Not for publication

FERTILIZATION OF DENSE JUVENILE WESTERN HEMLOCK (Project B.C. 2)

by

Y. (Jim) Lee

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CANADIAN FORESTRY SERVICE
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INTERNAL REPORT BC-15

DEPARTMENT OF FISHERIES AND FORESTRY

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INTRODUCTION

A fertilization trial on dense juvenile western hemlock (*Tsuga heterophylla* (Raf.) Sarg.) was initiated in 1967 at four study sites on Vancouver Island. This report records the progress made in 1967, 1968 and 1969.

THEORETICAL BASIS FOR THE STUDY

Western hemlock, a prolific seeder, yields some seed every year and heavy seed crops every three or four years. Cones are sometimes found on trees less than 20 years old, though seed-bearing usually starts between 25 and 30 years (Fowells 1965). When adequate moisture is available, germinants have an excellent chance on such diverse materials as moss, humus, decaying litter and mineral soils. Abundant seedlings are often found on moist seedbeds in open or clear-cut areas.

Because western hemlock germinates and survives under a wide variety of seedbed conditions, very dense stands, five to 15 years of age, often become established. There is intense competition for growing space, which in turn results in retarded dbh and height growth at an early stage of the stand development. Natural thinning does occur, but it is a very slow process. Early artificial thinning is therefore required to convert densely stocked areas to stands capable of producing merchantable trees.

The British Columbia Forest Service (1936) yield-tables show the relationships between average dbh and total number of trees per acre for site index 100 (Table 1). A stand with an average dbh of 1 inch has 10,600 trees per acre. When the stand grows to an average dbh of 2 inches, the number of trees per acre is reduced to 6,500 stems. When the same stand grows to an average of 3 inches, the number of stems is further reduced to 4,130. This means that 4,100 trees die

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Table 1. The relationship between average dbh and number of stems per acre for western hemlock stand, site index 100

dbh inches	Number of stems per acre	Mortality													
1	10,600														
2	6,500	4,100													
3	4,130	6,470	2,370												
4	2,700	7,900	3,800	1,430											
5	1,820	8,780	4,680	2,310	880										
6	1,300	9,300	5,200	2,830	1,400	520									
7	960	9,640	5,540	3,170	1,740	860	340								
8	740	9,860	5,760	3,390	1,960	1,080	560	220							
9	595	10,005	5,905	3,535	2,105	1,225	705	365	145						
10	500	10,100	6,000	3,630	2,200	1,320	800	460	240	95					
11	420	10,180	6,080	3,710	2,280	1,400	880	540	320	175	80				
12	360	10,240	6,140	3,770	2,340	1,460	940	600	380	235	140	60			
13	313	10,280	6,187	3,817	2,387	1,507	987	647	427	282	187	107	47		
14	272	10,328	6,228	3,858	2,428	1,548	1,028	688	468	323	228	148	88	41	
15	241	10,359	6,259	3,889	2,459	1,579	1,059	719	499	354	259	179	119	72	31

during the period of stand growth from an average dbh of 1 inch to an average dbh of 2 inches; 6,470 trees die during the period of stand growth from 1 inch to 3 inches; 7,900 trees from 1 inch to 4 inches, and so on.

The same yield tables show that it takes as long as seven years (Fig. 1) for a stand to grow an inch of average dbh for site index 100 between ages 10 and 50. The key word here is time. If we could increase the rate of average dbh growth and speed up mortality of suppressed trees by fertilizer treatment, rotation age could be reduced.

OBJECTIVES

The major objective of the study was to test the use of N fertilizer for stimulation of the growth of dominant and codominant trees, as a means of speeding up natural thinning. Other objectives were to study the nutrient status of foliage and soil in relation to forest fertilization.

