TIMBER HARVESTER PERCEPTIONS OF BENEFITS AND COSTS OF APPLYING WATER QUALITY BEST MANAGEMENT PRACTICES IN MINNESOTA

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INTRODUCTION

Nonpoint Source Prevention Programs

Water quality best management practices (BMPs) have been defined as a practice or combination of practices for preventing or reducing nonpoint source pollution to a level compatible with water quality goals (Minnesota Department of Natural Resources 1989). Implemented primarily at the state level, water quality BMPs were developed as a direct result of the 1972 Amendments to the Federal Water Pollution Control Act [33 U.S.C. 1288(b)(2)(F)] (Schoenbaum and Rosenberg 1991). While the Act focused primarily on point source pollution, Section 208 specifically addressed nonpoint source pollutants generated by agricultural, silvicultural and certain urban activities, and required that each state develop a plan and a program for managing such sources. Since the Act required extensive interpretation and called for the development of complex administrative relationships between federal, state and local governments, implementation of Section 208 of the Act was a gradual process (Brown et al., 1993).

The 1972 Amendments to the Federal Water Pollution Control Act were a historically important action leading to better management of water pollutants nationwide. However, heightened public interest in sustaining quality natural environments fostered additional policies and programs for addressing nonpoint sources of water pollutants. These were expressed in the Clean Water Act of 1977 and the Water Quality Act of 1987 which called for additional pollution prevention actions and appropriated new funds to help cover the costs incurred by some rural landowners for implementing BMPs. Section 318 of the 1987 Water Quality Act stipulated that states whose programs met federal guidelines, and are approved by the U.S. Environmental Protection Agency, could receive matching grants to facilitate programmatic implementation of the Act. This Act was particularly important in encouraging many states to develop and implement forestry BMP programs. A 1992 survey found that 13 states had mandatory programs, 23 had voluntary programs, and 5 states used a combination of the two (Brown et al., 1993). Only nine states had no formal BMP program at that time. The use of fiscal incentive programs as a means of encouraging the application of BMPs was found to be limited. As of 1992, only eleven states offered tax incentives, cost sharing or other financial arrangements to non-industrial private forest owners who used BMPs.

States with voluntary BMP programs focus their efforts on providing education and training, using seminars, manuals, mailings and personal contacts to develop knowledge of BMPs among timber harvesters and natural resource professionals. In some states, on-site compliance monitoring inspections are conducted following timber harvests on both public and private forest lands. Although sampling intensity and form of inspection vary widely from state to state, the results of these inspections are used to evaluate the effectiveness of educational efforts. States with mandatory programs require the application of BMPs by legal mandates (e.g., state forest practice laws); such are enforced by the imposition of fines and other penalties (Ellefson et al., 1995). Compliance monitoring inspections of some or all harvested sites are widely used as a means of assessing compliance with mandatory programs. In several states, regulatory programs are used for riparian zones, while voluntary programs are used for non-riparian forest sites.

Minnesota's voluntary forestry Water Quality BMP Program was implemented in 1990. A total of 97 recommended BMP practices were developed by a committee composed of representatives from both the public and the private sector. Since 1990, more than 50 workshops have been conducted across the state, introducing timber harvesters and natural resource professionals to the program. In addition, a guidebook entitled "Water Quality in Forest Management 'Best Management Practices in Minnesota," has been widely distributed (Minnesota Department of Natural Resources 1989). A revised guidebook was issued in 1995 (Minnesota Department of Natural Resources 1995). From 1991-1993, compliance monitoring qualitative surveys were conducted on 261 selected sites. Persons involved in compliance monitoring site visits included individuals from public agencies, wood-based industry, timber harvesters, non-industrial private landowners, and members of environmental and conservation groups. The average compliance rate across all ownerships in Minnesota between 1991-1993 was approximately 84 percent (Phillips et al., 1994) (Table 1).

Financial and Economic Implications

Although water quality BMP programs have been in existence throughout most of the United States since the late 1980s, their introduction has often surfaced significant controversy among persons and organizations that are responsible for their implementation. Frequently at issue is whether compliance with water quality BMPs increases, decreases, or has no effect on the net revenue received by persons or organizations that own timber or are responsible for its harvest. The net revenue that a

TABLE 1. Compliance with Water Quality BMPs in Minnesota, by Landowner Category. 1992. (Percent)

Best Management Practice	All Categories	Nonindustrial Private Forests	Industrial Forests	Federal Forests	State Forests	County Forests
Filter Strip Use	78	70	81	100	98	96
Filter Strip Width	85	63	92	94	93	91
Filter Strip Activities	46	70	35	35	33	48
Ford Construction	83	79	87	83	88	73
Road Maintenance	80	67	91	100	92	100
Road Drainage	68	46	91	92	94	100
Slash Disposal	92	93	89	82	89	96
Site Preparation Methods	50	23	78	76	84	92
Skid Trail Drainage	35	18	44	71	62	36
Landing Drainage	23	11	41	41	36	36
Pest Control	95	63	100	100	100	100
Prescribed Burn Methods	81	73	89	86	79	90

Source: Phillips et al., 1994.

timber harvester, for example, receives from a harvesting operation is a function of the costs of harvesting timber, including the application of BMPs, and the revenue that is received from the sale of the harvested timber. In many situations, timber harvesters are "price takers," meaning that as individual operators they have little influence over market-determined prices for their products (i.e., harvested timber). Timber harvesters face a constant marginal cost and can only influence their operation's net revenue by minimizing stumpage, production, and transportation costs. Included among the many costs of production may be the cost of applying BMPs.

Some timber harvesters believe that the application of BMPs increases harvesting costs without a concomitant benefit to their operation. Argued is that their application of BMPs results in benefits received, but not paid for, by the public. As such, logic suggests that the costs incurred by timber harvesters to produce these benefits should in some fashion be reimbursed by the general public. This issue was brought into clearer focus when in 1994, the Minnesota Legislature considered legislation that would have financially compensated timber harvesters for properly applying water quality BMPs. It was proposed that wood consuming mills be assessed a tax of $4 per cord, or $8 per 1,000 board feet, for each quantity over 1,000 cords or 500,000 board feet consumed annually. Some of the revenue from these taxes would be used to reimburse harvesters for costs incurred when properly applying BMPs. Although not enacted, the proposed legislation reflected the conviction that forestry BMPs are costly and provide little in return to those that are responsible for implementing them.

In spite of actions taken to implement BMP programs, there has been little research directed towards assessment of their net financial or net economic consequences, especially implications for benefit or revenue conditions. A notable recent exception is an analysis of BMP application in Virginia where the cost of BMP application was related to the value (benefit) of the sediment loss prevented (Aust et al. 1996). From a financial perspective, however, most studies have attempted to measure the additional costs of BMPs applied at specific harvest sites (e.g., Benson and Niccolucci, 1985; Ellefson and Miles, 1985; and Ellefson and Weible, 1980). Others have used computer simulation approaches to do so (e.g., Hrubes, 1984) or have applied forest engineering principles to topographic maps (e.g., Likwar et al., 1992). The focus of most studies, however, has been on analyzing the *cost* of BMP application. With the exception noted above, there has been only limited analytical focus on quantifying the economic *benefits* of BMPs. Where benefits have been assessed, the evaluations usually focused on the biophysical consequences of BMP application (e.g., reduced soil loss) without assessing the financial and economic consequences of their application. In part, this information void stems from difficulties associated with clearly identifying the economic benefits of BMPs to timber harvesters and subsequently assigning economic measures to them (e.g., economic value of benefits derived by timber harvesters from applying BMPs that are designed to reduce soil loss). This lack of information makes accurate assessment of the net financial and economic benefits of BMP program implementation very difficult.

Evaluation Options

Assessing the financial impact on timber harvesters of applying BMPs entails some variation of with-and-without analysis, namely a comparison of net financial conditions before BMP application was recommended, with net financial conditions existing after BMPs were applied. Even though agriculture and forestry literature provides little empirical analysis of the net financial or economic consequences to timber harvesters of BMP application, it does suggest at least three possible research methods.

- *Assess Past and Current Cost-Accounting Records*: Assess a sample of timber harvester cost accounting records for operations involving usual pre-BMP harvesting practices and for operations involving application of recommended BMPs. Compare the costs and revenues prior to the introduction of water quality BMPs (for example, 1990 in Minnesota) with net revenues resulting from compliance with specific water quality BMPs. This approach requires access to detailed information about the cost and revenue conditions of individual timber harvesters across a relatively large number of sites and operating conditions. The likelihood of obtaining such information is problematic. In addition, many timber harvesters often fail to keep detailed cost accounting records of their operations.

- *Evaluate Different Site Cost-Accounting Records*: Undertake a field study in which timber harvesting costs and benefits are carefully documented for sites where BMPs are applied and where not applied. Involved is identification of several sets of paired harvesting sites that have similar topographical and biophysical features. Each site is then harvested, half with conventional techniques used prior to implementing a BMP program and half harvested in a manner that fully complies with recommended BMPs. In each case, costs and revenues are carefully tracked to determine the marginal effect of water quality BMP compliance on harvesters' net revenue. Multiple sites would be required to derive an accurate representation of the production costs and revenue streams occurring under various operating conditions. Several trained field workers would be required to identify and track costs and revenues.

- *Examine Estimated Costs and Revenues*. Via a mailed questionnaire (or similar instrument), ask timber harvesters for information about net financial conditions they face with and without BMP application. Assumed is that most timber harvesters were already (before BMP introduction) implementing forest practices required by BMP standards which offer them direct financial or other types of returns, and that the net revenue for all additional practices included within the BMP program is negative (e.g., costs exceed benefits). The extent to which timber harvesters can accurately assess the exact costs and benefits of each specific BMP practice they undertake is uncertain. However, timber harvesters probably can record their perception or estimate of the net financial implications of applying water quality BMPs as a lump sum percentage figure. A questionnaire could offer timber harvesters a select sampling of practices for which they could record their perceptions about how those practices contribute or detract from that lump sum figure.

While use of a mailed questionnaire offers the potential to circumvent several of the logistical difficulties presented by other approaches, it also has drawbacks. Most importantly, timber harvesters may report impressions rather than facts. Consequently, the information could be highly subjective and thus potentially biased.

The first two options pose significant difficulties with regard to the lack of existing data and the expense and complexity of their implementation. As such, a mailed questionnaire querying timber harvesters about benefits and costs of BMP applications was judged to be the most cost effective and expeditious approach for collecting the desired information. In spite of the subjective nature of the method, it was concluded that the potential benefits to be derived from a survey approach outweighed its drawbacks. Although respondent perceptions may differ from reality, they form the basis for opinions and ideas, and help contribute to the ultimate acceptance or rejection of BMP programs. In this context, a survey assessing the effects of BMP practices on harvester net revenue can provide valuable information.

STUDY OBJECTIVES AND PROCEDURES

Objectives

The overall objective of the study was to assess the net financial consequences to Minnesota timber harvesters of applying forestry BMPs for water quality recommended within the 1990 program (Minnesota Department of Natural Resources, 1989). Specifically, the intent was to identify and document the following:

- Demographic profile of a sample of timber harvesters responsible for applying BMPs in Minnesota.
- Change in application rate of selected water quality BMPs in Minnesota since 1990.
- Additional cost of water quality BMP implementation borne by timber harvesters in Minnesota since 1990.
- Additional benefits of water quality BMP implementation accrued by Minnesota timber harvesters since 1990.
- Net financial cost to Minnesota timber harvesters of implementing water quality BMPs since 1990.

The study considered only those direct financial cost and revenues that accrued to timber harvesters. Intangible costs and benefits and broad economic consequences to large segments of the public (e.g., aesthetics, endangered species habitat, soil loss, change in site productivity, employment changes) were not assessed.

Procedures

Questionnaire. The information required to accomplish the study's objectives was gathered via a questionnaire (mail) survey of persons owning timber harvesting businesses in Minnesota (Appendix A). The survey was conducted with the cooperation of the State's two timber harvester associations, namely the Minnesota Timber Producers (TPA) and the Associated Contract Loggers (ACL). The questionnaire was organized into three parts. The first section gathered background information about the survey participants and assessed their knowledge and opinion of the BMP program. The second section evaluated changes in BMP use since the program's inception in 1990. The final section focused on the respondents' perceptions of the costs and benefits associated with BMP use.

The general practices and specific BMPs included in the questionnaire were taken from Phillips et al., (1994). Certain practices were excluded, namely practices that did not directly pertain to timber harvesting (e.g., mechanical site preparation, pesticide use, prescribed burnings), practices where respondents would infrequently report that they were not properly applying a practice (e.g., the construction, clearing, and excavation practice "proper placement of clearing debris"); and practices infrequently rated during the BMP audit process (e.g., the practice "install silt fences where needed" was only rated on one site).

