Maine Forestry Best Management Practices Use and Effectiveness 2008

Department of Conservation
Maine Forest Service
22 State House Station
Augusta, Maine 04333

Forest Policy and Management Division

August 2009

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Printed under Appropriation 010 04A 5440 512

Executive Summary

The 2008 Maine Forest Service (MFS) report on the use and effectiveness of forestry Best Management Practices (BMPs) presents the fourth year of data collection and analysis utilizing “Best Management Practices Implementation Monitoring Protocol,” an original project of the Northeastern Area Association of State Foresters’ (NAASF) Water Resources Committee. This protocol assesses the overall effectiveness of the suite of BMPs used rather than monitoring the simple installation of prescribed, individual practices, which do not necessarily guarantee success in protecting water quality.[1]

The findings present an analysis of data collected between May and December 2008. The objective of this ongoing effort is to assess the use and effectiveness of BMPs in Maine. MFS uses BMP monitoring to focus educational outreach efforts to loggers, foresters, and landowners and identify trends for targeting technical assistance. As BMPs are voluntary measures to protect water quality, MFS does not use BMP monitoring to assess compliance with nor enforce laws and rules. When monitoring staff observe concerns or minor issues during BMP monitoring, MFS works closely with the landowner in a non-regulatory manner to seek corrective measures. Education and intervention usually result in quick corrective action, thereby avoiding lengthy regulatory processes that may prolong erosion problems and result in greater negative environmental impacts. Dealing with minor issues in this manner also increases landowner willingness to cooperate with the BMP monitoring process, resulting in a more comprehensive picture of BMP use.

Assessing the overall effectiveness of the suite of BMPs used rather than monitoring the installation of prescribed individual practices supports MFS’s desire to pursue outcome-based forest policy, a science-based voluntary process that achieves mutually beneficial economic, environmental, and social outcomes in the state's forests. Outcome-based policies are an alternative to prescriptive regulation. They demonstrate measurable progress towards achieving statewide sustainability goals and allow landowners to use creativity and flexibility to achieve objectives, while providing for the conservation of public trust resources and the public values of forests.

MFS has conducted random, statewide monitoring of BMPs on timber harvesting operations since March 2000. MFS continues this monitoring effort as a part of regular field activities and expects to generate subsequent reports.

BMPs were used appropriately at 41% of the monitored harvests in 2000. In 2008, BMPs prevented measurable sediment from reaching the waterbody at 72% of stream crossings and 92% of approaches to the crossings.

[1] Welsch D., R. Ryder, T. Post. 2007. Best Management Practice (BMP) Manual –Field Guide: Monitoring, Implementation, And Effectiveness for Protection of Water Resources: U.S. Department of Agriculture, Forest Service, NA-FR-02-06, 129 pp.

For this reporting period, key findings regarding the use and effectiveness of BMPs are:

- **Of the 615 opportunities to observe soil conditions, 87% showed no sediment reached the waterbody, the same level as 2006-2007 and a 4% improvement from the 2005 reporting period.[2]**
- **BMPs were not applied on 4% of crossings, the same level as 2006-2007. BMPs were not applied at 2% of approaches, also the same as 2006-2007.**
- **Sedimentation events were most often related to the inadequate application of BMPs rather than a lack of BMP application.**
- **Forty-four percent of the sample units did not have water crossings. This may be due to no water present in the sample unit or a stream crossing purposely avoided through pre-harvest planning. Pre-harvest planning and harvest layout can help identify and protect sensitive areas, reduce skid trails, and avoid unnecessary stream crossings.**
- **11% more structures spanned the bankfull channel width in 2008 than 2006-2007. Stream channel bankfull width is measured from the average high water mark that is expected to occur two out of every three years. Crossings that span the bankfull width are less likely to impede the movement of aquatic organisms and are at lower risk of catastrophic failure due to high flow events.**

The monitoring identified two areas that need improvement:

1 - Sedimentation associated with crossing structures. Sedimentation associated with crossing structures has shown up as a consistent issue in BMP monitoring over the past 4 years. The 2008 data continue to show that crossing structures are the most common source of sedimentation. It can be extremely difficult to keep all soil from reaching a waterbody, but siltation and sedimentation can be minimized to the point that they do not affect the biological activity of the associated waterbody. To improve understanding of the potential impacts of crossing structure sedimentation, 2009 monitoring will collect data on sediment volumes entering waterbodies.

In most cases either inadequate maintenance or installation of additional BMPs was the primary cause of sedimentation at crossings. This indicates an opportunity for increased training of foresters, loggers and machine operators on the importance of maintaining BMPs once they are installed and reinforcing or installing additional BMPs as conditions change.

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[2] Note: Due to small sample sizes, movement of percentages up or down by 5% or less is considered insignificant.

2 - Undersized crossing structures. Although 2008 monitoring data showed a improvement over 2006-2007 in the percentage of stream crossings that spanned bankfull width, undersized crossing structures continue to be a problem. Undersized crossings can lead to conditions that limit fish passage including increased flow velocities, perched outlets and accumulated debris barriers. That undersized crossings would continue to be a problem is not surprising since upgrading crossing structures so they do not restrict the stream channel is costly and replacement of crossings would be expected to progress at a slow rate.