CO-OPERATORS

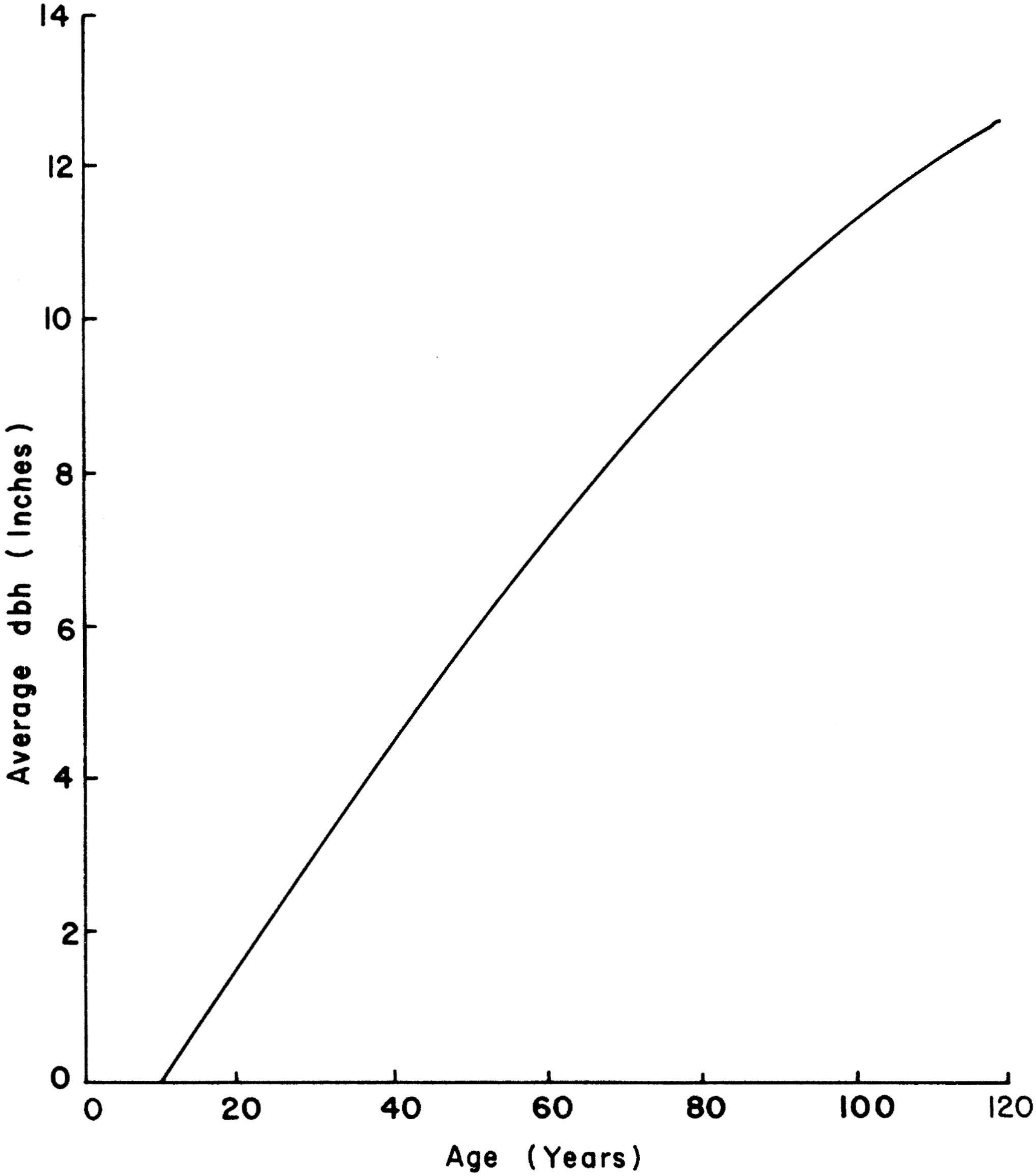
The study was planned and initiated in 1967. Establishment was completed in 1968, except for the Quadra Island plots, which were initially established by one of the co-operating companies and later included in the study. The study was co-ordinated by the British Columbia Forest Fertilization Board comprised of representatives from the B.C. Forest Service, Canadian Forestry Service and various forest industrial companies. The study sites were located on forest lands of four of these companies; each company maintained the trial on its land. The author collaborated with Dr. J. Baker of the Canadian Forestry Service, the former being responsible for mensurational aspects of the study, and the latter for soil and nutritional aspects.

THE STUDY SITES

Study sites were selected in four areas of the Southern Pacific Coast Section of the Coast Forest Region (Rowe 1959) on Vancouver Island.