Respondents were asked to rate their use of forty specific practices. They were asked to indicate whether their operation: a) never applied the practice, b) used the practice less today than it did before 1990, c) hadn't changed its use of the practice since before 1990, or d) used the practice more today than it did before 1990. The response rates to these questions were tabulated in percentage form and were compared to the results of Minnesota's BMP compliance monitoring program (Phillips et al. 1994). The monitoring program (implemented in 1991, 1992, and 1993) involved multi-organization field audit teams that rated the number of times that specific BMP practices were required and how they were applied. A practice was rated during the audit process each time that it was appropriate to an audit site, with a maximum of one rating per site. A high number of times rated (values of 100 or above) indicated the given practice had been observed quite frequently in the course of the survey. A total of 261 sites were rated over the course of the three-year audit process. The "number of times rated" (*ntr*) from the audit report served as a reference point for the data analysis in this report.

Respondents were also asked to specify whether they perceived that their operations had experienced changes, as noted by the approximate percent increase, in costs and revenues since BMPs were implemented in 1990. Focusing on 14 BMP categories, respondents were asked to note the approximate percent increase as either one to five percent, six to 10 percent, 11 to 15 percent, greater than 15 percent, or "don't know." The response rates to these questions were tabulated and recorded in percentage form. In addition, the response rates to each answer category (e.g., "no change," "up 1- 5 percent") were averaged across all 14 BMP categories.

Respondents also identified the sources of any changes in BMP applications. Five potential sources of increased costs were listed, namely: 1) increased number of days needed to complete harvest, 2) increased capital costs (e.g.; culverts, seeds), 3) increased cost of road, skid trail, or landing construction, 4) increased cost of road, skid trail, or landing maintenance, and 5) increased cost of maintaining equipment. Also listed were potential sources of increased benefits, namely: 1) increased productivity per day, 2) increased number of operable days on-site, 3) reduced cost of road, skid trail, or landing construction, 4) reduced cost of road, skid trail, or landing maintenance, and 5) reduced cost of maintaining equipment. An "other" source was also provided for both costs and benefits. At the end of the survey, one question allowed respondents to provide open-ended comments.

Draft copies of the questionnaire were reviewed by several individuals and organizations, including representatives from the Minnesota Department of Natural Resources and executives from the Timber Producers Association and the Associated Contract Loggers. A pretest survey was conducted with 12 timber harvesters to identify problems in wording, format, and questionnaire length. The pretest questionnaires were mailed in September 1994. Responses from the pretest indicated that the questionnaire was long but understandable. Modifications were made to improve the draft questionnaire.

The revised questionnaire was mailed on November 4, 1994 to individuals identified on TPA's and ACL's membership lists. A copy of the survey is contained in Appendix A. The mailing consisted of a cover letter, the questionnaire, and a stamped, pre-addressed return envelope addressed to the University of Minnesota. Each survey was numbered with an alphanumeric code to facilitate tracking of respondents. The code consisted of either the three letters "ACL" or "TPA" and a non-repeating three-digit code that began with 001 and ended with the number of individuals on each membership list. As there is some cross-over of membership between TPA and ACL, respondents were asked to return one completed survey and the first page (background) of the other questionnaire if they received two surveys. A follow-up postcard was mailed to everyone on November 11, 1994. It served to either thank those that had returned their questionnaire or to remind those that had not returned it. A final mailing with contents similar to that of the initial mailing was sent to non-respondents on December 1, 1994. Each piece of correspondence was signed by ACL's Executive Director, TPA's Assistant Vice President, and two individuals from the University of Minnesota.

Respondents' names were kept anonymous so as to ensure a higher response rate and a more objective response. In addition, both TPA and ACL wanted to keep their membership lists proprietary. To accomplish these objectives, the individual survey packages were assembled at the University of Minnesota and sent to TPA and ACL for addressing. At the University of Minnesota, the non-repeating three digit code portion of the alphanumeric code was placed on the outside of the exterior envelope. TPA and ACL numbered their membership lists to correspond to the sequence on the envelopes. They then applied the actual labels and mailed the envelopes. Responses were tracked by recording the alphanumeric survey identification code.

A total of 523 questionnaires were mailed, although the actual number of potential responses is less than that figure. Before sending out the survey, TPA attempted to identify and target those members who were timber harvesters, excluding their industrial membership and individuals who were only involved with trucking. The ACL mailing, however, did not exclude anyone. Retired members on both mailing lists may have received the questionnaire. As a result, the survey may have been sent to some individuals who were not timber harvesters and therefore would not be expected to respond. In addition, the amount of cross-over membership between TPA and ACL is unknown. As a result, the potential sample size of owners of timber harvest businesses in Minnesota is uncertain.

Analysis. A total of 200 questionnaires were returned, of which 126 were completed. Seventy-four questionnaires were returned with a note indicating that the questionnaire was not applicable to the person to whom it was sent. There were 63 respondents with TPA memberships, 75 respondents with ACL memberships, and 12 individuals with dual membership in both TPA and ACL. Responses from all returned questionnaires were entered into a database. Entries were coded by ACL and TPA alphanumeric codes, in addition to an independent numeric system used for tabulation purposes. Following the data entry, database queries were conducted to determine the breakdown of responses to each question. These breakdowns were used to tabulate percentage response values.

Following tabulation of demographic results, several more detailed analyses were performed. For example, an analysis was done to determine the relationship between the size of an operation and the owner/operator's perception of the net benefits of BMP use. The respondents were divided into two categories; part-time and full-time operators, and their answers re-evaluated. Part-time and full-time operators were defined as follows:

- *Part-time operators*: persons whose operations met all of the following criteria: purchase <=5 sales per year, harvest <= 200 acres per year, harvest <= 5,000 cords per year, and purchase <=$50,000 in stumpage annually.

- *Full-time operators*: (1) persons who met all of the following criteria: purchase >5 sales per year, harvest >200 acres per year, harvest >5,000 cords per year, and purchase >$50,000 in stumpage annually (i.e., everyone who met the opposite set of criteria from the part-time operators), and (2) persons who did not precisely fit into the category of part-time.

An analysis was also undertaken to determine the relationship between BMP use and knowledge of BMPs. A cross tabulation was done comparing changes in water quality use for specific best management practices since 1990 with participation in a water quality BMP workshop. The responses regarding change in use of BMPs since 1990 were broken down into two groups, namely individuals who had attended a BMP informational workshop, and those who had not.

Open-ended comments at the end of the survey were organized according to subject matter. Upon review it became apparent that these comments were extremely useful in further evaluating information reported in response to formal questions contained in the questionnaire. A number of these comments are included throughout the text of this report and are reported in their entirety in Appendix B.

Cautions. This study is one of the first attempts to quantify the costs and attendant benefits associated with timber harvester use of water quality BMPs. It should be recognized however, that the data compiled here represents the self-reported *perceptions* of a select group of timber harvesters, rather than objective reporting 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 they report generally represents a best estimate, as their business records do not usually reflect the level of detail required for an in-depth analysis. In addition, a timber harvester disgruntled with BMP standards, regulations in general, or reduced profit margins, may bring bias into the survey process. It should also be noted that the study made no attempt to perform on-the-ground evaluations to determine whether practices are being better applied today than they were prior to 1990.

In assessing the results of the study, it is also important to consider that individuals who join timber harvester associations like the Timber Producers Association and the Associated Contract Loggers may be the more progressive members of the timber harvesting industry. They may also be larger scale operators. As a result, the views expressed may be representative of a specific type of timber harvester rather than of the industry as a whole. Timber harvesters who are not members of these organizations may, for example, have different operating constraints, cash flows, or motivations. Also, they may be smaller businesses or more part-time operators as compared to association members. As the size and demographics of the timber harvesting community in Minnesota are largely unknown, it is not possible to tell how accurately the respondents in the survey population represent the entire timber harvesting industry within the state.

LOCATION AND SIZE OF OPERATIONS

Over 90 percent of the respondents who answered the questionnaire were owner/operators from North of the Twin Cities. The majority (over 75 percent) represented operations with one to five employees (Table 2). Most respondents worked from nine to 12 months per year (Table 2). Over half of the respondents (60 percent) harvested between one and nine timber sales per year; 58 percent harvested an average of 300 acres or less per year. Seventy-seven percent of the respondents harvested less than 10,000 cords of wood per year. An average annual stumpage value of less than $100,000 per year was cited by 67 percent of the respondents.

Most of the respondents harvested timber on state, county, and non-industrial private forest (NIPF) lands (Table 3). The importance of NIPF and forest industry lands

increased after 1990. As NIPF lands become more important, there may be associated concerns about water quality BMP compliance on those ownerships. While industrial forest lands had relatively high BMP compliance levels (90 percent of the rated BMPs met or exceeded the standard) (Phillips et al., 1994), compliance levels were second lowest (77 percent of the rated BMPs met or exceeded the standard) on NIPF lands.

TABLE 2. Business Characteristics of Responding Timber Harvesters, by Type of Characteristic. 1994.

Item	Response Rate (Percent)	Item	Response Rate (Percent)
Employees (123 respondents)		Number of Months (125 respondents)	
<=2	50	1-5	9
3-5	30	6-8	13
6-9	17	9-10	26
10-15	2	11-12	52
16-20	1		
30-35	2		
Average Number of Timber Sales (122 respondents)		Average Number of Acres (112 respondents)	
1-2	14	<= 100	24
3-5	26	101-200	21
6-9	20	201-300	13
10-15	26	301-400	13
16-20	5	401-500	8
21-25	3	501-1,000	15
26-30	3	>1,000	5
>30	2		
Cords Harvested (120 respondents)		Stumpage Value (99 respondents)	
<1,000	8	<=$50,000	44
1,000-5,000	40	$50,001-$100,000	23
5,001-10,000	29	$100,001-$200,000	19
10,001-15,000	11	$200,001-$300,000	4
15,001-20,000	6	$300,001-$400,000	2
20,001-30,000	3	>$400,000	7
> 30,000	3		

Note: For each item, response rates may not sum to 100 percent due to rounding errors.

TABLE 3. Ownership of Timber Harvested by Responding Timber Harvesters before 1990 and Thereafter.

Ownership Group	Distribution of Harvest Before 1990 (percent of respondents)				
	0%	1-25%	26-50%	51-75%	76-100%
Non-industrial private *(n=125)*	23	46	18	4	9
Forest industry *(n=125)*	58	18	9	10	5
County *(n=125)*	20	45	28	2	5
State *(n=125)*	17	50	29	3	2
Federal *(n=125)*	63	19	8	6	4
Ownership Group	**Distribution of Harvest After 1990 (percent of respondents)**				
	0%	1-25%	26-50%	51-75%	76-100%
Non-industrial private *(n=125)*	15	38	25	8	14
Forest industry *(n=125)*	53	22	14	6	6
County *(n=125)*	24	47	24	2	2
State *(n=125)*	24	50	22	1	3
Federal *(n=125)*	70	18	8	2	2

Note: Number of respondents (n) is noted for each ownership group. Rows may not sum to 100 percent due to rounding errors.

TABLE 4. Knowledge of Water Quality BMP Guidebook and Attendance at BMP Informational Workshops by Responding Timber Harvesters. 1994.

Item	Response (Percent)	
	Yes	No
Do you have a copy of the publication entitled "Water Quality in Forest Management: Best Management practices in Minnesota"? (*n = 126*)	80	20
Have you ever attended a logger informational workshop in which the state Water Quality BMP Voluntary Program was the primary focus of the workshop? (*n = 125*)	67	33

Note: Number of respondents (*n*) is noted for each item.

KNOWLEDGE OF BEST MANAGEMENT PRACTICES

A majority of the responding timber harvesters (80 percent) reported that they had a copy of Minnesota's BMP guidebook (Minnesota Department of Natural Resources, 1989) (Table 4). However, when asked how often they referred to the guidebook, nearly two-thirds of the respondents indicated that they did not use the publication often and an additional 17 percent indicated they never or almost never used the guidebook. Only two of 10 responding timber harvesters indicated they use the guidebook very or quite often. Specifically, 101 respondents were distributed as follows with regards to their reference to the guidebook: *Very often*: One percent; *Quite often*: 18 percent; *Not very often*: 65 percent; *Almost never*: 14 percent; and Never: 3 percent.

