Forestry BMP implementation costs for Virginia

R.M. Shaffer
H.L. Haney Jr.†
E.G. Worrell
W.M. Aust

Abstract

Forestry Best Management Practices (BMPs) are operational techniques used to protect water quality during timber harvesting operations. The implementation cost of BMPs is important to loggers, forest landowners, and the forest industry. This study provides an estimate of BMP implementation cost on a per harvested acre basis for the coastal plain, piedmont, and mountains of Virginia. BMPs were recorded during field inspections of 46 sample timber harvest sites. Loggers provided estimates of the cost of individual BMPs. From this data, the median per harvested acre BMP implementation cost was $8.11 for the coastal plain, $25.75 for the piedmont, and $29.29 for the mountains. Per acre BMP implementation costs on sample harvest sites ranged from $3.17 for a large harvest site in the coastal plain with no perennial streams to $94.41 for a small tract in the mountains with perennial streams, steep slopes, and difficult access.

Forestry Best Management Practices (BMPs) are operational techniques that, when properly implemented, protect stream water quality during and after timber harvesting operations. They include specific recommendations for pre-harvest planning, streamside management zones (SMZs), haul roads, skid trails, log landings, stream crossings, and soil stabilization. The 1972 Clean Water Act requires all forested states to have a forest water quality protection program based on acceptable BMPs. In many states, BMPs are the basis for a voluntary program that relies on logger and forest landowner education, while some states make them mandatory or include them as part of a broader state forest practices law.

In Virginia, BMPs are voluntary, but clean water is mandatory. Virginia's 1993 Forestry Water Quality Law provides penalties for loggers who cause excessive sediment to pollute a stream in the Commonwealth. A Forestry BMP Manual outlining recommended "voluntary" procedures is provided, and logger and landowner BMP education is widely offered. Additionally, the Virginia Department of Forestry (VDOF) closely monitors harvesting activity and has responsibility for enforcing the Water Quality Law.

Proper BMP implementation has a cost. Locating and constructing a haul road along the contour on a side slope to facilitate drainage will cost more than simply brushing out the old logging road along the stream. Correctly installing a properly sized culvert at a stream crossing will cost more than simply piling logs in the stream and pushing soil over them. Designating and protecting a proper SMZ will cost more than simply cutting right up to the stream banks.

Loggers are generally responsible for BMP implementation cost. In some cases, they may be able to pass all or part of these extra costs on to the landowner (in the form of lower stumpage prices), or to forest industry (in the form of higher cut and haul rates). In any case, loggers, forest landowners, and the forest industry must consider the cost of implementing BMPs in their operating area.

Two earlier studies examined this topic. Lickwar et.al.[1] estimated BMP costs for Georgia and Alabama using a review of pertinent literature to establish individual BMP costs and topographic maps of representative harvest sites to estimate the type and number of BMPs required per tract. No field validation was performed. Mean per acre costs for the coastal plain, piedmont, and mountains were estimated to be $15.77, $28.13, and $36.27, respectively.

The authors are, respectively, Professor, Forestry Operations; Garland Gray Professor, Forest Management & Economics; Dept. of Forestry, Virginia Tech, Blacksburg, VA 24061-0324; Manager, F & W Forestry Serv., Inc., Charlottesville, VA.; and Associate Professor, Forestry Operations, Virgina Tech. Partial funding for this study was provided by the USDA Forest Serv., Southern Res. Sta. This paper was received for publication in February 1998. Reprint No. 8786.
©Forest Products Society 1998.
† Forest Products Society Member.
Forest Prod. J. 48(9):27-29.

[1] Lickwar, P., C. Hickman, and F.W. Cubbage. 1992. Costs of protecting water quality during harvesting on private forestlands in the Southeast. Southern J. of Appl. Forestry 16(2):9-16.

TABLE 1 — BMP practices for the sample harvest sites.

