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A COMPARISON OF THE AMOUNTS DEDUCTED FOR DEFECT AS DETERMINED BY THE FOREST SERVICE, KARR, AND McINTYRE SCALING METHODS

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A Comparison of the Amounts Deducted for Defect as Determined by the Forest Service, Karr, and McIntyre Scaling Methods

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INTRODUCTION

Statement of problem.

Much of the timber scaled contains defects of one sort or another. Some of the rules of thumb used for computing the amount to deduct for the defects are of questionable accuracy. The purpose of this problem is to examine Karr's and McIntyre's rules and to compare the results obtained with them with the results obtained by use of the Forest Service rules on the same defects.

Importance of problem.

So far as I have been able to discover, no previous work has ever been done on this particular problem of comparing the relative accuracy of the commonly used rules of thumb. Most of the timber scaled is scaled with these rules, and some of them are grossly inaccurate. A man who is either buying or selling logs should be vitally interested in what rules are used as it is a matter of dollars and cents to him.

Method of procedure and sources of data.

In this problem the Forest Service method in all cases was considered correct and the results obtained by use of other rules were compared to it. All logs were considered to be thirty two feet long and to taper six inches from butt to top except where stated specifically otherwise. The taper was assumed to be the same in logs

of all sizes. This is, of course, not true, but for the purpose of comparison the factor of taper was kept constant throughout the entire paper. The gross scale of logs was taken by two inch diameter classes from twelve to seventy two inches inclusive. Scribner's log rule was used at all times. Next the defect deductions were computed by Karr's, McIntyre's, and the Forest Service methods. These allowances were subtracted from the gross scales to determine the net scales. The amounts deducted by the Forest Service formulae were considered to be correct. On the graphs they were plotted as zero and the results obtained by Karr's and McIntyre's rules were compared to this assumed correct deduction. The variations from the Forest Service allowances were obtained by subtraction. All of the data obtained were assembled in tables for ready comparison.

The statement of the rules used were taken from Mason and Nettleton's textbooks. (1 and 2).

PROCEDURE

Computing defect allowance for half circle pitch rings.

Forest Service method.

The Forest Service method computes the deduction by a formula based on the size of the defect. The rule for a half circle pitch ring showing in one end of a log only is

to determine the volume of the defect by the standard formula abl/15, where a is the width of the defect in inches plus one inch for trim, and b is the length of the defect in inches plus one inch for trim, and l is the length the defect penetrates in feet.

To use this formula measure the length and width of the partial pitch ring, add one inch to each dimension. Estimate the depth the ring penetrates in feet. In all of the computations in this problem the pitch ring was assumed to penetrate sixteen feet, be sixteen inches in diameter, and to show in the butt of the log only. Multiply these three dimensions together and divide the product by fifteen. The quotient is the amount to deduct in board feet. Subtract this quotient from the gross scale to determine the net scale of the log. The gross scale, net scale, and defect allowances for the log sizes used in this problem are listed in TABLE I.

The following sample calculation will show how the defect allowance is computed. Gross volume of a log thirty two feet long, top d.i.b., 30 inches, is 1,314 board feet. Dimensions of defect are 16 inches by 8 inches and sixteen feet into the log. Add one inch to give 17 inches by 9 inches and substitute in the formula. $\frac{17 \times 9 \times 16}{15} = 163$ board feet. Subtract this allowance of 163 board feet from the gross scale of 1,314 and obtain the net scale of 1,151 board feet.

Karr's method

Karr deducts for half circle closed pitch ring showing in one end of the log only, by reducing the scaling diameter of the log one inch. The size of the defect has no bearing on the deduction. The defect assumed was a half circle closed pitch ring sixteen inches in diameter extending sixteen feet into the butt end of the log.

This rule is very simple to apply. Simply reduce the scaling diameter one inch and look up the volume of a log of that size in the log volume table used.

As a sample problem consider a log thirty two feet long with a top d.i.b. of 30 inches and a 16 inch half circle pitch ring showing in the butt. Reducing the scaling diameter one inch gives a scaling diameter of 29 inches; hence, the net volume of the log is 1,218 board feet. The gross scale of this log would be 1,314 board feet. Subtracting the net from the gross volume gives a defect allowance of 96 board feet, or only a little more than half that given by the Forest Service method. The gross scale, net scale, and defect allowance for the log sizes used in the problem are given in Table I.

McIntyre's method.

McIntyre deducts for half circle closed pitch rings showing in one end of the log by reducing the gross scale of the log 1/8. The size of the defect making no difference. The defect assumed was a half circle closed pitch

TABLE I

ONE HALF CIRCLE PITCH RINGS IN ONE END OF LOG ONLY

Top	Forest Service			Karr			McIntyre		
d.i.b.	Gross Scale	Defect Deduction	Net Scale	Gross Scale	Defect Deduction	Net Scale	Gross Scale	Defect Deduction	Net Scale
12	158	163	-5	158	30	128	158	20	138
14	228	163	65	228	31	197	228	28	200
16	318	163	155	318	34	284	318	40	278
18	426	163	263	426	56	370	426	53	373
20	560	163	397	560	80	480	560	70	490
22	668	163	505	668	60	608	668	83	585
24	804	163	641	804	50	754	804	100	704
26	1,000	163	837	1,000	82	918	1,000	125	875
28	1,164	163	1,001	1,164	68	1,096	1,164	145	1,019
30	1,314	163	1,151	1,314	96	1,218	1,314	164	1,150
32	1,472	163	1,309	1,472	52	1,420	1,472	184	1,288
34	1,600	163	1,437	1,600	32	1,568	1,600	200	1,400
36	1,846	163	1,683	1,846	94	1,752	1,846	231	1,615
38	2,136	163	1,973	2,136	78	2,058	2,136	267	1,869
40	2,408	163	2,245	2,408	168	2,240	2,408	301	2,107
42	2,686	163	2,523	2,686	142	2,544	2,686	332	2,354
44	2,960	163	2,797	2,960	168	2,792	2,960	370	2,590
46	3,174	163	3,011	3,174	138	3,036	3,174	397	2,777
48	3,456	163	3,293	3,456	144	3,312	3,456	432	3,024
50	3,744	163	3,581	3,744	150	3,594	3,744	468	3,276
52	4,048	163	3,885	4,048	154	3,894	4,048	506	3,542
54	4,368	163	4,205	4,368	160	4,208	4,368	546	3,822
56	4,701	163	4,538	4,701	170	4,531	4,701	588	4,113
58	5,046	163	4,883	5,046	176	4,870	5,046	631	4,415
60	5,408	163	5,245	5,408	182	5,226	5,408	676	4,732
62	5,784	163	5,621	5,784	190	5,594	5,784	723	5,061
64	6,172	163	6,009	6,172	196	5,976	6,172	771	5,401
66	6,478	163	6,415	6,578	206	6,372	6,578	822	5,756
68	7,000	163	6,837	7,000	204	6,796	7,000	875	6,125
70	7,436	163	7,273	7,436	220	7,216	7,436	929	6,507
72	7,872	163	7,709	7,872	208	7,664	7,872	984	6,888

