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Predicting White Spruce Cone Crops

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Bountiful white spruce cone crops occur sporadically, usually once in about 5 years. Thus in seed years, seedbeds must be prepared on the most productive sites logged since the last seed crop, and seed collection for artificial reforestation has to cover expected needs for at least 5 years. A means of forecasting seed crops would permit better planning of reforestation programs in forest management.

Based on studies in the Central Interior of British Columbia, a sequential sampling method has been developed to estimate cone crop potential in the fall preceding the seed year. The method is based on the cumulative total count of female buds from one branch per tree collected from the third whorl from the top. It is also possible to use bud counts from three terminal nodes on a branch of the fourth or fifth stem node with slightly lower accuracy. The trees used for bud counts should be 45 to 80 years old, 50 to 60 feet high, of dominant class, with well-developed crowns. Old trees whose height growth has terminated and whose branches are distorted from previous cone crops are not suitable for accurate cone crop prediction.

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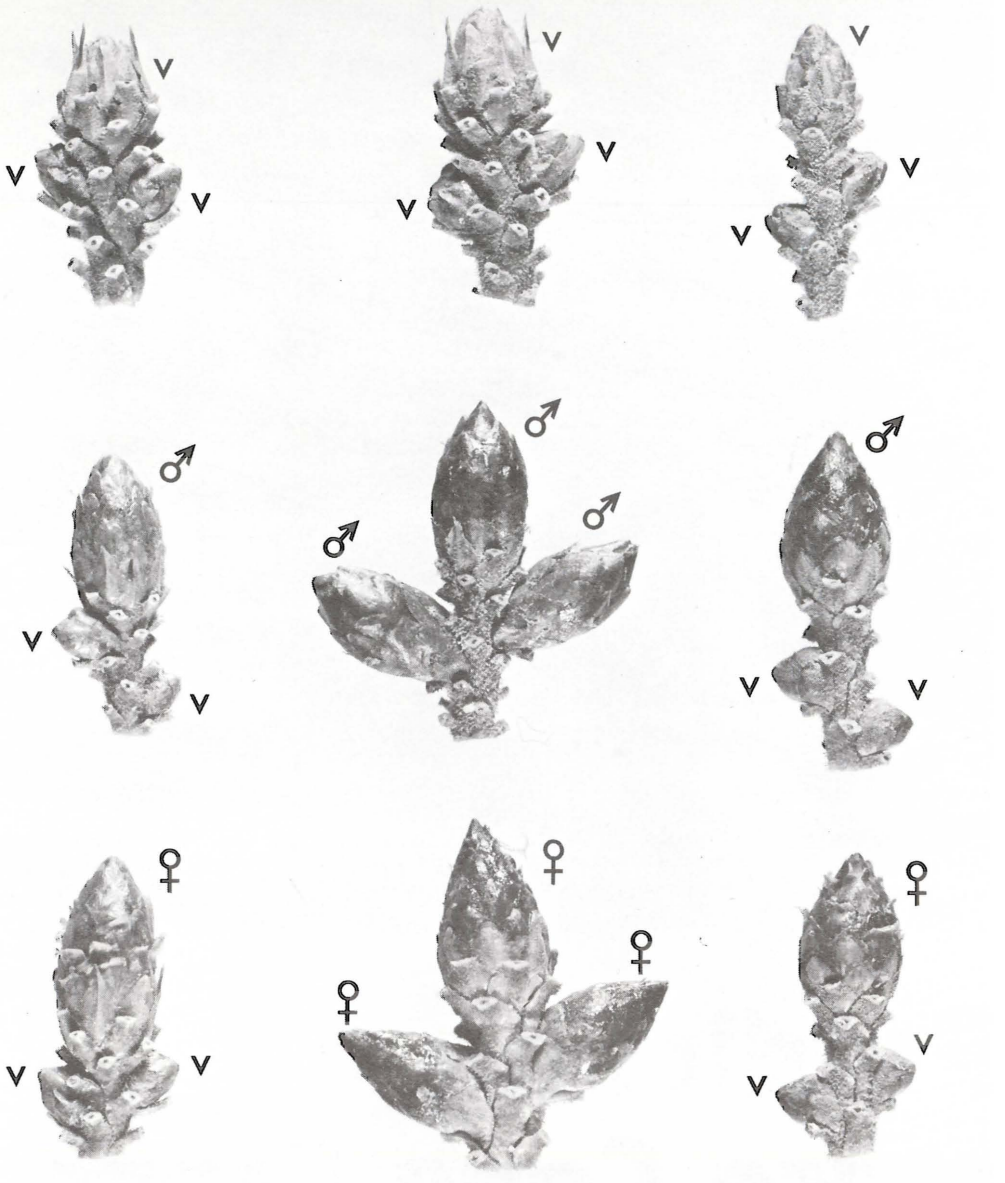

