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INVESTIGATION OF TREE FORM IN HARDWOODS

by

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RESUME

Après avoir expliqué le concept de la forme des arbres et des peuplements en ce qui concerne les forêts feuillues, l'auteur éclairci l'objectif de son étude, qui consiste à fournir une classification des arbres et des peuplements feuillus selon leurs défilements et en fonction des facteurs écologiques et sylvicoles pris en considération.

Puisque la première phase de son étude est orientée vers l'innovation des techniques et méthodes pour l'évaluation de la forme des arbres et des peuplements, l'auteur développe l'idée de son approche pour arriver à cette fin. De plus l'auteur met en évidence une corrélation tres satisfaisante entre le quotient de décroissance et la hauteur, qui va lui servir pour les études ultérieures pour la construction de tarifs de cubage et l'évaluation de l'accroissement courant des arbres et des peuplements.

Finalement, après avoir discuté les avantages de coefficient de forme normale par rapport à celui que l'on emploie traditionnellement dans la pratique courante en ce qui concerne la forme des peuplements, l'auteur réclame l'achat d'un dendromètre Barr et Stroud afin d'accélérer les travaux pour les études sur la forme des arbres et des peuplements feuillus.

INTRODUCTION

This study considers the mensurational (as opposed to the biological) aspects of tree form, and characterizes the form of the tree through mathematical formulae, a necessary prerequisite to the accurate determination of tree volume in general and stem volume in particular.

From the literature we know that form of an individual tree, and consequently of a stand, depends on many variables affecting stem form such as open-grown or stand-grown condition, crown or tree class, type of stand management and species being managed, site, heredity, silvicultural practices (thinning, pruning), age of stand, and so on.

OBJECTIVES

Since the form of hardwoods has for many reasons been neglected - the overwhelming majority of studies on this subject having been concentrated on coniferous species - we have undertaken this study of hardwoods in order to supply necessary information, which will lead to better and more accurate mensurational evaluation of hardwood trees and stands. In this context the main objective of our study will be concentrated on studying methods and techniques for evaluating the form of trees and stands according to age, different silvicultural and management treatments and sites. Along with it we will concentrate our efforts on constructing volume tables based on normal form factor (Popovich 1972) and evaluating the current increment of standing trees for species and stands. It goes without saying that all data gathered through our work will serve as a base for assessing normal and empirical growth and yield tables for species and stands concerned in this study.

Before entering into an explanation of our methods, it is

necessary to note that, in order to evaluate the form of trees, we accept the hypothesis that each tree has to be divided into three parts on the basis of form - the crown section, the clear bole and the butt or region of root swell, because each of these entities is subject to its own particular development.

METHODS

In this stage of work our attention is concentrated mostly on the clear bole, although the length and width of the crown have also been measured. The clear bole of each felled tree is divided into ten equal parts, using normal form factor as the means for calculating the volume of the bole. The standing trees are climbed with a ladder and the following measures on each tree are recorded: (a) Schiffel (1899) form quotient = q_2 (the ratio of diameter measured at one-half tree and bole height to diameter at breast height); (b) Girard form quotient q_g (the ratio of diameter inside bark at the top of the first standard log, = 17.3 ft from the ground, to diameter at breast height outside bark; (c) normal from quotient = $q_{0.5}$ (the ratio of a diameter measured at one-half tree and bole height to the diameter = $d_{0.1}$ at 10% of the total and bole height from the ground. This form quotient is described by Popovich (1972); (d) diameter at 10% = $d_{0.1}$ of the total and bole height; (e) total and bole height in feet. Moreover, on each sample tree the defect (cull) as a percentage of total log volume is estimated.

In the period covered by this report we measured and recorded the following data:

I Dudswell (hardwood forest where the dominant part of the stand is composed of sugar maple, beech and yellow birch). In 52 sample plots of this forest, which has been established, thinned and fertilized by Dr. M. Roberge, we took the following measurements: total and bole height, d.b.h. and diameters at 10,50 and 75% of the total and

bole height. We also measured the dimensions of the crown. In total we took data from 426 standing trees, i.e. 207 sugar maple and 219 yellow birch.

II Ste. Scholastique (hardwood forest where the dominant part of the stand is composed of sugar maple, beech, red maple, basswood, hickory, ironwood, elm, white oak and largetooth aspen). Last winter in the part of this forest called La Belle Rivière we recorded data from 57 felled sugar maple, which were cut in management operations under the leadership of M.J. Pfalzgraf. On these trees we took the following measurements: total height, bole height, and length and width of the crown. Moreover, each bole was divided into ten equal parts for estimating the volume of the stem.

In the other part of Ste. Scholastique's forest, called St. Placide (ca. 100 acres), which also has been put under management by M.J. Pfalzgraf, we established 25 semi-permanent sample plots (1/5 of acre each) by simple randon sampling. In each sample plot we recorded d.b.h. for trees 5 inches and greater; total and bole height on 30% of the trees of each main species in the sample plot; the forest condition and state of the regeneration. Moreover, on 62 sugar maples, 41 beeches, 20 red maples, 20 basswoods, 15 hickories, 10 elms, 10 ashes, 8 yellow birches and 5 white oaks taken at random, we measured the diameters at one-half total and bole height, at 17.3 feet from the ground and at d.b.h. From each of these standing trees increment cores were extracted with Pressler's increment borer at stump and breast height.