ring 16 inches in diameter showing at one end of the log only, and penetrating the butt end sixteen feet.

This rule is fairly easy to apply though not as easily used as Karr's. For a sample problem take a log thirty two feet long with a top d.i.b. of 30 inches. A half circle closed pitch ring 16 inches in diameter shows in the butt. Gross scale of the log is 1,314 board feet. One-eighth of this is 164 board feet. Subtracting 164 from 1,314 gives a net scale of 1,150 board feet. This particular size happens to give a result practically the same as the Forest Service method, but this is not true for all sizes by any means. The gross scale, net scale, and defect allowance for the log sizes used in this problem are given in TABLE I.

Comparison of the three methods on half circle pitch rings.

The amounts deducted by each of the three methods were compared in the following manner. The amount deducted by the Forest Service method was considered as correct. A table was prepared showing the deviation by two inch diameter classes from the correct deduction for the defect of the results given by Karr's and McIntyre's methods. This is tabulated in TABLE II. The deviations were figured as plus if the amounts deducted were greater than the amount deducted by the Forest Service method, and minus if the amounts deducted were less than the amount deducted by the Forest Service method. These data were

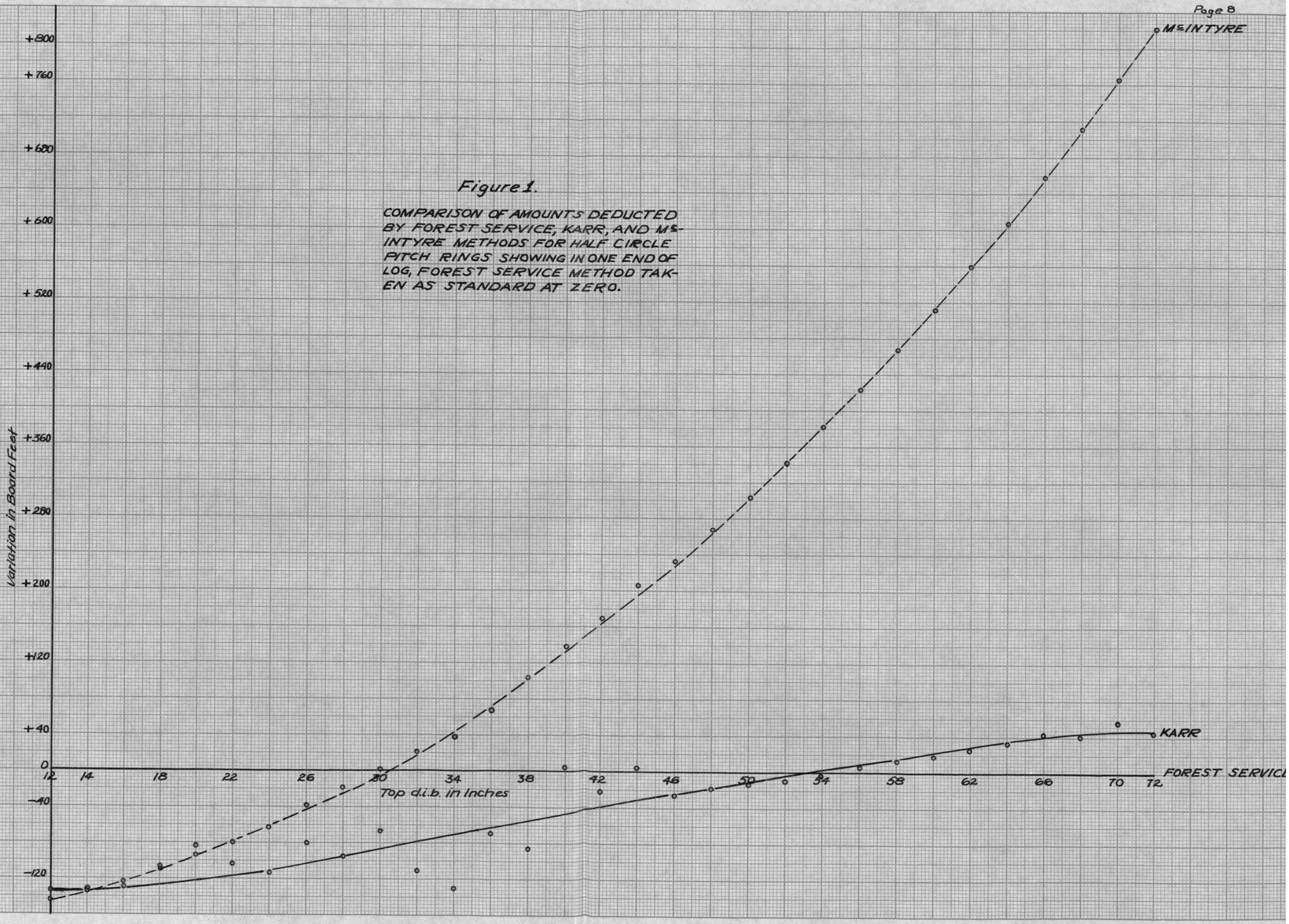
TABLE II

COMPARISON OF AMOUNTS DEDUCTED BY FOREST SERVICE, KARR, AND McINTYRE METHODS FOR HALF CIRCLE PITCH RING, FOREST SERVICE METHOD TAKEN AS STANDARD AT ZERO.