While the monitoring identified areas where there is room for improvement it is important to view the results in the proper historical context. Over the last several decades there has been a fundamental change for the better in how water quality is treated by forestry and logging professionals. This change has happened for many reasons but for most in the industry BMPs have become “just the way we do business”. The results speak for themselves - it is Maine’s working forests that produce the clean water that Mainers expect and depend on. In a recent analysis by the USDA Forest Service of 20 northeastern states “Maine scored the highest in its ability to produce clean water. The majority of it’s watersheds received the highest possible score in this index showing a watershed’s ability to produce clean drinking water”.[3]

Then and now. As recently as the 1970’s little consideration was given to protecting water quality on timber harvests as the highly eroded banks in the log drive photo on the left illustrates. In contrast, today there is a general acceptance of BMPs by the forestry and logging professions. Sights like forwarders being used to minimize ground disturbance and temporary bridges to protect the integrity of stream channels indicate how far BMPs have come.

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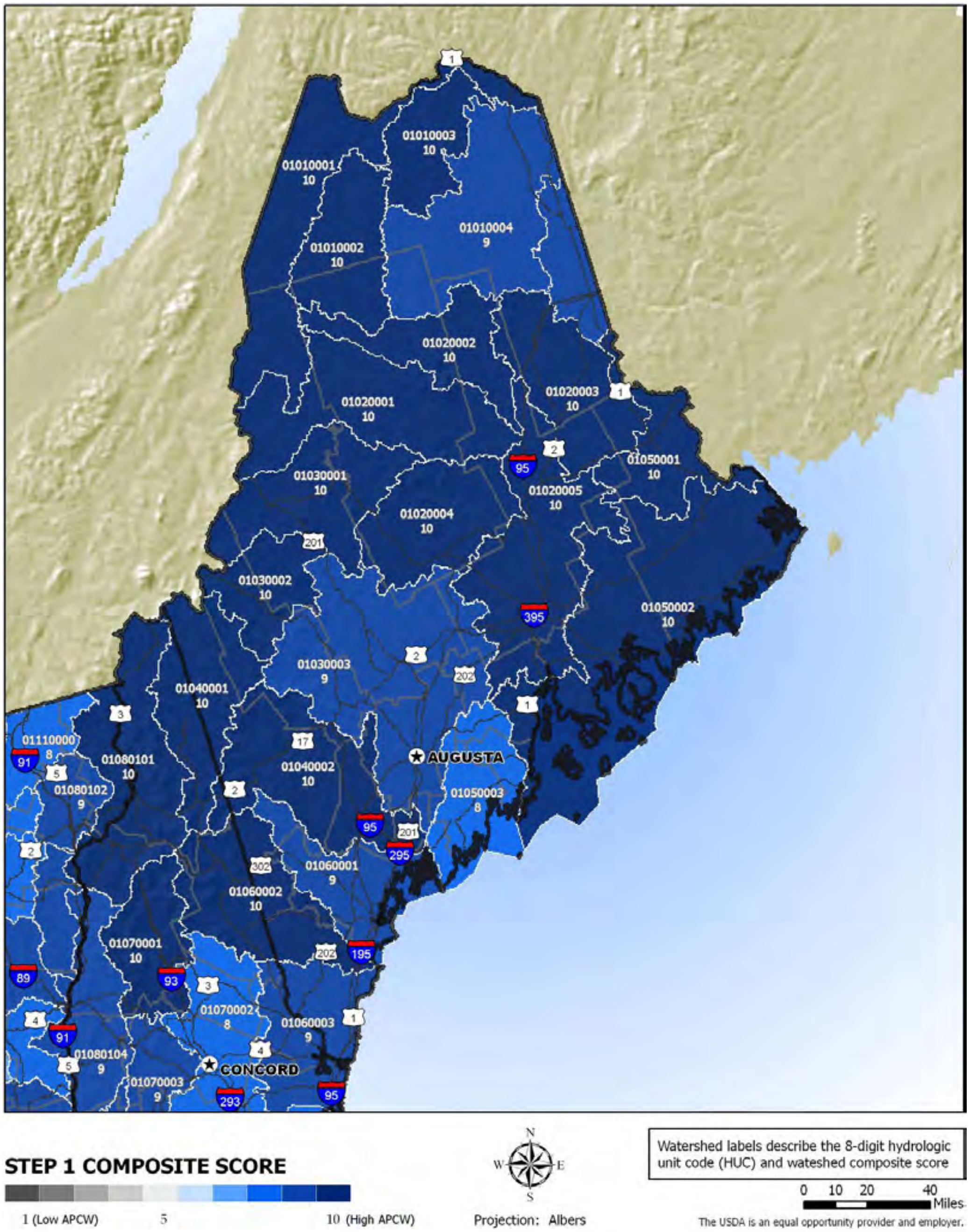
[3] Barnes, M., A.Todd, R.Whitney Lilja, and P. Barton. 2009. Forests, Water and People: Drinking water supply and forest lands in the Northeast and Midwest United States. USDA Forest Service, Northeastern Area State and Private Forestry, 11 Campus Boulevard, Suite 200, Newtown Square, PA 19073 NA-FR-01-08.



USDA Forest Service Analysis showing the ablilty of Maine's watersheds to produce clean drinking water . Darker colors indicate greater abilty to produce clean water. The same forests that produce this clean water also support a harvest of approximately 6,000,000 cords of wood annualy.

