FORESTRY BMP IMPLEMENTATION
COSTS FOR VIRGINIA

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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 tim-
ber harvesting operations. They include specific recommendations for pre-harvest
planning, streamside management zones (SMZs), haul roads, skid trails, log land-
ings, stream crossings, and soil stabilization. The 1972 Clean Water Act requires
all forested states to have a forest water quality protection program based on ac-
ceptable 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 exces-
sive sediment to pollute a stream in the Commonwealth. A Forestry BMP man-
nual outlining recommended "voluntary" procedures is provided, and logger and
landowner BMP education is widely offered. Additionally, the Virginia De-
partment of Forestry (VDOF) closely monitors harvesting activity and has re-
sponsibility 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 moun-
tains were estimated to be $15.77, $28.13, and $36.27, respectively.

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Forestry Operations, Virginia 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.
<table>
<thead>
<tr>
<th>BMP practice</th>
<th>Coastal plain</th>
<th>Piedmont</th>
<th>Mountains</th>
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<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
<td>Mean</td>
</tr>
<tr>
<td>Pre-harvest plan (no.)</td>
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<td>1</td>
<td>1</td>
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<tr>
<td>Haul road (mi.)</td>
<td>0</td>
<td>3.23</td>
<td>0.65</td>
</tr>
<tr>
<td>Broad-based ditches (no.)</td>
<td>0</td>
<td>1</td>
<td>0.1</td>
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<tr>
<td>Water turn-outs (no.)</td>
<td>0</td>
<td>7.0</td>
<td>0.95</td>
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<tr>
<td>Water bars (no.)</td>
<td>0</td>
<td>30</td>
<td>1.84</td>
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<td>5.0</td>
<td>0.53</td>
</tr>
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<td>Fords (no.)</td>
<td>0</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>Bridges (no.)</td>
<td>0</td>
<td>1</td>
<td>0.66</td>
</tr>
<tr>
<td>SMZs (no.)</td>
<td>0</td>
<td>1</td>
<td>0.63</td>
</tr>
<tr>
<td>Landings seeded (no.)</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</table>

Ellefon and Miles 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 ditch;
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 structure-crossing structures, including culverts, dikes, 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. 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
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.**

<table>
<thead>
<tr>
<th>BMP practice</th>
<th>Median cost (n = 64) ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-harvest planning</td>
<td>3.17 per acre</td>
</tr>
<tr>
<td>Haul road location and constructionb</td>
<td>801.00 per mile</td>
</tr>
<tr>
<td>Broad-based dip</td>
<td>25.00 per dip</td>
</tr>
<tr>
<td>Water turn-out</td>
<td>10.00 per turn-out</td>
</tr>
<tr>
<td>Water-bar</td>
<td>15.00 per water-bar</td>
</tr>
<tr>
<td>Culvert</td>
<td>200.00 per culvert</td>
</tr>
<tr>
<td>Ford</td>
<td>150.00 per ford</td>
</tr>
<tr>
<td>Temporary bridge</td>
<td>737.00 per bridge</td>
</tr>
<tr>
<td>SMZb</td>
<td>75.60 per SMZ</td>
</tr>
</tbody>
</table>

*a Reflects the additiontal 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.

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

<table>
<thead>
<tr>
<th>Physiographic region</th>
<th>BMP cost (n = 46)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Max.</td>
</tr>
<tr>
<td>Coastal plain</td>
<td>39.53</td>
</tr>
<tr>
<td>Piedmont</td>
<td>64.64</td>
</tr>
<tr>
<td>Mountains</td>
<td>94.41</td>
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<tr>
<td>State</td>
<td>94.41</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Physiographic region</th>
<th>Sites &lt; 75 acres</th>
<th>Sites &gt; 75 acres</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Max.</td>
<td>Min.</td>
</tr>
<tr>
<td>Coastal plain</td>
<td>9.30</td>
<td>8.11</td>
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<tr>
<td>Piedmont</td>
<td>29.46</td>
<td>25.05</td>
</tr>
<tr>
<td>Mountains</td>
<td>48.35</td>
<td>21.05</td>
</tr>
<tr>
<td>State</td>
<td>24.96</td>
<td>12.82</td>
</tr>
</tbody>
</table>

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.