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Costs of Forest Management Practices in the Lake States



Costs of Forest Management Practices in the Lake States

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Any organization needs to know the costs of operations it undertakes. For organizations involved in forestry in the Lake States this has become especially true. The general decrease of funds available to many organizations and the increasing intensity of forest management in the region have contributed to this need. In response, this study will report on the costs of common forest practices in the Lake States.

Earlier efforts to provide cost estimates for the Lake States were by Olson, Lundgren, and Rose (4); Conkin (1); and Hilliker, Webster, and Tritch (2). These studies were limited by the small numbers of practices considered and the low numbers of observations made. Cost estimates for an individual organization were obtained by inserting the organization's values for the independent variables (labor and machine rates, basal area removed, etc.) into the general regression equations the studies generated.

In the Southeastern United States a different approach was used. Moak, Watson, and Van Deusen (3) developed cost estimates from questionnaires sent to forestry organizations in the region. Cost estimations for the practices were then generated by averaging the questionnaire responses.

Questionnaire surveys lend themselves to a broad coverage of forest management practices from a variety of organizations. The estimates developed by this method can then be used by an individual organization to compare costs.

This study used questionnaires to develop cost estimates for the Lake States. The questionnaires were sent to 300 forest products companies, contractor/vendors, consultants, and state and federal agencies throughout Michigan, Wisconsin, and Minnesota. Those questioned were asked for the average total cost and a breakdown of this cost by component for forestry practices conducted in 1982. Fifty-nine usable returns were received (Table 1).

Although questionnaire response rate was only 20%, the low response can be attributed to uncertainty over who could provide the survey with this type of information. To lower the chances of missing possible

Table 1. Survey Response

Type of Organization	STATE			Total
	Michigan	Wisconsin	Minnesota	
Forest Industry	9	8	2	19
Contractor/Vendor	1	0	0	1
Consultant	17	6	2	25
State Agency	2	2	2	6
Federal Agency	4	2	2	8
TOTAL	33	18	8	59

sources, questionnaires were sent to all known organizations, regardless of the likelihood of a response. Many of the questionnaires were thus received by organizations which only contract out their forestry work, do not have forest land or operations, were not active in forestry in 1982, or do not keep cost records at the organizational level at which the questionnaire was received. A lack of adequate cost records, cutbacks in staff, apathy, and a bias against out-of-state surveys also may have contributed to the low response. Returns were received, however, from most of the organizations known to have active forestry operations.

The accompanying text and tables summarize the study's results. The tables show the average total cost for each practice, the average component cost and its percentage of the total cost. For many practices the sum of the components will not equal the reported total due to organizations reporting totals only. Each table includes the total number of responses for the practice, the standard deviation of the total, and the range.

In practices where conditions caused substantial differences in cost, the costs were separated by conditions (usually better than average, average, and worse than average). The questionnaire gave no guidelines on what would constitute the various conditions. It was felt that individual differences in classification would equal out when the returns were taken in aggregate. The resulting averages would provide representative costs for the various conditions.

Comparisons were also made on the differences in costs reported by each organization type (industry, consultants, state, and federal). The results of these comparisons are presented in Section II.

Section I: Average Costs of Management Practices

Planting Costs

Planting operations were separated by method of planting (hand or machine), by site preparation (intensive or non-intensive) and by species (pines, all other conifers, or hardwoods). The pines were then separated by planting density (less than 800 trees per acre or 800 or more trees per acre). (Tables 2-5).

In general, the cost of hand planting was less than machine planting on non-intensively prepared areas, but greater than machine planting on intensively prepared lands. Planting stock was the most costly component for nearly all methods, averaging 44 percent of the total cost. Labor cost was usually second highest, even for machine planting. A state-to-state comparison indicated very little cost differences between the states.

Mechanical Site Preparation

Costs of mechanical site preparation vary directly with the difficulty of the conditions (Table 6). There was a 98 percent difference in treatment cost between the less difficult and the most difficult sites. Under all conditions equipment was the most expensive component.