Site 1: Approximately five miles from Jeune Landing in a dense hemlock stand established in 1956. Average number of trees per acre was 15,700 stems. The soil is Orthic Humic Podzol.

Figure I· The relationship between average dbh and age for western hemlock stand, site index 100



Site 2: Near Woss Camp on Loon Lake road. The dense hemlock stand was established in 1952. Average number of trees per acre was 11,500 stems. The soil is Orthic Dystric Brunisol.

Site 3: Near Port Renfrew in Lens Creek, Spur 6170, Setting No. 89. The dense hemlock stand was established in 1954. Average number of trees per acre was 9,250 stems. The soil is Degraded Dystric Brunisol.

Site 4: On Quadra Island. The dense hemlock stand was established in 1939. Average number of trees per acre was 8,100 stems. The soil is Orthic Dystric Brunisol.

All four study sites were logged and burned prior to natural regeneration of hemlock.

PLOT ESTABLISHMENT

Fifteen 1/50-acre plots (29.5' x 29.5') were established at Jeune Landing (Site 1) and Port Renfrew (Site 3), and twelve at Woss Camp (Site 2). Each plot was divided into five equal strips at right angles to the contour. The buffer strip for each plot was at least 10 feet wide. On Quadra Island, nine 1/100 acre circular plots were treated in 1966.

Figure 2 shows in detail the plot layout for these four study sites.

PLOT TALLY

All living trees on each plot were tallied by strip, species and 1 inch dbh class. In addition, five well-spaced trees per strip (25 per plot) were selected and tagged. Dbh was measured to the nearest 1/20 inch, and height to the nearest 1/2 foot. Plot statistics are summarized and presented in Table 2.

SOIL AND FOLIAR SAMPLES

Soil profiles at Jeune Landing, Woss Camp and Port Renfrew were described by Dr. Baker. The illustrations shown in Figure 3 were prepared by the author. Soil and foliage samples before and after fertilization were collected for chemical analysis.

Table 2. Plot statistics for the four study areas.

Study area	No. of plots	Range	Number of trees per acre	Average dbh of the sample trees in each plot, in inches	Average height of the sample trees in each plot, in feet
Jeune Landing	15	Maximum	22,850	3.4	27.0
		Average	15,750	2.7	24.0
		Minimum	7,000	2.3	22.3
Woss Camp	12	Maximum	19,550	4.3	39.0
		Average	11,500	3.6	34.0
		Minimum	6,050	2.8	25.0
Port Renfrew	15	Maximum	18,450	3.6	33.0
		Average	9,250	3.0	28.0
		Minimum	4,150	2.3	23.0
Quadra Island	9	Maximum	10,200	3.3	35.0
		Average	8,000	3.0	33.0
		Minimum	6,100	2.9	31.0