Top d.i.b.	Forest Service	Karr	McIntyre
12	0	-133	-143
14	0	-132	-135
16	0	-129	-123
18	0	-107	-110
20	0	- 83	- 93
22	0	-103	- 80
24	0	-113	- 63
26	0	- 81	- 38
28	0	- 95	- 18
30	0	- 67	1
32	0	-111	21
34	0	-131	37
36	0	- 69	68
38	0	- 85	104
40	0	- 15	138
42	0	- 21	169
44	0	5	207
46	0	- 25	234
48	0	- 19	269
50	0	- 13	305
52	0	- 9	343
54	0	- 3	383
56	0	7	425
58	0	13	468
60	0	19	513
62	0	27	560
64	0	33	608
66	0	43	659
68	0	41	712
70	0	57	766
72	0	45	821

Figure 1.

COMPARISON OF AMOUNTS DEDUCTED BY FOREST SERVICE, KARR, AND McINTYRE METHODS FOR HALF CIRCLE PITCH RINGS SHOWING IN ONE END OF LOG, FOREST SERVICE METHOD TAKEN AS STANDARD AT ZERO.



then plotted on a curve. The Forest Service results being the zero line or standard. The other data were plotted and curves drawn to show the deviation at the different diameter classes. The curves for half circle pitch rings showing in one end of the log are given in Figure 1.

Computing defect allowance for a full circle pitch ring. Forest Service method.

In a log with a full circle pitch ring showing at both ends, the Forest Service method assumes that useable material will be salvaged from the core. In a log greater than sixteen feet long, measure the diameter in inches of the pitch ring at each end. Take the average diameter in inches and add one inch to it for trim. Compute the volume of this core by squaring the average diameter in inches plus one inch and multiply this product by the length of the log in feet. Divide this product by 15 and obtain the gross deduction in board feet. Measure the diameter of useable core at the small end of the log and obtain the volume of log of this diameter and the same length as the log being considered. Subtract this volume from the defect allowance and obtain the net or actual deduction. Subtract this actual deduction from the gross volume of the log to obtain the net scale.

In this problem the log was assumed to taper 6 inches in its thirty two feet of length. The top diameter of the

TABLE III

FULL CIRCLE PITCH RING SHOWING IN BOTH ENDS OF LOG

Top d.i.b.	Forest Service			Karr			McIntyre		
	Gross Scale	Defect Deduction	Net Scale	Gross Scale	Defect Deduction	Net Scale	Gross Scale	Defect Deduction	Net Scale
12	158	308	-150	158	94	64	158	79	79
14	228	308	- 80	228	120	108	228	114	114
16	318	308	10	318	160	158	318	159	159
18	426	308	118	426	198	228	426	213	213
20	560	308	252	560	242	318	560	280	280
22	668	308	360	668	242	426	668	334	334
24	804	308	496	804	244	560	804	402	402
26	1,000	308	692	1,000	332	668	1,000	500	500
28	1,164	308	856	1,164	360	804	1,164	582	582
30	1,314	308	1,006	1,314	314	1,000	1,314	657	657
32	1,472	308	1,164	1,472	308	1,164	1,472	736	736
34	1,600	308	1,292	1,600	286	1,314	1,600	800	800
36	1,846	308	1,538	1,846	374	1,472	1,846	923	923
38	2,136	308	1,828	2,136	536	1,600	2,136	1,068	1,068
40	2,408	308	2,100	2,408	562	1,846	2,408	1,204	1,204
42	2,686	308	2,378	2,686	550	2,136	2,686	1,343	1,343
44	2,960	308	2,652	2,960	552	2,408	2,960	1,480	1,480
46	3,174	308	2,866	3,174	488	2,686	3,174	1,587	1,587
48	3,456	308	3,148	3,456	496	2,960	3,456	1,728	1,728
50	3,744	308	3,436	3,744	570	3,174	3,744	1,872	1,872
52	4,048	308	3,740	4,048	592	3,456	4,048	2,024	2,024
54	4,368	308	4,060	4,368	624	3,744	4,368	2,184	2,184
56	4,701	308	4,393	4,701	653	4,048	4,701	2,350	2,350
58	5,046	308	4,738	5,046	678	4,368	5,046	2,523	2,523
60	5,408	308	5,100	5,408	707	4,701	5,808	2,704	2,704
62	5,784	308	5,476	5,784	738	5,046	5,784	2,892	2,892
64	6,172	308	5,864	6,172	764	5,408	6,172	3,086	3,086
66	6,578	308	6,270	6,578	794	5,784	6,578	3,289	3,289
68	7,000	308	6,692	7,000	828	6,172	7,000	3,500	3,500
70	7,436	308	7,128	7,436	858	6,578	7,436	3,718	3,718
72	7,872	308	7,564	7,872	872	7,000	7,872	3,936	3,936

pitch ring will be assumed to be 10 inches and the butt diameter to be 16 inches.

For a sample problem assume a log thirty two feet long with a top d.i.b. of 30 inches. A full circle pitch ring 10 inches in diameter is in the top end and a full circle pitch ring is in the butt end. The average diameter of the two rings is 10 + 16 = 13 inches. Thirteen inches plus one inch for trim gives 14 inches. Fourteen squared times thirty two feet and the product divided by 15 is 406 board feet gross defect deduction. The volume of a log thirty two feet long with a top d.i.b. of 10 inches is 108 board feet. 416 - 108 = 308 board feet net deduction. This deduction is subtracted from the gross scale of 1,314 board feet and gives the net volume of 1,006 board feet. The gross scale, net scale, and defect allowances for all log sizes used in this problem are in Table III.

