A Test of Survey Methods for Estimating Stumpage Prices

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The Forest Service needed information as to prices of standing timber and logs for use in a study of distribution costs and margins in the pine lumber industry of the Southeast. The study was conducted under the Agricultural Marketing Act of 1946 (RMA, Title II). As North Carolina, the chosen site for the study, has 4,600 sawmills and hundreds of thousands of wooded properties, some method of sampling had to be devised. Whom to sample, what kind and how large a sample to take, and how to assure a representative sample were some of the questions that arose. For this reason, and because it seemed an excellent opportunity for a test of price-survey techniques, the study that is reported in the following paper was designed to permit comparisons of several more or less obvious methods of obtaining price data.

Collection of Data

DATA ON PRICES of stumpage and logs in the Southeast are available from three sources—buyers, sellers, and informed outsiders such as local foresters who assist sellers. If a quick, rough estimate were sufficient, one could canvass the foresters and average the reported prices. But each reported price would, in itself, be the estimated mean of an unknown number of transactions and an unknown volume of material. In many cases even the specific area to which the price applied could not be ascertained.

Enumerating or sampling sellers would avoid this difficulty, but either method would impose the time-consuming task of finding the individuals. Not all farms or other land holdings include timber, for instance, and probably fewer than 1 in every 250 timbered tracts are sold in a single month. Another objection to sellers as a source of price data is the rather high proportion who sell stumpage "by the boundary" for a lump sum and have little or no idea of the quantity actually sold.

Buyers, on the other hand, are fewer than sellers. They ordinarily make several purchases during the course of a year, and are able to measure or estimate quantities with some degree of accuracy. In short, they are easier to find and can frequently report specific purchases as of several dates. For these reasons, buyers provided all the price data for this study.

Two adjacent areas in North Carolina, 1 of 12 counties in the Piedmont and 1 of 17 counties in the Coastal Plain, were selected for study (fig. 1). A complete mailing list of sawmills and concentration yards for each area was compiled in 1947.

A questionnaire was designed primarily for mail use. As only one species group, the yellow pines, was involved, it was possible to reduce the form to a few simple questions on one side of a letter-size sheet. The following information was requested: (1) Prices paid for pine stumpage and logs as of May 1, 1950; (2) the basis of payment, that is, lumber tally, either actual or estimated, versus one of the log rules; (3) board-foot volumes of stumpage and log purchases during the first 4 months of 1950; and (4) number of timber tracts purchased during the same period.

The Mail Survey

The first mailing of questionnaires went out about May 15, 1950, to all the sawmills and concentration yards on the 1947 list. It was followed at 10-day intervals by two more mailings to those who did not respond. In each case, the questionnaire was accompanied by a form letter explaining why the information was needed and promising confidential treatment of replies. For the second mailing, the letter was stamped "Second Request", for the third, "An Immediate Reply Is Requested". One paragraph read as follows:

"Unfortunately, our mailing list is several years old. If you are no longer in the lumber business, if you are not operating your sawmill (or sawmills) at present, or if you do only custom or contract sawing, please note this on the form and return it to us anyway".