Acknowledgements

MFS obtained landowner permission prior to conducting BMP surveys. Landowners, loggers, and foresters often accompany MFS field staff during site evaluations. With a 90% positive response to MFS survey requests, it is evident that Maine landowners are sincere about responsible timber harvesting practices that protect and enhance water quality. MFS is grateful for such a high rate of positive responses and active landowner participation, without which this comprehensive report would not be possible.

MFS also extends appreciation to Pat Sirois, Maine's Sustainable Forestry Initiative Coordinator, and Tim Post and Dick Morse, MFS Field Team Leaders, who acted as quality control teams, assuring consistent application and interpretation of the monitoring protocol by MFS field staff.

Ethel Wilkerson of the Manomet Center for Conservation Sciences and David Welsch, Watershed Specialist, USDA Forest Service Northeastern Area State & Private Forestry (NA) reviewed the draft manuscript and provided many helpful comments.

Additional appreciation is expressed to David Welsch for assistance and training in running the standardized reporting system, which greatly assisted in efficient final report development and timely public availability.

Absent significant changes in staffing levels or bureau priorities, MFS expects to continue BMP monitoring indefinitely and to report periodically on the most recent data utilizing the USDA Forest Service - Northeastern Area, Best Management Practices Protocol: Monitoring Implementation and Effectiveness for Protection of Water Resources.

Note: The data in this document were generated using the procedures outlined in the two volumes of the **Best Management Practices (BMP) Monitoring Manual: Implementation and Effectiveness for Protection of Water Resources**:

Field Guide (NA–FR–02–06)
Desk Reference (NA–FR–02–07)

Both documents were published by:

USDA Forest Service
Northeastern Area State and Private Forestry
11 Campus Boulevard, Suite 200
Newtown Square, PA 19073

Online versions are available at: http://na.fs.fed.us/watershed/bmp.shtm

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Introduction

The BMP protocol provides an efficient, economical, standardized, and repeatable BMP monitoring process that is automated from data gathering through the generation of a standard data summary. It uses commonly available software and inexpensive field data recording devices. It is compatible with existing state BMP programs and is available for use by forestry agencies, forest industry, and “green certification” programs.

More information, manuals, software programs, and training in the protocol procedures and report generation can be obtained from David Welsch of the NA Watershed Team, or Keith Kanoti, Water Resources Forester with the Forest Policy & Management Division of the Maine Forest Service.

Background

The BMP protocol project is a cooperative effort of the USDA Forest Service, and the NAASF–Water Resources Committee. The project originally was funded by grants from the USDA Forest Service and the U.S. Environmental Protection Agency (EPA).

The original concept and question sequence was developed by Roger Ryder and Tim Post of the Maine Forest Service in collaboration with David Welsch and Albert Todd of NA. The NA proposed the method to the NAASF and the EPA for development as a potential regional protocol.

State forestry agencies from Delaware, Indiana, Maine, Maryland, Massachusetts, New Hampshire, New York, Ohio, Pennsylvania, Vermont, Virginia, West Virginia, and Wisconsin; the New York City Watershed Agricultural Council Forestry Program; and the USDA Forest Service Northern Research Station and NA have collaborated in the development and testing of the BMP protocol.

A further discussion of the Maine Forest Service legislative mandate and BMP monitoring history can be found in the 2005 Maine Forestry Best Management Practices Use and Effectiveness: http://www.state.me.us/doc/mfs/pubs.htm.

Sampling

MFS selected a stratified random sample of harvest sites (Figure 1) from the MFS Forest Operations Notification database. To adequately represent different type of ownership (large investor and industrial as well as small family forest ownerships) the sample was stratified by harvest size, ownership size, and geographical area. At each sample site either one or two sample units were chosen for evaluation. The information in this report was compiled using measurements from **122** sample units covering an estimated **16,978** acres. These sample units included **68** skid trail and haul road crossings for which **26,035** feet of approaches were evaluated.

Each sample unit contains the potential for approximately 200 observations and includes a number of observations of some types of data. The data collection procedure and an explanation of delineating sample units is described in the U.S. Forest Service publication *Best Management Practices (BMP) Monitoring Manual—Field Guide: Implementation and Effectiveness for Protection of Water Resources* (NA–FR–02–06), which includes the question set and instructions for making and recording the observations. Diagrams and definitions are also included.