Karr's method.

Karr deducts for a full circle pitch ring showing in both ends of a log by reducing the scaling diameter four inches. This is a simple rule to apply but it is too inflexible to be very satisfactory.

For a sample problem consider a log thirty two feet long with a top d.i.b. of 30 inches. A full circle pitch ring 10 inches in diameter is in the top end, and one 16

inches in diameter is in the butt end. The gross scale of this log is 1,314 board feet. Reducing the diameter of the log four inches gives a scaling diameter of 26 inches, hence, the net scale is 1,000 board feet. Subtracting the net scale from the gross scale gives a deduction of 314 board feet. This is very nearly the same as the amount given by the Forest Service method, but the method as a rule is high for logs larger than this and low for logs smaller than this in the amount given for deduction. The gross scale, net scale, and defect allowance for all log sizes used in this problem are in Table III.

McIntyre's method.

McIntyre deducts for a full circle pitch ring showing in both ends of the log by reducing the gross scale 1/2. For large logs this method is far too high; for small logs, it is apt to be too low. This method is used as it is very simple to apply.

For a sample problem consider a log thirty two feet long with a top d.i.b. of 30 inches. A 10 inch full circle pitch ring is in the top end of the log and a 16 inch full circle pitch ring is in the butt of the log. The gross scale of the log is 1,314 board feet. The deduction is 1/2 of the gross scale or 657 board feet. Subtracting the allowance from the gross scale gives 657 board feet net scale. The gross scale, net scale, and defect allowance for all log sizes used in this problem are given in

TABLE IV

COMPARISON OF AMOUNTS DEDUCTED BY FOREST SERVICE, KARR, AND McINTYRE METHODS FOR FULL CIRCLE PITCH RING, FOREST SERVICE METHOD TAKEN AS STANDARD AT ZERO.

Top d.i.b.	Forest Service	Karr	McIntyre
12	0	-214	- 229
14	0	-188	- 194
16	0	-148	- 149
18	0	-110	- 95
20	0	- 66	- 28
22	0	- 66	26
24	0	- 64	94
26	0	24	192
28	0	52	274
30	0	6	349
32	0	0	428
34	0	22	492
36	0	66	615
38	0	228	760
40	0	254	896
42	0	242	1,035
44	0	244	1,172
46	0	180	1,279
48	0	188	1,420
50	0	262	1,564
52	0	284	1,716
54	0	316	1,876
56	0	345	2,042
58	0	370	2,215
60	0	399	2,396
62	0	430	2,584
64	0	456	2,778
66	0	486	2,981
68	0	520	3,192
70	0	550	3,410
72	0	564	3,628

Figure 2.

COMPARISON OF AMOUNTS DEDUCTED BY FOREST SERVICE, KARR, AND McINTYRE METHODS FOR FULL CIRCLE PITCH RING SHOWING IN BOTH ENDS OF LOG, FOREST SERVICE METHOD TAKEN AS STANDARD AT ZERO.