Fig. 1. Male, female and vegetative buds of white spruce. Sept. 30.

Recognition of Reproductive Buds

Assessment of cone crop potential requires recognition of reproductive buds which, in the fall preceding the seed year, can be distinguished by sight, without magnification. In white spruce, the vegetative buds are small and dome shaped. Reproductive buds are larger, ovate to obovate, and occur usually in terminal and subterminal positions on the new twigs. The outermost scales in all types of buds are alike, thick and green. They completely cover the small vegetative buds. In the larger reproductive buds, the inner scarious scales protrude and cover the upper portion of the bud (Fig. 1). Female buds are more pointed than male buds and are usually broadest near the base, whereas male buds are broadest in the central portion (Fig. 1). While it is often difficult to recognize the sex of reproductive buds from their outer appearance, male buds occur most abundantly in the middle portion of the crown and, except in heavy crop years, female buds are confined to the upper branches.

Estimation of Cone Crop Potential For a Stand

Cone crop potential may be rated according to a five-level scale, such as is usually used on the west coast (e.g. form no. 727, British Columbia Forest Service), or a simplified three-level scale when more general information is needed.

To assess the potential cone production of a stand, the bud counts for individual trees are progressively added. After each addition, the cumulative total is compared with the limit values given in Table I, which correspond with the number of trees in a sample. If the limits are not given, the cone crop cannot be classified because the number of trees in the sample is too small. When a cumulative bud count falls between given limits, the cone crop potential can be classified with 80% probability, and sampling stops. Four is the minimum number of trees required in the method (Table I and Fig. 2).

Example: Female buds were counted on one branch per tree in the following order: 3, 7, 10, 0, 1, 2, 9, 8, 12, . . . and added progressively to give the sequence: 3, 10, 20, 20, 21, 23, 32, 40, 52. In this example, on the first 4 trees, a total of 20 buds were counted. Since 20 buds on 4 trees do not fall within limits given in the table, sampling must continue. On 7 branches (i.e., 7 trees) with a total of 32 buds, the cone crop falls between ratings 2 and 3. On 8 trees, a total of 40 establishes the cone crop at rating 3. The sampling now stops.

If a cone crop cannot be classified when upper limits given in the tables are reached because the bud count falls between classes; for example, 35 buds on 14 trees (Table 1), the cone crop should be classified into the nearest category approached by the cumulative count, in this case rating 2.

A simplified three-level scheme is presented in Table 2 and Figure 3, in which the 2 and 3, and the 4 and 5 ratings were combined. The columns N_1, N_2, N_3 and N_4 are those from Table 1. Because simpler information is sought, a smaller sample size is usually required. In the above example, only 4 branches with 20 buds would be needed.

It is emphasized that no fixed sample size is required. This eliminates superfluous sampling once the bud count falls distinctly into one of the classes.

Table 1. Sequential table for assessment of prospective cone crops on white spruce, in a five-level scale. N_1 to N_5 are the limit values of cone crop ratings. They are identical with lines in Figure 2.

