Timber Harvester Perceptions of Costs and Benefits from Applying Water Quality BMPs in North-central USA

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ABSTRACT

Forestry Best Management Practices (BMPs) prevent or minimize the impact of forestry operations on water quality. Relatively little is known about the net financial effect to timber harvesters from applying water quality BMPs. A survey of Minnesota timber harvesters found them to be well acquainted and willing to comply with the state's water quality BMP program. Although the BMP program was officially implemented in 1990, many practices were apparently being widely applied prior to the program's initiation. These practices were probably already providing important financial benefits to timber harvesters. From 1990 through 1994, however, most timber harvesters (75 percent) reported increased costs associated with applying 40 individual water quality BMPs. Only 16 percent reported financial gains from applying the individual BMPs. When looking at the net financial effect across all 40 BMPs studied, 87 percent reported a net increase in costs from applying those practices. A number of recommendations are provided to assist BMP policy makers, program designers, and educators.

Keywords: *Best management practices, water quality, timber harvesters, harvesting costs, benefits.*

INTRODUCTION

Forestry water quality Best Management Practices (BMPs) are operational techniques that prevent or minimize the impact of forestry activities on water quality. These BMPs have been in existence throughout most of the United States since the late 1980s. It has been shown that harvesting operations that use BMPs protect water quality [10]. Various studies have reported compliance or implementation rates that exceed 80 percent for most practices [1, 3, 4, 6, 14].

Application of BMPs has raised concern from timber harvesters that their operational costs increase without a corresponding economic benefit to their business. They argue that application of BMPs results in a net cost to their business as the benefits are received by the public in the form of clean water.

Limited information exists about the financial or economic costs and benefits of applying BMPs. This is especially true of any benefits that may accrue to the logging business from applying the BMPs. Some studies have estimated forestry water quality BMP costs to timber harvesters [5, 7, 8, 9, 12, 16, 17]; far fewer, however, have attempted to quantify BMP benefits in a financial or economic sense [14] or relate benefits to costs [2]. Also, little information exists about how BMP implementation may provide economic benefits to a logging operation (e.g., increased number of operable days on-site, reduced maintenance costs). Policy makers, BMP program designers, and educators need better information about the costs and benefits of BMPs to timber harvesters to help ensure the appropriate design and successful implementation of those programs.

This study was conducted in Minnesota which is located in north-central USA along the Canadian border. Aspen [*Populus* species] (34 percent) and softwood species (30 percent) comprise the largest percentage of timberland area in the state (11).

OBJECTIVES AND APPROACH

A mail survey was conducted in 1995 to assess logging business owners' perceptions of the costs and benefits of voluntarily applying water quality best management practices in Minnesota under the state's 1990 program [13]. The intent of the study was to: 1) define changes in water quality BMP application rates from 1990 through 1994, 2) estimate the additional costs and benefits to timber harvesters from applying BMPs over this period, and 3) estimate the net financial consequences to timber harvesters of implementing the BMPs over the five-year period in question. The study was fundamentally a with-and-without analysis, comparing the perceptions of logging business owners about BMPs before the state's BMP program was initiated (pre-1990) with those after it was implemented (through 1994). While timber harvesting educational programming has been ongoing in Minnesota for more than 20 years, none of the programs had a focus on BMPs prior to 1990.

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The general practices and specific BMPs included in the questionnaire were taken from the field BMP audit form [14] which evaluated water quality BMP compliance on 261 sites between 1991-1993. The average compliance rate across all ownerships was approximately 84 percent during this period. Of the 97 practices evaluated during the field audit, 40 specific practices were included within the mail survey. Practices excluded from the mail survey either did not directly pertain to timber harvesting (e.g., mechanical site preparation, pesticide use, prescribed burnings), were infrequently rated during the BMP audit process, or were worded in a manner such that it was anticipated that respondents might infrequently report that they were improperly applying the practice (e.g., the practice "proper placement of clearing debris" might have few respondents indicate that they "improperly" applied the practice). The 40 specific BMP practices were also grouped into one of 14 major categories identified in Phillips et al. [14].

Draft versions of the survey were first reviewed by several individuals including loggers, logging association staff members, foresters, and survey design professionals. Review comments were incorporated into a revised survey which was then pilot tested with approximately 20 logging business owners. Responses from that pilot test were used to make final refinements to the survey. The final survey contained sections about firm demographics, changes in water quality BMP application rates from 1990 through 1994, changes in costs and benefits from applying BMPs, and solicited open-ended comments about applying BMPs.

