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The Adjusting Factor Method for Weight-Scaling Truckloads of Mixed Hardwood Sawlogs

by

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ABSTRACT

A new method of weight-scaling truckloads of mixed hardwood sawlogs systematically adjusts for changes in the weight/volume ratio of logs coming into a sawmill. It uses a conversion factor based on the running average of weight/volume ratios of randomly selected sample loads. A test of the method indicated that over a period of time the weight-scaled volume should average within 3.5 percent of the actual volume.

The Adjusting Factor Method for Weight-Scaling Truckloads of Mixed Hardwood Sawlogs

INTRODUCTION

WEIGHT-SCALING is a relatively new method for estimating log-scale volumes of sawlogs. Although several Northeastern sawmill operators use weight-scaling, many operators have expressed the need for a method of checking the accuracy of their systems and adjusting them to account for changes in timber size and species composition. The adjusting factor method of weight-scaling, discussed here, was developed to meet this need.

The adjusting factor method uses an average weight per board foot as a conversion factor to estimate the volumes of truckloads of mixed hardwood sawlogs from their weight. The method is simple and practical: it does not require a lot of data collection to start, requires little extra effort to check its accuracy, and makes systematic adjustments for changes in the log supply that affect the accuracy of weight-scaling.

Some of the factors that affect the accuracy of weight-scaling truckloads of sawlogs are: (1) changes in the species composition, (2) changes in the distribution of log sizes, (3) changes in the average amount of defect in the logs, (4) logs cut either shorter or longer than standard lengths, and (5) the effect on load weights of bark loss or the presence of mud and ice. Adjustments are not made individually for each factor. Instead, the corrections reflect the combined effect of all the factors on the weight/volume ratios of the loads coming into the sawmill.

I recommend that the adjusting factor method be used for each logging operator separately. Since the system adjusts for changes in the log supply, it is not usually necessary to start the system over when an operator moves from one logging site to another: the only exception is when there is a drastic change, as when a logger moves from an area of large overmature timber into an area of small sawlog-size timber. Although the system would eventually adjust for such a change, the adjustment would be gradual.

The adjusting factor method does not include a way of determining log quality. Of the mill operators presently using weight-scaling, those concerned with determining log quality evaluate the standing timber before cutting. I believe that this is the only practical way at this time.

Obviously, mills that purchase most of their logs on the open market cannot determine quality in the standing timber. Mills that purchase logs by grade cannot use the adjusting factor method. But if they purchase logs of uniform quality, or if quality is of minimum importance, the method should give satisfactory results.

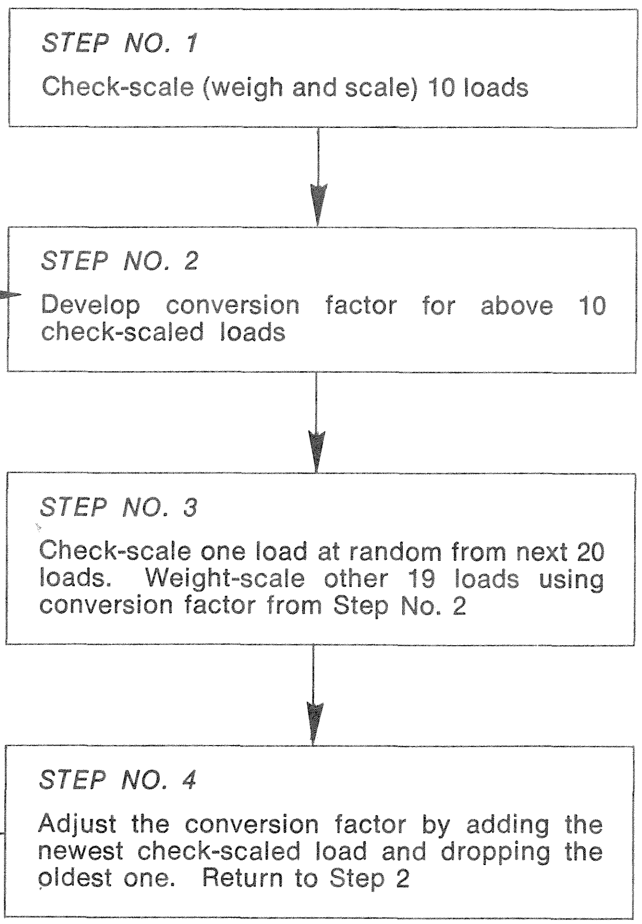
THE ADJUSTING FACTOR METHOD

How It Works

The average weight per board foot used as a conversion factor is systematically adjusted to reflect changes in the weight/volume ratio of truckloads of logs coming into a sawmill. The conversion factor is adjusted by a running average of randomly selected sample loads.

