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POTENTIAL PRODUCTIVITY OF DENSE, YOUNG THICKETS OF RED ALDER

by
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Abstract. Total above-ground production was evaluated in 28 natural alder thickets, aged 1 to 14 years. On a per acre basis, mean annual production varied from 3 to more than 20 tons of green wood per acre. Such yields warrant preliminary trials of short-rotation cultural systems with red alder.

Densely-spaced stands of several different species have been reported to produce high yields in short rotations. Such species range from sycamore (McAlpine et al., 1966) and loblolly pine (Harms and Langdon, 1972) in the South to black cottonwood in the Northwest (Heilman et al., 1972). Several foresters predict that at least part of the future supply of wood fiber will be grown by short rotation management (Herrick and Brown, 1967; Schreiner, 1970; Zivnuska, 1972). It is now apparent that small hardwood stems can be harvested and utilized with only minor changes in existing technology. However, additional information is needed on the economics and biological aspects of growing short-rotation timber crops.

Crown Zellerbach's Forestry Research Group has been doing background studies to determine potential yields that might be obtained under highly mechanized, intensive culture of short-rotation hardwoods. Initial work

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in cooperation with Washington State University indicated that yields up to 13 green tons per acre per year were produced by coppiced black cottonwood (Heilman _et al_., 1972). Although the cottonwood yields were promising, Smith (personal communication) suggested that higher yields could be obtained in young stands of dense, red alder. Because of its apparent capacity for such rapid growth in very dense, young stands, red alder seemed a likely candidate for short-rotation management. In order to estimate the potential yield of red alder under intensive culture, we studied the upper limits of productivity in natural alder thickets. Our methods and findings are discussed in this paper.

METHODS

Young alder thickets of maximum density were located in the lower Columbia River Valley. Six by six-foot plots were established in the densest clumps within each thicket. Other than density, the only criterion for plot location was presence of a border of at least two to three feet of like-spaced trees between the plot and any area which received additional sunlight. This requirement gave some confidence that plot yields could be reproduced on a per acre basis.

All trees on the six by six-foot plot were cut, bundled, and weighed to determine total green weight for the plot. Total height and root-collar diameter (outside bark) were tallied for each tree. Next, five sample trees representing the range in sizes found within the plot were selected for additional measurements. Data were collected from the sample trees to develop relationships of total tree weight or plot weight to weight of stems, branches, and leaves. A disc was cut from the base of each tree for age determination. Sub-samples of component parts of the trees were collected and evaluated for green weight/oven-dry weight relationships. In addition, two-inch stem sections were collected at root-collar, breast height, and half height for determinations of volume, specific gravity, bark content, and moisture content of stem portions.

The data were analyzed by standard multiple regression techniques.

RESULTS AND DISCUSSION

In total, twenty-eight plots were measured--their characteristics are listed in Table 1.

TABLE 1

CHARACTERISTICS OF RED ALDER PLOTS

	Mean	Min.	Max.
Elevation	1000	50	4000
Age (yrs)	6	1	14
Avg. Dom. Ht. (ft)	17	3	46
Avg. Dbh (in.)	2.4	0.2	8.2
No. of Stems (M/acre)	50	1	243
Basal Area (ft^2/acre)	240	40	910
Tot. Gr. Wt. (tons/acre)	64	3	270
Green M.A.I. (tons/acre)	8	3	25

The plots were located at elevations ranging from 50 to 4000 feet above sea level. Average plot age varied from 1 to 14 years. The height of the six tallest dominant trees averaged 17 feet, but varied from 3 to 46 feet. Average dbh ranged from 0.2 to 8.2 inches. The last four characteristics (Table 1) indicate stocking and yield, and are expressed on a per acre basis. Number of stems per acre averaged 50 thousand but range up to 243 thousand. Basal area at the root-collar varied from 40 to more than 900 square feet and averaged 240 square feet. Maximum yield was 25 green tons per acre per year.