A total of 521 questionnaires were mailed by the Minnesota Timber Producers Association (TPA) and the Associated Contract Loggers (ACL). While the production of TPA and ACL members is unknown, other unpublished studies have found that the larger logging businesses in the state are members of one or both associations and that they harvest more than 70 percent of the wood. For a variety of reasons (e.g., the survey tabulators did not have access to the associations' mailing lists, some individuals are members in both TPA and ACL, there were several retired members on both mailing lists, the ACL list contained truckers) it was not possible to determine how many individual active timber harvester business owners were actually sent a survey. Each individual first received a cover letter, a copy of the survey, and a postage paid return envelope. Everyone was sent a post card one week after the initial mailing to either thank them for their response or to serve as a reminder to return the survey. Non-respondents were mailed a second cover letter, survey, and a postage paid return envelope one month following the initial mailing.

This study is one of the first attempts to quantify the costs and attendant benefits associated with timber harvesters applying water quality BMPs. It should be recognized that the data compiled here represent self-reported *perceptions* rather than field sampling of the *actual* financial effects of these practices. While respondents may sincerely attempt to estimate the effect of BMP compliance on their net revenue, the information that they report generally represents a best estimate, as their business records do not usually collect data at the level of detail required for an in-depth analysis. A timber harvester disgruntled with BMP standards, regulations in general, or reduced profit margins, could bring bias into the survey process. Finally, the study did not attempt to evaluate whether the practices were implemented in the same way before and after 1990.

RESULTS

A total of 202 questionnaires were returned of which 127 were completed. The 75 respondents who did not complete the survey indicated that they were not currently a logging business owner (e.g., retired, trucker). There were 70 respondents with a TPA membership, 55 with an ACL membership, and 12 who indicated a dual membership in both associations. Respondents covered a range of firm sizes, almost all of which were located in northern Minnesota. It is evident from table 1 that during 1994, 59 percent of the respondents harvested between one and nine timber sales per year (n = 120), 59 percent harvested 121 hectares or less per year (n = 113), 77 percent harvested fewer than 36,246 cubic meters (n = 126), and 65 percent indicated that their annual stumpage value was less than $100,000 per year (n = 101). Average 1994 production was approximately 29,140 cubic meters with a median production of 21,385 cubic meters. The average timber sale yielded approximately 3,170 cubic meters. The relative importance of nonindustrial private forest stumpage increased 42 percent after 1990 while federal stumpage decreased by 47 percent.

Most of the respondents possessed a copy of the state's water quality BMP guidebook (80 percent) or had attended a logger education workshop focused on water quality BMPs (67 percent). Sixteen percent of the respondents neither had a copy of the guidebook nor attended a BMP workshop. Sixty-eight (68) percent of the respondents who indicated that they do not have a copy of the BMP guidebook and 76 percent who indicated that they had not attended a BMP workshop were relatively small producers whose annual production was below the median.

Table 1. Business characteristics of respondents, by type of characteristic, during 1994. (The number of respondents [n] is noted for each item.)[1]

Item	Response rate (percent)	Item	Response rate (percent)
Number of employees (n = 122)		Number of months logging/year (n = 124)	
≤ 2	49	1-5	10
3-5	28	6-8	12
6-9	18	9-10	26
10-15	2	11-12	52
16-20	1		
> 20	2		
Number of timber sales harvested/year (n = 120)		Number of hectares harvested/year (n = 113)	
1-2	14	≤ 40	23
3-5	24	41 - 81	23
6-9	21	82 - 121	13
10-15	27	122 - 162	13
16-20	5	163 - 202	8
21-25	3	203 - 405	15
26-30	3	> 405	5
>30	2		
Number of cubic meters harvested/year (n = 126)		Stumpage value/year (n = 101)	
≤ 3,625	9	≤ $50,000	42
3,626 - 18,123	38	$50,001-$100,000	23
18,124 - 36,246	30	$100,001-$200,000	21
36,247 - 54,369	12	$200,001-$300,000	6
54,370 - 72,492	4	$300,001-$400,000	2
72,493 - 108,738	5	>$400,000	7
> 108,738	2		

[1]Totals may not sum to 100 percent due to rounding.

Sixty-four (64) percent of the individuals who had a copy of the guidebook indicated that they did not use the publication "*often*" while an additional 16 percent indicated they "*never*" or "*almost never*" used it. The relatively low rate of use of the guidebook may be due to the fact that the study was conducted four years after the BMP program was initiated.

Although most of the responding business owners seldom referred to the water quality BMP guidebook, 93 percent of the respondents indicated they were "*very*," "*fairly*" or "*somewhat*" knowledgeable about water quality BMP practices (n = 126) (Table 2). Also, 84 percent of the respondents were either "*very*" or "*fairly*" willing to comply with the water quality BMPs (n = 126); ninety-three (93) percent indicated that the BMPs are either "*very*," "*fairly*," or "*somewhat*" restrictive on their operations (n = 125); and sixty-five (65) percent indicated that the BMPs are "*fairly*" or "*very*" effective in protecting natural resources (n = 123).