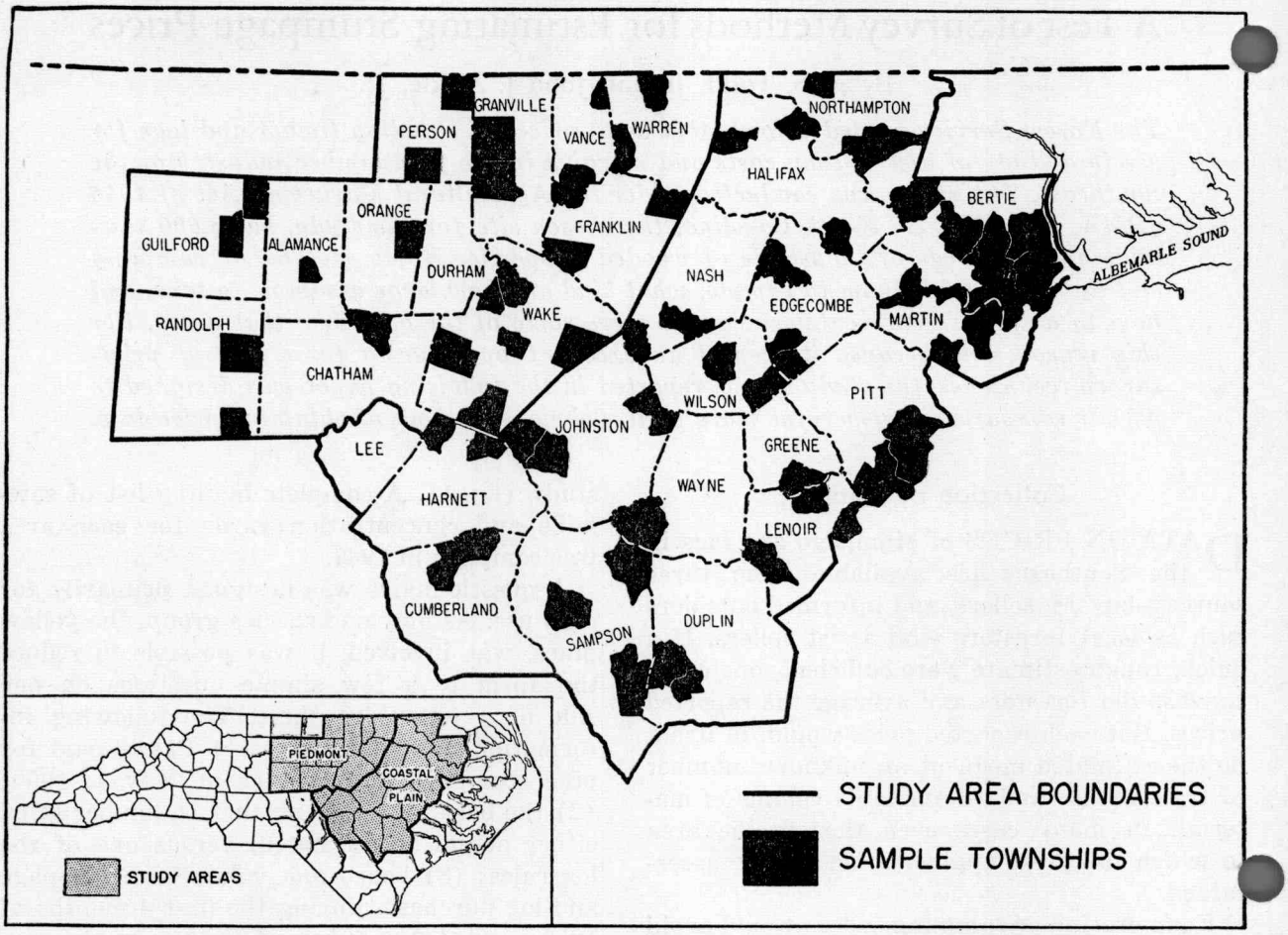

Figure 1

This plea brought replies from many operators who were not in the market for stumpage or logs and would not have responded otherwise. A tally of returns indicates that not more than 30 percent of the names on the 3-year-old lists were even potential sources of price information. This indicates that mail canvasses of this type may achieve a higher percentage response than they appear to attain. Table 1 summarizes the results of the three mailings.

During the course of the three mailings, 3,411 questionnaires were mailed—1,664 in the Piedmont and 1,747 on the Coast—to the 1,441 listed operators in the two study areas. Of 1,357 addressees who apparently received their questionnaires, 659, or practically 50 percent, responded. Thirty-two percent of the returns were in response to the first mailing, 48 percent to the second, and 20 percent to the third. Only 192 of the 659 respondents reported prices. The price reports numbered 105 with stumpage price only, 82 with both stumpage and log prices, and 5 with log price only. Of the others, 144 operated private, custom, or contract sawmills that bought no stumpage or logs, while the remaining 323 were variously reported as deceased, out of business, idle, or buying only hardwoods.

The Field Sample of Nonrespondents

Tests of mail canvasses have shown that the individual's readiness to respond is usually proportional to his interest in the subject matter of the questionnaire. For example, if production of some commodity were the item called for, high producers would be more likely to respond than low producers. Thus, mail responses may not properly represent the entire

population for which information is sought.

In the case of stumpage and log prices, it was not apparent whether this principle would apply. Data were needed to test the mail sample for bias from this source and provide a correction should this be necessary. Accordingly, a random sample of 100 operators in each area was drawn from those who had not responded to any of the mailings. These individuals were interviewed by field men.

The interviews yielded 99 reports in the Piedmont and 98 in the Coastal Plain. The other three names turned out to be duplicates. The 99 reports from the Piedmont included 35 with stumpage price only, 2 with both stumpage and log prices, and 2 with log price only; the 98 Coastal Plain reports included 25 with stumpage price only, 12 with both stumpage and log prices, and 1 with log price only.

TABLE 2.—*Number of nonrespondents sampled and stumpage and log price reports received, by study area*

Area	Sampled	Reports received with			
		Stumpage price [1]		Log price [1]	
		Actual	Percentage	Actual	Percentage
	Number	*Number*	*Percent*	*Number*	*Percent*
Piedmont	99	37	37	4	4
Coastal Plain	98	37	38	13	13

[1] Includes returns with both stumpage and log prices given.