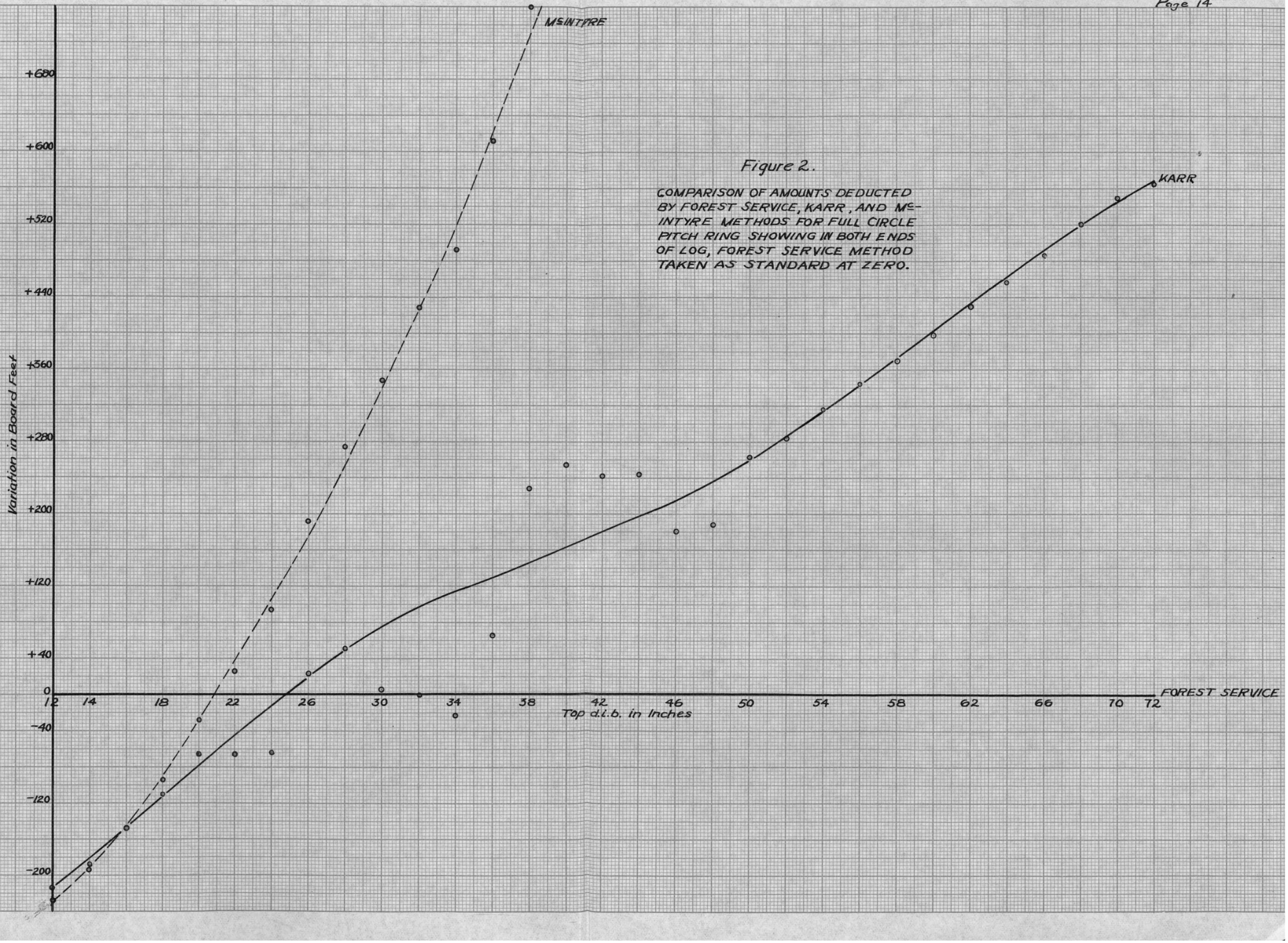


Table III.

Comparison of the three methods on full circle pitch rings.

The defect allowances obtained by these three methods were compared. The allowances obtained by the Forest Service method were considered as correct and allowances obtained by the other two methods were figured as deviations from the normal. These deviations were computed in the same manner as for half circle pitch rings and are listed in Table IV. These variations were then plotted on graph paper and curves drawn. The allowances figured by the Forest Service method are plotted as zero and standard, and the others as variations from the standard. These data are shown in Figure 2.

Computing defect allowance for butt rot.

Forest Service method.

The Forest Service method of deducting for butt rot is by either reducing the length of the log or by the ab1/15 formula. The rules can be stated simply. When the diameter of the butt rot exceeds or nearly exceeds the scaling diameter of the log, reduce the log in length a number of feet equal to the depth of the defect in the log. The net scale of the log is the scale of a log with a diameter equal to the top d.i.b. of the log and a length equal to length of the original log minus the number of feet deducted for defect. The defect allowance is the

difference between the gross and net scales of the log.

When the defect is small in comparison to the scaling diameter of the log, compute the defect allowance by the abl/15 formula. To obtain the net scale subtract the defect allowance from the gross scale of the log.

In this problem the logs were assumed to be all thirty two feet long with a taper of 4 inches exclusive of the butt swell. Butt swell is assumed to extend eight feet up the log and increase the butt diameter 6 inches. Butt rot is 20 inches in diameter and extends into the log eight feet.

As a sample problem illustrating the first method of deducting, assume a log thirty two feet long with a top d.i.b. of 14 inches with a butt rot of 20 inches in diameter. The log has the same taper and butt swell as given in the paragraph above. Gross scale of the log is 228 board feet. Butt rot exceeds the scaling diameter so cut the log in length eight feet or the length of the butt swell as that is about the depth to which the rot will penetrate. The net scale for the log is then the scale of a log 14 inches in diameter and twenty four feet long or 172 board feet. This gives a defect allowance of 56 board feet when the net scale is subtracted from the gross scale.

As an illustration of the second rule, assume a log with a top d.i.b. of 30 inches and thirty two feet long

TABLE V

BUTT ROT

Top d.i.b.	Forest Service			Karr		
	Gross Scale	*Defect Deduction*	*Net Scale*	*Gross Scale*	*Defect Deduction*	*Net Scale*
12	158	40	118	158	40	118
14	228	56	172	228	35	193
16	318	80	238	318	50	268
18	426	106	320	426	52	374
20	560	140	420	560	70	490
22	668	167	501	668	84	584
24	804	198	606	804	98	706
26	1,000	235	765	1,000	122	878
28	1,164	235	929	1,164	146	1,018
30	1,314	235	1,079	1,314	164	1,150
32	1,472	235	1,237	1,472	184	1,288
34	1,600	235	1,365	1,600	200	1,400
36	1,846	235	1,611	1,846	232	1,614
38	2,136	235	1,901	2,136	268	1,868
40	2,408	235	2,173	2,408	302	2,106
42	2,686	235	2,451	2,686	336	2,350
44	2,960	235	2,725	2,960	370	2,590
46	3,174	235	2,939	3,174	398	2,776
48	3,456	235	3,221	3,456	432	3,024
50	3,744	235	3,509	3,744	234	3,510
52	4,048	235	3,813	4,048	253	3,795
54	4,368	235	4,133	4,368	273	4,095
56	4,701	235	4,466	4,701	294	4,407
58	5,046	235	4,811	5,046	315	4,731
60	5,408	235	5,173	5,408	338	5,070
62	5,784	235	5,549	5,784	362	5,422
64	6,172	235	5,937	6,172	386	5,786
66	6,578	235	6,343	6,578	412	6,166
68	7,000	235	6,765	7,000	438	6,562
70	7,436	235	7,201	7,436	466	6,970
72	7,872	235	7,637	7,872	474	7,398

with a butt rot 20 inches in diameter. All other dimensions the same as in the example above. The gross scale of the log would be 1,314 board feet. The defect which is 20 inches in diameter does not exceed the scaling diameter; hence, the allowance would be computed by the formula. Add one inch to the diameter of the defect giving 21 inches. Square 21 inches and multiply the product by eight, the depth of the defect in feet. Divide this product by 15 and the quotient is 235 board feet, the allowance for the defect. Subtract this from the gross scale, and it gives the net scale of 1,079 board feet. The gross scale, net scale, and defect allowance for all log sizes used in this problem are given in Table V.

Karr's method.