A higher percentage of the respondents whose production was above the median indicated that they were either "*very*" or "*fairly*" knowledgeable about the BMPs and that the BMPs were either "*very*" or "*fairly*" effective in terms of resource protection. Both groups gave similar responses in terms of their willingness to comply with and the level of restrictiveness of the BMPs.

Change in water quality BMP application rates from 1990 through 1994

Overall, over half the respondents indicated they apply the forty specific water quality BMPs "*more often*" in

1994 than they did in 1990 (Table 3). This option was selected most frequently for 25 of the 40 practices. Many of the practices where the "*use more*" category was preferred may not provide direct benefits to timber harvesters. Examples of some of the BMPs in this category include 1A ("Adequate storage and disposal for fuel, debris, lubricants, fluids and rinsate from equipment cleanup"), 7C ("Restrict use of roads during wet periods and spring breakup if use could impact water quality"), 11D ("Avoid felling timber into nonforested wetlands"), and 12A ("Maintain vegetation adjacent to designated trout streams or lakes"). The relatively "*use more*" rating for practice 12A may be due to educational programming which focused on the importance of maintaining shade adjacent to trout water bodies.

An average of 41 percent indicated there had been "*no change*" in their application of BMPs from 1990 through 1994 (Table 3). For the 14 BMPs where "*no change*" was the most frequently selected option, those BMPs may have been providing some gain (financial or otherwise) to the timber harvester prior to the BMP program's introduction in 1990. Examples of some of the BMPs that fall into this category include 2A ("Minimize the total road mileage required to meet the landowner's objectives"), 3A ("Cross streams at right angles"), and 10B ("Stabilize temporary road surface during sale activity").

Careful planning of timber harvesting activities is considered one of the most important BMPs that can be applied since it has such a large impact on the effectiveness of other BMPs. Many of the practices where "no change" was most frequently selected are part of the process of carefully planning a logging operation. For example, careful planning would be expected to reduce the amount of roads and skid trails (practices 2A and 13A, respectively) and to locate the best stream crossing sites (practice 3A).

An average of 7 percent of the timber harvesters indicated that they "*never apply*" practices contained within the major BMP categories, while 1 percent indicated the "*use less*" option, as compared to pre-1990 (Table 3). Low frequencies for the "*never apply*" and "*use less*" categories might be expected given that the practices included within the survey tended to be most frequently rated during the compliance monitoring field audits [13]. Respondents who selected the "*never apply*" category were more likely to be smaller operators (i.e., below average and below median production) who had increased their percentage of volume harvested from nonindustrial private forest ownerships.

For many of the practices where the "*use more*" option was favored, there were relatively low compliance rates reported [13]. In contrast, compliance rates were generally much higher for practices where the "*no change*" option was favored.

Table 2. Timber harvester perceptions of Minnesota's water quality BMP program in 1994. (The number of respondents [n] is noted for each item.)[1]

Item	Response (percent of respondents)				
	Very	Fairly	Somewhat	Not very	Not at all
Knowledge of water quality BMPs and the voluntary BMP program (n = 126)	19	52	22	3	3
Willingness to comply with water quality BMP requirements (n = 126)	40	44	12	2	1
Restrictiveness of current water quality BMPs in terms of hindering logging activity (n = 125)	13	32	48	6	2
Effectiveness of current water quality BMPs in terms of resource protection (n = 123)	25	40	27	7	1

[1]Rows may not sum to 100 due to rounding.

Table 3. Change in use of water quality BMPs by responding timber harvesters in Minnesota from 1990 through 1994. (The number of respondents [n] is noted for each item.)[1]

		Change in use (percent of respondents)			
	Best Management Practice	Never apply	Use less	No change	Use more
1.	**Fuel, lubricant, and equipment management**				
A.	Adequate storage and disposal for fuel, debris, lubricants, fluids and rinsate from equipment cleanup (n = 122)	1	0	21	78
2.	**Forest road alignment**				
A.	Minimize the total road mileage required to meet the landowner's objectives (n = 123)	4	2	58	36
B.	Avoid activity below the ordinary high water mark (n = 122)	7	2	43	48
C.	Provide filter strips between roads and lakes, streams, and intermittent waterways (n = 123)	4	1	39	56
3.	**Forest road water crossings**				
A.	Cross streams at right angles (n = 118)	9	4	58	29
B.	Minimize amount of natural stream channel disturbance (n = 118)	6	3	32	59
C.	Design crossings to avoid obstruction of fish migrations (n = 115)	19	1	46	34
4.	**Winter roads or temporary crossings**				
A.	Avoid use of mineral soil as fill on winter crossings (n = 121)	3	1	42	54
B.	Remove temporary/winter crossings prior to breakup (n = 121)	4	0	43	53
5.	**Forest road drainage**				
A.	Install water diversion devices on road surfaces using broad based dips/grade rolls, open culverts, water bars, or outsloping (n = 121)	7	1	31	62
B.	Drain surface water into filter strip or vegetative draw (n = 122)	6	2	48	45
C.	Remove all berms (n = 119)	12	3	53	33