Table 2. Machine Planting Intensively Prepared Lands

Species	Pines < 800/acre	Pines ≥ 800/acre	Other Conifers	Hardwoods
Average seedlings per acre	635	900	922	538
Average cost per acre for:				
Planting Stock	\$38.54 (40)	\$58.63 (44)	\$62.38 (49)	\$61.45 (61)
Labor	23.54 (25)	27.84 (21)	18.56 (15)	16.64 (16)
Equipment	19.91 (21)	32.74 (25)	34.56 (27)	8.70 (9)
Supervision	8.86 (9)	8.74 (7)	7.78 (6)	8.63 (9)
Other	4.40 (5)	4.18 (3)	3.00 (3)	4.80 (5)
Total Cost	\$84.22	\$130.25	\$120.79	\$103.12
standard deviation	\$22.0	\$46.8	\$34.0	\$34.5
range	\$60-119	\$62-220	\$86-198	\$50-139
number of responses	13	13	9	6

*The number in parenthesis is the component's percent of the sum of the components.

Chemical Site Preparation

Chemicals were 49 percent of the total cost of chemical site preparation (Table 7). The cost of preparing land by chemical means was similar to the cost of mechanical site preparation on less difficult and average sites.

Table 3. Hand Planting Intensively Prepared Lands

Species	Pines < 800/acre	Pines ≥ 800/acre	Other Conifers	Hardwoods
Average seedlings per acre	678	911	884	518
Average cost per acre for:				
Planting Stock	\$48.10 (44)	\$59.75 (42)	\$83.28 (51)	\$58.70 (54)
Labor	49.44 (45)	63.94 (45)	64.76 (39)	35.46 (33)
Equipment	0.15 (0)	4.36 (3)	2.09 (1)	0.80 (1)
Supervision	8.42 (8)	10.97 (8)	12.96 (8)	7.74 (7)
Other	3.00 (3)	2.06 (2)	1.86 (1)	5.00 (5)
Total Cost	\$104.68	\$142.42	\$156.97	\$109.23
standard deviation	\$27.7	\$60.2	\$62.0	\$38.6
range	\$60-145	\$39-300	\$87-300	\$60-161
number of responses	15	17	16	6

Table 4. Machine Planting Non-Intensively Prepared Land

Species	Pines < 800/acre	Pines ≥ 800/acre	Other Conifers	Hardwoods
Average seedlings per acre	714	901	804	
Average cost per acre for:				
Planting Stock	\$44.86 (36)	\$49.71 (36)	\$55.33 (41)	
Labor	46.33 (35)	32.61 (24)	44.58 (33)	
Equipment	17.33 (13)	46.04 (34)	18.92 (14)	
Supervision	11.50 (9)	6.00 (4)	10.00 (8)	
Other	9.33 (7)	2.77 (2)	4.83 (4)	
Total Cost	\$128.50	\$140.20	\$133.17	
standard deviation	\$30.5	\$47.2	\$48.7	
range	\$60-149	\$63-205	\$60-200	
number of responses	6	9	4	

Table 5. Hand Planting Non-Intensively Prepared Lands

Species	Pines < 800/acre	Pines ≥ 800/acre	Other Conifers	Hardwoods
Average seedlings per acre	666	856	643	648
Average cost per acre for:				
Planting	\$48.87	\$46.49	\$52.36	\$98.87
Stock	(41)	(46)	(41)	(57)
Labor	55.45	40.85	55.71	55.58
	(46)	(40)	(44)	(32)
Equipment	1.27	5.46	2.68	0.50
	(1)	(5)	(2)	(0)
Supervision	10.13	7.24	12.43	13.67
	(9)	(7)	(10)	(8)
Other	4.07	2.10	4.09	5.75
	(3)	(2)	(3)	(3)
Total Cost	\$118.79	\$110.92	\$122.47	\$174.20
standard deviation	\$40.0	\$32.9	\$62.4	\$54.2
range	\$65-192	\$78-171	\$15-200	\$111-243
number of responses	18	9	11	4

Table 6. Mechanical Site Preparation

Average cost per acre for:	Conditions		
	less difficult than average	average	more difficult than average
Labor	\$15.70	\$23.07	\$33.81
	(33)	(39)	(35)
Equipment	22.99	28.13	51.12
	(49)	(48)	(53)
Supervision	7.00	5.89	9.41
	(15)	(10)	(10)
Other	1.30	2.05	1.80
	(3)	(4)	(2)
Total Cost	\$49.22	\$61.73	\$97.41
standard deviation	\$35.5	\$46.5	\$29.0
range	\$13-125	\$4-159	\$17-180
number of responses	13	19	13

Prescribed Burning

Prescribed burning is a very labor intensive practice (Table 8). Almost half of the total cost of this practice was attributable to labor. When it is a feasible alternative, the cost of preparing sites by prescribed burning compares quite favorably with the other site preparation methods.