No. of trees		N_1	N_2		N_2	N_3	N_3	N_4	N_4	N_5	
4										173	
5						26	29	63	69	200	
6		3				30	38	73	93	227	
7		4	9		11	34	47	82	122	253	
8	Cone crop rating 1	5	10	Cone crop rating 2	14	37	56	91	149	280	Cone crop rating 5
9		6	11		17	40	65	101	176	307	
10		7	12		20	43	75	110	202	334	
11		8	12		23	46	84	119	229	361	
12		9	13		26	49	93	128	256	387	
13		10	14		29	53	102	137	283	414	
14			15		32	56	112	147	310	441	
15						59	121	156	336	495	
16						62	131	165	363		

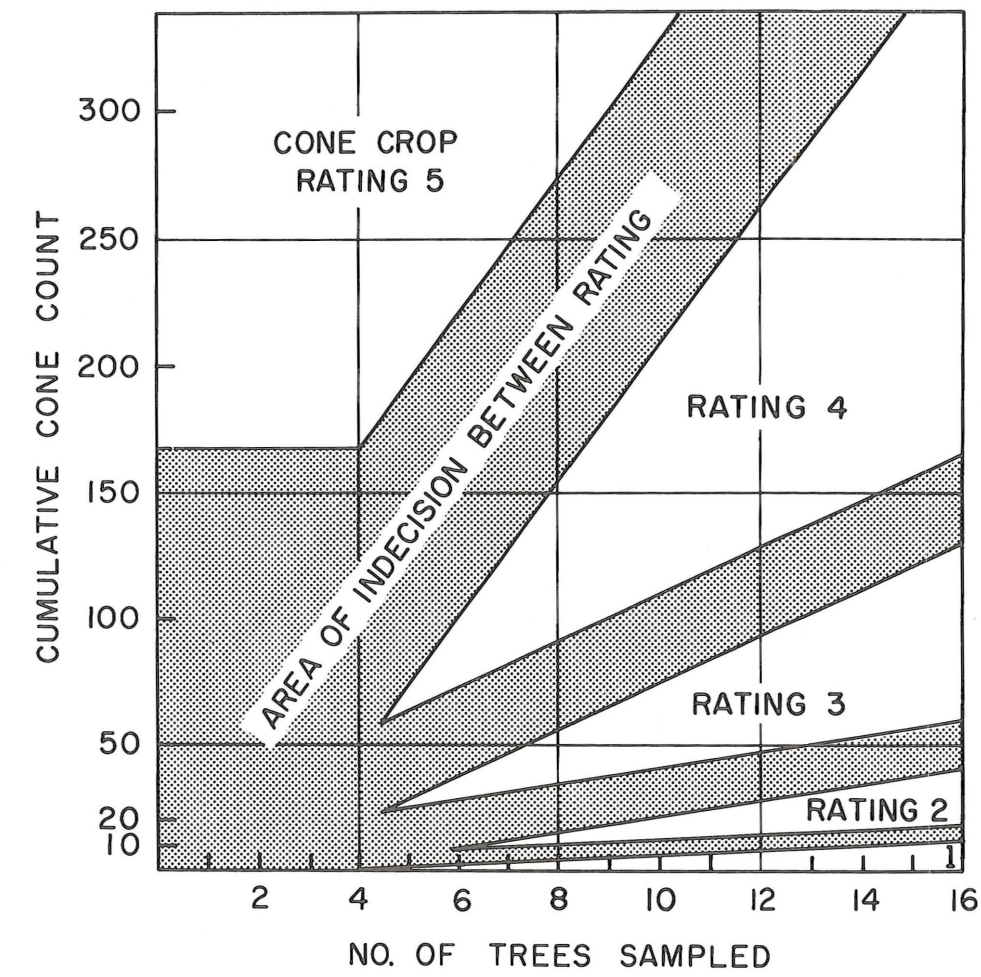

Fig. 2. Critical lines for cone crop assessment in a five-level scale. The lines are those from Table 1.

Table 2. Sequential table for assessment of prospective cone crops on white spruce, in a three-level scale. N_1 to N_5 are the limit values of cone crop ratings. They are identical with lines in Figure 3.