6.	**Forest road construction, clearing and excavation**				
A.	Shape inslopes and backslopes of 1 1/2:1 or flatter to stabilize soils (n = 122)	10	1	40	50
B.	Stabilize erodible soils by seeding (n = 121)	18	2	38	43
C.	Surface road to minimize water quality impacts (n = 120)	13	0	55	32
7.	**Maintenance of all roads during or after the sale**				
A.	Maintain erosion control features in working order (n = 123)	4	1	48	48
B.	Stabilize erodible soils by seeding (n = 122)	21	0	39	40
C.	Restrict use of roads during wet periods and spring breakup if use could impact water quality (n = 124)	2	2	40	57
8.	**Maintenance of active roads during sale activity**				
A.	Maintain proper surface to maintain drainage and prevent erosion (n = 123)	0	1	47	52
9.	**Maintenance of occasional use roads during sale activity**				
A.	Properly close when not in use (n = 121)	7	1	48	43
B.	Maintain water diversion devices in working order (n = 122)	7	1	48	44
10.	**Maintenance of temporary roads during sale activity**				
A.	properly close roads when use is complete (n - 123)	7	1	47	45
B.	Stabilize road surface (n - 124)	7	0	56	37
11.	**Timber harvesting: General practices**				
A.	Time harvest compatible with soil and topography (n = 124)	0	1	30	69
B.	Minimize mineral soil exposure in filter strip to less than 5% (n = 121)	6	0	48	47
C.	Keep streams, lakes, wetlands free of logging debris (n = 124)	2	1	24	73
D.	Avoid felling timber into nonforested wetlands (n = 124)	1	1	28	71

12. Shade strips				
A. Maintain vegetation adjacent to designated trout streams or lakes (n = 123)	10	1	29	61
13. Skid trails				
A. Minimize the total main skid trail mileage required to meet the landowners objectives (n - 125)	2	2	54	43
B. Locate skid trails outside of filter strips (n = 125)	4	0	35	60
C. Design main skid trails to avoid concentrating runoff (n = 122)	0	0	38	62
D. Install water diversion devices on main skid trails using broad based dips/grade rolls, open culverts, water bars, or outsloping (n = 124)	9	1	41	50
E. Drain surface water into filter strip or vegetative draw (n - 124)	7	1	48	45
F. Minimize amount of natural stream channel disturbance (n = 122)	7	0	32	61
G. Rehabilitate skid trails when needed (n = 123)	5	1	34	60
14. Landings				
A. Locate landings outside of filter strips (n = 125)	3	0	37	60
B. Provide for maximum cross-drainage and minimum down slope flow (n - 125)	4	1	46	49
C. Drain surface water into filter strip or vegetative draw (n = 124)	3	1	48	49
D. Stabilize erodible soils by seeding (n = 125)	17	0	43	40
E. Rehabilitate landings when needed (n = 125)	7	0	39	54
Average percent for each column	**7**	**1**	**42**	**51**

[1]Rows may not sum to 100 percent due to rounding.

There were several practices that respondents indicated they used more since 1990 but which had relatively low compliance as noted during the field audits [13]. As noted above, those practices tended to be those that might not provide direct benefits to timber harvesters.

Attendance at continuing education workshops appeared to be closely linked to a perceived increase in BMP application rates after 1990. For each of the 40 BMP practices listed, timber harvesters who had attended a workshop selected the "*use more*" option more frequently then those individuals who had not attended a workshop. Sixty-seven percent of the time, the difference in the "*use more*" option between those who had attended a workshop and those who had not was at least 50 percent.

Respondents whose production was above the median were more likely to indicate either "*no change*" or "*use more*" for each of the 40 BMP practices. The practices where the difference was greatest tended to be those that might not provide direct benefits to timber harvesters such as 6C ("Surface road to minimize water quality impacts"), 4A ("Avoid use of mineral soil as fill on winter crossings"), and 3B ("Minimize amount of natural stream channel disturbance"). In contrast, practices that might provide direct benefits to timber harvesters tended to show little difference in the amount of change in application rate between the two groups.