The calculation and use of this running average is not difficult. First the scaler weighs and stick-scales the first 10 truckloads of logs. This procedure is called check-scaling. From the total weight and total volume of these 10 loads, he computes an average weight per board foot (conversion factor). Next, he selects one load at random out of the next 20 loads and check-scales it. The other 19 loads are weighed and their volumes are estimated by using the conversion factor. The scaler then adds the weight and volume of the randomly-selected load to those of the last nine previously check-scaled loads to develop a new average. This procedure is repeated for each 20 loads. Figure 1 shows a step-by-step outline of the procedure.

Figure I. — Step-by-step procedure for the adjusting factor method of weight-scaling.



This method produces a new conversion factor every 20 loads. Each new factor is based on the 10 most recent check-scaled loads. In this way, the adjusting factor method determines changes in the weight/volume ratios of loads coming into the mill and adjusts the conversion factor to reflect these changes. If the adjustments were not made, these changes could eventually cause considerable error in weight scaling.

A Practical Example

The following example illustrates application of the adjusting factor method, using actual weight-scaling data. Form 1 is used to develop and adjust the conversion factors. And Form 2 is used to weight-scale truckloads of sawlogs. Although I used the Doyle log rule in the example, any log rule can be used with the system.

Step 1

Weigh and stick-scale (check-scale) the first 10 loads. Enter load numbers and corresponding weights and volumes for the 10 loads on Form 1 (opposite page).

Step 2

Add the weights of the 10 loads and enter the total on Form 1 (253,240 pounds, in this example). Add the volumes of the 10 loads and enter the total on Form 1 (20,501 board feet, in this example).

Divide the total weight by the total volume and enter the resulting conversion factor on the form (12.353 pounds/board foot, in this example).

FORM 1

(Adjusting Factor Method)

Load number	Load weight	Total weight for 10 most recent loads	Load volume	Total volume for 10 most recent loads	Average weight per board foot
1	26840		2047		
2	18725		1587		
3	28940		2254		
4	31300		2513		
5	20935		1947		
6	25315		2480		
7	27520		1592		
8	22405		1643		
9	20650		2001		
10	30610		2437		
		253240		20501	12.353

Add the 10 load weights

Enter total load weight here

Add the 10 load volumes

Enter total load volume here

Divide total weight by total volume and enter conversion factor here

Step 3

Determine at random which load out of the next 20 is to be check-scaled. When the selected load is check-scaled, enter the load number, weight, and stick-scaled volume on Form 2 (below). Circle the load number to identify it for use in Step 4 (load number 17, in this example).

Weigh the other 19 loads and enter the load numbers and load weights on Form 2. Enter the current conversion factor from Form 1 on Form 2 (12.353, in this example). For all except the check-scaled load, divide the load weights by the conversion factor and enter the resulting estimated load volumes on Form 2. Total the estimated load volumes and the check-scale volume to determine total volume for this 20 load group (40,691 board feet, in this example).

FORM 2

(Adjusting Factor Method)

Load number	Truckload weight	Conversion factor from Form 1	Estimated load volume
11	26645	12.353	2157
12	28470		2305
13	22935		1857
14	25410		2057
15	32520		2633
16	29180		2362
(17)	24715		1963
18	31480		2548
19	18630		1508
20	22145		1793
21	29620		2398
22	26240		2124
23	28230		2285
24	25380		2055
25	24565		1989
26	17400		1409
27	26800		2170
28	24805		2008
29	15930		1290
30	21990		1780
		Total volume	40691

Circle the check-scaled load

Use this conversion factor for all but the stick-scaled load

Stick-scale volume is entered for the check-scaled load

Step 4

Transfer the load number, weight, and stick-scaled volume for the check-scaled load from Form 2 to Form 1 (below). On Form 1, mark out the information for the oldest of the last 11 check-scaled loads (load 1, in this example). Also mark out the previous total weight, total volume, and the conversion factor. Return to Step 2 and determine a new conversion factor by using the 10 most recent check-scaled loads on Form 1. In this example, the new total weight (251,115), divided by the new total volume (20,417) results in a new conversion factor of 12.299 (below).

FORM 1

(Adjusting Factor Method)

Load number	Load weight	Total weight for 10 most recent loads	Load volume	Total volume for 10 most recent loads	Average weight per board foot
~~1~~	~~26840~~		~~2047~~		
2	18725		1587		
3	28940		2254		
4	31300		2513		
5	20935		1947		
6	25315		2480		
7	27520		1592		
8	22405		1643		
9	20650		2001		
10	30610		2437		
		253240		20501	12.353
17	24715		1963		
		251115		20417	12.299

Cross out oldest check-scaled load

Add newest check-scaled load

Compute new conversion factor

Accuracy of the Adjusting Factor Method

To test the adjusting factor method, 500 truckloads of mixed hardwood sawlogs were both weighed and stick-scaled at a sawmill. The loads were brought into the mill by 11 different operators from 11 different logging areas. The combined loads contained 10,079 logs, weighed 12,672,450 pounds, and contained a total of 1,000,763 board feet (net Doyle). The study loads contained 12 species and a wide range of log sizes (table 1).