No. of trees	N_1		N_2		N_3		N_4	
4	Cone crop rating 1	Area of indecision between ratings	7	Combined cone crop rating 2 and 3	20	Area of indecision between ratings	53	Cone crop rating 4 and 5
5	2		7		29		63	
6	3		8		38		73	
7	4		9		47		82	
8	5		10		56		91	
9	6		11		65		101	
10	7		12		75		110	
11	8		12		84		119	
12	9		13		93		128	
13	10		14		102		137	
14	10		15		112		147	
15					121		156	
16					131		165	

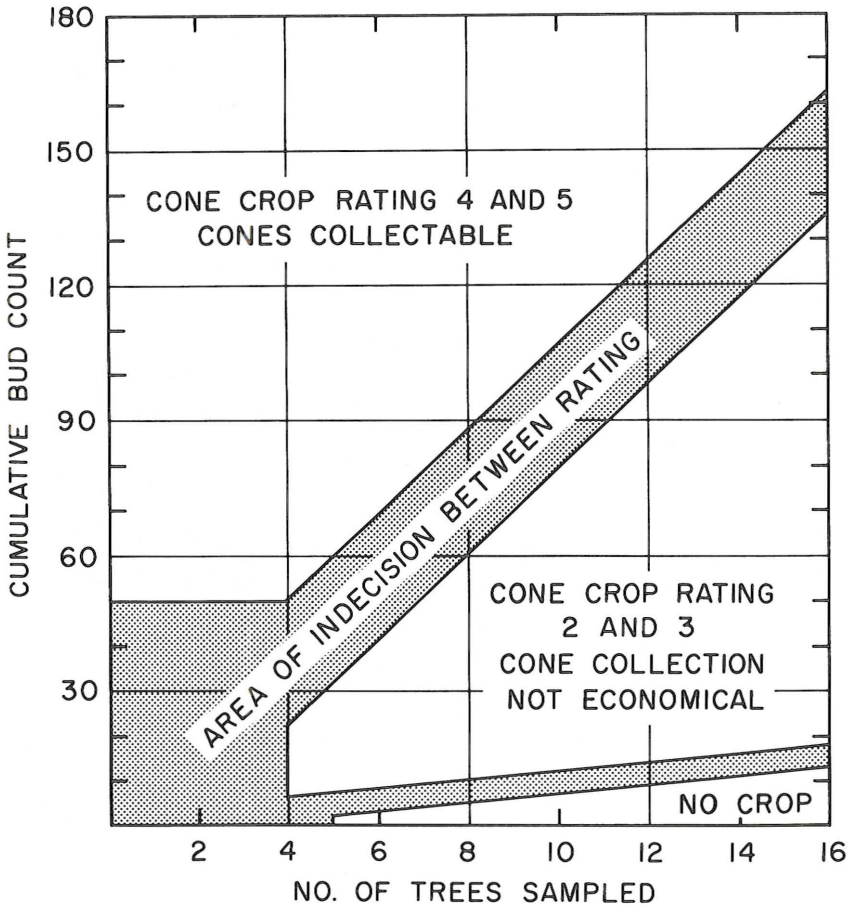

Fig. 3. Critical lines for cone crop assessment in a three-level scale. The lines are those from Table 2.

Application Over a District or Region

Cone crops of spruce are usually fairly uniform over extensive territories and, within the range studied, individual trees of similar size were usually found to have similar numbers of ovulate buds, regardless of their habitat. For these reasons, the size of sampled stands can be quite large and stratification into uniform habitats is not necessary. However, in practical cone crop assessment, trees should be similar to those described in this study and spread throughout the area.

The described method can be applied in cone crop assessments on a regional basis by sampling several stands distributed throughout the region. Thus a start might be made with 3 stands (a total of 15 to 25 trees) in a ranger district.

Knowledge of local conditions should govern the application and modification of tables and graphs to different regions. The method has, of necessity, been developed from a limited amount of data. Application and testing in practice over a wide range of conditions will therefore enable its refinement and modification to meet local conditions.

Conclusion

It must be stressed that the described technique provides only an estimate of cone crop potential. If the prospective cone crop is classified as light to heavy and abnormally large losses occur (e.g. a frost after initiation of reproductive bud activity or unusually heavy insect damage), their effect must be evaluated and the original estimate reduced. However, a failure or a very light crop can be classified accurately from the lack of reproductive structures. It will be known that seed for natural regeneration cannot be expected and that seed collection cannot be made economically.

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