through the implementation of research findings. The British research commitment amounts to \$1,820,000 or three percent of Forestry Commission expenditures, in personnel it amounts to some 15 percent of the graduate staff and 5 percent of the technical. Additional are the costs and staffing (comprising an additional 5 percent of the graduate and 5 percent of the technical staff) of the two Management Services Division sections, and of the forest related efforts of the other research agencies that would in the United States be undertaken by foresters.

As to the exportability of the organizational structures and policies, each country has its own special circumstances and the pattern of research that evolves must reflect national needs. Similarly in regard to the scale and orientation of the program. American research is of a high calibre and its extent impressive. It may be presumed to have developed to its present form in response to national require-

ments. Its methods of deployment of resources for research into the basic relationships and the close connections between the U.S.F.S. and University research are worthy of study in the development of a Canadian solution.

Nevertheless the British method of deployment of considerably lesser resources and the high return for the research dollar invested would seem to provide several indications for possible development of a problem-solving, developmental oriented Canadian forest resources research, that can make a major impact on practice through answering those questions that are of concern to the practitioner.

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The Physical and Mechanical Properties of Whitebark Pine

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"Knowledge of the basic physical and mechanical properties of whitebark pine is needed to determine its potential use and proper classification in the lumber market."

Abstract

The results of physical and mechanical tests on samples from five whitebark pines (Pinus albicaulis Engelm.) clearly indicate that this species should be classed as soft pine.

Les propriétés physiques et mécaniques du Pin à blanche écorce (Pinus albicaulis Engelm.)

Résumé

Les résultats obtenus à la suite d'essais sur les propriétés physiques et mécaniques d'échantillons de cinq individus du pin à blanche écorce (Pinus albicaulis Engelm.) montrent clairement que cette espèce forestière devrait être classée dans la catégorie des pins à bois mou.

Introduction

Paul (5) indicated that whitebark pine belongs to the soft pine group which includes western white pine (*Pinus monticola* Dougl.), eastern white pine (*Pinus strobus* L.) and sugar pine (*Pinus lambertiana* Dougl.), but he does not present physical evidence other than botanical classification and

visual observation to support his position. Because there is no basic information on the physical and mechanical properties available for whitebark pine, the lumber from this species is being marketed as lodgepole pine (3).

Knowledge of the basic physical and mechanical properties of whitebark pine is needed to determine its potential use and proper classification in the lumber market.

Methods

An area in the Crowsnest Forest, in southwestern Alberta, (Latitude 49° 48' and Longitude 114° 35') was selected for sampling whitebark pine (3). The five trees selected according to A.S.T.M. standard D-143-52 (1965) (1) averaged 16.1 inches in diameter outside bark, 73 feet in total height, 53 feet in merchantable height, 47.3 cubic feet in gross volume and 303 years of age.

One 8-foot butt log was taken from each of five whitebark pine trees selected to be used for mechanical-property tests. The samples were marked out on the logs according to A.S.T.M. Standard D-143-52 (1965) (1). The logs were sawn into 2½-inch planks at a local sawmill. The planks were further reduced to obtain required dimensions for mechanical-property tests. The tests conducted were on static bending, compression parallel and perpendicular to the grain, and shear.

Table 1. Comparison of physical and mechanical properties of whitebark and other species of pine grown in Canada¹

Properties	Soft Pines			Hard Pines	
	Whitebark Pine	Eastern White Pine ²	Western White Pine ²	Lodgepole Pine ²	Ponderosa Pine ²
Place of growth of material tested.....	Alta.	N.B., Que. Ont.	B.C.	B.C. Alta.	B.C.
No. of locations sampled.....	1	4	3	2	3
No. of trees tested.....	5	25	17	13	17
Specific gravity (oven-dry).....	0.428	0.384	0.398	0.455	0.489
Specific gravity (basic) (volume green weight oven-dry).....	0.369	0.364	0.355	0.403	0.438
Rings per inch.....	32	15	19	25	26
Static Bending:					
Stress at proportional limit (psi).....	3,295	3,000	2,890	2,970	3,320
Modulus of rupture (psi).....	5,415	5,140	4,830	5,650	5,700
Modulus of elasticity (1000 psi).....	1,056	1,180	1,190	1,270	1,130
Work to proportional limit (in.lb./cu.in.)	0.592	0.44	0.40	0.40	0.55
Compression parallel to grain:					
Stress at proportional limit (psi).....	2,043	1,950	2,030	2,220	2,140
Maximum crushing stress (psi).....	2,318	2,590	2,520	2,860	2,840
Modulus of elasticity (1000 psi).....	1,165	1,260	1,300	1,420	1,260
Compression perpendicular to Grain:					
Stress at proportional limit (psi).....	287	238	235	276	349
Shear Parallel to Grain:					
Maximum stress (psi).....	682	635	652	724	720

¹Averages for material tested in green condition.²The properties of these species were obtained from Kennedy, E. I. 1965.

Strength and Related Properties of Woods Grown in Canada. Dept. of Forestry Publication No. 1104.

Preparation of each test specimen and performance of each test followed specifications given by A.S.T.M. designation D-143-52 (1965) (1). Since whitebark pine is not a major tree species in Alberta or elsewhere in Canada, the mechanical property loads were determined only for specimens in green condition.

Disks six inches thick were taken from each tree at stump height and then at intervals of 8 feet for determination of specific gravity and percent summerwood. The north side was marked and an average radius was determined for each disk. The average radius closest to north was also marked and a sample strip was cut along this radius.

The cross-sectional face of the strip was smoothed, with a microtome knife, for measurement of ring width and determination of percent summerwood. Ring width was measured to 0.001 inch with a tree-ring measuring instrument (4). The strips were then cut into samples representing 10-year increments from the bark to the pith. These samples were used for determination of specific gravity by the green-volume-oven-dry-weight method (2).

Results and Discussion

Results of the mechanical tests are presented in Table 1. The measured properties of the whitebark pines agree closely with those of other species in the white pines or soft pines classification but compared with the hard pines, whitebark pine is generally weaker.

Table 1 shows whitebark pine to have a slightly higher average specific gravity than the two soft pines; but whitebark has a considerably lower average specific gravity than the hard pines.

Results of the tests on physical properties of the samples from whitebark pine are given in Table 2.

Table 2. Physical properties of whitebark pine*

Properties	Mean	Minimum	Maximum	Standard Error of the Mean
Specific gravity (basic)	0.369	0.186	0.529	0.0015
Ave. ringwidth (inches)	0.023	0.002	0.081	0.00054
Ave. percent summerwood per ring	8.53	2.27	30.25	0.148

*Based on 740 observations.

The patterns observed in the data were: (a) specific gravity decreased with tree height, (b) specific gravity decreased with the age from the pith and (c) percent summerwood decreased as ring width increased.

The evidence collected from five trees indicates clearly that whitebark pine should be classified with other soft pine lumber.

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