Figure 2· Fertilization plot layout for the four study areas

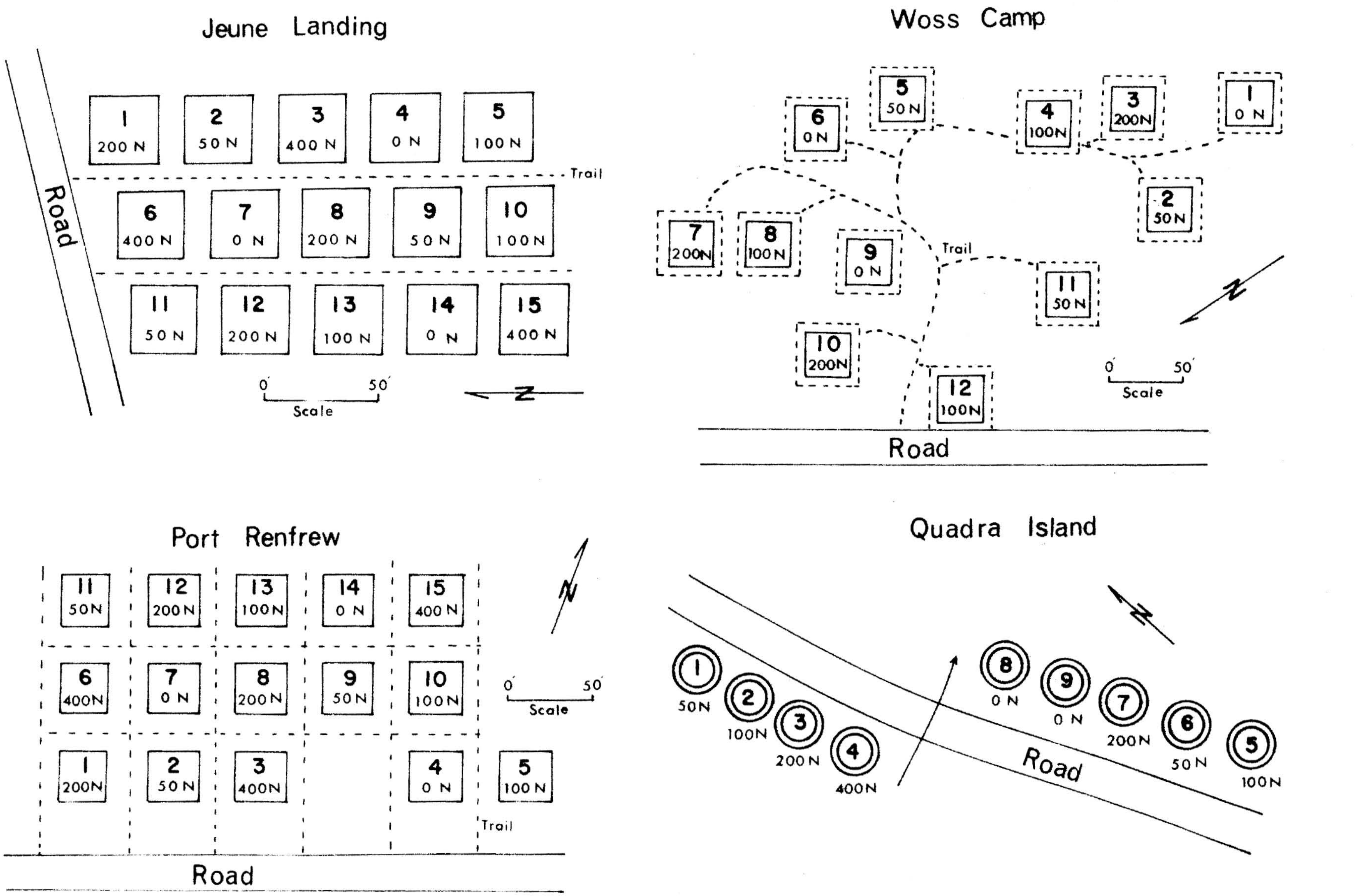
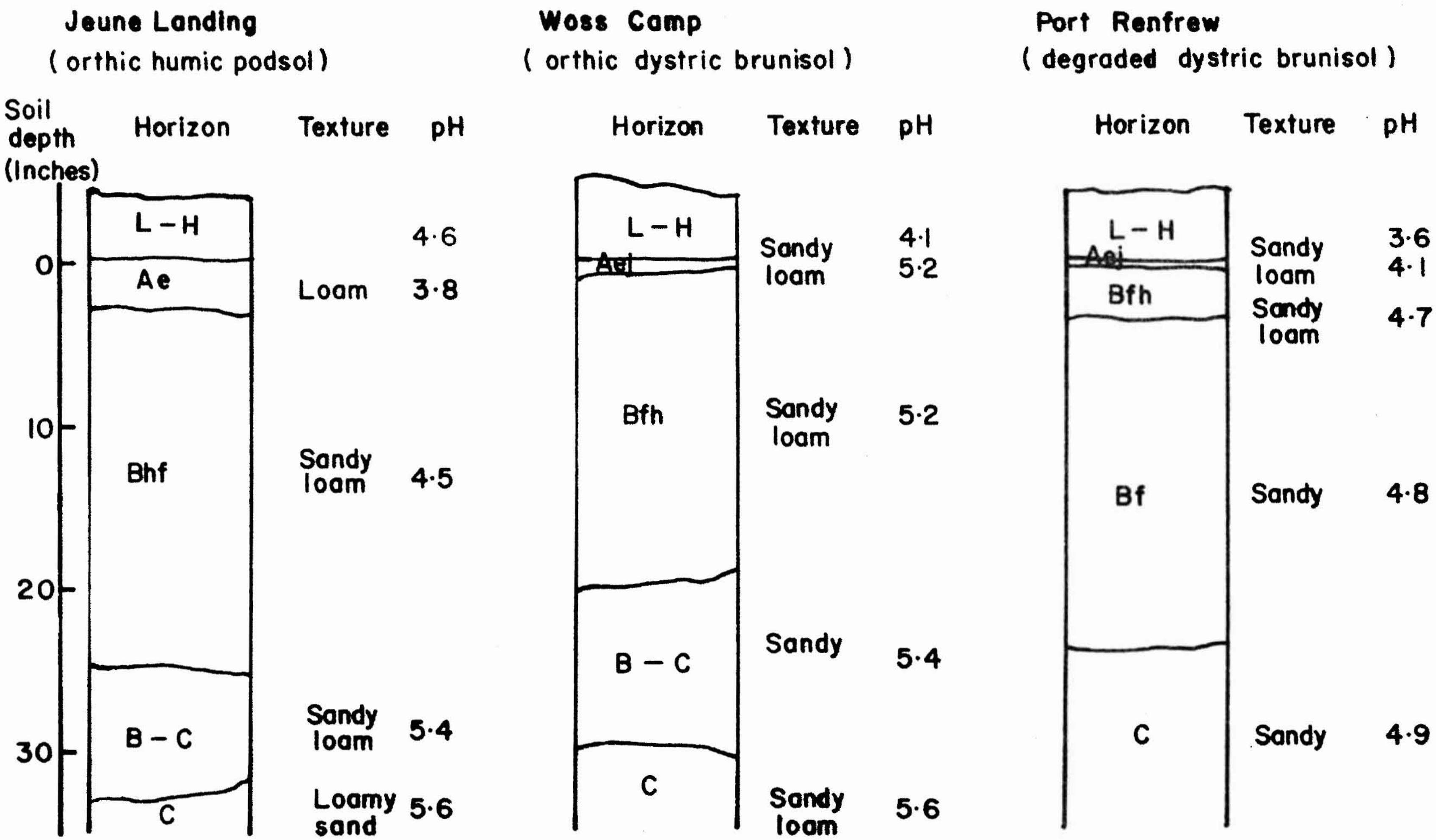