Karr's method of allowing for butt rot is to reduce the length of the log for all sizes of butt rot. His rules are: (1) If the rot diameter does not exceed 1/3 of the butt end diameter of the log, deduct from the log length not more than 1/4 of the length of the butt swell. (2) If the rot diameter averages 2/3 of the butt end diameter of the log, deduct from the log length 1/2 of the length of the butt swell. (3) If the rot diameter averages 5/6 of the butt end diameter of the log, deduct from the log length 2/3 of the length of the butt swell. (4) If the rot covers the entire butt end of the log, cut the log

length to the upper end of the butt swell. For large diameter rots Karr handles the allowance practically the same as the Forest Service, and as would follow, the results compare very closely.

In this problem the logs were assumed to be thirty two feet long with a 4 inch taper. Butt swell extends eight feet up the log from the butt end and increases the butt end diameter 6 inches. The diameter of the butt rot is 20 inches in all size logs and penetrates the log eight feet or the length of the butt swell.

For a sample problem assume a log thirty two feet long with a top d.i.b. of 30 inches and a butt rot with a diameter of 20 inches, all other conditions the same as stated in the preceding paragraph. The total butt diameter of the log is 40 inches after allowing for taper and butt swell. The butt rot is 50% of the butt diameter; hence, the deduction would be by rule 2. Reducing the log length half the length of the butt swell, reduces its length to twenty eight feet. Therefore the net scale is that of a log 30 inches in diameter and twenty eight feet in length or 1,150 board feet. The gross scale of the log is 1,314 board feet. Subtracting the net scale from the gross scale gives a defect allowance of 164 board feet.

The gross scale, net scale, and defect allowance for all sizes of logs used in this paper are given in Table V.

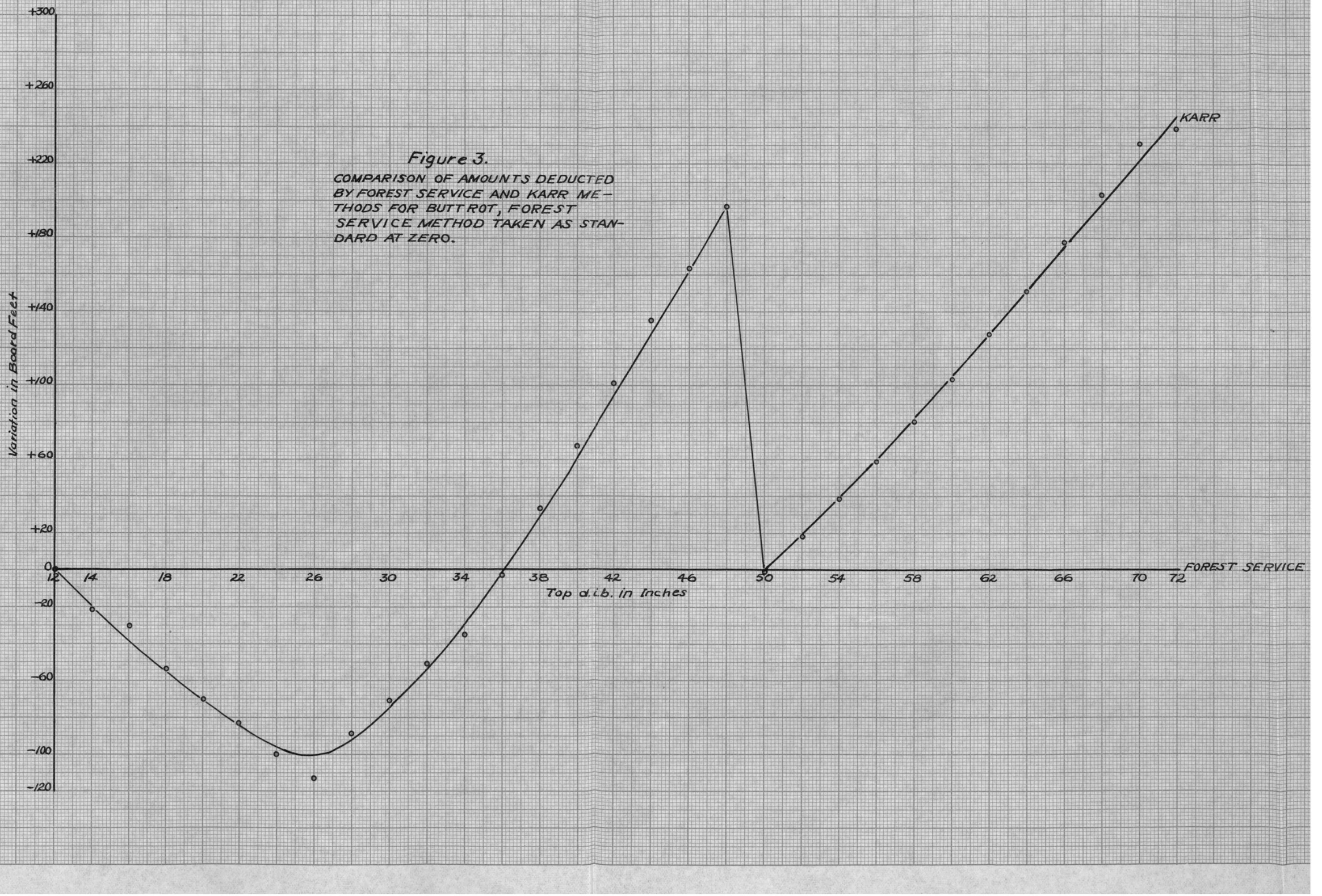
TABLE VI

COMPARISON OF AMOUNTS DEDUCTED BY
FOREST SERVICE AND KARR METHODS FOR BUTT ROT,
FOREST SERVICE METHOD TAKEN AS STANDARD AT ZERO.

Top d.i.b.	Forest Service	Karr
12	0	0
14	0	- 21
16	0	- 30
18	0	- 54
20	0	- 70
22	0	- 83
24	0	-100
26	0	-113
28	0	- 89
30	0	- 71
32	0	- 51
34	0	- 35
36	0	- 3
38	0	33
40	0	67
42	0	101
44	0	135
46	0	163
48	0	197
50	0	- 1
52	0	18
54	0	38
56	0	59
58	0	80
60	0	103
62	0	127
64	0	151
66	0	177
68	0	203
70	0	231
72	0	239

Figure 3.