The relatively low rate of use of the Minnesota BMP guidebook by timber harvesters may be due to a number of factors, including a previously high level of knowledge of the forestry practices contained in the guidebook; judgement that the guidebook is technically inadequate in demonstrating the application of the various forestry practices; or a conclusion that the information contained in the guidebook is not different from forestry practices that are already being applied. Also a factor in the low rate of use of the guidebook is that respondents harvested a high percentage of timber on nonindustrial private forests where the voluntary BMP program has relatively low compliance levels.

Although most of the responding timber harvesters seldom referred to the water quality BMP guidebook, more than nine of 10 (94 percent) respondents indicated they were "very," "fairly" or "somewhat" knowledgeable about water quality BMP practices and the voluntary program used to deliver them (Table 5). Most timber harvesters were willing to comply with the water quality BMPs, namely 85 percent were either "very" or "fairly willing" to do so. Only three percent indicated they were "not very" or "not at all" willing to comply with recommended BMPs. As for timber harvesters perception of the restrictiveness of water quality BMPs on their operations, nearly half (49 percent) indicated they were "somewhat restrictive," while an additional four of 10 (44 percent) considered them "fairly" or "very restrictive." Most responding timber harvesters (75 percent) acknowledge that water quality BMPs are "fairly" or "very protective" of natural resources. Only one of 10 (8 percent) considered them "not very" or "not at all" effective in this respect.

Two-thirds of the timber harvesters indicated that they had attended a water quality BMP informational workshop (Table 4). For each of the 40 BMP practices listed, those timber harvesters that had attended a workshop selected the "use more" category more frequently than those individuals who had not attended a workshop (Appendix C). Seventy-two percent of the time, the difference in the "use more" column between those who had attended a workshop and those who had not was 15 percent or greater. Forty-five percent of the time, the difference between these groups was 20 percent or greater. Timber harvesters who had not attended a BMP workshop selected the "never apply" category more frequently than those respondents who had attended a workshop for 26 out of the 40 practices presented.

TABLE 5. Water Quality BMP Program Perceptions of Responding Timber Harvesters, by Knowledge of Program, Willingness to Comply, Restrictiveness, and Effectiveness. 1994.

Item	Response (percent of respondents)				
	Very	Fairly	Somewhat	Not Very	Not at All
Knowledge: How knowledgeable are you about water quality BMPs and the Voluntary BMP Program? (*n = 125*)	19	53	22	3	3
Willingness: How willing are you to comply with water quality BMP requirements? (*n = 125*)	40	45	12	2	1
Restrictiveness: How restrictive are the current water quality BMPs in terms of hindering you logging activity? (*n = 124*)	13	31	49	6	2
Effectiveness: How effective are the current water quality BMPs in terms of resource protection? (*n = 122*)	25	40	26	7	1

Note: Rows may not sum to 100 percent due to rounding errors.

In general, timber harvesters attending informational workshops were more likely to apply the water quality BMPs. For timber harvesters failing to do so, the "never apply" response was selected for 65 percent of the practices specified. For some categories, the BMP application rate between those attending versus not attending an informational workshop was especially noteworthy. For example, for the practice "stabilize erodible soils by seeding" for the BMP categories "maintenance of all roads during or after the sale" and "landings," respondents who had not attended a workshop selected the "never apply" option more than twice as often as those who had attended a workshop. This particular practice received low compliance ratings on this survey, and relatively low number of times rated (*ntr*) during the BMP compliance monitoring process (Phillips et al., 1994).

All practices that received a "never apply" percentage of greater than 10 percent were isolated. All timber harvesters who had selected "never apply" for these practices where then identified in an effort to develop a respondent profile. These harvesters were tracked in their responses concerning both demographic information and knowledge of water quality BMPs. No consistent pattern emerged. Respondents who answered "never apply" for one BMP practice did not necessarily select it for others, and these individuals represented a range of backgrounds and opinions.

In summary, the majority of the responding timber harvesters were owner/operators of fairly small timber harvesting operations who work throughout most of the year in northern Minnesota. A majority of these individuals had been exposed to state water quality BMP information in the form of the BMP guidebook or an informational workshop, and most were at least "fairly knowledgeable" about BMP practices. While indicating that they were at least "fairly willing" to comply with BMPs, and rating them as at least "somewhat" effective, most respondents indicated that the practices were at least "fairly"

restrictive. Although a positive relationship exists between workshop attendance and water quality BMP use, the results of the analysis are not sufficiently detailed to pinpoint the reasons for the relationship. It may be that better understanding of the overall Water Quality BMP Program leads to greater use of the practices, or, conversely, that timber harvesters attending workshops are already predisposed toward using water quality BMPs.

CHANGE IN USE OF BEST MANAGEMENT PRACTICES

Overall, relatively few respondents indicated that they "never apply" or "use less" any of the forty specific water quality BMP practices specified included in the questionnaire, as compared to pre-1990 levels (Table 6). An average of seven percent of the respondents indicated that they "never apply" any of the practices, while one percent indicated the "use less" category, as compared to pre-1990. Low frequencies for "never apply" and "use less" categories might be expected given that practices selected for inclusion in the questionnaire were those that tended to be most frequently rated during the compliance monitoring field audit (Phillips et al., 1994).

As for specific forestry practices never applied, nine of the 40 practices specified in the questionnaire were cited by 10 percent or more of the respondents (Table 6). The practice of "stabilizing erodible soil by seeding," which appeared under three different categories, received the highest rates of never apply. Twenty-one percent of the respondents indicated that they did not apply that practice as a part of the "maintenance of all roads during or after the sale" category. Eighteen percent said that they never used that practice in the process of "forest road construction, clearing and excavation," and 17 percent indicated that they never used the practice related to the category of "landings." The relatively low number of times rated (*ntr*) scores for these categories (35, 53, and 55 respectively) (Phillips et al., 1994), which indicate that stabilizing erodible soil by seeding was not frequently rated during BMP monitoring, also suggest that this practice does not need to be used as frequently as other practices.

Approximately 10-20 percent of the respondents indicated that they never apply several additional practices, such as "design crossings to avoid the obstruction of fish migration" (*ntr*=20) and "maintain vegetation adjacent to designated trout streams and lakes" (*ntr*=16) (Table 6). These practices also had extremely low *ntr*s (20 or less). The combination of high "never apply" percentages with low *ntr* ratings, and the specific nature of these practices (they relate primarily to trout streams and lakes) would seem to indicate a lack of applicability for those particular water quality BMPs within most sites rather than a lack of compliance.

An average of 42 percent of the respondents indicated no change in their use of specific water quality BMP practices since 1990 (Table 6). Several practices, however, received particularly high rates for no change in use. For example, under the category of "forest road alignment," 60 percent of the respondents indicated that they had already practiced minimizing the total road mileage required to meet the landowner's objectives

TABLE 6. Change in Use of Water Quality BMPs by Responding Timber Harvesters from 1990 through 1994.

BEST MANAGEMENT PRACTICES	Change in Use (percent of respondents)			
	Never Apply	Use Less	No Change	Use More
1. FUEL, LUBRICANT, AND EQUIPMENT MANAGEMENT				
Adequate storage and disposal for fuel, debris, lubricants, fluids and rinsate from equipment cleanup *(n=124)*	1	0	21	78
2. FOREST ROAD ALIGNMENT				
Minimize the total road mileage required to meet the landowner's objectives *(n=122)*	4	1	60	36
Avoid activity below the ordinary high water mark *(n=122)*	7	2	43	48
Provide filter strips between roads and lakes, streams, and intermittent waterways *(n=124)*	4	1	39	57
3. FOREST ROAD WATER CROSSINGS				
Cross streams at right angles *(n=118)*	9	4	58	29
Minimize amount of natural stream channel disturbance *(n=119)*	7	3	32	59
Design crossings to avoid obstruction of fish migrations *(n=115)*	20	1	44	35
4. WINTER ROADS OR TEMPORARY CROSSINGS				
Avoid use of mineral soil as fill on winter crossings *(n=121)*	3	1	41	55
Remove temporary/winter crossings prior to breakup *(n=121)*	4	0	42	54
5. FOREST ROAD DRAINAGE				
Install water diversion devises on road surfaces using broad based dips/grade rolls, open culverts, water bars, or outsloping *(n=120)*	7	1	31	62
Drain surface water into filter strip or vegetative draw *(n=121)*	6	2	48	45
Remove all berms *(n=118)*	12	2	53	33

BEST MANAGEMENT PRACTICES	Never Apply	Use Less	No Change	Use More
6. FOREST ROAD CONSTRUCTION, CLEARING & EXCAVATION				
Shape inslopes and backslopes to 1½:1 or flatter to stabilize soils *(n=121)*	10	1	40	50
Stabilize erodible soils by seeding *(n=120)*	18	2	38	43
Surface road to minimize water quality impacts *(n=120)*	13	0	55	32
7. MAINTENANCE OF ALL ROADS DURING OR AFTER THE SALE				
Maintain erosion control features in working order *(n=123)*	4	1	47	48
Stabilize erodible soils by seeding *(n=121)*	21	0	39	40
Restrict use of roads during wet periods and spring breakup if use could impact water quality *(n=123)*	2	2	40	57
8. MAINTENANCE OF ACTIVE ROADS DURING SALE ACTIVITY				
Maintain proper surface to maintain drainage and prevent erosion *(n=123)*	0	1	48	52
9. MAINTENANCE OF OCCASIONAL USE ROADS DURING SALE ACTIVITY				
Properly close when not in use *(n=121)*	8	1	48	43
Maintain water diversion devices in working order *(n=121)*	7	1	48	44
10. MAINTENANCE OF TEMPORARY ROADS DURING SALE ACTIVITY				
Properly close roads when use is complete *(n=122)*	7	1	47	45
Stabilize road surface *(n=123)*	7	0	56	37
11. TIMBER HARVESTING: GENERAL PRACTICES				
Time harvest compatible with soil and topography *(n=123)*	0	1	30	70
Minimize mineral soil exposure in filter strip to less than 5% *(n=120)*	6	0	48	47
Keep streams, lakes, wetlands free of logging debris *(n=122)*	2	1	24	73
Avoid felling timber into nonforested wetlands *(n=122)*	1	1	28	70
12. FILTER STRIPS				
Maintain vegetation adjacent to designated trout streams or lakes *(n=121)*	10	1	29	60

BEST MANAGEMENT PRACTICES	Never Apply	Use Less	No Change	Use More
13. SKID TRAILS				
Minimize the total main skid trail mileage required to meet the landowners objectives *(n=125)*	2	2	54	42
Locate skid trails outside of filter strips *(n=125)*	4	0	36	60
Design main skid trails to avoid concentrating runoff *(n=122)*	0	0	38	62
Install water diversion devices on main skid trails using broad based dips/grade rolls, open culverts, water bars, or outsloping *(n=124)*	9	1	40	50
Drain surface water into filter strip or vegetative draw *(n=123)*	7	1	48	45
Minimize amount of natural stream channel disturbance *(n=123)*	10	0	33	61
Rehabilitate skid trails when needed *(n=123)*	5	1	34	61
14. LANDINGS				
Locate landings outside of filter strips	3	0	39	58
Provide for maximum cross-drainage and minimum down slope flow	4	1	47	48
Drain surface water into filter strip or vegetative draw	3	1	48	48
Stabilize erodible soils by seeding	17	0	43	40
Rehabilitate landings when needed	7	0	39	54
Average percent for each column	7	1	42	51

Note: Number of respondents (n) is noted for each practice. Rows may not sum to 100 percent due to errors in rounding.

(*ntr*=166) prior to 1990. In the category of "forest road water crossings," 58 percent of the respondents indicated no change in the practice of crossing streams at right angles (*ntr*=45). Fifty-five percent of the respondents said that they had not changed their road surfacing to minimize water quality impact (*ntr*=77) under the category of "forest road construction, clearing and excavation." In the category of "maintenance of temporary roads during sale activity," 56 percent of the respondents indicated no change in practices to stabilize road surfaces (*ntr*=43). Widespread use of these practices before the introduction of the Water Quality BMP Program in 1990 suggests that these particular BMPs provide obvious financial benefits to timber harvesters and landowners. Although these results do suggest that some practices were widely used before 1990, it is not possible to tell whether or not the practices were implemented in the same way during the two time periods.