The Area Samples

If an up-to-date mailing list had been available, the sampling of nonrespondents might have been adequate protection against the possibility of an unrepresentative sample. But our list was 3 years old and since its compilation a few operators had died, others had moved, and some had sold out. As sawmill machinery is long-lived and the pine-lumber market was booming, it seemed probable that many of the missing mills were still operating, perhaps under new owners. In addition, new operators with new equipment had undoubtedly entered business each year. Failure to sample them might have meant the omission of the youngest and most enterprising lumbermen.

Lacking any knowledge of the names or whereabouts of the new operators, the only

TABLE 1.—*Number of addressees, questionnaires returned, and number returned with stumpage and log prices, by mailing and study area*

Mailing	Addressees	Questionnaires returned					
		Total		With stumpage price [1]		With log price [1]	
		Actual	Percentage	Actual	Percentage	Actual	Percentage
	Number	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*
Piedmont							
First	715	[2] 96	13	23	3	6	1
Second	554	159	29	50	9	12	2
Third	395	47	12	9	2	2	1
Total	715	[2] 302	42	82	11	20	3
Coastal Plain							
First	726	[3] 117	16	34	5	23	3
Second	590	159	27	49	8	32	5
Third	431	81	19	22	5	12	3
Total	726	[3] 357	49	105	14	67	9

[1] Includes returns with both stumpage and log prices given.
[2] Excludes 65 returned unclaimed. Nonresponse—348.
[3] Excludes 19 returned unclaimed. Nonresponse—350.

feasible method of sampling them was by 100 percent canvass of randomly selected areas. If reports were obtained for all mills, listed as well as unlisted, in these areas, they could be used to provide independent and unbiased estimates of the total mill population and of mean stumpage and log prices for all mills as well as for the new or unlisted mills.

As quality of timber and other characteristics affecting its price are subject to considerable local variation, wide geographic distribution of the sample was necessary. For this reason, the sample areas had to be small. Therefore, a comparatively large number of small areas was preferable to a few large ones. Another requirement was that their boundaries should be well defined for ease of working. Minor civil divisions (MCD's) seemed to meet these needs. Furthermore, detailed road maps with MCD's delineated were available for each county in both study areas.

The MCD's to be sampled were drawn from an alphabetical list using a table of random numbers. As a guide to deciding how many to draw, there was a count of sawmills by MCD's made in 1947. On this basis, 23 of the 146 MCD's in the Piedmont area and 38 of the 203 in the Coastal Plain area were selected.

Of 130 operators enumerated in the Piedmont MCD's and 126 in the Coastal Plain MCD's, 52 and 64, respectively, reported prices. The Piedmont count was 46 with stumpage price only, 4 with both stumpage and log prices, and 2 with log price only; the Coastal Plain count was 40 with stumpage price only, 18 with both stumpage and log prices, and 6 with log price only.

Twenty-five of the 116 reports with prices were for operators not on the 1947 list. In other words, the mail canvass and field follow-up of nonrespondents apparently failed to sample nearly one-fourth of the price-reporting population. If, for one reason or another, the unsampled mills paid different prices than the sampled mills, exclusive reliance on the out-of-date mailing list might seriously have biased the results of the price survey.

TABLE 3.—*Number of sawmills in sample MCD'S and stumpage and log price reports obtained by study area and area sample*

Area sample	Mills in sample	Reports obtained with			
		Stumpage price [1]		Log price [1]	
		Actual	Percentage	Actual	Percentage
	Number	*Number*	*Percent*	*Number*	*Percent*
Piedmont					
Listed	85	35	41	6	7
Unlisted	45	15	33	0	0
Total	130	50	38	6	5
Coastal Plain					
Listed	97	48	49	23	24
Unlisted	29	10	34	1	3
Total	126	58	46	24	19

[1] Includes returns with both stumpage and log prices given.

Analysis of Results

Using the three classes of data (mail, nonrespondent, and area), it was possible to compute mean stumpage and log prices representing five alternative methods of sampling. The five sampling methods could then be compared on two counts—accuracy and cost.

Accuracy depends upon both sampling and non-sampling errors. Of these, non-sampling errors are the more difficult to evaluate and control. In the present instance, they include biases arising from reporting errors and from the use of a sample that is not representative of the entire population.