Many timber harvesters provided written comments about their use of BMPs. Several of those comments further supported the idea that some BMPs can provide direct advantages to timber harvesters and were applied before the program was initiated in 1990. Examples are, "*I have been logging for 50 years and during that time I have always tried to do what is best for the land and water . . . I do what the landowner wants, " "Common sense equals most BMP practices . . . therefore, we haven't done anything different since 1990, "* and "*We have always done most of this before BMPs were ever around."*

Estimate of additional costs and benefits to timber harvesters

Seventy-five percent of the respondents indicated that they had incurred additional costs associated with implementing the 14 major water quality BMP categories since 1990 (Table 4). Most (52 percent) indicated these cost increases were in the range of 1 percent to 10 percent, although 9 percent of the respondents indicated cost increases greater than 15 percent. The three BMP categories with the highest average increase in cost were "Timber harvesting: General practices," "Forest road construction, clearing, and excavation," and "Forest road crossings." The three BMP categories with the lowest average increase in cost were "Fuel, lubricant, and equipment management," "Winter roads or temporary crossings," and "Maintenance of occasional use roads during sale activity."

Timber harvesters experiencing increased costs specified a variety of sources for those additional costs. Excluding the "*no change*" responses, the most frequently cited sources of additional costs (in descending order) were road, skid trail, and landing construction (25 percent of respondents); cost of road, skid trail, and landing maintenance (23 percent); days needed to complete harvest (22 percent); capital costs (e.g., culverts, seed) (18 percent); and maintenance of equipment (11 percent). On average, 1 percent indicated that there were other miscellaneous sources for the increased costs. The following practices (sorted by source) were mentioned by at least 30 percent of the respondents identifying additional costs:

- Increased cost of road, skid trail, and landing construction: "forest road construction, clearing, and excavation" (45 percent); "winter roads or temporary crossings" (42 percent); "forest road alignment" (41 percent); "landings" (36 percent); and "shade strips" (33 percent).

- Increased number of days needed to complete the harvest: "timber harvesting: general practices" (48 percent), "shade strips" (32 percent), and "skid trails" (32 percent).

- Increased cost of road, skid trail, and landing maintenance: "maintenance of occasional use roads during sale activity" (47 percent), "maintenance of temporary roads during sale activity" (47 percent), "maintenance of all roads during or after the sale" (43 percent), and "maintenance of active roads during sale activity" (43 percent).

- Increase in capital costs (e.g., culverts, seed): "forest road water crossings" (48 percent) and "forest road drainage" (40 percent).

- Increased cost of maintaining equipment: "fuel, lubricant, and equipment management" (42 percent).

Many timber harvesters freely offered opinions about the cost of applying BMPs. Example comments are: "*The cost of implementing water quality BMPs is totally absorbed by the logger . . . there has been no increase in mill prices," "We log mostly on Federal lands . . .*

Table 4. Timber harvester perception of change in cost of using water quality BMPs in Minnesota, by major BMP category, 1990 through 1994. (The number of respondents [n] is noted for each major BMP category.)[1]

Major BMP category	Change in cost to harvester (percent of respondents)				
	No change	Up 1 - 5%	Up 6 - 10%	Up 11 - 15%	Up >15%
Fuel, lubricant and equipment management [one BMP] (n = 111)	28	37	21	8	5
Forest road alignment [three BMPs] (n = 110)	21	28	27	17	6
Forest road water crossings [three BMPs] (n = 106)	20	21	28	18	13
Winter roads or temporary crossings [two BMPs] (n = 114)	32	29	15	18	6
Forest road drainage [three BMPs] (n = 107)	20	33	28	14	5
Forest road construction, clearing and excavation [three BMPs] (n = 111)	15	17	29	21	18
Maintenance of all roads during or after sale [three BMPs] (n = 109)	25	25	19	16	15
Maintenance of active roads during sale activity [one BMP] (n = 112)	32	28	18	13	10
Maintenance of occasional use roads during sale activity [two BMPs] (n = 104)	34	29	24	9	4
Maintenance of temporary roads during sale activity [two BMPs] (n = 100)	33	24	29	7	7
Timber harvesting: General practices [four BMPs] (n = 112)	9	23	33	15	19
Shade strips [one BMP] (n = 105)	38	22	18	13	9
Skid trails [seven BMPs] (n = 112)	26	37	23	8	5
Landings [five BMPs] (n = 113)	21	36	23	13	7
Average for each column	25	28	24	14	9