COMPARISON OF AMOUNTS DEDUCTED BY FOREST SERVICE AND KARR METHODS FOR BUTT ROT, FOREST SERVICE METHOD TAKEN AS STANDARD AT ZERO.



Comparison of the two methods on butt rot.

The defect allowances obtained by these two methods were compared. The results obtained by the Forest Service method were considered correct and the results obtained by Karr's method were compared to it. The Forest Service method was considered zero, and the amount of the deviation of the defect allowance as determined by Karr's method was determined by adding or subtracting the allowance from the Forest Service allowance. These calculations are given in Table VI.

These deviations were plotted and show graphically the variation in the amounts deducted at each diameter class by the two methods. The curves are shown in Figure 3.

SUMMARY

Findings.

By examining Figures 1, 2, and 3, the variation that occurs in the amounts allowed in different size logs for a defect of constant size is readily seen. It stands to reason that a defect of a constant size would contain a constant number of board feet, yet, the amount allowed for it varies enormously. Examine first Figure 1. The defect was of a constant size in all sizes of logs. This constant defect would probably never occur naturally, but for

the purpose of this paper it was assumed it would. McIntyre's method on the half circle pitch ring on a 12 inch log is about 140 board feet low. It is equal to the Forest Service deduction at 30 inches, but it is greater for logs larger than this. At 72 inches it is 820 board feet greater than the Forest Service deduction. At 72 inches the rule gives a deduction of 984 board feet for a simple half circle pitch ring and only showing in one end of the log at that. Of course this is the variation from a particular defect of constant size, but a similar variation would occur from correct result for a defect of any size over a large range of log sizes. The only difference would be at the point where the two curves would cross, as McIntyre's allowances are constant for defects of any size.

The results obtained by Karr's rule also vary considerably, though for a defect of the size considered it is fairly accurate. Under these particular conditions it shows the most variation at the lower limits where it is 130 board feet or so low. At 72 inches it is 50 board feet high. It is equal to the Forest Service allowance for this defect at 54 inches. Even though this method gives a more accurate result, it gives allowances of from 30 to 208 board feet for a defect of constant size. McIntyre's method, however, gives a variation of from 20 to 984 board feet for the same defect.

If the amounts allowed for a constant defect seems to vary for a half circle pitch ring, check Figure 2. The variation here is much greater. Mc Intyre's method is worthless for anything approaching accurate results. For a constant defect his method deducts amounts varying from 79 to 3,936 board feet. This tremendous range is for a defect of exactly the same size, the only difference being the size of the log in which it occurs. It gives the same deduction as the Forest Service only at 19 inches. Karr's method is little better. It is equal to the Forest Service allowance at 25 inches but at no other size. It also has too great a range for a constant defect. This method allows 94 board feet at 12 inches and 872 board feet at 72 inches. A truly great variation in the amount allowed for a defect which remains the same size at all times.

Figure 3 shows the comparison of the amount deducted by Karr's rules and the Forest Service rules for butt rot. This rule compares fairly well, at least for this size of a defect. At 12 inches it allows the same as the Forest Service method. At 36 inches and 50 inches it also allows the same amounts. But at 26 inches it does not allow enough and from 36 to 50 inches allows too much as a rule. From 50 inches on it allows too much in steadily increasing amounts. Karr's rules allow from 122 to 474 board feet, though, for the same butt rot defect. It is

better than his other rules, however.

Conclusions.

The allowances made by the Forest Service methods are the most accurate for one basic reason: the allowance is made for the defect. In most of the rules, the size of the log has nothing to do with the amount deducted. Now in the rules of thumb, the exact opposite is true in most cases. Deduction is made by reducing the diameter or by reducing the gross scale a certain fraction. This gives a different allowance for the same sized defect in logs of different sizes which is obviously incorrect. A 10 inch pitch ring in a 30 inch log spoils just as much lumber as a 10 inch pitch ring in a 70 inch log, yet a rule of thumb will give a larger allowance for the defect in the larger log. In all of the examples used in this paper a certain arbitrarily selected defect was used and its size kept constant in all diameter classes. Hence, the curves given are only correct for the assumptions used, but the same general variation would occur for any size defect. The only difference in curves would be the points at which the rule of thumb allowances would equal the Forest Service allowance.

Recommendations.

Since most rules of thumb are simple to apply, they will probably continue in use. But it is recommended,

however, that before any rules of thumb are used, the results obtained with them be compared with the results obtained by some known accurate rule. Also a rule is seldom accurate for a wide range of log sizes; hence, it should be discovered at what sizes it is reliable and its use restricted to logs of that size.

ADDITIONAL TABLES

TABLE VII

PART OF SCRIBNER'S LOG RULE

Top d.i.b.	Length of Log in Feet			
	4	8	16	32
8	8	16	32	64
9	10	21	42	84
10	13	27	54	108
11	16	32	64	128
12	19	39	79	158
13	24	49	98	197
14	28	57	114	228
15	35	71	142	284
16	39	79	159	318
17	46	92	185	370
18	53	106	213	426
19	60	120	240	480
20	70	140	280	560
21	76	152	304	608
22	83	167	334	668
23	94	188	377	754
24	100	201	402	804
25	114	229	459	918
26		250	500	1,000
27		274	548	1,096
28		291	582	1,164
29		304	609	1,218
30		328	657	1,314
31		355	710	1,420
32		368	736	1,472
33		392	784	1,568
34		400	800	1,600
35		438	876	1,752
36		461	923	1,846
37			1,029	2,058
38			1,068	2,136
39			1,120	2,240
40			1,204	2,408
41			1,272	2,544
42			1,343	2,686