In comparing the five sampling methods, an attempt has been made to show the direction and the approximate extent of the non-sampling errors in total. Except by inference, there was no way to discover what types of biases were present or their relative severity. For instance, the study provided no specific test for reporting bias. However, by cross-comparison of means between classes of reports and survey methods, it was sometimes possible to identify a bias with some confidence.

All comparisons are in terms of stumpage price. Log prices were omitted partly because

TABLE 4.—*Mean stumpage price (based on lumber tally) and standard error, by class of report and study area*

Class of report	Piedmont			Coastal Plain		
	Reports	Mean price	Standard error	Reports	Mean price	Standard error
	Number	*Dollars*	*Dollars*	*Number*	*Dollars*	*Dollars*
Mailing						
First	23	18.32	[1] ±0.56	34	15.91	[1] ±0.57
Second	50	16.84	[1] ±0.30	49	14.30	[1] ±0.50
Third	9	17.78	[1] ±1.28	22	15.00	[1] ±0.81
Nonrespondent	37	16.43	±0.48	37	16.83	±0.70
Area						
Listed mills	35	17.43	±0.07	36	14.44	±0.09
Unlisted mills	15	17.80	±0.23	10	14.92	±0.16

[1] Not strictly valid, as the mail returns are not a random sample of the entire population, but these errors do provide a useful indication of the magnitude of the differences among means.

not enough data for close analysis were available and partly to avoid the complication of presenting duplicate comparisons. As stumpage price is, in effect, a derivative of log price, there is no reason to suspect that a similar comparison based on log price would lead to different conclusions.

Effect of Log Rules

As stumpage prices were reported in terms of various log rules, it was necessary, first to convert prices to a common base. Lumber tally, on which more than 75 percent of reported prices were quoted, was the base adopted. A mean price and standard error were then calculated for each class of report (table 4).

Estimates of mean stumpage prices were lower on the Coastal Plain than in the Piedmont for all classes of reporters except nonrespondents. This consistent difference was due largely to the prevalence of the use of the Doyle log rule on the Coastal Plain. This rule, when applied to logs of average size for the area, gives volumes one-third below what they will actually saw out, but Doyle prices did not reflect this fact. Thirty-six percent of the Coastal Plain operators reported prices based on Doyle rule as compared with only 1 percent of the Piedmont operators. Yet their mean price, before conversion to a lumber-tally basis, was $17.94 for three mailings, only $0.39 more than the $17.55 in the Piedmont. Converting all prices to lumber tally reduced the Coastal Plain price of $2.97 and the Piedmont price by only $0.19.

This effect of log rules was evident in interarea comparisons and in comparisons by class of report for the Coastal Plain alone. Apparently any price sample would be meaningless if it ignored the question of how volumes are measured, and biased if it failed to secure a correct representation of the various methods of measurement. This adds another source of price-survey bias to those previously mentioned.

Other Differences in Mean Price by Class of Report

In the Piedmont, mean stumpage prices ranged from $16.43 for nonrespondents to $18.32 for the first mailing, a gross difference of $1.89 (table 5). On the Coastal Plain, the low was $14.30 for the second mailing. High was $16.83 for nonrespondents, the class that paid the least in the Piedmont. This is a gross difference of $2.53 for the Coastal Plain.

The paradoxical situation of the highest-price class in one area paying the lowest in the other was explainable by the fact that very few of the Coastal Plain nonrespondents were reported as using Doyle rule, while a considerable number in each of the other reporting classes there did use it. Actually, aside from the differences introduced by log rules, prices in the two areas were rather similar, even to the trend in price by class of report. As a result, a few tentative conclusions can be drawn:

1. Stumpage buyers who responded to the

first mailing of questionnaires paid higher prices than those who responded to the second. The difference between means in the Piedmont was $1.48; in the Coastal Plain $1.61. This suggested the possibility of a correlation between price and promptness in responding, but the results of the third mailing did not support this hypothesis. This mailing brought a hodgepodge of high and low prices. The means were higher than for the second mailing in both survey areas, but not substantially so. As only 10 days separated the mailings, it is conceivable that a "carry-over" effect partly concealed the true relation (if any) between price and promptness of response.

2. The response hypothesis again received support, however, when the field sample of Piedmont nonrespondents was tested. Buyers of stumpage who responded to none of the mail requests tended to pay less than those who did respond, but the only pronounced difference was between the means of the first mailing and the nonrespondents and between the area means and the nonrespondents. The effect of log rules may have concealed comparable differences between the same classes of reports on the Coastal Plain.

In the last connection, it should be noted that 36 percent of the Coastal Plain respondents reported prices based on the Doyle rule, compared with only 11 percent of the nonrespondents. The reason for this apparent discrepancy is not definitely known, but there is strong reason to suspect reporting errors in the nonrespondent returns. The nonrespondent mean was extremely high compared to every other class mean on the Coastal Plain.