[1]Number of BMPs in each major category that were included within the survey are indicated in brackets. Rows may not sum to 100 due to rounding

comply to their specs which increases our cost some . . . maybe not more than 5 percent to 10 percent," "The costs of BMPs have to be considered as part of the cost of doing business and figured accordingly . . . the only benefit is in knowing your operation isn't hurting water quality and you can continue harvesting timber without undo regulations," "In most cases, the enforcement of BMPs has led to increased harvest time on-site due to construction of filter strips (skidding time increase) and moving costs away from the sale (if too wet to operate) and back to the sale when conditions improve . . . landing cost has also increased due to placement on upland sites rather than swampy areas during the winter months," and *"It is probable that sale design and size have a greater impact on cost than actual practices . . . it is difficult to assign cost to a specific action, but average production per day is down . . . it may be unfair to assign all loss to BMPs . . . "*

An average of 84 percent of the respondents indicated they did not receive any additional benefits from applying BMPs from 1990 through 1994 (Table 5). Of the 16 percent indicating that additional benefits did accrue to their operations, most indicated that the magnitude of the increase was 10 percent or less. Approximately 25 percent of the respondents noted additional benefits for the BMP categories "forest road alignment" and "forest road drainage."

Timber harvesters reporting benefits from applying water quality BMPs cited the following as the most common sources of benefits: increased number of operable days on-site (34 percent of respondents); reduced cost of road, skid trail, and landing maintenance (26 percent); increased productivity per day (23 percent); reduced cost of road, skid trail, and landing construction (8 percent); and reduced cost of maintaining equipment (7

Table 5. Timber harvester perception of benefits to business of using water quality BMPs in Minnesota, by major BMP category, 1990 through 1994. (The number of respondents [n] is noted for each major BMP category.)[1]

Major BMP category	Change in benefits to harvester (percent of respondents				
	No change	Up 1 - 5%	Up 6 - 10%	Up 11 - 15%	Up > 15%
Fuel, lubricant and equipment management [one BMP] (n = 71)	90	4	3	0	3
Forest road alignment [three BMPs] (n = 66)	76	15	9	0	0
Forest road water crossings [three BMPs] (n = 64)	87	2	8	1	2
Winter roads or temporary crossings [two BMPs] (n = 67)	93	4	3	0	0
Forest road drainage [three BMPs] (n = 69)	75	15	9	1	0
Forest road construction, clearing and excavation [three BMPs] (n = 67)	87	1	10	1	0
Maintenance of all roads during or after sale [three BMPs] (n = 65)	83	11	5	1	0
Maintenance of active roads during sale activity [one BMP] (n = 66)	83	9	5	2	0
Maintenance of occasional use roads during sale activity [two BMPs] (n = 68)	84	9	4	2	0
Maintenance of temporary roads during sale activity [two BMPs] (n = 70)	86	9	4	1	0
Timber harvesting: General practices [four BMPs] (n = 70)	84	9	1	3	1
Shade strips [one BMP] (n = 66)	86	9	3	1	0
Skid trails [seven BMPs] (n = 68)	84	10	4	1	0
Landings [five BMPs] (n = 67)	81	12	4	1	1
Average for each column	**84**	**8**	**5**	**2**	**<1**

[1]Number of BMPs in each major category that were included within the survey are indicated in brackets. Rows may not sum to 100 due to rounding.

percent). On average, three percent indicated that there were other miscellaneous sources for the increased benefits. For the two benefit sources "reduced cost of road, skid trail, and landing construction" and "reduced cost of maintaining equipment" respondents failed to indicate any benefits for six of the 14 categories of BMPs.

The following are representative comments regarding benefits from applying water quality BMPs: "*BMP benefits are mostly for the logging site . . . the only real benefit for the logger is that we are doing a neater, cleaner job than was done in the past." "I really don't feel there have been significant costs to me in my small operation . . . I truly believe that my fellow loggers are extremely interested in the protection of the environment and implementation of BMPs," "BMPs are extremely beneficial in relationship to preservation of our environment and should be part of every logging operation . . . however, they do cost the logger and should be considered in the marketplace, "* and "*Some of the benefits are well and good for the environment."*

Net financial effects of applying BMPs

Only 8 percent of the respondents indicated that there was a net financial benefit to their harvesting operation since 1990 from implementing water quality BMPs. The majority (87 percent) indicated that costs exceeded benefits. Large production respondents tended to report higher net costs. The breakdown of respondents perception of net financial effects on their operations (n = 97) is noted below.