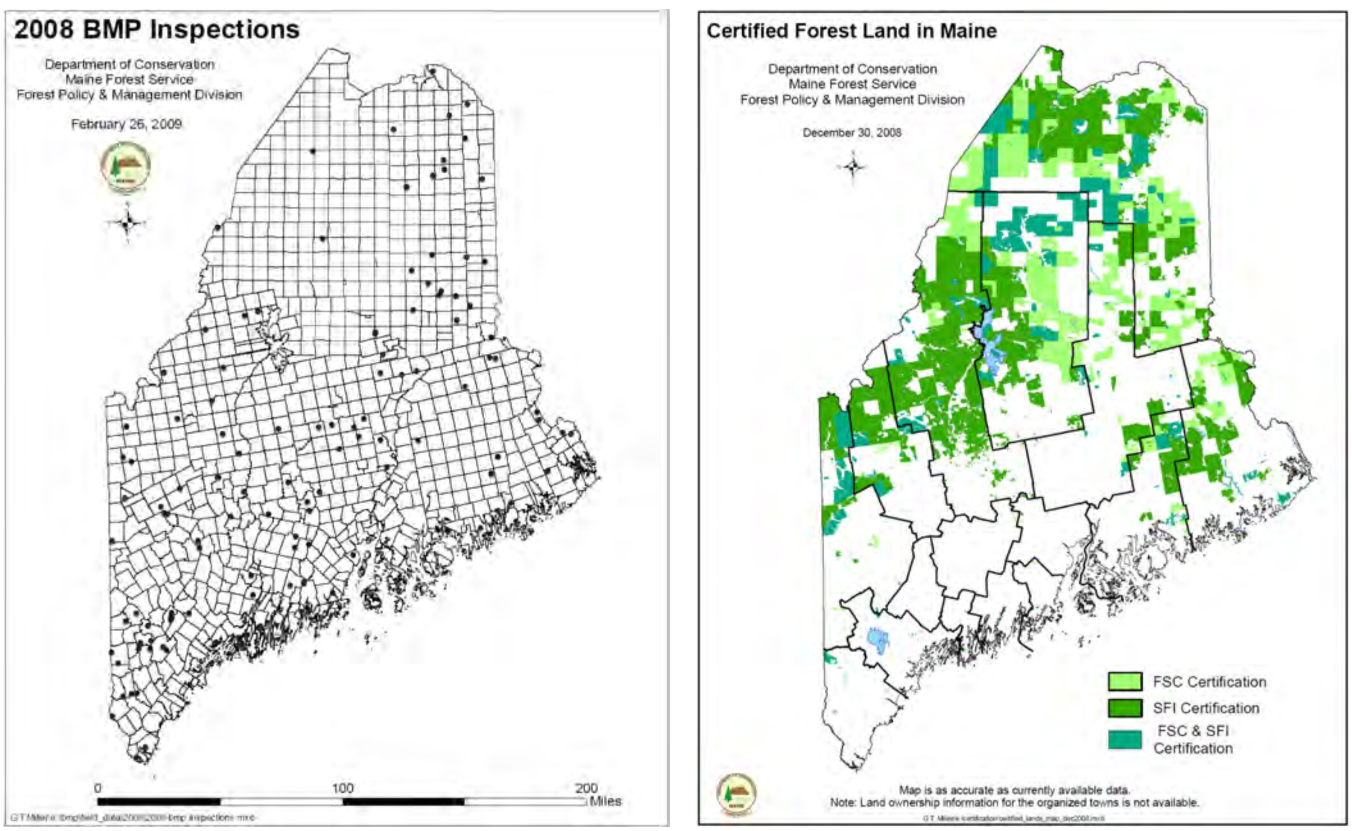


Figure 1. Locations of 2008 BMP monitoring sites and third party certified forest land in Maine. Note: Lands certified by the American Tree Farm System are also third party certified but are not depicted on this map.

General Information

For each sample unit a set of general information questions pertaining to the sample unit as a whole were answered. These included ownership category, ownership size class, type of harvest system used and who was assigned responsibility for BMPs.

Ownership Category

Regional protocol updates made during 2006 allowed distinction between family forests (also known as non-industrial private forest or NIPF) and land retained as forest land for investment purposes. The 2005 report grouped these landowner types together. Family forests are defined as smaller family forests or groups not directly associated with primary forest industries. The investor owned category includes corporate private entities such as institutional investors, logging companies, timberland investment organizations, and land acquired on behalf of individuals yet managed by private companies. Much of this acreage is third party certified (Figure 1). In recent years the numbers of acres in investor ownership has increased as the number in industrial ownership has decreased. The ownership category of the sample units reflects this trend (Figure 2)