Table 1.—Percentage by volume and average log volume for each species in sample

Species	Percentage of sample by volume	Average log volume
	Pct.	*Bd. ft.*
Ash	1	71
Basswood	3	70
Beech	4	87
Birch	1	44
Black cherry	1	61
Gum	1	50
Hickory	3	77
Hard maple	5	109
Red maple	4	80
Red oak	27	110
White oak	41	123
Yellow-poplar	9	71

Data from the 500 truckloads were then used to simulate the variations in weight/volume ratios that a logging operator might experience over a 1- to 2-year period (about 2,000 loads). To accomplish this, I assumed that the 500 loads were brought in by one operator from 11 different areas. The loads from each of the 11 logging areas were grouped and arranged in the order of their arrival at the mill. Each group was assigned a number from 1 through 11. From this array, groups were picked at random, with replacement, and arranged in order as they were picked. This procedure was continued until the desired 2,000 loads were obtained.

To provide a reliable estimate of the error in using the adjusting factor method, I applied the method 200 separate times to the 2,000 truckloads. The average percent difference between the actual total net volume and the total volume estimated by weight-scaling was —1.0 percent with two standard deviation limits of +1.2 and —3.2 percent. In other words, approximately 95 out of 100 differences between the scaled volumes and the estimated volumes fell between +1.2 percent and —3.2 percent of the actual volume.

The cumulative percent difference between the actual volume and the estimated volume changed as weight-scaling progressed through the 2,000 test loads. For example, at load 100 the average cumulative difference was —6.6 percent, with 95 of 100 differences falling between —5.0 percent and —8.2 percent; at load 1,600 the average cumulative difference was —0.6 percent, with 95 of 100 differences falling between +1.8 percent and —3.2 percent. When the adjusting factor method is used on more than 1,600 truckloads, the estimated volume should be within ±3.5 percent of the actual net volume. This is less than the difference one would expect to find from one scaler to another.

The weight-scaling error of the adjusting factor method can be reduced by starting the system with loads that are representative for a given logging operator. In the test, I started the method with 10 loads containing very small logs. After 440 loads, the average cumulative difference between stick-scaled volume and weight-scaled volume was ±5.0 percent. I then replaced the first 10 loads with 10 loads that were more representative of the log supply, and repeated the test. The ±5.0 cumulative percent difference between stick-scaled and weight-scaled volume was reached before 200 loads had been scaled. And the 95 percent confidence limits for the percent difference fell below ±3.5 percent within 700 loads in this test, compared with 1,600 loads in the first test.

The test indicated that the adjusting factor method should prove satisfactory for weight-scaling truckloads of mixed hardwood sawlogs. If there is a change in the weight-volume ratio of the loads coming into the mill, the average will lag in adjusting to it, because the conversion factor is based on samples of previous loads. However, since this lag will occur when the weight/volume ratios are increasing as well as when they are decreasing, the effect on the accuracy of the volume estimate should average out.

APPLICATION

For best results, the adjusting factor method should be used separately for each operator. This would eliminate the possibility of overpaying some operators and underpaying others. Also, in starting the method, it is important to begin with timber that is representative of that to be cut by a given operator. Beginning with loads that contain unusually large logs or unusually small logs will increase the time required for initial adjustment of the conversion factor. However, even if the method is begun with nonrepresentative loads, the error should not be greater than ± 3.5 percent when the method is used on at least 1,600 loads.

Sawmill operators who want to use the adjusting factor method should use forms similar to Forms 1 and 2, and follow the step-by-step procedure described in this paper. I also suggest that the user continue to stick-scale all loads until both he and the log suppliers are satisfied with the accuracy of the weight-scaling.

Some of the adjustments in the conversion factor may seem too small to bother with, but all adjustments must be made to ensure that the running average does in fact average out. If only the larger adjustments are made, a bias will be introduced into the system and its accuracy will be questionable. The only time I would recommend *not* adjusting the average is when there is a temporary, unusual change in the weight/volume ratio, such as could be caused by a bad ice storm or a few loads of severely seasoned logs. In such situations, the user may wish to stick-scale the affected loads and exclude them from the weight-scaling system.

The Adjusting Factor Method requires that the conversion factor be changed every 20 loads. Users should take time to explain to logging operators that this is as much to their benefit as it is to the sawmill operator's benefit. Some of the logging operator's fears may be alleviated if he is allowed to check the weight-scaling records for his loads periodically.

The adjusting factor method can also be used to check other weight-scaling methods. For example, an operator who is using a single weight-per-board-foot conversion factor can apply the Adjusting Factor Method at the same time with little extra effort and cost, and use it to check the error of his method.

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