Returns Exceed Costs by:
One to 5 percent — 1 percent of respondents
Six to 10 percent — 3 percent
11 to 15 percent — 3 percent
More than 15 percent — 1 percent

Returns Equal Cost: 5 percent of respondents

Costs Exceed Returns by:
One to 5 percent — 22 percent of respondents
Six to 10 percent — 30 percent
11 to 15 percent — 16 percent
More than 15 percent — 19 percent

SUMMARY AND OBSERVATIONS

Water quality BMPs are applied to ensure the availability of quality water. Previous studies have demonstrated that the application of those BMPs includes a cost element that is usually absorbed by timber harvesters. Less clear, however, is whether those expenditures produce any financial benefits to timber harvesters. The intent of this study was to gain greater insight to the operational linkages timber harvesters perceive between the cost and benefits of applying water quality BMPs. Information gathered by the study is a major step toward understanding the perceptions of timber harvesters about Minnesota's forestry water quality BMPs. Knowledge about the costs and benefits of applying BMPs can help both timber harvesters and foresters select the most cost-effective methods to protect water quality.

Timber harvesters are generally willing to apply water quality BMPs. While respondents reported that their use of 25 of the 40 practices has increased since the BMP program was initiated in 1990, the "no change" option was most frequently selected for 14 practices. Also, practices with above average BMP compliance levels [13] were more likely to show "no change" in the rate of application after the formal introduction of the state's water quality BMP program in 1990. This suggests that some water quality BMPs were being applied before 1990 because they provide benefits to timber harvesters or because they were told to apply the practices by a forester or a landowner. Respondent open-ended comments indicate that timber harvesters were receiving benefits from applying some of the practices before 1990.

Timber harvesters' water quality BMP application rates increase by attending education programs. Timber harvesters who attended BMP educational workshops reported increasing their rate of application of the BMPs more than those who did not attend any workshops. Workshops appear to be a useful mechanism to increase application rates.

Timber harvesters incur costs and receive some financial benefits from applying water quality BMPs. Most timber harvesters (75 percent) experience additional costs when applying individual BMPs. A large portion (84 percent) reported no financial gain from applying those BMPs. While construction and maintenance of roads, skid trails, and landings appear to be the most common sources of additional costs, several respondents noted that they also derive some benefits from maintaining that infrastructure. Some timber harvesters believe that the application of BMPs can increase their productivity and to reduce certain costs.

Timber harvester net financial effects of water quality BMP applications are overwhelmed by the added costs. Few timber harvesters (8 percent) report that the benefits of applying BMPs exceed the operational costs. Most (87 percent) report that the cost of applying BMPs exceeds the financial gains.

The information provided by this study and the experiences of the authors may be useful to BMP policy makers, program designers, and educators in the following ways.

Suggestions for BMP policy makers

1. Recognize that the application of water quality BMPs may incur additional costs that do not provide direct financial benefits to timber harvesters. It is generally difficult for timber harvesters to pass along their additional net costs to the landowner, forest industry, or society.

2. Create a financial incentive system that reimburses timber harvesters who correctly apply BMPs, especially those practices that have little or no operational benefit. This may be most important on nonindustrial private forest lands to encourage higher implementation rates. Some of the options for funding an incentive system include dedicated monies from a government's general funds, a financial incentive system on stumpage when the timber sale is closed or for the next sale on that ownership, or as a higher delivered value at a mill.

Suggestions for BMP program designers

1. Design practices that are practical and cost-effective.

2. Build flexibility into the program so that specific practices can be accomplished in a variety of ways, as long as the intent of the practice is achieved. This allows forest managers and timber harvesters to identify the most cost-effective solution based on landowner objectives, site conditions, and the on-site harvesting operation.

3. Assess the economic effects of a proposed set of practices before they are approved. Consider the impact of volume removed on a timber harvester's profitability. Application costs per unit removed may be reduced on sales where more volume is harvested.

4. Use monitoring information to increase the implementation rates and effectiveness of individual practices.

Suggestions for BMP educators

1. Focus the content of education programs on practices that are "new" or were not commonly practiced before program implementation.

2. Implementation may be increased if education programs address why specific practices were developed. Present background information about the management issues or concerns addressed by the individual practices (e.g., shade strips maintain moderate water temperatures which is important to fish).

3. Where appropriate, discuss how BMPs with low application rates can provide operational benefits (e.g., appropriate road shaping can help maintain the road's ability to support traffic).

4. As high volume producers may have more knowledge of BMPs than low volume producers, separate training courses which target the specific educational needs of each audience may be appropriate for the two groups.

5. Use field demonstrations to increase application rates for those practices with relatively low compliance rates. Be aware that low compliance rates for individual practices may be due to a variety of factors including increased cost, lack of knowledge about how to correctly apply the practice, or the lack of knowledge about the range of options for accomplishing the intent of the practice. Increasing knowledge about the range of options can both increase application rates as well as reduce application costs.