Fifty-one percent (on average) of the respondents indicated that they use specific practices more now than they did prior to 1990 (Table 6). Response rates for a number of specific practices were quite high. For example, under the category of "fuel, lubricant, and equipment management," 78 percent of the respondents indicated that they used BMP practices related to "adequate storage and disposal for fuel, debris lubricants, fluids and rinsate from equipment cleanup" more now than they did before the BMP program began in 1990. This practice was also evaluated frequently during the compliance monitoring field audits (*ntr* = 243), a fact which would seem to confirm need to apply this practice. In the "forest road water crossings" category, 59 percent of the respondents indicated that they "minimized the amount of natural stream channel disturbance" (*ntr* =48) more now than they did before 1990. A number of respondents (62 percent) indicated that they "installed water diversion devises on road surfaces using broad based dips/grade rolls, open culverts, water bars, or outsloping" (*ntr*=65) more now than they did before 1990 (in the "forest road drainage" category).

Several BMPs under the category of "timber harvesting: general practices" also showed a significant increase in application after 1990 (Table 6). Seventy percent or more of the respondents indicated that they "time harvest to be compatible with soil and topography;" "keep streams, lakes and wetlands free of debris;" and "avoid felling timber into nonforested wetlands" more now than before 1990. The *ntr* figures, 227, 199 and 135 respectively, also reflect the need for widespread use of these practices. In the category of "skid trails," 60 percent or more of the respondents indicated an increase in their use of four separate practices, namely "locate skid trails outside of filter strips" (*ntr* = 220), "design main skid trails to avoid concentrating runoff" (*ntr* = 196), "minimize amount of natural stream channel disturbance" (*ntr* = 52), and "rehabilitate skid trails when needed" (*ntr* = 86).

It was interesting to compare the results from this study to the corresponding compliance monitoring field audit data (Phillips et al., 1994). Some of the practices which were rated frequently during the field audits had relatively low departure rates. Survey respondents frequently indicated that these were the practices for which they had not

changed their operation. Widespread use of these practices before the introduction of the water quality BMP program in 1990 suggests that these particular BMPs provide obvious financial benefits to timber harvesters and/or landowners. As an example, the practice "minimize total road mileage required" was rated 166 times during the audit process and was not properly applied on only three percent of the sites. Correspondingly, 60 percent of the respondents indicated that there was "no change" in their rate of application of this practice after 1990. Similarly, the BMP practice "minimize total skid trail mileage required," which was rated 195 times, had a departure rate of only seven percent while 54 percent of the respondents indicated that there was "no change" in their rate of application. Although these results do suggest that some practices were widely used before 1990, it is not possible to tell whether or not the practices were implemented in the same way during the two time periods.

In contrast, there were several practices where respondents indicated that they used the practice more after the BMP program was implemented in 1990. These practices tended to be those which apparently did not provide direct benefits to loggers. As an example, for the practice "adequate storage and disposal for fuel, debris, lubricants, fluids and rinsate from equipment cleanup," which was rated 243 times and had a departure rate of 22 percent (Phillips et al., 1994), 78 percent of the respondents indicated that they used the practice more after 1990. Similarly, for the practice "keep streams, lakes, and wetlands free of logging debris," which was rated 199 times and had a departure rate of 37 percent, 73 percent of the respondents indicated that they used the practice more after 1990.

In addition to the formal responses timber harvesters made to inquiries specified in the questionnaire, many provided written comments about BMP use. Further insight to the use of BMPs since 1990 can be gained from these comments, examples of which 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."

"We have always done most of this -- before BMPs were ever around."

"I really don't notice any benefits from it [BMP implementation]. I feel I have always complied with BMPs for the sake of just doing it right, and to satisfy the landowner in any way. I am willing to be informed even more."

"To sum it up, we have been applying water quality BMPs for many years. Good stewardship would be all that is needed. BMPs have to be enforced on some sales and some loggers. Some try to get away with things based on who they know and where they are and who they are. I wouldn't even try it -- it just isn't right! Good loggers do it right, they think about the future!"

In summary, use of 40 specific water quality BMPs by timber harvesters in Minnesota has either stayed the same or increased modestly since 1990. While the exact reasons for the increases are unknown, it seems likely that they may be related to the implementation of the state's Water Quality BMP Program. In this respect, some of the increase may be attributable to BMP educational efforts which may have increased timber harvester awareness and understanding of the value of these practices. However, judgements about a positive influence of the program on application rates must be tempered by the reality that a fairly high percentage of timber harvesters claim they were already using specific water quality BMP practices before the program's inception in 1990. Respondent comments support this finding. Many timber harvesters apparently feel (and have always felt) that water BMP practices make sense from either a financial or environmental point of view. Whether implementation of the BMP program by public and private concerns has made this attitude more pervasive, leading to more widespread application of water quality BMPs, is subject for continuing speculation.

COST OF BEST MANAGEMENT PRACTICE APPLICATION

Extent of Cost Changes

Seven of ten timber harvesters reflecting on the potential for change in costs (respondents indicating change, no change, or don't know), indicated that they had incurred additional costs associated with implementing 14 water quality BMP categories since 1990 (Table 7). Most of these cost increases were in the range of one percent to 10 percent, although approximately one of 10 respondents indicated cost increases greater than 15 percent. Cost increases due to BMP use were not experienced by all responding timber harvesters. On average, twenty-two percent indicated that there was no change in their costs associated with applying 14 different BMPs since 1990 (Table 7). As for BMP categories for which no change in costs was most common, the following were cited: "filter strips" (34 percent of respondents), "winter roads or temporary crossings" (30 percent), and maintenance of active, temporary, and occasional use roads during sale activity (29 percent each) -- all of which had *ntrs* of 26 or lower, indicating extremely low use. In contrast, only 8 percent of the respondents reported no change in their perceived cost for the category "timber harvesting: general practices" (practices had *ntrs* of 135 or more).

An average of 25 percent of the responding timber harvesters (respondents indicating change, no change, or don't know) indicated that their costs of applying the 14 BMP categories had increased by one to five percent (Table 7). In the categories of "fuel, lubricant, and equipment management," "skid trails," and "landings," however, 36 percent or more of the respondents indicated a one to five percent increase. Only 16 percent of the respondents reported an increase of one to five percent in the "forest road construction, clearing and excavation" category. Twenty-two percent (on average) of the responding timber harvesters indicated that their costs had increased by 6-10 percent. With the exception of the "timber harvesting: general practices" category (33 percent), responses for any one category were close to this average response rate.

Table 7. Change in Costs to Timber Harvesters Due to Water Quality BMP Use from 1990 Through 1994, by Major BMP Category.

Major BMP Category	Changes in Costs of BMP Application (percent of respondents)					
	No Change	Up 1% to 5%	Up 6% to 10%	Up 11% to 15%	Up >15%	Don't Know
Fuel, lubricant, and equipment management (n=118)	25	36	19	8	5	6
Forest road alignment (n=120)	19	27	24	16	7	8
Forest road water crossings (n=118)	17	19	25	17	12	9
Winter roads or temporary crossings (n=119)	30	29	15	17	6	3
Forest road drainage (n=115)	18	30	29	14	4	6
Forest road construction, clearing, and excavation (n=118)	12	16	27	20	18	6
Maintenance of all roads during or after the sale (n=116)	22	23	19	16	14	6
Maintenance of active roads during sale activity (n=117)	29	26	18	12	11	3
Maintenance of occasional use roads during sale activity (n=116)	29	27	22	9	3	10
Maintenance of temporary roads during sale activity (n=112)	29	22	25	7	6	11
Timber harvesting: General practices (n=118)	8	23	32	14	19	4
Filter strips (n=115)	34	21	16	12	8	9
Skid trails (n=118)	23	36	22	9	5	5
Landings (n=118)	18	36	22	14	7	4
AVERAGE FOR EACH COLUMN	22	25	22	14	9	6

Note: "n" is the number of timber harvesters responding to a major BMP category. Rows may not sum to 100 due to rounding.

Table 8. Source of Additional Costs to Timber Harvesters Due to Water Quality BMP Use from 1990 Through 1994, by Major BMP Category..

Major BMP Category	Respondent Data			Sources of Costs (percent of responses)					
	Number of Eligible Respondents[a]	Number of Actual Respondents[b]	Number of Responses[c]	Increase in days needed to complete harvest	Increase in capital costs (e.g., culverts, seed)	Increased cost of road, skid trail, and landing construction	Increased cost of road, skid trail, and landing maintenance	Increased cost of maintaining equipment	Other
Fuel, lubricant, and equipment management	82	78	119	17	9	17	14	41	2
Forest road alignment	88	75	113	13	27	42	12	7	0
Forest road water crossings	86	81	114	12	48	26	8	5	0
Winter roads or temporary crossings	79	65	84	17	23	43	12	6	0
Forest road drainage	87	78	118	11	41	26	17	5	0
Forest road construction, clearing, and excavation	99	94	143	18	17	45	11	8	0
Maintenance of all roads during or after the sale	83	77	106	22	10	14	42	10	2
Maintenance of active roads during sale activity	79	72	106	20	12	12	43	11	1
Maintenance of occasional use roads during sale activity	71	57	76	21	11	8	49	9	3
Maintenance of temporary roads during sale activity	68	54	72	18	14	8	49	11	0
Timber harvesting: General practices	104	96	148	47	11	14	15	14	1
Filter strips	66	53	71	32	13	30	17	8	0
Skid trails	86	80	114	32	11	23	27	8	0
Landings	92	87	120	23	11	34	25	6	1
AVERAGE FOR EACH COLUMN	84	75	107	22	18	24	24	11	1

[a] All respondents who identified a change in costs equal to or greater than one percent.

[b] Number of respondents who responded to this question.

[c] Respondents were permitted to cite more than one source of cost per major BMP category.

Relatively few timber harvesters (an average of 14 percent) indicated that their costs had risen by 11-15 percent, with the category "forest road construction and excavation" being most notable (20 percent of respondents). An average of only 9 percent of the responding timber harvesters indicated BMPs increased their costs by 15 percent or more. However, in two categories, "forest road construction, clearing, and excavation" and "timber harvesting: general practices," 18 and 19 percent, respectively, of responding timber harvesters indicated an increase in costs of greater than 15 percent. Six percent of the responding timber harvesters did not know if their costs had increased due to increased BMP use.

Source of Cost Changes

Timber harvesters experiencing increased costs specified a variety of sources for the additional costs that were required to implement the water quality best management practices (Table 8). In some cases, they indicated more than one source of increased costs. In descending order averaged across the 14 BMP categories, respondents indicated the following as major sources of increased costs:

- *Construction activities*: increased cost of road, skid trail and landing construction (24 percent).
- *Maintenance activities*: increased cost of road, skid trail and landing maintenance (24 percent).
- *Harvest time*: increase in number of days to complete harvest (24 percent of respondents).
- *Capitol Improvements*: Increased capitol costs (e.g., culverts) (18 percent)
- *Equipment maintenance*: Increased cost of maintaining equipment (11 percent).

Across the 14 BMP categories, the most frequently identified BMPs causing an increase in costs were (a) added road and landing maintenance (49 percent of respondents) associated with BMPs in the "maintenance of occasional use roads during sale activity," and "maintenance of temporary roads during sale activity" categories, and (b) increased capital investments (48 percent of respondents) resulting from "forest road water crossings" BMPs. If only the BMP categories mentioned by 40 percent or more of the responding timber harvesters as leading to a particular increase in costs are highlighted, the following is noted:

- *Increase in days needed to complete harvest*: Caused by additional attention to certain general timber harvesting practices (47 percent of respondents).
- *Increase in capital costs*: Caused by additional attention to forest road water crossings (48 percent) and forest road drainage (40 percent).

- *Increased cost of road, skid trail, and landing construction*: Caused by additional attention to forest road construction, clearing and excavation (45 percent); winter roads or temporary crossings (43 percent); and forest road alignment (42 percent).
- *Increased cost of road, skid trail, and landing maintenance*: Caused by additional attention to maintenance of temporary roads during sale activity (49 percent); maintenance of occasional use roads during sale activity (49 percent); maintenance of active roads during sale activity (43 percent), and maintenance of all roads during or after a sale (42 percent).
- *Increased cost of maintaining equipment*: Caused by additional attention to management of fuel, lubricant and equipment (41 percent).

As with comments regarding changes in the use of water quality BMPs, responding timber harvesters provided a number of insightful written statements about BMPs and the cost impacts on their operations. These comments provide further insight to the costs of using water quality BMPs since 1990. Example are:

"The cost 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."

"We log mostly on Federal lands. We comply to their specs which increases our cost some. Maybe not more than 5 percent to 10 percent."

"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."

"The cost of implementing water quality BMPs is totally absorbed by the logger. There has been no increase in mill prices."

"Costs should be passed on to the consumer."

