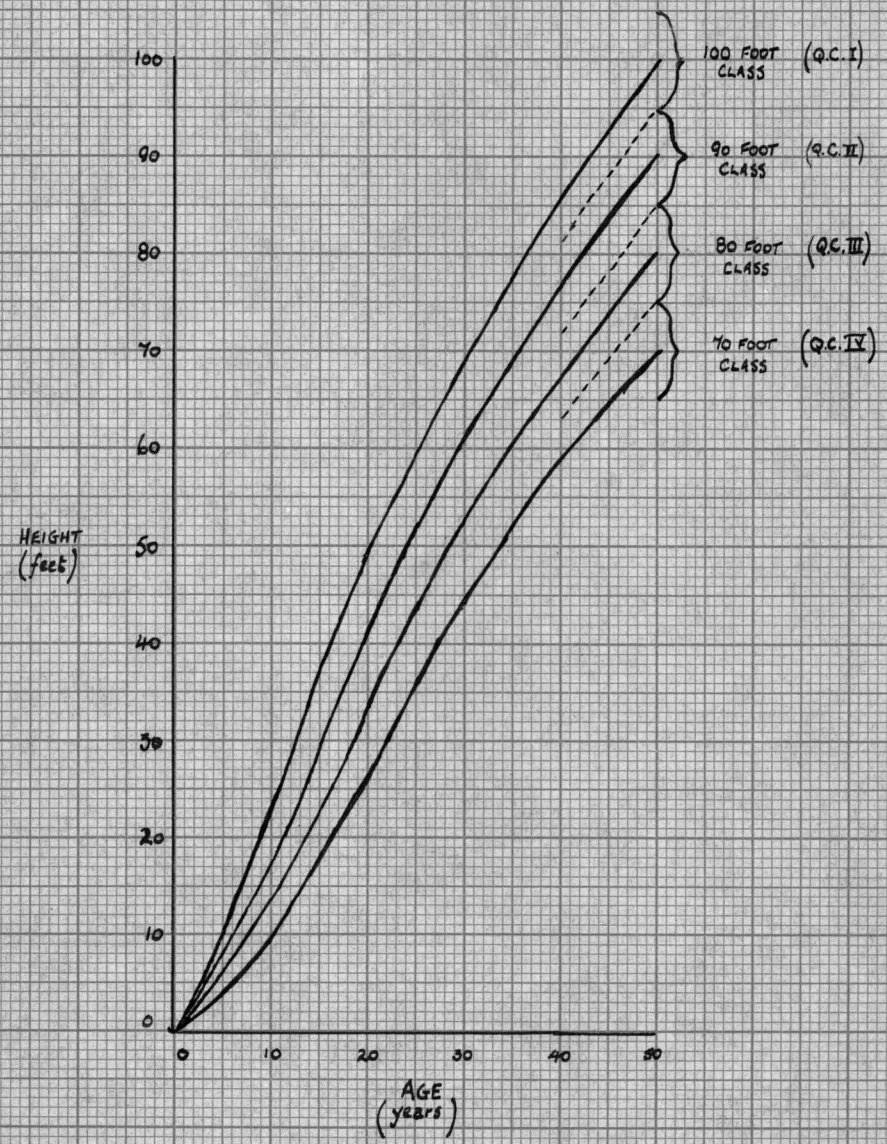
20	33½	25	1230	1900	1950	1270	97	63		
25	43½		810		3450		138		291	211
30	52½	45	610	1700	4850	3380	162	113		
35	60½		490		6120		175		231	222
40	67½	62	400	1140	7170	5600	179	140		
45	74		325		8120		180		183	221
50	80	78	270	780	9000	7810	180	156		

Quality Class IV compared with Site Index 80

20	26½	17	1780	1200	890	420	44	21		
25	36		980		2320		93		272	127
30	44½	30	690	1800	3610	1690	120	56		
35	52		545		4780		137		219	137
40	58½	41	445	1820	5800	3060	145	76		
45	64½		380		6730		150		173	138
50	70	51	320	1450	7530	4440	151	89		



SITKA SPRUCE



REFERENCE MATERIAL USED IN THE PREPARATION OF PARTS I AND II.

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