6. Address the economic impacts of applying BMPs. Include information which identifies and demonstrates low-cost options for accomplishing the intent of the BMPs.

7. Use creative methods to increase participation levels at educational programs (e.g., increase awareness of the BMP program with nonindustrial private landowners, create local woodland or logger councils that address local programming issues).

8. Provide forums for timber harvesters and foresters to cross-train each other about BMPs.

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REFERENCES

[1] Adams. T. O., and D. L. Hook. 1994. Compliance with silvicultural best management practices on harvested sites in South Carolina. Southern Journal of Applied Forestry 18:163-167.

[2] Aust, W. M., R. M. Shaffer, and J. A. Burger. 1996. Benefits and costs of forestry best management practices in Virginia. Southern Journal of Applied Forestry 20(1):23-29.

[3] Briggs, R. D., J. Cormier, and A. Kimball. 1998. Compliance with forestry best management practices in Maine. Northern Journal of Applied Forestry 15(2):57-68.

[4] Brynn, D. J., and J. C. Clausen. 1991. Postharvest assessment of Vermont's acceptable silvicultural management practices and water quality impacts. Northern Journal of Applied Forestry 8(4):140-144.

[5] Cubbage, F., and P. Lickwar. 1991. Estimating the costs of water quality protection on private forest lands in Georgia. Georgia Forestry Commission Resource Division, Georgia Forestry Resource Paper 86. 11 p.

[6] Egan, A. F., R. D. Whipkey, and J. P. Rowe. 1998. Compliance with forestry best management practices in West Virginia. Northern Journal of Applied Forestry 15(4):211-215.

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

[8] Hawks, L. J., F. W. Cubbage, H. L. Haney, Jr., R. M. Shaffer, and D. H. Newman. 1993. Forest water quality protection. Journal of Forestry 91(5):48-54.

[9] Huyler, N. K., and C. B. LeDoux. 1995. Estimating the cost of applying Vermont's acceptable management practices to logging on moderate slopes. pp. 165-171. In Proceedings of the 18th Annual Meeting of the Council on Forest Engineering, Cashiers, NC, June 5-8. 280 p.

[10] Kochenderfer, J. N., and J. W. Hornbeck. 1999. Contrasting timber harvesting operations illustrate the value of BMPs. pp. 128 - 136. In (Stringer, J. W., and D. L. Loftis, editors) Proceedings, 12th Central Hardwood Forest Conference, February 28 - March 2, 1999, Lexington, KY. USDA Forest Service, Southern Research Station, General Technical Report SRS-24. 293 p.

[11] Leatherberry, E. C., J. S. Spencer, Jr., T. L. Schmidt, and M. R. Carroll. 1995. An analysis of Minnesota's fifth forest resources Inventory, 1990. USDA Forest Service, North Central Forest Experiment Station, Resource Bulletin NC-165. 102 p.

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

[13] Minnesota Department of Natural Resources. 1989. Water quality in forest management: Best Management Practices in Minnesota. Minnesota Department of Natural Resources, Division of Forestry, St. Paul, MN. 104 p.

[14] Phillips, M. J., R. Rossman, and R. Dahlman. 1994. Best management practices for water quality evaluating BMP compliance on forest lands in Minnesota: A three-year study. St. Paul, MN: Minnesota Department of Natural Resources, Division of Forestry. 50 p.

[15] Ribaudo, M. O., and C. E. Young. 1989. Estimating the water quality benefits from soil erosion control. Water Resources Bulletin 25(1):71-78.

[16] Shaffer, R. M., H. L. Haney, E. G. Worrell, and W. M. Aust. 1998. Forestry BMP implementation costs for Virginia. Forest Products Journal 48(9):27-29.

[17] Worrell, G., B. Shaffer, H. Haney, and M. Aust. 1998. Cost of implementing BMPs in Virginia. American Pulpwood Association, Washington, DC. Technical Release 98-R-15. 2 p.

Where Are All The Forest Engineers?

One dimension of the mission of the Journal of Forest Engineering is to help link the forest engineering community all over the world. There is a host of research institutions and groups, technology development units and departments spread throughout most forested countries of the world. The Journal would like to publish brief profiles of those research and development groups, institutes and organizations whose activities overlap with the Journal's technical scope (see the "scope" statement at the front of this issue).

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The profiles should describe the technical and geographic scope of the organization, their location, a brief list of some publications and products that might give an idea of the kind of work carried on there, a description of the organization itself (location, number of staff, affiliations with university or government institutions and key personnel). In addition, complete contact information (mailing, phone/fax, electronic mail and Web addresses) should be provided to allow further contact by readers.

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