In summary, seven of ten timber harvesters reflecting on the potential for change in costs (respondents indicating change, no change, or don't know), indicated that they had incurred additional costs associated with implementing 14 water quality BMP categories since 1990. An average of 45 percent of the respondents indicated that their costs had increased by 6 percent or more. The source of these increased costs was nearly equally attributable to increased time to complete harvests; increased road, skid trail, and landing construction; and increased road, skid trail and landing maintenance. Increased capital costs were of somewhat lesser concern, while the added cost of maintaining equipment

was the least in terms of an added cost source. In written comments, many timber harvesters focused specifically on the frustration of having to absorb additional costs without any form of reimbursement.

BENEFITS OF BEST MANAGEMENT PRACTICE APPLICATION

Extent of Benefit Changes

Timber harvesters potentially could receive a number of benefits (positive impacts on net revenue) from the application of recommended BMPs. However, when given an opportunity to specify whether they were of aware of such benefits, whether or not benefits had actually occurred, and, if so, the magnitude of these benefits, an average of 64 percent of the responding timber harvesters indicated there was no perceived change in benefits associated with applying one or more of 14 categories of BMPs since 1990 (Table 9). The BMP categories cited most frequently as not leading to a change in benefits received were "maintenance of temporary roads during sale activity" (71 percent of respondents), "winter roads or temporary crossings" (69 percent), and "fuel, lubricant and equipment management" (69 percent).

Although the vast majority of responding timber harvesters indicated no change in benefits, almost three of 10 (29 percent) indicated that BMP application did on average result in positive changes to their operations (Table 9). As for the magnitude of these changes, an average of 13 percent cited an increase of one to five percent (attributable most often to positive changes in "maintenance of all roads during or after sale" and "forest road alignment"), while an average of 8 percent indicated an increase in benefits of six to 10 percent. Only four percent of the responding timber harvesters cited an increase in benefits of 11 to 15 percent; similarly, four percent reported an increase greater than 15 percent. Regarding the latter, no single BMP category stood out as a major source of added benefits range of increases. An average of 10 percent of the respondents indicated that they were unsure or did not know if their operations had experienced additional benefits because of BMP application.

Source of Benefit Changes

Focusing on timber harvester responses indicating an increase in benefits from BMP application, an average of 32 percent indicated they had experienced an "increased number of operable days on-site" as a result of BMP use (Table 10). This was followed (descending order of frequency cited) by "reduced cost of road, skid trail, and landing maintenance" (25 percent of responding timber harvesters), "increased productivity per day" (22 percent),"reduced cost of road, skid trail and landing construction" (9 percent), and "reduced cost of maintaining equipment" (8 percent).

Table 9. Change in Benefits to Timber Harvesters Due to Water Quality BMP Use from 1990 Through 1994, by Major BMP Category.

Major BMP Category	Change in Benefits to Timber Harvesters Due to Water Quality BMP Use (percent of respondents)					
	No Change	Up 1% to 5%	Up 6% to 10%	Up 11% to 15%	Up >15%	Don't Know
Fuel, lubricant, and equipment management (n=97)	69	11	6	0	4	9
Forest road alignment (n=96)	57	17	11	1	3	10
Forest road water crossings (n=94)	61	10	10	3	4	13
Winter roads or temporary crossings (n=95)	69	9	8	0	3	10
Forest road drainage (n=95)	60	15	10	4	2	8
Forest road construction, clearing, and excavation (n=96)	64	7	15	2	5	7
Maintenance of all roads during or after the sale (n=96)	62	18	6	2	4	7
Maintenance of active roads during sale activity (n=95)	63	16	5	2	4	10
Maintenance of occasional use roads during sale activity (n=95)	65	13	6	3	3	10
Maintenance of temporary roads during sale activity (n=94)	71	10	7	1	3	7
Timber harvesting: General practices (n=96)	62	9	7	5	6	9
Filter strips (n=94)	65	14	4	3	3	11
Skid trails (n=95)	63	14	7	1	3	11
Landings (n=94)	60	15	8	1	4	12
AVERAGE FOR EACH COLUMN	64	13	8	4	4	10

Note: "n" is the number of timber harvesters responding to a major BMP category. Rows may not sum to 100 due to rounding.

Table 10. Source of Additional Benefits to Timber Harvesters Due to Water Quality BMP Use from 1990 Through 1994, by Major BMP Category.

	Respondent Data			Sources of benefits (percent of respondents)					
Major BMP Category	Number of Eligible Respondents[a]	Number of Actual Respondents[b]	Number of Responses[c]	Increased productivity per day	Increased number of operable days on-site	Reduced cost of road, skid trail, and landing construction	Reduced cost of road, skid trail, and landing maintenance	Reduced cost of maintaining equipment	Other
Fuel, lubricant, and equipment management	21	6	7	14	0	14	0	57	14
Forest road alignment	31	15	16	31	25	19	25	0	0
Forest road water crossings	25	6	7	0	43	29	29	0	0
Winter roads or temporary crossings	20	3	4	0	50	25	25	0	0
Forest road drainage	31	16	20	15	55	10	10	5	5
Forest road construction, clearing, and excavation	29	8	11	27	36	9	18	9	0
Maintenance of all roads during or after the sale	29	11	14	14	29	14	36	7	0
Maintenance of active roads during sale activity	26	11	16	19	31	6	38	6	0
Maintenance of occasional use roads during sale activity	24	9	10	20	40	0	40	0	0
Maintenance of temporary roads during sale activity	20	9	10	10	40	0	50	0	0
Timber harvesting: General practices	27	9	11	27	36	0	18	9	9
Filter strips	23	7	7	43	14	0	14	0	29
Skid trails	24	9	10	50	20	0	20	10	0
Landings	27	11	12	42	25	0	25	8	0
AVERAGE FOR EACH COLUMN	26	9	11	22	32	9	25	8	4

[a] All respondents who identified an increase in benefits equal to or greater than one percent.

[b] Number of respondents who responded to this question.

[c] Respondents were permitted to cite more than one source of benefit per major BMP category.

The most frequently cited BMP category leading to increased benefits were activities involving forest road drainage that led to an increase in the number of operable timber harvesting days on-site (55 percent of responding timber harvesters). If only the BMP categories mentioned by 30 or more percent of the responding timber harvesters as leading to increased benefits are identified, the following is the result:

- *Increased productivity per day*: Caused by additional attention to skid trails (50 percent of respondents), filter strips (43 percent), landings (42 percent), and forest road alignment (31 percent).
- *Increased number of operable days on-site*: Caused by additional attention to forest road drainage (55 percent), winter roads or temporary crossings (50 percent), forest road water crossings (43 percent), maintenance of occasional use roads during sale activity (40 percent), maintenance of temporary roads during sale activity (40 percent), forest road construction, clearing and excavation (36 percent), and timber harvesting: general practices (36 percent).
- *Reduced cost of road, skid trail, and landing construction*: No BMP category was noted by 30 percent or more of the respondents.
- *Reduced cost of road, skid trail and landing maintenance*: Caused by additional attention to maintenance of temporary roads during sale activity (50 percent), maintenance of occasional use roads during sale activity (40 percent), maintenance of active roads during sale activity (38 percent), and maintenance of all roads during or after sale (36 percent).
- *Reduced cost of maintaining equipment*: Caused by management of fuel, lubricants and equipment (57 percent).

As with cost implications of water quality BMP application, responding timber harvesters presented written comments that provide additional insight to their perception of benefits received from applying water quality BMPs since 1990. Examples are:

"We're headed in the right direction if we can police ourselves and not become more regulatory."

"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 market place."

"It is good to improve logging practices for both loggers and the environment, but costs need to be met by forest agencies and companies."

"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."

"Some of the benefits are well and good for the environment. Some are Mickey Mouse and should be looked at."

In summary, when timber harvesters were given an opportunity to specify whether they were aware of any benefits (positive impacts on net revenues) from the application of water quality BMPs, whether or not any benefits had actually occurred, and, if so, the magnitude of these benefits, an average of 64 percent of the responding timber harvesters indicated there was no perceived change in benefits associated with applying one or more of 14 categories of BMPs since 1990. However, of those who did indicate an increase in benefits, the greatest benefit increases to their operations resulted in an "increase in the number of operable days on-site," and "reduced cost of road, skid trail, and landing maintenance." Over half the timber harvesters noted that an increase in the number of operable days on-site resulted from accelerated forest road drainage activities. Respondent comments seem to indicate that while some timber harvesters do feel that water quality BMPs are useful, they are also concerned about the additional costs that must be incurred to achieve such benefits. This would seem to imply that many respondents do not necessarily feel that the benefits offset the costs incurred by the implementation of BMPs.

NET FINANCIAL EFFECTS OF BMP APPLICATION

When asked to consider the net effect that implementing water quality BMPs had on the financial condition of their harvesting operations since 1990, only 8 percent of the responding timber harvesters indicated that benefits had exceeded costs (Table 11). Seven percent of the responding timber harvesters indicated that benefits and costs were equal, while the majority (85 percent) indicated that costs exceeded benefits. Of the latter, 21 percent reported that costs exceeded benefits by one to five percent, over half (51 percent) indicated that costs exceeded benefits by one to 10 percent, and 34 percent reported costs exceeding benefits by more than 11 percent.

Part-time and full-time operators apparently perceive the costs and benefits of BMP use differently. Part-time harvesters were on average slightly more positive about the benefits of BMP use than full-time operators (Table 11). For example, 8 percent of the part-time harvesters (Category A) felt that the benefits of water quality BMP use exceeded the costs by more than 11 percent. No full-time harvesters in Category B felt that benefits exceeded costs at any level. Six percent of all full-time harvesters Category C felt that benefits exceeded costs in any way. While 24 percent of the full-time respondents in Category B and 21 percent of all full-time respondents in Category C felt that costs exceeded benefits by more than 15 percent, only 7 percent of the part-time operators in Category A agreed with them.

TABLE 11. Net Financial Effects on Responding Timber Harvester Operations of Using Water Quality BMPs from 1990 through 1994.

Type of Effect	Type of Timber Harvesters (percent responding)			
	All Responding Timber Harvesters *(n=100)*	Part-Time Timber Harvesters: A *(n=27)*	Full-Time Timber Harvesters: B *(n=33)*	All Full-Time Timber Harvesters: C *(n=73)*
Returns exceed costs by:				
One to five percent	1	0	0	1
Six to 10 percent	3	0	0	4
11 to 15 percent	3	4	0	1
More than 15 percent	1	4	0	0
Returns equal costs	7	11	6	5
Costs exceed returns by:				
One to five percent	21	26	15	21
Six to 10 percent	30	33	36	29
11 to 15 percent	16	15	18	19
More than 15 percent	18	7	24	21

Note: *Category A: Part-Time Harvesters*: person that are annually involved in five or fewer sales, harvest less than 200 acres, harvest less than 5,000 cords, and purchase less than $50,000 in stumpage; *Category B: Full-Time Harvesters*: persons that are annually involved in more than five sales, harvest more than 200 acres, harvest more than 5,000 cords, and purchase more than $50,000 in stumpage; *Category C: All Full-Time Harvesters*: persons not exactly matching the above part-time criterion in Category A.

Further insight to the net financial effects on timber harvesting operations of using water quality BMPs since 1990 can also be gained from respondent written comments. Examples are:

> *"I would like to make the comment that BMPs are good for the forest and water quality, but they have been an extra cost because of longer skidding distance. They also require more extensive road systems and wider tires that use more fuel and cost more to operate. There have been no benefits to a logger with implementing BMPs, only extra costs. I thank you for asking the questions and showing concern."*

> *"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 BMP's..."*

> *"It is good to improve logging practices for both loggers and the environment, but costs need to be met by forest agencies and companies."*

"I personally feel the program is somewhat going in the right direction in protecting the environment, just so the regulations don't go overboard. The filter and buffer strips are sometimes unrealistic. The biggest factor is that once again, the whole burden is put on the loggers' shoulders. The state should help with these costs (also the county and federal) along with industry -- not just the loggers."

The application of water quality BMPs can affect the financial condition of the timber harvesting sector generally. The magnitude of these effects depends on the size and number of active timber businesses operating within the state. If 700 active timber harvesting business are annually averaging $400,000 to $800,000 in gross receipts, these 700 businesses (in total) are probably investing between $940,000 and $1.9 million annually in activities involving the application of water quality BMPs (Table 12). If 1,100 timber harvesting businesses are active in the state, they are probably investing in the range of $1.4 million to slightly over $2.9 million in the application of water quality BMPs.