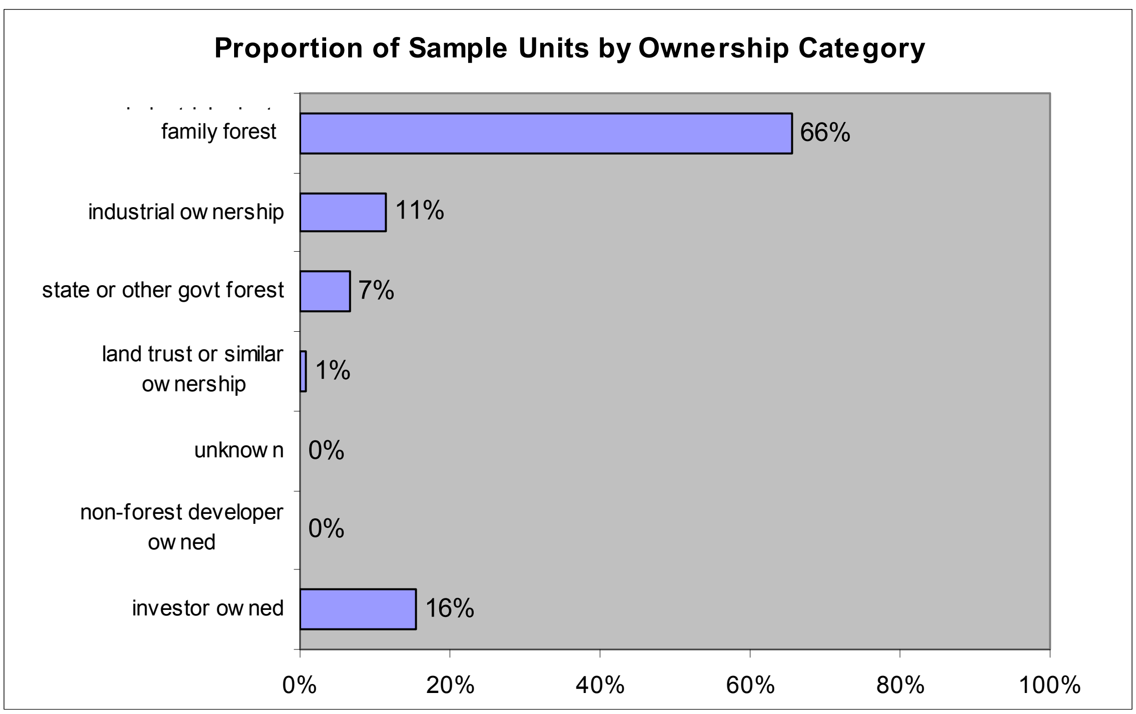


Figure 2 Ownership category of sample units. **(n=122)**

Harvest Systems Used

Ground based harvesting is by far the most common type of system in Maine. **Ground based - dragged** harvesting systems involve the use of cable or grapple skidders, where trees are harvested individually or pre-bunched mechanically and dragged to the landing for further processing, sorting, and loading for off-site transport. Ground based - dragged harvests typically result in greater amounts of exposed soil. In certain situations exposing mineral soil on a harvest is desirable for silvicultural proposes. However, if not planned properly, mineral soil scarification can increase the risk of waterbody sedimentation. **Ground based - carried** harvesting systems generally result in less exposed soil and hence reduced environmental risk as trees typically are cut to length in the woods and then carried or forwarded to the landing for further processing, sorting, and loading for off-site transport.

MFS encourages operators to upgrade to carried wood systems by offering low interest loans through its Direct Link Loan program. This program, backed by the Maine Municipal Bond Bank, offers loans at reduced interest rates to logging contractors who purchase or upgrade equipment designed to minimize soil disturbance associated with timber harvesting.

When used properly carried wood systems (e.g. the forwarder seen on the right) can result in less soil disturbance vs. dragged wood systems (e.g. the cable skidder seen on the left). Regardless of the type of system used, operator skill and training are critical to good results.

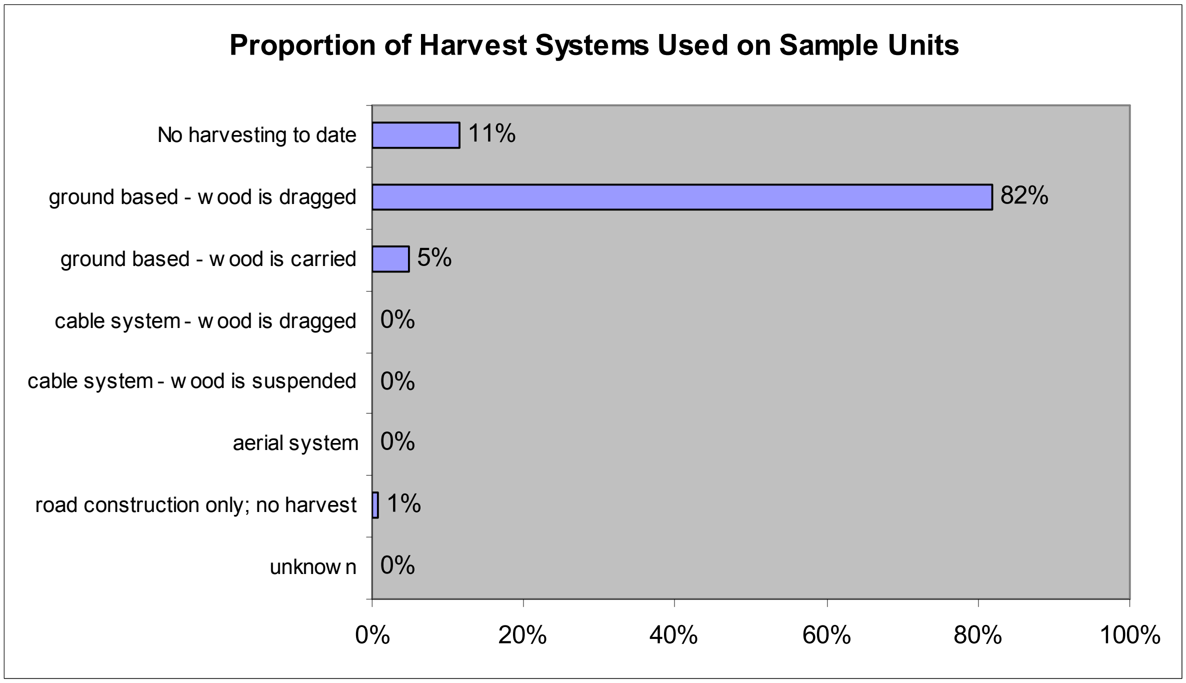


Figure 3 Harvest systems used on all sample units **(n=122)**

BMP Responsibility

BMPs are voluntary in Maine. However, mandatory BMPs may be resultant of contractual agreements between the landowner, logger, and forester or an enforcement action where remedial activities need to follow specific BMP practices to stabilize an erosion or sedimentation problem. BMPs also are mandatory under the third party forest and logger certification systems in Maine.