3. There was evidence that buyers on the 1947 mailing list paid less for stumpage than the new or unlisted buyers. The difference was significant at the 5-percent level on the Coastal Plain.

Accuracy and Cost of Price Survey Methods

Having compared the means from the three classes of reports (mail, nonrespondent sample, and enumeration of sample areas), the final step was to examine complete stumpage price surveys based on them. Five methods of survey were considered. They were (1) a straight mail sample, (2) mailings supplemented by a sample of nonrespondents, (3) mailings supplemented by an area sample of unlisted operators, (4) mailings supplemented by a sample of nonrespondents plus an area sample of unlisted operators, and (5) a 100-percent canvass of randomly selected MCD's.

All five methods were subject to reporting errors, which may have differed as between mail and interview reports. But the last two

TABLE 5.—*Differences in mean stumpage price, by class of report and study area*

Class of report and area	Mailing		Non respondent	Mills in area sample	
	Second	Third		Listed	Unlisted
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*
First mailing					
Piedmont	+1.48	+ .54	+1.89	+ .89	+ .52
Coastal Plain	+1.61	+ .91	− .92	+1.47	+ .99
Second mailing					
Piedmont		− .94	+ .41	− .59	− .96
Coastal Plain		− .70	−2.53	− .14	− .62
Third mailing					
Piedmont			+1.35	+ .35	− .02
Coastal Plain			−1.83	+ .56	+ .08
Nonrespondent					
Piedmont				−1.00	−1.37
Coastal Plain				+2.39	+1.91
Listed mills in area samples					
Piedmont					− .37
Coastal Plain					− .48

methods (4 and 5) should have been otherwise free of bias. The entire stumpage-buying population was given representation, and the sampling was random. Method 2, on the other hand, failed to sample the unlisted operators—nearly 25 percent of the population. Method 3 failed to sample the nonrespondents, or 50 percent of the population. As for the mail surveys, they had to stand or fall on the risky assumption that neither the unlisted operators nor the nonrespondents paid prices different from those paid by operators who reported by mail. Yet, against the theoretical superiority of methods 4 and 5 had to be balanced the likelihood that one of the more questionable methods might yield sufficiently precise estimates at lower cost. To investigate this possibility, a collection of the better of the unbiased estimates was set up as a standard by which to judge the accuracy of the others. The area sample (method 5) was the standard selected, as it had the smallest sampling error.

The first step in the comparison was to compute the standard error of the difference between the area mean and the mean obtained by each of the other survey methods. Any difference between means in excess of this standard error was attributed to bias in the method under examination and was tested for significance (table 6).

Three mean prices with significant biases were disclosed. In the Piedmont, the mail survey adjusted for nonresponse (method 2) showed a negative bias of $0.45. At two standard errors, bias was still present. On the Coastal Plain, both method 2 (mail survey adjusted for nonresponse) and method 4 (mail survey adjusted for nonresponse and unlisted mills) showed bias in excess of three standard errors. As both of these Coastal Plain means involved the suspect nonrespondent sample (see above), the highly significant biases probably arose from reporting errors.

The lack of bias in the straight mail survey and its introduction when the nonrespondents were sampled was contrary to the findings of several experimental surveys conducted by the Bureau of Agricultural Economics, the Bureau of the Census, and others. A clue to this discrepancy was the fact that the new or unlisted sawmills paid more for stumpage than those on the 3-year-old mailing lists. It seems likely that the negative bias incurred by omitting the unlisted mills compensated for the expected positive bias of the mail sample. Adjustment of the latter sample for nonresponse destroyed this chance balance. If this interpretation is correct, a straight mail survey based on an up-to-date list would be biased by omission of the nonrespondents. However, at least for the study area, the bias would not be serious enough to invalidate the use of such a survey. It would still be possible to obtain a mean price sufficiently accurate for most purposes.