BMP practice	Coastal plain			Piedmont			Mountains		
	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
Pre-harvest plan (no.)	1	1	1	1	1	1	1	1	1
Haul road (mi.)	0	3.23	0.65	0	1.19	0.39	0	1.7	0.46
Broad-based dips (no.)	0	1	0.1	0	3.0	0.2	0	25	3.4
Water turn-outs (no.)	0	7.0	0.95	0	11.0	2.2	0	15	3.17
Water-bars (no.)	0	30	1.84	0	39	7.2	0	200	22.83
Culverts (no.)	0	5.0	0.53	0	5.0	0.6	0	2	0.42
Fords (no.)	0	1	0.1	0	1	0.7	0	0	0
Bridges (no.)	0	1	0.05	0	2	0.27	0	1	0.17
SMZs (no.)	0	1	0.63	0	1	0.67	0	2	0.58
Landings seeded (no.)	0	0	0	0	7	1.60	0	4	1.83

Ellefson and Miles[2] examined the incremental cost of implementing BMPs on 18 National Forest timber sales in the Midwest. They estimated that implementing all recommended BMPs increased overall harvesting cost by 8.52 percent. The most expensive BMP was the opportunity cost incurred by not harvesting and selling the timber in SMZs, and the least expensive was pre-harvest planning.

The objective of this study was to provide a credible, field-validated estimate of BMP implementation cost for the coastal plain, piedmont, and mountain regions of Virginia.

Study Methods

Forty-six randomly chosen harvest sites across the State of Virginia were examined in the field. Each of these harvest sites had previously passed the local VDOF "final inspection" for BMP voluntary compliance. This on-site examination was done in cooperation with the VDOF as part of their 1995 statewide BMP audit program. For each sample harvest site, the description and number of individual BMPs actually implemented on the site were observed and recorded.

Individual BMP costs were estimated by respondents to a mail questionnaire sent to 272 randomly selected Virginia loggers located throughout the state. The loggers were asked to provide the average cost of implementing the following individual BMPs in their normal operating areas:

1. Pre-harvest planning;
2. The additional cost incurred in locating and constructing one mile of haul road *to BMP specifications*;
3. Constructing a broad-based dip;
4. Constructing a water turn-out;
5. Constructing a water bar;
6. Flagging a SMZ and the additional cost of operating according to BMP recommendations within the protected streamside area;
7. Constructing various types of stream-crossing structures, including culverts, fords, and temporary bridges;
8. Seeding and mulching log landings or other extensive bare soil areas.

Each BMP was carefully defined in the questionnaire, and conformed to Virginia's BMP Manual.[3] Loggers were asked to consider the cost of labor, equipment, and supplies necessary for each BMP, and to base their response on their records and length of time each practice normally took to implement.

For each sample harvest site, the per acre BMP implementation cost was estimated as follows:

$$\text{Per acre BMP implementation cost} = \frac{(\text{No. of individual BMPs} \times \text{Estimated cost per practice})}{\text{No. of acres harvested}}$$

The 46 sample harvest sites were summarized and the maximum, minimum, and median estimated per acre BMP implementation cost was determined for each of the three physiographic regions within the state. The median (the central value in a string of values arranged from lowest to highest) was chosen as the proper statistic for this study since it is not affected (skewed) by a few extreme "outlying" estimates common to this type of survey research.

Results and Discussion

Nineteen of the sample harvest sites were located in the coastal plain region of Virginia, 15 were in the piedmont, and 12 were in the mountains. Harvest sites ranged from 12 to 207 acres, with a mean of 63 acres. The minimum, maximum, and mean number of individual BMPs per site for each of the three physiographic regions are shown in **Table 1**.

The average number of individual BMPs implemented per site was lowest in the coastal plain and highest in the mountains. This was expected, since controlling surface water flow, direction, and velocity on steep slopes typically requires more BMP structures and/or additional practices than on relatively flat ground. Note that the minimum implementation for all practices in all regions is zero, except for pre-harvest planning, which is required for all sites. The explanation for this result is that at least one harvest site in each of the three regions did not require any haul road construction (i.e., the only landing was located adjacent to a public road), and/or did not contain a perennial stream that required protection.

Virginia BMPs recommend seeding and mulching log landings located on slopes greater than 5 percent. Since few landing sites in the relatively flat coastal plain exceed 5 percent, it was not surprising that the landings in this region had not been seeded.

Sixty-four loggers correctly completed questionnaires that provided information used to estimate the statewide median cost of individual BMPs, which are reported in **Table 2**. Due to the relatively

[2] Ellefson, P.V. and P.D. Miles. 1985. Protecting water quality in the Midwest: Impact on timber harvesting costs. Northern J. of Appl. Forestry 2(2):57-61.

[3] Virginia Department of Forestry. 1989. Forestry Best Management Practices for Water Quality in Virginia. Virginia Dept. of Forestry, Charlottesville, Va. 76 pp.

small number of responses from each physiographic region, regional estimates of individual BMPs were used to determine a statewide median. This was considered acceptable for the study, since regional differences in total site and per acre BMP implementation cost are primarily due to the difference in the number and scope of BMPs required per site, rather than any small regional difference in the estimated cost of implementing individual practices.