MFS recommends identifying by name the person responsible for BMP implementation in a written timber sale agreement that clearly explains landowner, logger, and forester expectations. Where assignment of responsibility for BMPs by oral or written agreement could be determined, 83% of harvests evaluated had BMP responsibility assigned. This suggests a general knowledge among the forestry community of BMPs and their importance. 2008 also showed what appears to be an increase in written contracts for both loggers and foresters. **In 2008 at least 40% of sample units evaluated had written contracts, up from 29% in 2005.**

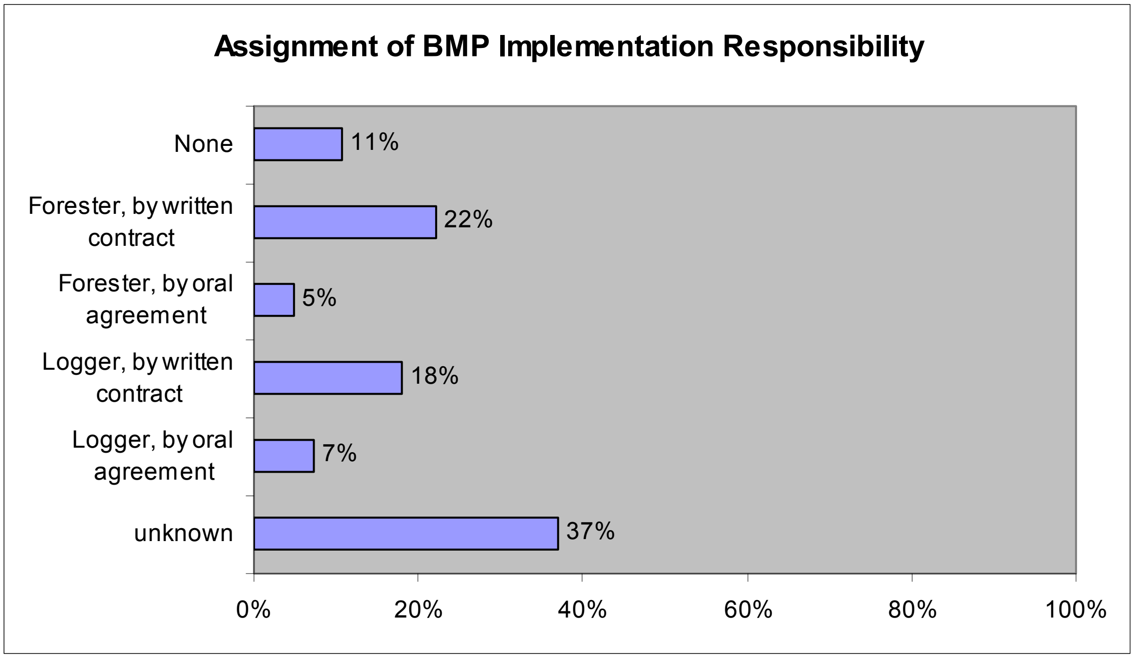


Figure 4 Assignment of BMP responsibility on evaluated sample units. **(n=122)**

BMP Assignment and Soil Conditions

The Maine Forest Service recommends that landowners having timber harvested have a written contract with the logger. The contract should specify by name the specific person who will be responsible for implementing and maintaining the BMPs on the logging job. In 2008 sample units that had BMPs assigned had the lowest rates of measurable sedimentation (Table 1). This is consistent with larger samples taken from the Northeast Region have shown lower levels of sedimentation when BMP responsibility is assigned to a particular person[4].

[4] David Welsch USDA Forest Service. Personal Communication. August 2008.

Table 1. Assignment of BMP responsibility and soil stabilization and sedimentation at approaches.

BMP Assignment	Soil stable	Soil Moves (does not reach water body)	Sedimentation (trace)	Sedimentation (measurable)	No Crossing
Not assigned n=52	0%	10%	4%	10%	77%
Forester (by contract n=112)	39%	18%	9%	1%	37%
Logger (by contract n=89)	57%	13%	3%	5%	23%

A pre-harvest meeting between the landowner, logger and forester to define objectives for the harvest and assign responsibility for the Best Management Practices is a fundamental BMP.

Soil Movement, Sedimentation and Stabilization

Soil entering surface waterbodies can have many negative effects on water quality. Sedimentation can result in embeddedness of gravel substrates which degrades aquatic organism habitat, including spawning habitat for important fish species such as brook trout and Atlantic salmon; increases turbidity, and alters the chemical properties of rivers, streams, lakes and wetlands. BMPs are designed to be simple, cost effective measures that, when applied appropriately, stabilize soil and decrease or eliminate soil moment and sedimentation.

There are five opportunities to observe the occurrence of soil movement, soil sedimentation, or stabilization for each sample unit, four at the approaches and one at the crossing structure. Therefore, for the **122** new sample units, there were **615** opportunities to observe soil conditions.

Of the 615 opportunities to observe soil conditions *87% showed no sediment entering the waterbody,* the same level as the 2006-2007 survey. Of the remaining 13% of opportunities to evaluate soil movement 6% showed trace and 7% showed measurable amounts of sediment entering the waterbody; again these are identical levels to 2006-2007 (Figure 5).

Forty-four percent of the sample units did not have water crossings. **This is due to either the absence of water or the purposeful avoidance of stream crossings through pre-harvest planning.** 10% of sample units with no water crossings had streams on the lot that were avoided by harvest planning. (On these sites harvesting took place on both sides of the stream but the stream was not crossed). On the ground harvest layout can help identify sensitive areas, reduce skid trails, and avoid unnecessary stream crossings. The remaining sites without water crossings, either no water was present on the lot or harvesting only took place on one side of the waterbody. On sites with stream crossings 77% of the observations showed no sediment entering the water. This is a 6% greater rate of sedimentation compared to the 2006-2007 time period.