In summary, the vast majority of responding timber harvesters are of the opinion that the costs of applying water quality BMPs exceed the financial benefits that they receive from their application. Over half of the respondents (64 percent) felt that costs exceeded benefits by more than 5 percent. Sector-wide, the cost to the timber harvesting industry of applying water quality BMPs is probably in the range of one to three million dollars annually.

Table 12. Estimated Change in Timber Harvesting Sector Net Cash Flow Due to the Application of Water Quality BMPs, by Number and Size of Businesses. 1994.

Change in Net Cash Flow Due to BMP Application (percent)	Timber Harvesters Experiencing Change (percent)	Active Timber Harvesting Businesses: 700		Active Timber Harvesting Businesses: 1,100	
		Sector-Wide Change in Net Cash Flow for $400,000 Businesses	Sector-Wide Change in Net Cash Flow for $800,000 Businesses	Sector-Wide Change in Net Cash Flow for $400,000 Businesses	Sector-Wide Change in Net Cash Flow for $800,000 Businesses
+ 2.5	1	$ 3,500	$ 7,000	$ 5,500	$ 11,000
+ 7.5	3	31,500	63,000	49,500	99,000
+ 12.5	3	52,500	105,000	82,500	165,000
+ 15.0 or more	1	21,000	42,000	33,000	66,000
Subtotal	8	$ +108,500	$ +217,000	$ +170,500	$ +341,000
- 2.5	21	$ 73,500	$ 147,000	$ 115,500	$ 231,000
- 7.5	30	315,000	630,000	495,000	990,000
- 12.5	16	280,000	560,000	440,000	880,000
- 15.0 or more	18	378,000	756,000	540,000	1,180,000
Subtotal	85	$ -1,046,500	$ -2,093,000	$ -1,644,500	$ -3,289,000
Net Sector-Wide Change	--	$ -938,000	$ -1,876,000	$ -1,474,000	$ -2,948,000

Note: Seven percent of timber harvesters experienced no change in net cash flow due to the application of water quality BMPs. Net financial returns (profit) to business operations is estimated to be 5 percent of gross cash flow (net cash flow of a business with a gross cash flow of $400,000 is $20,000). If the $20,000 net cash flow of a business is increased 2.5 percent when BPMs are applied (a $500 increase for the business) and such is realized by one percent of 700 timber harvesting businesses (namely seven businesses), the total increase in net cash flow for all seven timber harvesting businesses is $3,500.

SUMMARY AND OBSERVATIONS

The application of water quality best management practices during timber harvesting activities are designed to ensure the water quality of public and private forests. Doing so implies investments by persons engaged in timber harvesting and a concomitant production of certain benefits that contribute to this sustainability. The forestry literature demonstrates quite well that the application of best management practices includes a cost element that very often must be absorbed by owners of harvested timber or persons that are employed to harvest such timber. Less clear, however, are the nature of the financial and economic benefits that such investments produce. If those benefits occur, they can accrue to individual timber harvesters in the form of reductions in costs associated with a timber harvesting operation, or they may accrue to society in general in the form of maintained or improved water quality. The intent of this study was to gain greater insight to the benefit side of the equation, especially benefits that directly affect the financial condition of persons conducting timber harvesting operations.

The study focused on timber harvesters that are members of the MN Timber Producers Association and the MN Associated Contract Loggers. Since members of these organizations are in all likelihood more progressive timber harvesters (by whatever measure), the study results may not be reflective of broader populations of timber harvesters that operate in Minnesota. Furthermore, the study relies on the perceptions that timber harvesters have of costs incurred and benefits received as a result of water quality BMP application. For various reasons, these perceptions may represent inaccurate estimates of reality. Responding timber harvesters may well know the nature of the benefits and costs of BMP application, yet may choose to falsely report them; or timber harvesters may not know such information and proceed to make estimates that are inaccurate. Regardless, the information gathered by the study is a major step toward understanding both the benefits and costs to timber harvesters of applying water quality best management practices. Within this context, the study provides a number of useful insights, including:

- *Knowledge and Use of BMPs*. Timber harvesters are generally well-acquainted with water quality BMPs in Minnesota, although only a very modest portion of them refer to the Minnesota Water Quality BMP Guidebook. Timber harvesters appear willing to comply with recommended BMPs; consider such recommendations to be protective of the forest environment; and are only somewhat concerned about the alleged restrictive nature of water quality BMPs. However, most timber harvesters suggest that their use of BMPs has remained at levels occurring before the forestry Water Quality BMP program was initiated in 1990, with a modest increase in some instances. Timber harvesters attending BMP workshops tend to be more willing to apply water quality BMPs than those that have not attended a workshop.

- *Cost and Benefits of BMPs.* An important portion of timber harvesters (22 percent) are of the opinion that the application of water quality BMPs have not increased the cost of their operations. Furthermore, some timber harvesters (29 percent) suggest they are able to increase their productivity and reduce certain costs when applying BMPs. Timber harvesters that are engaged full-time in timber harvesting operations tend to perceive increased costs associated with the application of water quality BMPs more frequently than do part-time timber harvesters. This may reflect a greater sensitivity to and interest in BMP application by persons engaged full-time in timber harvesting.

- *Net Financial Effects.* When the net benefit of BMP applications are considered, most timber harvesters are of the opinion (85 percent) that the cost of applying BMPs exceeds the benefits they realize by a substantial margin. Noteworthy, however, is the fact that so many timber harvesters suggest that they are applying BMPs today at rates the same as occurred prior to 1990 (when BMPs were not in place). Such suggests that any changes in the net financial situation of timber harvesters may not be attributable to the application of water quality BMPs.

- *Sector-Wide Economic Effects.* Suggested is that the financial condition of the timber harvesting sector generally is affected by the application of water quality BMPs. Depending on the number and size of the state's timber harvesting businesses, the cost to the timber harvesting industry of applying water quality BMPs is probably in the range of one to three million dollars annually. Such can be viewed as the minimum value of the quality water that results from the application of water quality BMPs.

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APPENDIX A: QUESTIONNAIRE

BACKGROUND

1. Which category best describes you?

   a. Logger: crew member
   b. Logger: crew supervisor
   c. Logger: owner/operator
   d. Other _____

2. In which part of the state do you operate?

   a. North of the Twin Cities
   b. South of the Twin Cities

3. How many employees are in your operation? _____

4. How many months per year are you employed logging? _____

5. On average, how many timber sales does your operation harvest per year? _____

6. On average how many acres does your operation harvest per year? _____acres

7. On average, how much wood is harvested by your operation per year?

   _____ cords _____ MBF

8. On average, what is the total stumpage value your operation harvests per year? $_____

9. Considering all the timber sales purchased, please indicate the percentages of stumpage your operation purchased from the following owners **before 1990** (must total 100 percent).

   ____ Private, non-industrial
   ____ Forest Industry
   ____ County
   ____ State
   ____ Federal
   = 100%

10. Considering all the timber sales purchased, please indicate the percentages of stumpage your operation purchased from the following owners **after 1990** (must total 100 percent).

    ____ Private, non-industrial
    ____ Forest Industry
    ____ County
    ____ State
    ____ Federal
    = 100%

11. Do you have a copy of the Minnesota Department of Natural Resources publication entitled Water Quality in Forest Management: Best Management Practices in Minnesota?

    Yes No

12. If you have a copy of Water Quality in Forest Management: Best Management Practices in Minnesota, how often do you refer to it?

    a. Very often
    b. Quite often
    c. Not very often
    d. Almost never
    e. Never

13. Have you ever attended a logger informational workshop in which the state Water Quality BMP volunteer program was the primary focus of the workshop?

    Yes No

14. How would you describe your understanding of the volunteer program and the Water Quality BMPs?

    a. Very knowledgeable (understand program and all practices)
    b. Fairly knowledgeable (understand program and some practices)
    c. Somewhat knowledgeable (know only the goals of program)
    d. Not very knowledgeable (name recognition only)
    e. Not at all (never heard of the program)

15. How would you describe your willingness to comply with Water Quality BMP requirements?

    a. Very willing
    b. Fairly willing
    c. Somewhat willing
    d. Not very willing
    e. Not at all willing

16. In your estimation, how restrictive are the current Water Quality BMPs in terms of hindering your logging activity.

    a. Very restrictive
    b. Fairly restrictive
    c. Somewhat restrictive
    d. Not very restrictive
    e. Not at all restrictive

17. In your opinion, how effective are the current water quality BMPs in terms of resource protection?

    a. Very effective
    b. Fairly effective
    c. Somewhat effective
    d. Not very effective
    e. Not at all effective

FOREST PRACTICE USE

18. For each practice in the following 14 Water Quality BMP categories please indicate with a check (✓) whether your operation never applies the practice; uses the practice less today than it did before 1990; hasn't changed its use of the practice since before 1990; or uses the practice more today than it did before 1990.

BEST MANAGEMENT PRACTICES	Never Apply	Use Less	No Change	Use More
1. FUEL, LUBRICANT, AND EQUIPMENT MANAGEMENT				
Adequate storage and disposal for fuel, debris, lubricants, fluids and rinsate from equipment cleanup				
2. FOREST ROAD ALIGNMENT				
Minimize the total road mileage required to meet the landowner's objectives				
Avoid activity below the ordinary high water mark				
Provide filter strips between roads and lakes, streams, and intermittent waterways				
3. FOREST ROAD WATER CROSSINGS				
Cross streams at right angles				
Minimize amount of natural stream channel disturbance				
Design crossings to avoid obstruction of fish migrations				
4. WINTER ROADS OR TEMPORARY CROSSINGS				
Avoid use of mineral soil as fill on winter crossings				
Remove temporary/winter crossings prior to breakup				
5. FOREST ROAD DRAINAGE				
Install water diversion devises on road surfaces using broad based dips/grade rolls, open culverts, water bars, or outsloping				
Drain surface water into filter strip or vegetative draw				
Remove all berms				

BEST MANAGEMENT PRACTICES	Never Apply	Use Less	No Change	Use More
6. FOREST ROAD CONSTRUCTION, CLEARING & EXCAVATION				
Shape inslopes and backslopes to 1½:1 or flatter to stabilize soils				
Stabilize erodible soils by seeding				
Surface road to minimize water quality impacts				
7. MAINTENANCE OF ALL ROADS DURING OR AFTER THE SALE				
Maintain erosion control features in working order				
Stabilize erodible soils by seeding				
Restrict use of roads during wet periods and spring breakup if use could impact water quality				
8. MAINTENANCE OF ACTIVE ROADS DURING SALE ACTIVITY				
Maintain proper surface to maintain drainage and prevent erosion				
9. MAINTENANCE OF OCCASIONAL USE ROADS DURING SALE ACTIVITY				
Properly close when not in use				
Maintain water diversion devices in working order				
10. MAINTENANCE OF TEMPORARY ROADS DURING SALE ACTIVITY				
Properly close roads when use is complete				
Stabilize road surface				
11. TIMBER HARVESTING: GENERAL PRACTICES				
Time harvest compatible with soil and topography				
Minimize mineral soil exposure in filter strip to less than 5%				
Keep streams, lakes, wetlands free of logging debris				
Avoid felling timber into nonforested wetlands				
12. FILTER STRIPS				
Maintain vegetation adjacent to designated trout streams or lakes				

BEST MANAGEMENT PRACTICES	Never Apply	Use Less	No Change	Use More
13. SKID TRAILS				
Minimize the total main skid trail mileage required to meet the landowners objectives				
Locate skid trails outside of filter strips				
Design main skid trails to avoid concentrating runoff				
Install water diversion devices on main skid trails using broad based dips/grade rolls, open culverts, water bars, or outsloping				
Drain surface water into filter strip or vegetative draw				
Minimize amount of natural stream channel disturbance				
Rehabilitate skid trails when needed				
14. LANDINGS				
Locate landings outside of filter strips				
Provide for maximum cross-drainage and minimum down slope flow				
Drain surface water into filter strip or vegetative draw				
Stabilize erodible soils by seeding				
Rehabilitate landings when needed				

19. Consider the following list of potential **costs** associated with the implementation of Water Quality BMPs:

Increase in days needed to complete harvest
Increase in capital cost (e.g. culverts, seed)
Increased cost of road, skid trail, or landing *construction*
Increased cost of road, skid trail, or landing *maintenance*
Increased cost of maintaining equipment

Now, for each of the following 14 Water Quality BMP categories please indicate with a check (✓) how implementing Water Quality BMPs have increased your costs within the category (refer to the table in question 18 to note which BMPs are within a particular category). **Consider only the additional costs associated with those BMPs you have been implementing in order to comply with the state's voluntary Water Quality BMP program which began in 1990.** If the increase in costs is greater than 15%, please specify the amount of increase in the "Up >15%" column.