Chemical Release

As shown in Table 9, chemicals were the predominant cost of chemical release operations. Nearly half (46%) of the total cost of this practice was for chemicals.

Table 7. Chemical Site Preparation

Average cost per acre for:	
Chemicals	\$25.07 (49)
Labor	\$11.88 (23)
Equipment	\$10.02 (20)
Supervision	\$2.60 (5)
Other	1.66 (3)
Total Cost	\$50.00
standard deviation	\$49.4
range	\$10-200
number of responses	17

Table 8. Prescribed Burning

Average cost per acre for:	
Labor	\$18.25 (45)
Equipment	\$12.80 (31)
Supervision	\$8.21 (20)
Other	\$1.71 (4)
Total Cost	\$38.80
standard deviation	\$18.0
range	\$7-78
number of responses	16

Post-Harvest Removal of Non-Commercial Trees

Removal of non-commercial trees after a harvest is a very labor intensive practice (Table 10). Labor averaged 69 percent of the total cost. Operating conditions caused a 66 percent cost difference between the less difficult and the more difficult sites.

Timber Stand Improvement (Hardwoods)

Both chemical and non-chemical methods were employed in conducting timber stand improvement practices. Non-chemical users predominated. Their costs are reported in Table 11.

Labor was the most expensive component of timber stand improvement for both methods. For those using chemicals the average cost of the chemicals was \$15.55 per acre. Average labor and total cost were both higher for the practices using chemicals (\$27.06 for labor,

Table 9. Chemical Release After Planting

Average cost per acre for:	
Chemicals	\$18.92 (46)
Labor	7.65 (19)
Equipment	9.73 (24)
Supervision	4.33 (10)
Other	0.50 (1)
Total Cost	\$43.89
standard deviation	\$15.6
range	\$18-78
number of responses	16

Table 10. Post-Harvest Removal of Non-Commercial Trees

Average cost per acre for:	Conditions		
	less difficult than average	average	more difficult than average
Labor	\$16.00 (75)	\$18.18 (66)	\$21.59 (65)
Equipment	9.47 (2)	2.44 (9)	1.43 (4)
Supervision	3.50 (17)	3.25 (12)	2.88 (9)
Other	1.25 (6)	3.53 (13)	7.25 (22)
Total Cost	\$20.61	\$24.51	\$34.29
standard deviation	\$9.8	\$15.2	\$15.0
range	\$11-40	\$5-60	\$15-60
number of responses	9	20	7

\$54.93 total). It should be cautioned, however, that this was based on a sample of only four chemical users.

Pre-Commercial Thinning (Softwoods)

Three-fourths of the total cost of pre-commercial thinnings were for labor (Table 12). Thinning softwoods was more expensive than improvement practices in hardwoods.

Pruning

Pruning cost estimates were developed for the pines and black walnut (Table 13). Pruning height for the pines was almost evenly divided between 8 and 16 feet. Cost per foot averaged \$0.0242 for 8 foot high pruning,

Table 11. Timber Stand Improvement (Hardwoods)

Average cost per acre for:	
Labor	\$25.15 (74)
Equipment	2.88 (8)
Supervision	2.35 (7)
Paint	1.58 (5)
Other	1.91 (6)
Total Cost	\$36.76
standard deviation	\$17.6
range	\$13-74
number of responses	13

Table 12. Pre-Commercial Thinning (Softwoods)

Average cost per acre for:	
Labor	\$34.05 (76)
Equipment	2.73 (6)
Supervision	4.93 (11)
Paint	0.80 (2)
Other	2.20 (5)
Total Cost	\$53.11
standard deviation	\$15.2
range	\$34-74
number of responses	7

and \$0.0448 for 16 foot high pruning. On a per acre basis the average total cost per acre for 8 foot high pruning was \$23.60, with 16 foot high pruning averaging \$87.38.

Most black walnuts were pruned to an 8 foot height. The average cost per foot pruned for black walnut was \$0.0590. On a per acre basis, the average total cost per acre was \$68.01.

Road Construction

Equipment is the major cost in road construction (Table 14). Depending on conditions, equipment costs represented 59 to 68 percent of the total. There was a 319 percent cost difference between the better than average and the worse than average conditions.