TABLE 6.—*Mean stumpage price, standard error, and estimated difference by survey method and study area*

Method	Mean price	Standard error	Difference
	Dollars	*Dollars*	*Dollars*
Piedmont			
Mail survey			
1. Unadjusted	17.36	[1](±0.24)	— .18±.26
Adjusted for—			
2. Nonresponse	16.79	[1](±0.29)	[2]— .75±.30
3. Unlisted mills	17.51	(±0.41)	— .03±.42
4. Nonresponse and unlisted mills	17.10	±0.42	— .44±.43
5. Area survey	17.54	±0.09	----------
Coastal Plain			
Mail survey			
1. Unadjusted	14.97	(±0.28)	+ .43±.29
Adjusted for—			
2. Nonresponse	16.00	(±0.35)	[3]+1.46±.36
3. Unlisted mills	14.96	(±0.32)	+ .42±.34
4. Nonresponse and unlisted mills	15.81	±0.40	[3]+1.27±.41
5. Area survey	14.54	±0.08	----------

[1] Not strictly valid as the returns used are not a random sample of the entire population, but these errors do provide a useful indication of the accuracy of the differences among means. The error equations for the mean prices obtained by the various survey methods were developed by R. A. Chapman of the Forest Service. Their development is based on Deming's propagation of error equation (see "Statistical Adjustment of Data," by W. Edwards Deming, pp. 39, 40). Copies of these equations can be obtained from the authors.

[2] Indicate bias in excess of 2 standard errors of the difference.

[3] Indicate bias in excess of 3 standard errors of the difference.

Reporting errors aside, all five survey methods appeared capable of producing price estimates of acceptable accuracy. Therefore, selection of a method might well be based on the comparative costs and personnel requirements. In other words, the most suitable method for a particular survey is the one that meets the specified standard of accuracy at the lowest cost and can be carried through with the type of personnel available.

Records of the experimental surveys gave the following direct costs of sampling:

$0.09 per questionnaire mailed
3.54 per nonrespondent interviewed
18.49 per MCD canvassed.

Using these costs and the estimated variances and biases of the different methods, it was possible to predict the cost of surveys of any desired degree of accuracy. In the case of combined samples (for instance, mail plus unlisted mills), the most efficient combination of sample intensities could also be calculated. Table 7 shows for each of the five survey methods the probable cost of obtaining a mean price within ±$0.50 of the true mean, taking into account both the sampling error and the expected bias, if any.

TABLE 7.—*Direct cost of estimating stumpage price, by survey method* [1]

Method	Cost [2]
	Dollars
Mail survey	
1. Unadjusted	133
Adjusted for:	
2. Nonresponse	1,374
3. Unlisted mills	774
4. Nonresponse and unlisted mills	1,705
5. Area survey	91

[1] Excluding supervision and other overhead.
[2] Cost of estimating stumpage price within ±0.50 (2 standard errors + bias).

The estimates in table 7 reflect the extent of estimated bias attributed to the survey procedure. If less bias is assumed, with more of the variation attributed to sampling errors, the estimated costs for methods 2 and 4 would be less than indicated in table 7.

Apparently, the area estimate is not only the most precise of those studied but the most efficient as well. However, under the conditions in the area of the study, its efficiency was only slightly greater than that of the straight mail estimate, and it requires the services of a canvasser. It should be pointed out that this study applies to only two sample areas. Additional studies in similar areas probably would have to be made before it would be possible to conclude definitely that straight mail estimates are satisfactory for this type of population. If an agency that wanted information as to stumpage prices were primarily an office organization, it might prove cheaper to make a mail survey than to hire and train a field man and provide him with automobile transportation. As for the surveys using combined samples (methods 2, 3, and 4), their efficiency is extremely low by comparison with either the mail or area method. Their high cost and greater complexity rule them out of consideration.

If periodic price reports, either monthly or quarterly, were desired, it might be possible to combine area and mail samples to good advantage. Stumpage buyers enumerated in the sample areas could be placed on mailing lists. Once adequate lists were thus established, area canvassing might be restricted to the minimum necessary to replace losses and create samples of new sawmill operators.

Office Corrections for Bias in Mail Surveys

If lack of field personnel dictates the use of straight mail surveys, computational techniques can sometimes detect and correct biases due to nonresponse. Two such techniques were applied to the mail data from North Carolina.

One consisted of separating and weighting the response by sawmill production class. In this way, bias could be eliminated if it arose from a tendency for sawmills of different sizes to pay different stumpage prices and if also, their responses were not in proportion to their actual numbers in the various sizes.

First, all the mills on the mailing lists were classified according to the volumes of lumber they produced in 1946. The mail returns, both with and without prices, then provided an estimate of the proportion of stumpage buyers in each production class. Finally, the reports with prices were sorted, class means computed, and the class means weighted by estimated proportions of buyers to obtain

grand means. Table 8 illustrates the method and compares the estimated distribution of buyers with the distributions of price reports from the mail and area surveys.

There was a tendency, particularly in the Piedmont, for the larger mills to pay more for stumpage. But this apparently introduced no bias, because all mill classes were properly represented in the mail response. In other words, the distribution of price reports by mill-production class closely approximated the distribution of buying mills in the population. As a result, the weighted price was identical ($17.36) with the unadjusted price in the Piedmont and differed by only $0.10 in the Coastal Plain.