The maximum, minimum, and median BMP implementation cost per acre by physiographic region is shown in **Table 3**. The large range in BMP cost per acre would be expected. For example, a large harvest site on easily accessible flat ground in the coastal plain with no perennial stream normally will have a very low *per acre* BMP cost, while a small, inaccessible mountain tract in steep terrain with several streams would likely have a high per acre cost.

Median per acre BMP implementation cost estimates for large harvest sites (75 acres or more) versus small sites (less than 75 acres) is shown in **Table 4**. As expected, *per acre* BMP implementation cost is lower for large harvest sites than for small sites in all physiographic regions of Virginia because certain "fixed" BMP-related costs involving haul roads, landings, and stream crossings can often be spread over a larger number of harvested acres.

Conclusions

The estimated median BMP implementation costs per acre for the Virginia coastal plain, piedmont, and mountains of $8.11, $25.75, and $29.29, respectively, are somewhat lower than Lickwar's 1992 Georgia/Alabama regional estimates of $15.77, $28.13, and $36.27. A possible explanation for this may be due to differences in the study methodology. In the Lickwar study, researchers used a topographic map to *estimate* all recommended BMPs for sample harvest sites, and assumed their full implementation on each site. This study used on-site field inspections to record BMPs *actually implemented* on the sample harvest sites.

TABLE 2. — Median estimated cost of individual BMPs.

BMP practice	Median cost (n = 64)
	($)
Pre-harvest planning	3.17 per acre
Haul road location and construction[a]	801.00 per mile
Broad-based dip	25.00 per dip
Water turn-out	10.00 per turn-out
Water-bar	15.00 per water-bar
Culvert	200.00 per culvert
Ford	150.00 per ford
Temporary bridge	737.00 per bridge
SMZ[b]	75.60 per SMZ
Seeding and mulching landing	268.00 per landing

[a] Reflects the *additional* cost to locate and construct 1 mile of haul road to meet BMP specifications (such as maximum slope, minimum distance from an SMZ) compared to locating and constructing the road without regard to BMPs.

[b] Includes the cost of flagging the SMZ and the *additional* cost of marking and/or removing selected individual trees with minimum ground disturbance within the SMZ compared to harvesting the timber along the stream without regard to BMPs.

BMP implementation is most expensive in the mountain region of Virginia. Per acre BMP cost for the mountains was estimated to be approximately 3.6 times the cost for harvest sites in the coastal plain. Steep slopes, difficult accessibility, many streams and traditional logging practices like "bladed" skid trails make forest water quality protection during and after harvest more difficult and expensive in this physiographic region. The highest per acre BMP implementation cost estimated in the study was $48.35 for harvest sites less than 75 acres in size and located in the mountain region.

The wide range in estimated BMP implementation cost per harvested acre found in this study underscores the necessity to use extreme caution when applying these study results to estimate the BMP cost for any specific forest harvest site.

By any measure, BMP implementation cost is significant. Virginia's 1992 Forest Survey reports that an average of 183,000 acres is harvested in the State each year. Assuming implementation of BMPs at the level found on the sample tracts in this study, Virginia loggers, forest landowners, and forest industry firms are contributing nearly $3.5 million annually in BMP implementation costs to forest water quality protection. Add the logger's cost of lost production due to suspended operations during periods when wet ground may cause BMP violations, larger wood inventories at forest industry mills to cover BMP-related wood flow shortages, and timber values sacrificed by forest landowners in retaining streamside buffer zones, and total water quality protection costs are much greater.

TABLE 3. — Median estimated BMP implementation cost per harvested acre for Virginia.

Physiographic region	BMP cost (n = 46)		
	Max.	Min.	Median
	------ ($ per acre) ------		
Coastal plain	39.53	3.17	8.11
Piedmont	64.64	3.17	25.75
Mountains	94.41	12.10	29.29
State	94.41	3.17	18.90

TABLE 4. — Median estimated per acre BMP implementation cost for large versus small harvest sites.

Physiographic region	Median BMP cost (n = 46)	
	Sites < 75 acres	Sites > 75 acres
	----- ($ per acre) -----	
Coastal plain	9.30	8.11
Piedmont	29.46	25.05
Mountains	48.35	21.05
State	24.96	12.82