Table 13. Pruning

Species	Pine	Black Walnut
Average number of trees/acre treated	121.9	132.5
Average height of pruning (feet)	13.0	8.7
Average cost per foot pruned:		
Labor	\$0.0229 (77)	\$0.0506 (84)
Equipment	0.0013 (4)	0.0021 (4)
Supervision	0.0033 (11)	0.0056 (9)
Other	0.0023 (8)	0.0021 (4)
Total Cost	\$0.0351	\$0.0590
standard deviation range	\$9.9104 \$0.0196-0.0472	\$0.0396 0.0244-0.1154
number of responses	9	4

Costs of road construction from state and federal agencies were substantially higher than those in the private sector. Consequently, public agency costs are not included in the table. Average total costs per mile for the state and federal agencies were \$15,250, \$12,285, and \$22,290 for better than average, average, and worse than average conditions, respectively. The large differences in costs between private and public sectors are not due to expenses alone. Substantial differences in specifications and the type of road constructed account for much of this difference in cost.

Boundary Line Establishment and Maintenance

Both line establishment and maintenance are labor intensive practices (Table 15). Seventy-eight percent of the total line establishment cost, and 58 percent of the total line maintenance cost were for labor. Cost from state and federal agencies are not included in the table. Their average total costs for line establishment and maintenance were \$1,799 and \$227 respectively. Once again, the large difference in costs indicate probable differences between private and public sectors in specifications and types of boundary lines.

Timber Inventory

Labor is the predominant cost of timber inventory, comprising nearly 90 percent of the total (Table 16). A state by state comparison showed the average total cost to be \$5.00, \$7.24 and \$1.26 for Michigan, Wisconsin, and Minnesota respectively. Statistical testing did not show these differences to be significant.

Table 14. Road Construction

Average cost per mile for:	Conditions		
	less difficult than average	average	more difficult than average
Labor	\$167.67 (27)	\$387.86 (33)	\$310.00 (21)
Equipment	423.43 (68)	700.63 (59)	983.20 (67)
Supervision	26.29 (4)	67.50 (6)	47.80 (3)
Other	3.57 (1)	34.38 (3)	119.20 (9)
Total Cost	\$892.90	\$1564.80	\$3738.78
standard deviation range	\$501 \$195-1550	\$1932 \$350-6485	\$3806 \$600-12159
number of responses	10	15	9

Table 15. Boundary Line Work

Average cost per quarter-mile for:	line establishment	line maintenance
Labor	\$31.94 (78)	\$11.98 (58)
Equipment	2.13 (5)	2.70 (13)
Supervision	1.03 (3)	0.08 (0)
Paint	2.50 (6)	2.39 (12)
Other	3.26 (8)	3.52 (17)
Total Cost	\$38.26	\$25.29
standard deviation range	\$31.2 \$4.20-152.00	\$17.0 \$7.00-62.50
number of responses	21	15

Timber Marking—Individual Tree Selection

The cost of marking individual tree selection timber sales is presented in Table 17. Labor costs comprise 73 percent of the total. The average total cost for Michigan was \$13.85; for Wisconsin it was \$12.62. Response from Minnesota was too low to develop a meaningful average.

Sale Layout, Clearcuts

Sixty-four percent of the cost of laying out clearcuts was attributed to labor (Table 18). Average total cost was \$8.14 for Michigan, \$5.15 for Wisconsin and \$23.30 for Minnesota. Statistical testing did not show these differences to be significant. An interesting note to this data is that reported clearcut size averaged 60 acres, compared to 42 acres for the average selection harvest.

Table 16. Timber Inventory

Average cost per plot for:	
Labor	\$4.84 (89)
Equipment	0.22 (4)
Supervision	0.14 (3)
Other	0.22 (4)
Total Cost	\$6.43
standard deviation	\$10.6
range	\$0.27-55.00
number of responses	45

Table 17. Timber Marking (Individual Tree Selection)

Average cost per acre for:	
Labor	\$9.91 (74)
Equipment	0.74 (6)
Supervision	0.58 (4)
Paint	1.54 (11)
Other	0.73 (5)
Total Cost	\$15.63
standard deviation	\$12.1
range	\$1.45-37.88
number of responses	37

Section II: Comparison of Costs Between Organization Types

The averages reported in the previous section are aggregates of all returns received (with the exception of the road construction and boundary line costs). While developing these averages, considerable differences were often noted between the costs of the various organization types (industry, consultants, state, and federal).