Although all mill-production classes were properly represented in the total mill response, this was not true of the response to individual mailings. The larger mills, which paid the higher prices, were quick to return their questionnaires. Most responded to the first mailing.

TABLE 8.—*Estimated distribution of buyers on the 1947 mailing list, and of the mail and area survey price reports and mean stumpage price paid by mail respondents, by mill production and study area*

Mill production, 1946	Distribution of buyers			Mean stumpage price
	1947 list	Survey price reports		
		Mail	Area	
1,000 board feet	*Percent*	*Percent*	*Percent*	*Dollars*
Piedmont				
0–49	12	16	10	16.00
50–499	33	36	30	17.04
500–999	36	32	32	17.88
1,000–2,999	19	16	18	17.80
3,000 and over	----	----	10	----
All classes	100	100	100	17.36
Coastal Plain				
0–49	9	6	8	14.88
50–499	34	37	40	14.66
500–999	23	19	21	14.77
1,000–2,999	28	29	23	15.14
3,000 and over	6	9	8	15.10
All classes	100	100	100	14.87

This explains the extremely high average price for the first mailing in the Piedmont and, to a lesser degree, the first mailing in the Coastal Plain (table 4).

Weighting a sample on the basis of a several-years-old production classification is open to one serious objection: The mills may no longer be producing at the same rate. Annual production of small sawmills is determined more by the number of days operated than by the capacity of the machinery. A change of ownership, or merely a change in the price or manufacturing cost of lumber, can shift a mill from one production class to another. Also, a change of ownership may of course be accompanied by a change from high-priced to low-priced stumpage, or vice versa.

The second method of removing bias from mail surveys, known as the "method of repeated mailings," [1] was based on the possibility of a correlation between an operator's willingness to respond and the price he paid for stumpage. It consisted essentially of fitting a regression to the trend of the average prices paid by respondents to successive mailings. In the Piedmont, the method gave a mean $0.10 less than the unadjusted mail price; in the Coastal Plain it was $0.44 less. Probably neither of these differences is meaningful, for the correlation was weak. Contrary to what would have been expected had there been strong correlation, the estimate based on the second mailing of questionnaires was lower than that from either the first or third.

Three Kinds of Mean Prices

The mean stumpage prices discussed above have been means obtained by summing the reported prices and dividing by the number of reports. In other words, they are mean prices per reporter, that is, buyer. They ignore the fact that some buyers purchase more, or larger, boundaries of timber than others. As our principal interest was in comparing price-survey methods rather than in the prices themselves, unweighted means served the purpose. Ordinarily, however, another kind of

[1] HENDRICKS, W. A. ADJUSTMENT OF DATA FOR NON-RESPONSE IN MAIL SURVEYS. From "The Agricultural Estimating and Reporting Services of the U. S. Department of Agriculture", U. S. Dept. Agr. Misc. Pub. 703.

mean would be more suitable.

When a stumpage price survey is made, it is usually with the object of estimating either the mean price per 1,000 board feet of all the timber purchased (or sold) in an area during a specified time, or the mean price per 1,000 board feet of all the timber tracts purchased (or sold). The former represents, among other things, the average raw-material cost of lumber production; the latter represents the average price per timber transaction. They are obtained by weighting each reported price by the reporter's volume of purchases in board feet or number of tracts, respectively. Table 9 offers a comparison, for the present survey, of the unweighted mean prices with those weighted by January-April quantities of reported stumpage purchases.

With certain exceptions, notably the first mailing in the Piedmont, the weighted prices are higher than the unweighted. The price per tract slightly exceeds the price per buyer and, in turn, is exceeded by the volume price. The inference is not only that the larger buyers paid more for timber than the smaller buyers, but that the highest prices were paid for the larger tracts, that is, those with a greater-than-average volume. Thus, in planning a survey, it is essential that the reason for collecting price information be kept in mind. Provision can then be made for obtaining the kind of mean prices desired.

TABLE 9.—*Mean stumpage price, unweighted and weighted, by class of report and study area*

Class of report	Mean stumpage price		
	Unweighted	Weighted by	
		Tracts	Volume
	Dollars	*Dollars*	*Dollars*
Piedmont			
Mailing			
First	18.32	17.64	17.80
Second	16.84	16.85	16.91
Third	17.78	18.26	20.82
Nonrespondent	16.43	16.20	16.24
Area			
Listed mills	17.43	17.45	18.00
Unlisted mills	17.80	17.78	18.87
Coastal Plain			
Mailing			
First	15.91	16.31	16.39
Second	14.30	14.52	14.59
Third	15.00	15.61	17.17
Nonrespondent	16.83	17.92	17.87
Area			
Listed mills	14.44	14.65	15.00
Unlisted mills	14.92	14.97	17.55

Realized Versus Reported Prices

To estimate accurately volume in standing trees is a somewhat complex and time-consuming task. The "cruise" of a tract of timber also calls for experienced judgment of timber quality which is a highly variable factor even within the operating radius of a single sawmill.