Figure 3· Soil profile descriptions



FERTILIZER APPLICATION

Fertilizer (Urea, 46% Nitrogen) was hand broadcast at 0, 50, 100, 200 and 400 pounds of nitrogen per acre in early April, 1968, except at Woss Camp where the study area was large enough for only three treatments. Table 3 shows the number of plots for each treatment at each site.

PERCENTAGE DISTRIBUTION OF TOTAL NUMBER OF TREES BY DBH CLASS

To compare the distribution of trees among the four study sites, the percentages of total number of trees for each dbh class were plotted against dbh classes (Fig. 4). It was found that the distributions were compatible except at Quadra Island, where the stand was the oldest of the four under study. The size and shape of plots at the Quadra Island site differed from those at the other three, being 1/100 acre as against 1/50 acre, and circular as against square.

RESULTS TO DATE

(1) Soil and foliar samples

Soil and foliar samples were analyzed by Dr. J. Baker, from whose report (Baker 1969) the following notes have been taken.

For foliar samples, nitrogen (N) and phosphorus (P) levels appeared to be adequate for tree growth. Potassium (K) levels were low. For soil samples, urea fertilizer increased the nitrogen content of the litter layer and in some cases that of the 0-2 inch mineral layer. The nitrogen content of the deeper mineral layers was not affected. The pH value of the litter layer was increased, to the greatest extent at the Port Renfrew study site, followed in decreasing order by Jeune Landing and Woss Camp. The pH values of the underlying mineral soils were, however, the same.

(2) Basal area growth

Diameters at breast height of tagged trees were measured on all plots one and two years after fertilization (two and three years at Quadra Island). The measured trees were sorted by crown class, treatment and location, and the results are presented in Table 4. The average basal area growth for each crown class and treatment was expressed in terms of multiples of the average basal area growth for intermediate and suppressed trees on the untreated control plots, i.e.,

Table 3. Number of plots for each treatment at each site.