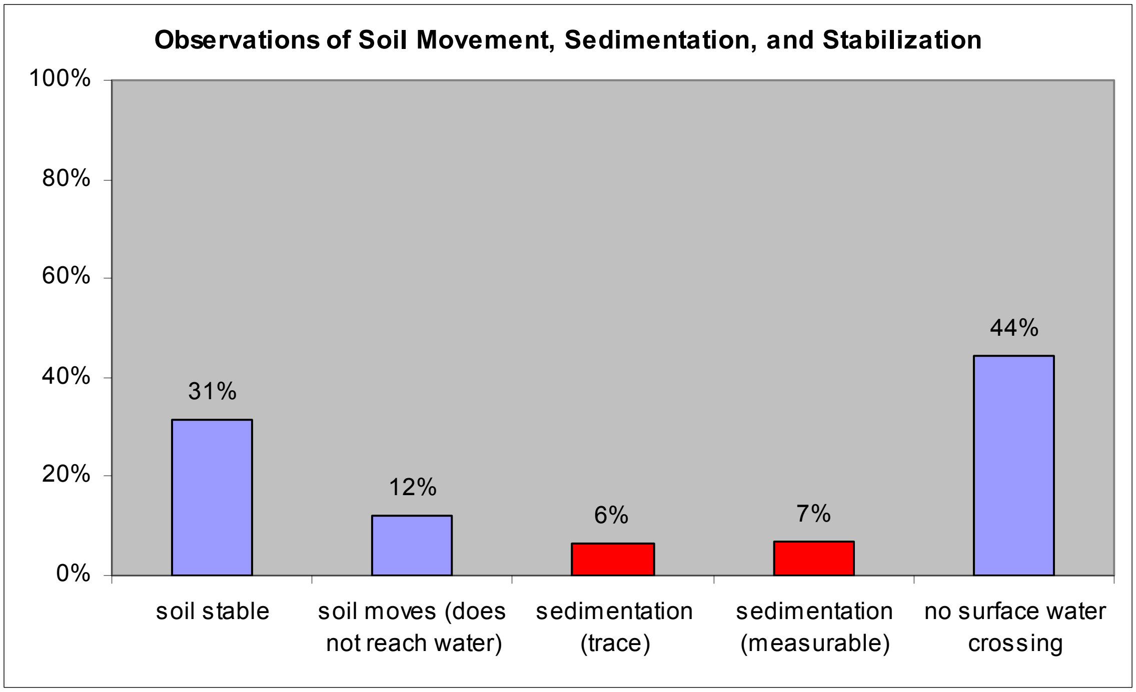


Figure 5 Observations of soil movement, sedimentation and stabilization as a proportion of total opportunities to observe soil conditions in the protocol **(n=615).**

Sedimentation Associated with Water Crossings

Water crossings and their associated approaches have the greatest potential to negatively impact waterbodies during forest management operations. Improper design and/or maintenance of crossings can lead to sediment and hazardous materials being carried by equipment or runoff into waterbodies. In addition, crossings can modify water flow, disrupt the movement of aquatic organisms, cause upstream ponding, increase scouring or destabilize stream banks. The impacts of improperly designed, maintained or closed out crossings can be substantial and long lasting if corrective actions are not taken.

Because water crossings have a high potential to negatively impact water quality, the BMP Protocol examines them in detail. *Data reported in this section only contains information from sites that had surface water crossings*. By limiting the analysis to sites with water crossings, we are better able to understand the issues associated with these features.

Sedimentation by Area of Origin

In sample units with crossings, 77% of observations showed that no soil reached the waterbody or was deposited within bankfull width of the channel. (See **Appendix A** for a further explanation on bankfull elevation and width.) For the 23% of the observations where sediment reached the waterbody, the sediment was just as likely to originate from the buffer (approaches) as from the crossing structure. Sediment originating from the approaches *outside* the buffer accounted for about one-quarter of the cases of sedimentation. These levels are similar to the 2006-2007 time period. The fact that sedimentation was just as likely to originate from the approaches as the crossing structure indicates the importance of extending erosion control measures to the point where overland flow originates.