Top d.i.b.	Length of Log in Feet	
	16	32
43	1,396	2,792
44	1,480	2,960
45	1,518	3,036
46	1,587	3,174
47	1,656	3,312
48	1,728	3,456
49	1,797	3,594
50	1,872	3,744
51	1,947	3,894
52	2,024	4,048
53	2,104	4,208
54	2,184	4,368
55	2,265	4,531
56	2,350	4,701
57	2,435	4,870
58	2,523	5,046
59	2,613	5,226
60	2,704	5,408
61	2,797	5,594
62	2,892	5,784
63	2,988	5,976
64	3,086	6,172
65	3,186	6,372
66	3,289	6,578
67	3,398	6,796
68	3,500	7,000
69	3,608	7,216
70	3,718	7,436
71	3,832	7,664
72	3,936	7,872

TABLE VIII

TABLE GIVING DEFECT ALLOWANCE IN BOARD FEET PER LINEAL FOOT OF DEFECT

Width of Defect In Inches	Length of Defect in Inches																	
	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
4	2	2	2	3	3	3	3	4	4	4	5	5	5	5	6	6	6	6
5	2	3	3	3	4	4	4	5	5	5	6	6	6	7	7	7	8	8
6	3	3	4	4	4	5	5	6	6	6	7	8	8	8	8	9	9	10
7	3	4	4	5	5	6	6	7	7	7	8	8	9	9	10	10	11	11
8	4	4	5	5	6	6	7	7	8	9	9	10	10	11	11	12	12	13
9	4	5	5	6	7	7	8	8	9	10	10	11	11	12	13	13	14	15
10	5	5	6	7	7	8	9	9	10	11	11	12	13	13	14	15	15	16
11	5	6	7	7	8	9	10	10	11	12	12	13	14	15	15	16	17	18
12	6	6	7	8	9	10	10	11	12	13	14	14	15	16	17	18	18	19
13	6	7	8	9	10	10	11	12	13	14	15	16	16	17	18	19	20	21
14	7	7	8	9	10	11	12	13	14	15	16	17	18	19	20	20	21	22
15	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
16	7	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	25	26
17	8	9	10	11	12	14	15	16	17	18	19	20	21	23	24	25	26	27
18	8	10	11	12	13	14	16	17	18	19	20	22	23	24	25	26	28	29
19	9	10	11	13	14	15	16	18	19	20	22	23	24	25	27	28	29	30
20	9	11	12	13	15	16	17	19	20	21	23	24	25	27	28	29	31	32
21	10	11	13	14	15	17	18	20	21	22	24	25	27	28	29	31	32	34
22	10	12	13	15	16	18	19	21	22	23	25	26	28	29	31	32	34	35
23	11	12	14	15	17	18	20	21	23	25	26	28	29	31	32	34	35	37
24	11	13	14	16	18	19	21	22	24	26	27	29	30	32	34	35	37	38

Defect allowance computed by $\frac{abl}{15}$ formula, to the nearest whole board foot.

To use table: Measure each dimension of defect adding one inch to both length and width measurement. Look up these dimensions in table and obtain defect allowance per foot. Multiply this amount by the length of the defect in feet to obtain total amount to deduct for defect.

APPENDICES

APPENDIX A

STATEMENT OF DEFECT DEDUCTION RULES USED IN COMPUTING THIS PROBLEM

Forest Service Method of Allowing for Defect:

Butt rot:

1. When the diameter of the butt rot exceeds or nearly equals the scaling diameter of the log, reduce the log in length a number of feet corresponding to the depth of the rot in the butt of the log. The net volume of the log is the scale of a log having a diameter equal to the diameter of the original log and a length equal the length of the original log minus the number of feet deducted for defect.
2. When the diameter of the butt rot is small in comparison to the scaling diameter, compute the amount to deduct by the formula abl/15, where a is the length of the defect plus one inch, and b is the width of the defect plus one inch, and l is the length of the defect in feet. Dividing this product by 15 gives the answer in board feet. The quantity determined by this formula subtracted from the gross scale of the log gives the net scale.

Pitch rings:

1. For a half circle pitch ring showing in one end of

the log only, compute the deduction by the standard formula abl/15 and subtract this amount from the gross scale of the log to determine the net scale.

2. For a full circle pitch ring extending the full length of the log and containing a merchantable core, compute the volume of the defect as follows:
   a. Compute the volume of the core by the standard formula abl/15, taking the average measurement of the two ends of the pitch ring plus one inch. From this amount subtract the volume of a log equal to the diameter of the merchantable core at the small end and the length of the log.
   b. Subtract this defect deduction from the gross volume of the log to obtain the net volume.

Karr's Rules for Allowing for Defect:

Butt rot:

1. If the rot diameter does not exceed 1/3 of the butt end diameter of the log, deduct from the log length not more than 1/4 the length of the bell or butt swell.
2. If the rot diameter averages 2/3 of the butt end diameter of the log, deduct from the log length 1/2 of the length of the bell or butt swell.
3. If the rot diameter averages 5/6 of the butt end

diameter of the log, deduct from the log length, 2/3 of the length of the bell or butt swell.

4. If the rot covers the entire butt end of the log, cut the log length to the upper end of the bell or butt swell.

Pitch rings:

1. For a half circle closed pitch ring showing in one end of the log only, reduce the scaling diameter one inch.
2. For a full circle pitch ring showing in both ends of the log, reduce the scaling diameter four inches.

McIntyre's Rules for Allowing for Defect:

Pitch rings:

1. For a half circle pitch ring showing in one end of a log only, reduce the gross scale of the log 1/8.
2. For a full circle pitch ring showing on both ends of a log, reduce the gross scale of the log by 1/2.

LITERATURE CITED

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1. Mason, Earl G., Nettleton, Harry I., Forest Mensuration, fourth edition, OSC Cooperative Association, Corvallis, Oregon, 1938.

2. Mason, Earl G., Nettleton, Harry I., Forest Mensuration, Fifth edition, OSC Cooperative Association, Corvallis, Oregon, 1940.