Study site	Rate of application					Total no. of plots
	0	50	100	200	400	
Jeune Landing	3	3	3	3	3	15
Woss Camp	3	3	3	3	-	12
Port Renfrew	3	3	3	3	3	15
Quadra Island	2	2	2	2	1	9
Total	11	11	11	11	7	51

Figure 4· Percentage distribution of total number of trees in each dbh class for the four study areas

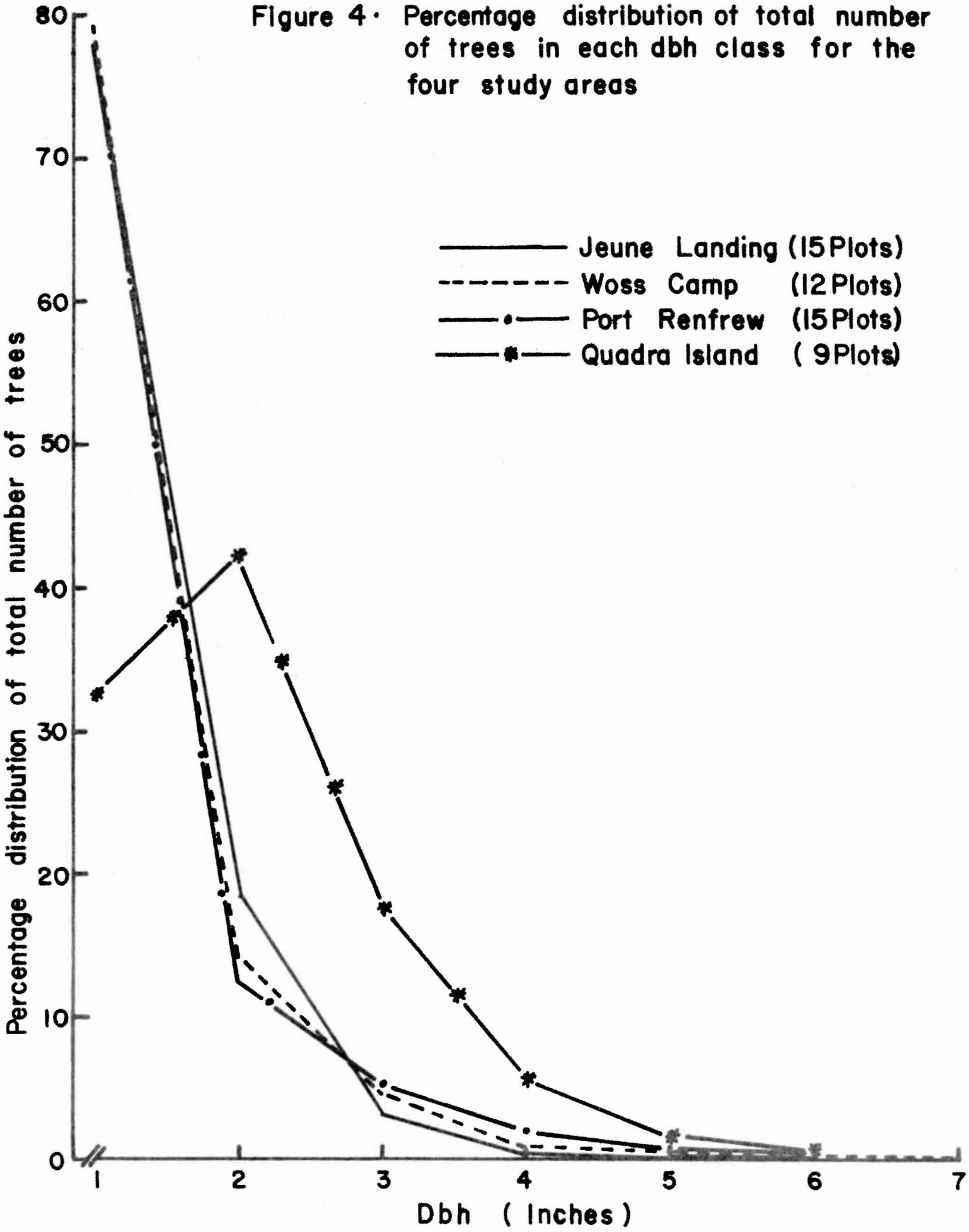


Table 4. Average basal area growth for treatments of 0, 50, 100, 200 and 400 lb of N per acre expressed as multiples of the average basal area growth for intermediate and suppressed trees on the untreated control plots.