In the light of the work performed in this field, the results presented here are preliminary. They illustrate a part of our approach to the problem of finding the true form of trees and stands, according to our objectives.

Since the number of sample trees in this phase of the study have been limited to show the differences between various treatments, sites etc., our approach stems from the deductive reasoning that at

first we ought to establish the most efficient relationship between different bole parameters in general; and afterwards to find an answer to the problem of tree and stand form factor according to treatment, site, age et cetera.

RESULTS

In this mode we tried to find a relationship or degree of association between two variables, in this case, d.b.h. class and form quotient (q_2), and total and bole height also with form quotient (q_2). In the first case (d.b.h. and form quotient) the degree of association was very small ranging from r = 0.20 to r = 0.28 according to different species and stands. On the contrary, in the case of relationship between total and bole height with form quotient we found that the degree of association was much better (Tables I and II).

DISCUSSION

The next step of our study will be to apply, to these and other data, more sophisticated formulae such as Hojer's and Behre's equations (Behre 1923); and eventually to make stem analyses and tree volume evaluations in order to find the relationship (not only of the stem but also of the whole tree) between form quotient and form factor, and to check the accuracy of the above mentioned formulae. This work has to be done before entering into detailed studies of such variables affecting tree and stem form as thinning, fertilization, stand density and stocking, site, age etc. In my opinion, it is the basis for research in this field of work.

As far as the form factor of the stand is concerned, my experience with coniferous species (in particular with white spruce stands) shows that the advantages of normal form factor (Popovich 1972)

Table I

Dudswell 1973 Traitments 63 - 69

Sugar Maple

Total Height		Bole Height	
q_2 H = - 0.95943 + 0.74402H (r = 0.85)		q_2 h = 3.61082 + 0.75729h (r = 0.95)	
ft	q_2	ft	q_2
40	.720	15	.998
45	.723	20	.938
50	.725	25	.902
55	.727	30	.878
60	.728	35	.861
65	.729	40	.847
70	.730	45	.837
75	.731	50	.829
80	.732		
85	.733		
90	.733		

Yellow Birch (N = 217)

q_2 H = 6.43514 + 0.61263H (r = 0.79)		q_2 h = 3.06839 + 0.77158h (r = 0.95)	
ft	q_2	ft	q_2
40	.773	15	.976
45	.756	20	.925
50	.741	25	.894
55	.730	30	.874
60	.720	35	.859
65	.712	40	.848
70	.704		
75	.698		
80	.693		

Table II

Ste. Scholastique

Sugar Maple

Total Height — Bole Height — (N = 119)

q_2 H = -3.3190 + 0.74271H (r = 0.86) q_2 h = 1.83607 + 0.79413h (r = 0.94)

ft	q_2	ft	q_2
40	.660	20	.886
45	.669	25	.868
50	.676	30	.855
55	.682	35	.847
60	.687	40	.840
65	.692	45	.835
70	.695	50	.831
75	.698	55	.827
80	.701	60	.825
85	.704		
90	.706		
95	.708		
100	.709		

Beech (N = 41)

q_2 H = -4.00545 + 0.75244H (r = 0.92) q_2 h = 1.65386 + 0.80363h (r = 0.96)

ft	q_2	ft	q_2
40	.652	20	.886
45	.663	25	.870
50	.672	30	.859
55	.680	35	.851
60	.686	40	.845
65	.691	45	.840
70	.695	50	.837
75	.699	55	.834
80	.702	60	.831
85	.705		
90	.708		
95	.710		
100	.712		

over breast-height form factor are very evident (Table III).

Table III

Comparison between breast-height and normal form factor for white spruce plantations at Grand'Mère

Site Quality	Mean Age	Sample Plots (N)	Stand Breast-height form factor average	Stand Breast-height form factor 2σ	Stand Normal form factor average	Stand Normal form factor 2σ
Very good	42	9	0.464	0.020	0.474	0.005
Good	45	12	0.472	0.013	0.482	0.006
Fair	45	40	0.501	0.010	0.493	0.004
Poor	43	36	0.542	0.021	0.504	0.006
Very poor	42	22	0.548	0.020	0.511	0.004

From this comparison of 119 sample plots of almost the same age, we can see that the dispersions around the mean value of the breast-height form factor in each site are from 2 to 4 times greater than those of the normal form factor. This fact confirms the hypothesis of uniformity of trees around their mean value in the stands for each particular forest species, which also means that the utilization of the normal form factor is justified biologically. The advantage of normal form factor over breast-height form factor is very important in the construction of volume tables and for calculation of the current total volume increment of stands, because of the use of normal form factor in this kind of work requires only half as many sample trees for stem analysis as are required with the other factor.

CONCLUSIONS

Finally, I believe that the investigation of tree and stand form in hardwood forest is scientifically and economically justified. The only objection I have to make is that the pace of work, with the primitive equipment we have at our disposal, climbing with ladders etc., is very slow and that it is time to buy a Barr and Stroud dendrometer, for which the price is $3,900.00. With this instrument, many difficulties we have in our work on tree and stand form will be resolved.

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DISCUSSION

(1) The study is now ready to proceed with measurement of diameter growth response to stand treatment.

(2) It is proposed to use a dendrometer for upper stem measurement. A modified Spiegelrelaskop, such as that now in use at the PFRC, was suggested as a cheaper and simpler instrument than a Barr and Stroud.