BMP Category	Change in Costs					
	No Change	Up 1% to 5%	Up 6% to 10%	Up 11% to 15%	Up >15%	Don't Know
Fuel, Lubricant, and Equipment Management						
Forest Road Alignment						
Forest Road Water Crossings						
Winter Roads or Temporary Crossings						
Forest Road Drainage						
Forest Road Construction, Clearing, and Excavation						
Maintenance of All Roads During or After the Sale						
Maintenance of Active Roads During Sale Activity						
Maintenance of Occasional Use Roads During Sale Activity						
Maintenance of Temporary Roads During Sale Activity						
Timber Harvesting: General Practices						
Filter Strips						
Skid Trails						
Landings						

20. For each of the following 14 Water Quality BMP categories please indicate with a check (✓) the primary source of any **costs** identified in the previous table. **Again, consider only the additional costs associated with those BMPs you have been implementing in order to comply with the state's voluntary Water Quality BMP program which began in 1990.** If the source of the cost is not listed, please indicate that in the "Other" column with a short description.

BMP Category	Source of Costs						
	No additional costs	Increase in days needed to complete harvest	Increase in capital costs (e.g. culverts, seed)	Increased cost of road, skid trail, and landing construction	Increased cost of road, skid trial, and landing maintenance	Increased cost of maintaining equipment	Other (specify)
Fuel, Lubricant, and Equipment Management							
Forest Road Alignment							
Forest Road Water Crossings							
Winter Roads or Temporary Crossings							
Forest Road Drainage							
Forest Road Construction, Clearing, and Excavation							
Maintenance of All Roads During or After the Sale							
Maintenance of Active Roads During Sale Activity							
Maintenance of Occasional Use Roads During Sale Activity							
Maintenance of Temporary Roads During Sale Activity							
Timber Harvesting: General Practices							
Filter Strips							
Skid Trails							
Landings							

21. Consider the following list of potential **benefits** associated with the implementation of Water Quality BMPs:

Increased productivity per day
Increased number of operable days on-site
Reduced cost of road, skid trail, or landing *construction*
Reduced costs of road, skid trail, or landing *maintenance*
Reduced cost of maintaining equipment

Now, for each of the following 14 Water Quality BMP categories please indicate with a check (✓) how implementing Water Quality BMPs have increased your derived benefits within the category (refer to the table in question 18 to note which BMPs are within a particular category). **Consider only the additional benefits associated with those BMPs you have been implementing in order to comply with the state's voluntary Water Quality BMP program which began in 1990.** If the increase in costs is greater than 15%, please specify the amount of increase in the "Up >15%" column.

BMP Category	Change in Benefits					
	No Change	Up 1% to 5%	Up 6% to 10%	Up 11% to 15%	Up >15%	Don't Know
Fuel, Lubricant, and Equipment Management						
Forest Road Alignment						
Forest Road Water Crossings						
Winter Roads or Temporary Crossings						
Forest Road Drainage						
Forest Road Construction, Clearing, and Excavation						
Maintenance of All Roads During or After the Sale						
Maintenance of Active Roads During Sale Activity						
Maintenance of Occasional Use Roads During Sale Activity						
Maintenance of Temporary Roads During Sale Activity						
Timber Harvesting: General Practices						
Filter Strips						
Skid Trails						
Landings						

22. For each of the following 14 Water Quality BMP categories please indicate with a check (✓) the primary source of any **benefits** identified in the previous table. **Again, consider only the additional benefits associated with those BMPs you have been implementing in order to comply with the state's voluntary Water Quality BMP program which began in 1990.** If the source of the benefit is not listed, please indicate that in the "Other" column with a short description.

BMP Category	Source of Benefits						
	No additional benefits	Increased productivity per day	Increased number of operable days on-site	Reduced cost of road, skid trail, and landing construction	Reduced cost of road, skid trail, and landing maintenance	Reduced cost of maintaining equipment	Other (specify)
Fuel, Lubricant, and Equipment Management							
Forest Road Alignment							
Forest Road Water Crossings							
Winter Roads or Temporary Crossings							
Forest Road Drainage							
Forest Road Construction, Clearing, and Excavation							
Maintenance of All Roads During or After the Sale							
Maintenance of Active Roads During Sale Activity							
Maintenance of Occasional Use Roads During Sale Activity							
Maintenance of Temporary Roads During Sale Activity							
Timber Harvesting: General Practices							
Filter Strips							
Skid Trails							
Landings							

23. Considering all of the costs and benefits associated with those BMPs you have been implementing in order to comply with the state's Water Quality BMP program, please indicate the *net effect* implementing these BMPs has had on your operation since 1990 (the difference between the benefit of implementing BMPs and the cost of implementing BMPs is the net effect).

    a. benefits exceed costs by more than 15%
    b. benefits exceed costs by 11% to 15%
    c. benefits exceed costs by 6% to 10%
    d. benefits exceed costs by 1% to 5%
    e. benefits and costs are equal
    f. costs exceed benefits by 1% to 5%
    g. costs exceed benefits by 6% to 10%
    h. costs exceed benefits by 11% to 15%
    i. costs exceed benefits by more than 15%

24. Are there any additional comments you would like to make regarding your implementation of Water Quality BMPs or the costs and benefits associated with their implementation?

Thank you for your cooperation. Please return the completed survey by November 18, 1994.

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APPENDIX B: RESPONDENT COMMENTS

"WE HAVE ALWAYS DONE THIS"

- "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."

- "I would like to say, we have practiced BMPs for years."

- "When we log we try to do as the landowner wants the job done -- as neat and clean and effective as possible. At the same time we want the land and water and air protected as much as possible. Without land protection there wouldn't be any more trees to cut in the future. We have always done this even before the new laws. Therefore I don't have any estimation as to additional costs."

- "Common sense equals most BMP practices. Therefore, we haven't done anything different since 1990."

- "We log mostly on private lands, and have not experienced any additional costs for BMPs. We have always practiced good logging operations."

- "For road construction and maintenance I have changed little. I've always strived for a good road. You don't get a good road without proper drainage alignment."

- "We have always done most of this -- before BMPs were ever around."

- "A lot of the practices were in place in our operation before BMPs, because they were good practices anyway, so we remain unchanged on these."

- "I really don't notice any benefits from it [BMP implementation]. I feel I have always complied with BMPs for the sake of just doing it right, and to satisfy the landowner in any way. I am willing to be informed even more."

- "I always cleaned my permits of garbage (filters, debris, etc.) I have done some other practices before they were mandated also! I cannot understand why the foresters get so upset about the skidder tracks in the mud on skid trails. When they plant trees, they plow the furrows to plant trees in!"

- "It's hard to know because we have always tried to use culverts or bridges on streams. We have always left buffer zones for filter and sometimes we have to build longer roads to avoid sensitive areas. Therefore, our roads are not necessarily shorter. We have done these things since the 1960's so its hard to tell the difference in cost."

- "I have always tried very hard to protect the land and water we all need and share, while others I know over the years have exploited it. I believe the cost of implementation will always be taken out of the logger's pocket. Every time industry increases the price of logs or pulp, stumpage prices and trucking consume any profit from any price increase. It has always been this way. I make the same money today on my products (net), as I did 10 years ago. If the Department of Natural Resources thinks they will be able to compensate loggers for BMP implementation through industry taxes or whatever other ideas they may come up with, the logger will never see just compensation. The ideas may look good on paper, but the timber producers gross and net revenues will always continue to distance themselves from each other. That's the way it's always been and always will be."

- "I have been practicing most of these since 1966."

- "To sum it up, we have been practicing water quality BMPs for many years. Good stewardship would be all that is needed for BMPs. BMPs have to be enforced on some sales and for some loggers. Some loggers try to get away with things based on who they know and where they are and who they are. I wouldn't even try it -- it just isn't right! Good loggers do it right, they think about the future!"

"IT'S MORE EXPENSIVE"

- " ...The price of timber is going up, yet we see hardly any increase in logs or pulpwood. Especially in our only market in Cook County."

- "The cost of implementing water quality BMPs is totally absorbed by the logger. There has been no increase in mill prices."

- "Costs should be passed on to the consumer."

- "There is cost involved, but we have nothing to gauge the cost against."

- "Implementation of water quality BMPs is a cost factor. I think the cost factor is higher than I put down but I really don't know exactly."

- "To comply costs many dollars that we're not getting back from the mills. If Wise Mills keep backing their producers and stumpage prices continue to rise, we will quit. All producers must be made to comply with work comp and meet all BMP laws or we can't compete with the cost of our competitors."

- "Some costs should be put on all who benefit from these practices."

- "We log mostly on Federal lands. We comply to their specs which increases our cost some. Maybe not more than 5% to 10%."

- "Pay us to implement BMPs."

- "1)If water quality is maintained, it is a benefit to all of us. 2)A well drained landing may increase your days of productivity. 3) The costs of implementation are (in my opinion) far greater than any realized financial benefit. I have no accurate way of answering questions 19-22 at this time."

- "I would like to make the comment that the BMPs are good for the forest and water quality, but they have been an extra cost because of longer skidding distance. They also require more extensive road systems and wider tires that use more fuel and cost more to operate. There have been no benefits to a logger with implementing BMPs, only extra costs. I thank you for asking the questions and showing concern."

- "1) Lost time and wages paid out for workshops for BMP training with loss of production. 2) Lost production for implementing BMPs. 3) Lost production during wet periods."

- " 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 of upland sites rather than swampy areas during winter months."

- "It would be nice to get paid for doing this."

- "It just takes longer and cost more."

- "The cost is greater."

- "Loggers should be compensated for the additional work and cost involved in implementing BMPs."

- "It costs more to meet the BMP standards as they are laid out in the handbook."

- "We have no problem implementing BMPs. They are however, going to increase the cost of operating timber sales by 25%. Several of the BMPs have been in practice for years. Timber sale administration are in many cases however, over reacting to legislative intent. I was involved in the wetlands legislation and on the rules on it. If common sense prevails, it will work out over time."

" I LIKE 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 market place."

- "We're headed in the right direction if we can police ourselves and not become more regulatory."

- " I personally feel the program is somewhat going in the right direction in protecting the environment, just so the regulations don't go overboard. The filter and buffer strips are sometimes unrealistic. The biggest factor is that once again, the whole burden is put on the loggers' shoulders. The state should help with these costs (also county and federal) along with the industry -- not just the loggers!"

- "It is good to improve logging practices for both loggers and the environment, but costs need to be met by forest agencies and companies."

- "Though the benefits exceed the costs of BMPs, I really don't feel there have been that significant costs to me in my small operation. I truly believe my fellow loggers are extremely interested in the protection of the environment and true implementation of BMPs. I also feel that the foresters and "Joe public" have to be sensitive to the logger ....is truly telling them about a substantial cost of a certain implementation. I feel the land agencies must have funds available to offset some of these more expensive and necessary implementations. Let's all remember that we are all part of the environment and not be so industry driven or emotionally driven."

"I DISLIKE BMPS"

- "We as loggers in the state of Minnesota are good people. We have not committed a crime or destroyed a single forest. We have always operated with the idea that we would be back to the same place to harvest again. There is an obvious overkill in the BMP implementation and everyone knows it -- it was planned that way. It's only for show. We were already taking care of our plants, soils, and waters. No book or policy would change that. Yet we quietly consume all the extra costs involved because we know we must, because we are expected to."

- "The different government agencies don't agree or apply BMPs the same way. The US Forest Service is more difficult than the others to apply procedures. Some loggers are treated differently – get away with more damage to the environment than others. The different government agencies do more damage than loggers or industry in many areas."

- "I am not pleased with some of the BMPs but will comply with them nevertheless, as this is needed to comply with the terms of agreements signed by State and County officials."

- "Logging has not done the damage to wetlands that some people think -- BMPs did an overkill on the rules."

- "I think that the rules and regulations are too particular."

- "I have been logging for 21 years. I don't think somebody in some office can tell me how to do it better."

- "This is a whole lot of environmental fanaticism where big government rules change our lives. The changeover in the congress should change some of this kooky thinking. Listen to Rush Limbaugh or Gordon Liddy to get the facts!"

"THIS SURVEY IS TOO COMPLICATED"

- "This survey is too time consuming to complete."

- "I would be surprised if many loggers answer this type of confusing questionnaire."

- I would just like to say, this survey is repeating itself too much. I don't think anyone can keep this close of a record on his logging job. A lot of this is multiple guess."

- "The benefits are to the harvest sites, not the logger. This was too time consuming and should be broken down next time."