Duration of response	lb of N per acre	Jeune Landing			Port Renfrew			Woss Camp			Quadra Island			Combined Data		
		I & S	CD	D	I & S	CD	D	I & S	CD	D	I & D	CD	D	I & S	CD	D
One year	0	1.0[c]	1.7	2.3	1.0[b]	2.5	7.0	1.0[b]	2.3	4.7	1.0[a]	1.0	7.0	1.0[b]	2.0	5.0
	50	0.6	2.0	2.7	1.0	3.0	5.5	-	2.3	4.0	1.0	2.0	4.0	1.0	2.5	4.5
	100	1.0	2.0	4.0	1.5	3.0	6.5	1.3	2.7	6.0	2.0	2.0	6.0	1.5	2.5	5.5
	200	1.0	2.0	2.7	1.5	2.5	6.0	1.0	2.7	5.0	1.0	4.0	8.0	1.0	2.5	5.0
	400	1.3	2.3	4.0	1.5	4.0	9.0				1.0	3.0	4.0	1.5	3.0	7.0
Two year	0	1.0[e]	1.8	2.8	1.0[d]	2.5	6.2	1.0[c]	2.0	4.5	1.0[a]	2.0	11.0	1.0[c]	2.7	5.7
	50	0.8	2.2	2.8	0.8	3.0	5.8	-	2.5	4.0	2.0	5.0	10.0	1.0	3.0	5.3
	100	1.0	2.4	4.6	1.2	2.8	6.5	1.5	2.5	5.0	2.0	3.0	11.0	1.3	3.3	7.0
	200	0.8	2.2	3.4	1.5	2.0	6.2	1.0	2.5	4.5	2.0	6.0	14.0	1.3	3.0	6.3
	400	1.4	2.8	4.8	1.5	3.5	9.2				2.0	6.0	12.0	1.3	3.3	9.7

[a] Basic basal area growth 0.001 sq ft
[b] Basic basal area growth 0.002 sq ft
[c] Basic basal area growth 0.003 sq ft
[d] Basic basal area growth 0.004 sq ft
[e] Basic basal area growth 0.005 sq ft

D: dominant
CD: codominant
I: intermediate
S: suppressed

$$\text{Multiple} = \frac{\text{Average basal area growth}}{\text{Basic basal area growth}}$$

Average basal area growth = growth for each crown class and treatment.

Basic basal area growth = average growth for intermediate and suppressed trees on the untreated control plots.

As expected, dominant and codominant trees grew more than intermediate and suppressed trees in all cases, and trees maintained their relative dominance.

In general, for a two-year period, the growth of dominant and codominant trees ranged from two to 14 times that of the intermediate and suppressed trees. This growth varied with location and fertilizer treatment. It was noted that the pattern of treatment effects was not always regular. Thus, at Jeune Landing and at Port Renfrew, response to the treatment of 200 lb of N was less than that for 100 lb. At Woss Camp (where treatment of 400 lb of N per acre was not used), the best growth was in the stand treated with 100 lb of N per acre. However, the pattern of treatment effects for these three sites showed a similar trend. This was probably due to the fact that the percentage distribution of trees by dbh classes for the three sites was almost identical (Fig. 4). On Quadra Island, increment was greater for the 200 lb of N per acre than for 100 or 400 lb. The distribution of trees by dbh classes at this study site was entirely different from that at the other three.

In all cases where it was applied, the treatment of 400 lb of N per acre gave the highest response after two years.

FUTURE WORK

In order to assess the initial effect of fertilizing on natural thinning, all living trees are to be re-tallied for each plot by strip, species, and 1-inch dbh classes in 1970. Increment borings, stem analysis and re-tallying, to assess the fertilizer effect on growth and natural thinning, are scheduled for 1973.

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