Farmers and other owners of small woodlands are generally unable to appraise their own timber. A few call upon public foresters or consultants for assistance, but most of them enter timber transactions with little knowledge of the quantity or value they offer for sale. Under these circumstances, their only protection is to sell on the basis of log or lumber measurement or to encourage competitive bidding. Unfortunately, the former is an often inconvenient method of selling so that lump-sum transactions predominate, while competition among buyers is seldom so intense as to assure an equitable price.

Confronted by uninformed sellers and by the expense and possibility of misjudgment involved in making thorough appraisals of their own, prospective buyers are likely to rely on rough approximations that allow liberal margins for error. The consequent overrun when the timber is cut results in a "realized" price per 1,000 board feet that is substantially below the price received for measured timber.

As the primary object of the present survey was to ascertain the cost of raw material to lumber manufacturers, the question arose as to what sort of prices had been reported on the stumpage price questionnaires. Accordingly, a random sample of 34 recently cut-over sale areas, ranging in size from 1 to 192 acres, was drawn. The timber on each of these areas had been purchased and logged by one of the sawmill operators who reported prices.

After the tracts were selected, the land-owners were interviewed to obtain information per-

tinent to the sales—notably, the total price received. Tract boundaries were then mapped on aerial photographs by ground reconnaissance and the acreages planimetered. The 34 tracts totaled 1,411 acres.

The next step was to estimate the actual volume logged from the sample areas. A stump tally was taken of 183 one-fifth-acre circular plots, which were allocated to tracts according to the reported volume sold and were mechanically located within tract boundaries. In addition to a complete tally of stumps by diameters and heights, the utilized length and the diameter at the top of the utilized length were measured on every fifth-cut tree. Net plot volumes were expanded to full tract size and summed to obtain an estimate of the volume logged from all 34 tracts. This amounted to 7,491,000 board feet of pine and 1,609,000 of hardwoods, a grand total of 9,100,000 board feet with a standard error of ±388,000 or 4.3 percent.

Summing the total prices received by the landowner-sellers gave $128,737 as the amount actually paid for all the timber on the 34 tracts. It is, of course, free of sampling error. A corresponding grand total of $172,516 was obtained by multiplying each buyer's reported average price by the estimated logged volume of the tract he had purchased and summing these tract totals. This figure, which represents what the 34 tracts should have brought had each buyer paid for the full logged volume at the average price he reported, is subject to the variances of the estimates of volume for the individual tracts and has a standard error of ±$7,491.

Dividing the two total prices by the estimated total volume gave a realized mean price of $14.15 per thousand board feet for all 34 tracts as compared to a mean of $18.96 based on the questionnaire prices. The $4.81 difference between the two is significant at the 1-percent level.

Thus it appears that in cases in which realized stumpage prices are desired, the average prices reported by sawmill operators may require correction. The ratio "realized price: reported price" provides this. In the present case, it is merely the ratio of the two total prices and equals 0.746. The standard error is .0324 or 4.3 percent.

Summary

The test of the several methods for estimating the average price of pine stumpage in the two areas of North Carolina led to the following conclusions:

1. Any price sample would have been biased that ignored the question of how volumes were measured or that failed to secure a correct representation of the various methods of measurement, that is, lumber tally and log rules.

2. Stumpage buyers who paid the highest prices were the first to respond by mail. Thus, a number of mailings was necessary to minimize bias from this source.

3. Mail nonrespondents tended to pay less than respondents.

4. Evidence was present that new or unlisted operators of sawmills paid more for stumpage than the listed operators.

5. Tests of the differences between means disclosed some biases but none severe enough to invalidate the use of any of the survey methods tried.

6. The area survey yielded estimates of acceptable accuracy at a lower cost than any other method; the straight mail survey ranked second. Neither weighting by mill-size class nor the "method of repeated mailings" made any significant differences in the mail means.

7. When planning a stumpage price survey, one must decide what kind of mean price is desired—whether per buyer, per transaction, or per 1,000 board feet purchased—and must design the questionnaire accordingly.

8. The volumes of timber logged from boundaries overran buyers' estimates, with the result that actual realized prices averaged only 75 percent of reported prices.