MISCELLANEOUS COMMENTS

- "Program is fine but part of it wouldn't be needed if the beavers were controlled. They dam up water in fine aspens and when aspen is cut they eat the regeneration and the land is dead -- of no value for timber, wildlife or birds. Part of the increase in stumpage the state gets should be used for beaver control. The future aspen will depend on beaver control."

- "Our operation works almost exclusively in jack pine stands on flat sandy soil conditions, thus we do not have many of the problems that occur on many operations."

- "The cost 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."

- "1) I am a forester. 2) I am primarily a stumping vendor. 3) I invited the inspection team to analyze my sales a couple of years ago. 4) It has been a learning experience with some categories logical to me but depending on the terrain and circumstances on a given site, some are not logical. 5) It depends on one's background and training but BMPs make us aware of potential degradation of our ecosystems."

- "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 have found that each forester has their own view of how the BMPs should be implemented. We can't read the book and do exactly what it says, we have to log according to how each individual forester reads the book. We have no major problems with the BMPs, but we log a little different on each forester's sale."

- "More informational meetings are needed so we all know what's required before the job starts, so us loggers can more accurately determine costs necessary to comply on each job."

- "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. 'Education tried to create [people] who will 'autonomously' serve collective interests, that is, who will do on their own initiative what in other societies they must be commanded or induced to do. It must also create [people] who will voluntarily respond to state and party when either asks for specific performance.' *Charles Lindblom, Politics and Markets*"

- "On State and County timber sales the cost of implementing BMPs varies greatly from forester to forester or supervisor to supervisor."

- "The cost of BMPs changes from sale to sale. This summer we worked on relatively flat land, and had little or no BMP work, except to stay out of wetlands. Since we bought an old grader road maintenance comes easier and increases the number of truck hauling days. The biggest cost is when you have to move back in after the trucks are done hauling. Although it could cost extremely more if the crackpots take over and worry about every handful of dirt moving a few feet and treat mother nature as an invalid."

- "Additional BMPs will not help water quality, they will only hinder timber harvesting. I feel that some general BMPs are necessary but let's not go overboard."

- "Some of the benefits are well and good for the environment. Some are Mickey Mouse and should be looked at."

- "Give me and my son time in the processing/forwarding end of logging, and then I will have better answers. I am willing to comply as long as I don't loose money.

- " I never gave it much thought, but I log mostly hardwoods, which is 10%-20% usually of the wood -- so hopefully plan to return years later to reharvest. Plan to and .... BMP implementation it only makes good public relations to do a good job. I believe most loggers do the best they can."

- "Most of this does not pertain to my logging operation."

- "We have had two BMPs; one on private land and on county land; we did not get any letters on either sale telling us how we did and what grade we got. The logger is the one that cuts the wood; so he should be one of the ones to get a grade, then he'll know if he has to make any changes for BMPs."

- " I think there should be more enforcement of hydraulic oils and motor oils being drained into containers and recycled rather than being drained on the ground and covered up."

APPENDIX C: BMP RESPONSE TO WORKSHOPS

Changes in Timber Harvester Use of Specific Best Management Practices in Response to Participation in Water Quality BMP Workshops

Changes in Timber Harvester Use of Specific Best Management Practices in Response to Participation in Water Quality BMP Workshops

BEST MANAGEMENT PRACTICES	Change in Use Since 1990 (Percent)			
	Never Apply	Use Less	No Change	Use More
1. FUEL, LUBRICANT, AND EQUIPMENT MANAGEMENT				
Adequate storage and disposal for fuel, debris, lubricants, fluids and rinsate from equipment cleanup				
Have attended a BMP informational workshop (*n=84*)	0	0	15	85
Have not attended a BMP informational workshop (*n=39*)	3	0	31	66
2. FOREST ROAD ALIGNMENT				
Minimize the total road mileage required to meet the landowner's objectives				
Have attended a BMP informational workshop (*n=82*)	4	0	56	40
Have not attended a BMP informational workshop (*n=39*)	5	3	64	28
Avoid activity below the ordinary high water mark				
Have attended a BMP informational workshop (*n=83*)	7	0	40	53
Have not attended a BMP informational workshop (*n=38*)	8	5	47	40
Provide filter strips between roads and lakes, streams, and intermittent waterways				
Have attended a BMP informational workshop (*n=84*)	4	0	32	64
Have not attended a BMP informational workshop (*n=39*)	5	3	51	41
3. FOREST ROAD WATER CROSSINGS				
Cross streams at right angles				
Have attended a BMP informational workshop (*n=81*)	7	3	52	38
Have not attended a BMP informational workshop (*n=36*)	14	8	70	8
Minimize amount of natural stream channel disturbance				
Have attended a BMP informational workshop (*n=81*)	5	1	27	67
Have not attended a BMP informational workshop (*n=37*)	11	5	43	41
Design crossings to avoid obstruction of fish migrations				
Have attended a BMP informational workshop (*n=78*)	17	1	38	44
Have not attended a BMP informational workshop (*n=36*)	28	0	55	17

BEST MANAGEMENT PRACTICES	Never Apply	Use Less	No Change	Use More
4. WINTER ROADS OR TEMPORARY CROSSINGS				
Avoid use of mineral soil as fill on winter crossings				
Have attended a BMP informational workshop *(n=83)*	2	0	36	62
Have not attended a BMP informational workshop *(n=37)*	3	3	54	40
Remove temporary/winter crossings prior to breakup				
Have attended a BMP informational workshop *(n=83)*	4	0	37	59
Have not attended a BMP informational workshop *(n=37)*	3	0	54	43
5. FOREST ROAD DRAINAGE				
Install water diversion devises on road surfaces using broad based dips/grade rolls, open culverts, water bars, or outsloping				
Have attended a BMP informational workshop *(n=83)*	7	0	25	68
Have not attended a BMP informational workshop *(n=36)*	3	3	44	50
Drain surface water into filter strip or vegetative draw				
Have attended a BMP informational workshop *(n=83)*	6	1	42	51
Have not attended a BMP informational workshop *(n=37)*	3	3	62	32
Remove all berms				
Have attended a BMP informational workshop *(n=81)*	12	0	53	35
Have not attended a BMP informational workshop *(n=36)*	8	5	56	31
6. FOREST ROAD CONSTRUCTION, CLEARING & EXCAVATION				
Shape inslopes and backslopes to 1½:1 or flatter to stabilize soils				
Have attended a BMP informational workshop *(n=82)*	7	1	36	56
Have not attended a BMP informational workshop *(n=38)*	13	0	50	37
Stabilize erodible soils by seeding				
Have attended a BMP informational (*n=81)*	16	0	33	51
Have not attended a BMP informational workshop *(n=38)*	21	5	48	26
Surface road to minimize water quality impacts				
Have attended a BMP informational workshop *(n=81)*	11	0	56	33
Have not attended a BMP informational workshop	16	0	55	29

BEST MANAGEMENT PRACTICES	Never Apply	Use Less Use Less	No Change No Change	Use More Use More
7. MAINTENANCE OF ALL ROADS DURING OR AFTER THE SALE				
Maintain erosion control features in working order				
Have attended a BMP informational workshop (*n=84)*	2	0	43	55
Have not attended a BMP informational workshop (*n=38)*	5	3	58	34
Stabilize erodible soils by seeding				
Have attended a BMP informational workshop (*n=82)*	15	0	35	50
Have not attended a BMP informational workshop (*n=38)*	32	0	47	21
Restrict use of roads during wet periods and spring breakup if use could impact water quality				
Have attended a BMP informational workshop (*n=84)*	2	1	37	60
Have not attended a BMP informational workshop (*n=38)*	0	3	45	52
8. MAINTENANCE OF ACTIVE ROADS DURING SALE ACTIVITY				
Maintain proper surface to maintain drainage and prevent erosion				
Have attended a BMP informational workshop (*n=84)*	0	0	44	56
Have not attended a BMP informational workshop (*n=38)*	0	3	52	45
9. MAINTENANCE OF OCCASIONAL USE ROADS DURING SALE ACTIVITY				
Properly close when not in use				
Have attended a BMP informational workshop (*n=82)*	10	0	44	46
Have not attended a BMP informational workshop (*n=38)*	3	3	58	36
Maintain water diversion devices in working order				
Have attended a BMP informational workshop (*n=82)*	7	0	42	51
Have not attended a BMP informational workshop (*n=38)*	8	3	60	29
10. MAINTENANCE OF TEMPORARY ROADS DURING SALE ACTIVITY				
Properly close roads when use is complete				
Have attended a BMP informational workshop (*n=83)*	7	1	45	47
Have not attended a BMP informational workshop	5	0	53	42

BEST MANAGEMENT PRACTICES	Never Apply Never Apply	Use Less Use Less	No Change No Change	Use More
Stabilize road surface				
Have attended a BMP informational workshop (*n=84*)	8	0	48	44
Have not attended a BMP informational workshop (*n=38*)	3	0	74	23
11. TIMBER HARVESTING: GENERAL PRACTICES				
Time harvest compatible with soil and topography				
Have attended a BMP informational workshop (*n=84*)	0	0	21	79
Have not attended a BMP informational workshop (*n=38*)	0	3	47	50
Minimize mineral soil exposure in filter strip to less than 5%				
Have attended a BMP informational workshop (*n=83*)	5	0	38	57
Have not attended a BMP informational workshop (*n=36*)	8	0	67	25
Keep streams, lakes, wetlands free of logging debris				
Have attended a BMP informational workshop (*n=84*)	1	0	20	79
Have not attended a BMP informational workshop (*n=37*)	3	3	35	59
Avoid felling timber into nonforested wetlands				
Have attended a BMP informational workshop (*n=83*)	1	0	23	76
Have not attended a BMP informational workshop (*n=38*)	0	3	37	60
12. FILTER STRIPS				
Maintain vegetation adjacent to designated trout streams or lakes				
Have attended a BMP informational workshop (*n=83*)	11	0	23	66
Have not attended a BMP informational workshop (*n=37*)	8	3	40	49
13. SKID TRAILS				
Minimize the total main skid trail mileage required to meet the landowners objectives				
Have attended a BMP informational workshop (*n=84*)	0	1	50	49
Have not attended a BMP informational workshop (*n=40*)	8	2	60	30
Locate skid trails outside of filter strips				
Have attended a BMP informational workshop (*n=84*)	2	0	29	69
Have not attended a BMP informational workshop	8	0	52	40

BEST MANAGEMENT PRACTICES	Never Apply	Use Less	No Change	Use More
Design main skid trails to avoid concentrating runoff				
Have attended a BMP informational workshop (*n=82)*	0	0	37	63
Have not attended a BMP informational workshop (*n=39)*	0	0	38	62
Install water diversion devices on main skid trails using broad based dips/grade rolls, open culverts, water bars, or outsloping				
Have attended a BMP informational workshop (*n=83)*	5	1	39	55
Have not attended a BMP informational workshop (*n=40)*	15	0	45	40
Drain surface water into filter strip or vegetative draw				
Have attended a BMP informational workshop (*n=82)*	4	1	41	54
Have not attended a BMP informational workshop (*n=40)*	13	0	60	27
Minimize amount of natural stream channel disturbance				
Have attended a BMP informational workshop (*n=83)*	7	0	25	68
Have not attended a BMP informational workshop (*n=39)*	5	0	46	49
Rehabilitate skid trails when needed				
Have attended a BMP informational workshop (*n=82)*	5	0	28	67
Have not attended a BMP informational workshop (*n=40)*	5	2	48	45
14. LANDINGS				
Locate landings outside of filter strips				
Have attended a BMP informational workshop (*n=84)*	1	0	35	64
Have not attended a BMP informational workshop (*n=40)*	8	0	45	47
Provide for maximum cross-drainage and minimum down slope flow				
Have attended a BMP informational workshop (*n=84)*	2	0	43	55
Have not attended a BMP informational workshop (*n=40)*	8	2	55	35
Drain surface water into filter strip or vegetative draw				
Have attended a BMP informational workshop (*n=83)*	2	0	47	51
Have not attended a BMP informational workshop	5	2	50	43

BEST MANAGEMENT PRACTICES	Never Apply	Use Less	No Change	Use More
Stabilize erodible soils by seeding				
Have attended a BMP informational workshop (*n=84)*	8	0	44	48
Have not attended a BMP informational workshop (*n=40)*	32	0	43	25
Rehabilitate landings when needed				
Have attended a BMP informational workshop (*n=84)*	5	0	38	57
Have not attended a BMP informational workshop (*n=40)*	12	0	40	48

Note: Number of respondents (*n*) is noted for each category. Rows may not sum to 100 percent due to rounding errors.