To isolate the differences, the average cost of each practice was calculated for each organization type. These averages are presented in Table 19. Also shown are the results of testing for significant differences in costs between the organization types. The Kruskal-Wallis Test was used to test for significant differences

Table 18. Sale Layout (Clearcut)

Average cost per acre for:	
Labor	\$4.00 (64)
Equipment	0.80 (13)
Supervision	0.43 (7)
Paint	0.68 (11)
Other	0.34 (5)
Total Cost	\$8.97
standard deviation	\$11.6
range	\$0.40-55
number of responses	26

as the data did not meet the assumptions of homogeneity of variances required by the analysis of variance test. This testing showed that for most of the practices there were significant differences in costs between the organizations.

For most practices, the federal agencies had the highest costs, industries the lowest, with consultants and state agencies in between. However, for planting practices the state agencies often had the lowest costs. Most of the planting practices had relatively low cost variations between the organization types. The largest differences in costs occurred in boundary line and road construction practices. For boundary line establishment a 5,759 percent difference existed between the average cost for industries and the average cost for federal agencies. As mentioned in Section I, a difference of this magnitude may indicate differences between the organizations on specifications and the type of line established.

There were also differences between the organizations in the costs of the various components. Industries tended to be more equipment intensive than the other organizations. Their equipment costs were usually higher than normal and their labor and the other costs usually lower. Consultants were just the opposite, due to a more labor intensive approach. Their labor costs were usually the highest of all the organizations while their equipment costs were usually quite low.

The state agencies tended to have lower labor cost for the labor intensive practices (such as planting by hand). This was due in part to their use of prison and other work project laborers for these jobs (three of the six returns from state agencies mentioned arrangements of this nature). This savings was often offset, however, by higher than normal supervision costs. The

Table 19. Comparison of Costs by Organization Type

Practice	Average, All Organizations	Industry	Consultants	State	Federal	Significantly* Different
Planting Pines — Intensively preped land Machine planted	\$107.23	105.67	108.23	98.68	126.86	No
Planting Pines — Intensive preped land Hand planted	124.73	106.26	138.05	95.17	143.50	Yes
Planting Other Conifers — Intensively preped land Hand planted	156.97	149.50	199.00	---	132.17	No
Planting Pines — Non-intensively preped land Machine planted	135.52	139.80	82.50	99.06	154.80	Yes
Planting Pines — Non-intensively preped land Hand planted	116.17	94.18	110.28	123.61	139.37	Yes
Mechanical Site Preparation (all conditions)	68.42	64.44	48.27	55.29	102.57	Yes
Chemical Site Preparation (all conditions)	50.00	43.17	45.25	31.47	51.68	No
Post Harvest Removal (all conditions)	25.44	21.87	29.95	25.95	31.65	No
Timber Stand Improvement	36.76	----	29.76	38.68	50.14	No
Road Construction (all conditions)	6104.39	1395.57	----	4017.50	17310.31	Yes
Boundary Line Establishment	110.55	24.12	29.83	14.50	312.40	Yes
Timber Inventory	6.43	5.54	4.44	15.84	12.83	Yes
Selection Marking	15.63	9.31	16.12	21.90	24.26	Yes
Clearcut Layout	8.97	3.14	9.98	3.15	19.77	Yes

*0.25 level of significance, Kruskal and Wallis Test

state agencies also had the lowest seedling costs for all of the planting practices. Federal agencies had high costs for all components. Especially high were their labor and supervision costs.

It is important that proper care be taken in the use and interpretation of the study's results. The average costs reported in Section I are just the averages of the costs reported to us; they should be treated accordingly. They do not necessarily provide for the varying conditions and circumstances that will be present on individual jobs. Section II shows that there can be significant differences in the cost of forest operations depending on the type of organization performing the operation.

This study neither recommends nor condones the costs or practices of any organization, but it does give an indication of the potential magnitude of differences between organizations' costs. It also points out the potential for misleading results when costs are taken from a study of one type of organization and applied to other organizations.

The Michigan State University Agricultural Experiment Station is an equal opportunity employer and complies with Title VI of the Civil Rights Act of 1964 and Title IX of the Education Amendments of 1972.

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