Regression analyses of several combinations of these plot variables revealed that total plot weight could be predicted accurately from basal area (measured at the root-collar) and the average height of the six tallest trees:

$$\text{Plot Green Wt. (lbs)} = 0.03327 - 545.2155\,(X_1)^2 + 28.7871\,(X_1X_2)$$

Where X_1 = root-collar basal area

X_2 = avg. ht. of 6 dom. trees

$R^2 = 0.9860$ SEE (%) = 16%

Age was not a significant variable in the regression analysis, primarily because of much variation in yields and densities of stands more than five years old. However, it was interesting to look at the stocking and growth figures averaged by age class (Table 2). At age four, the thickets averaged more than 100 sq. ft. of basal area at the root-collar. While large increases in basal area was occurring, there also was considerable mortality. Apparently, we sampled more productive sites in the 8 to 11 year age class than in the 12 to 14 year age class.

TABLE 2

STOCKING AND GROWTH OF YOUNG RED ALDER AS RELATED TO AGE CLASS

Age Class	Number of Stems	Root Collar B.A.	Avg. Dom. Height	Mean Annual Wood Production	
				Fr. Wt.	O.D. Wt.
-yrs-	-M-	$-ft^2-$	-ft-	--tons--	
1-2	122	46	6	3.7	1.7
3-4	60	109	11	3.8	1.7
5-7	39	213	17	7.1	3.2
8-11	14	715	33	19.3	8.8
12-14	13	440	29	9.8	4.4

Yields shown were based on the complete tree--they include leaves and branches as well as stems. In order to estimate the yield of component parts of the trees, relationships between the parts and total tree weights were evaluated by linear regression.

On the average, 74 percent of total tree weight was contained in the stem, 16 percent in branches, and 10 percent in leaves (Table 3). Because our sampling was done in September, these percentages may not be generally applicable to alder thickets sampled at other times of the year. However, if we exclude leaves and consider only the woody portions, stem and branch weight would amount to 82 percent and 18 percent of the total wood weight, respectively.

Component	with Leaves	Without Leaves
Stems		82
Branches	16	18
Leaves		--
Total	100	100

Laboratory analyses of stem sections showed that moisture content, bark content, and density of stem wood (expressed on an oven-dry weight basis) were 119 percent, 19 percent, and 27 lbs per cubic foot, respectively.

shown in Table 4.

TABLE 4

ESTIMATED ANNUAL PRODUCTION OF STEM WOOD VOLUME ON THE FIVE BEST PLOTS

Plot	Age	Productivity Ranking	Stem Wood With Bark	Stem Wood Without Bark
			---ft^3/acre---	
25	11	1	700	560
20		2	660	530
28	13	3		370
26	9	4	450	
5	14	5	390	320

Volume of stem wood including bark produced on these plots ranged from 390 to 700 cubic feet per acre per year. Corresponding values without bark were 320 to 560 cubic feet. Although we sampled plots in age classes from 1 to 14 years, the most productive plots tended to be the oldest ones measured.

We were somewhat skeptical of such high yields, and wondered whether they could be reproduced on a large-scale basis. However, in terms of dry matter production, our highest yields were not out of line with data reported for maximum production achieved by alder and other plant communities in temperate zones. Our study indicated a maximum value of 11.6 oven-dry tons per acre per year whereas Zavitkovski and Stevens (1972) suggested that aboveground production might exceed 11 tons per acre per year on better sites between the ages of 10 and 15 years. Moreover, Westlake's (1963) survey of data on maximum production indicated 13.4 tons per acre per year for total production of temperate perennial crops--an efficiency of about 3%. He also listed 12.5 tons per acre for coniferous forests and 5.3 tons per acre for deciduous forests. Although our maximum values are much higher than Westlake's figures for deciduous forests, they are comparable to his values for coniferous forests and to Zavitkovski and Steven's data on red alder.

By controlling stand density at early ages, production could probably be increased. The best plots had 1 thousand to 17 thousand stems per acre at ages varying from 9 to 14 years. The average stocking for plots of five years and less was 70 thousand stems; therefore, a great deal of mortality must have occurred on the best plots. Under intensive, short-rotation culture, density would be controlled by initial planting or by early weeding if the land was seeded to alder. Growth could thereby be concentrated on fewer, larger stems. However, work is needed to determine the inter-relationships of age, site productivity, stand density, and yield. Because young alder stems sprout readily after cutting, alder can perhaps be coppiced with several rotations coming from an initial establishment.

To sum up, our study of natural thickets indicated that very high yields were achieved in dense, young alder stands. Although additional economic and silvicultural information is needed, it is obvious that red alder is an attractive candidate for intensive culture on short-rotations.

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