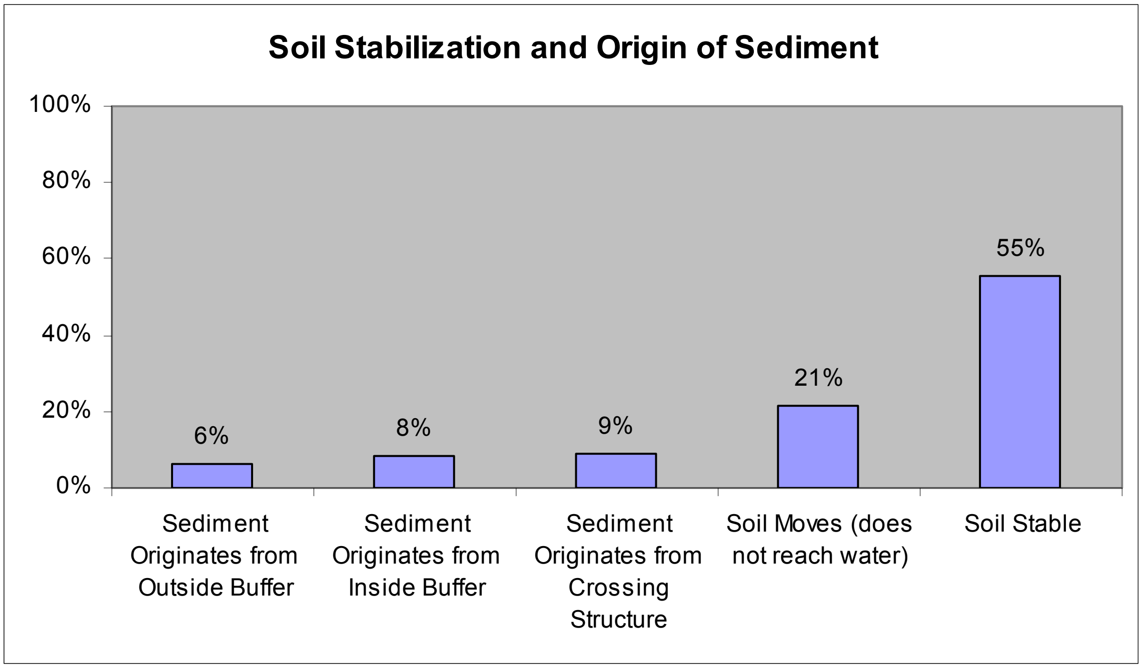


Figure 6 Soil stabilization and origin of sediment from sample units with water crossings **(n=345)**.

Approaches

Soil Stabilization and Sedimentation from the Approaches

During 2008 MFS Field Staff evaluated **26,035** feet of water crossing approaches. Each water crossing offered four opportunities to evaluate approaches: once inside the buffer and once outside the buffer on both sides of the crossing. On the sample units with crossings, there were a total of **277** opportunities to evaluate soil conditions at the approaches.

In 82% of the cases no soil reached the water body from the approaches (Figure 7). This indicates that planning and implementation of BMPs keeps sediment from entering the water in most cases. Analysis of the18% of cases where sedimentation occurred from the approaches indicates the majority of sedimentation was due to inadequate maintenance or inadequate installation of additional BMPs (Figure 8). These are the same causes as were identified in the 2006-2007 monitoring. Assessment of BMP application when sedimentation occurred indicates that in sedimentation was most often due to inadequate application of BMPs rather than BMPs not being applied (Figure 9). Again these findings agree with past years monitoring data. This reinforces the need for improved or increased education for loggers, machine operators and foresters on the importance of controlling water flow on roads and skid trails *throughout the operation.* These educational efforts should also stress the importance of adapting to changing site conditions and reinforcing or installing additional BMPs as needed.

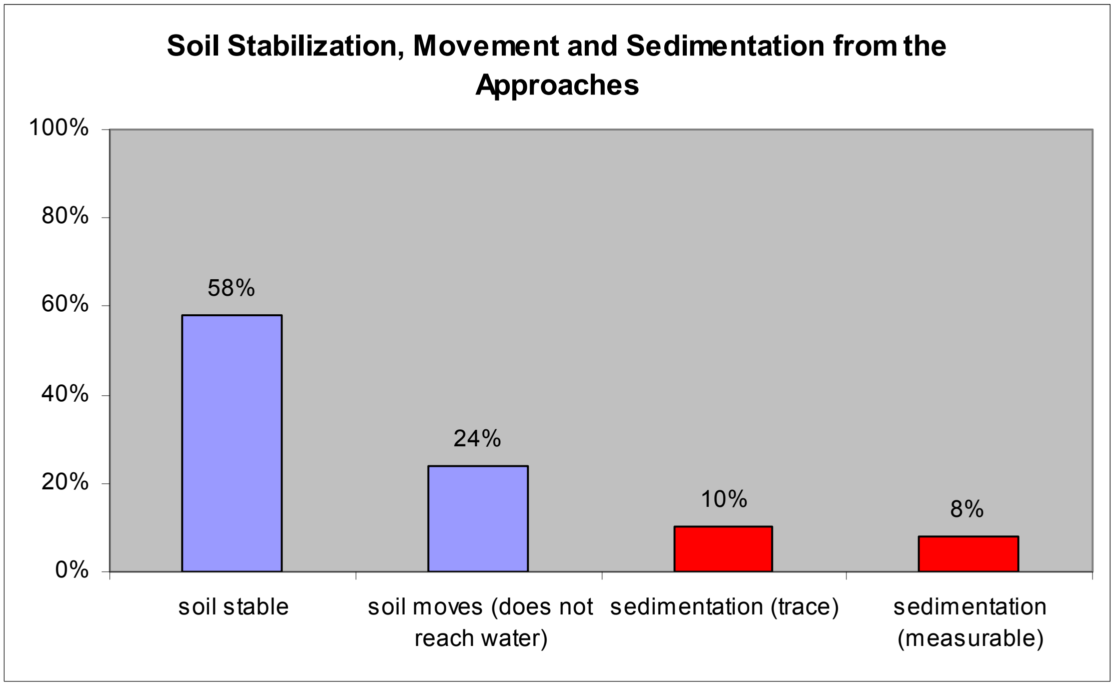


Figure 7 Soil stabilization, movement and sedimentation from the approaches **(n=277)**.

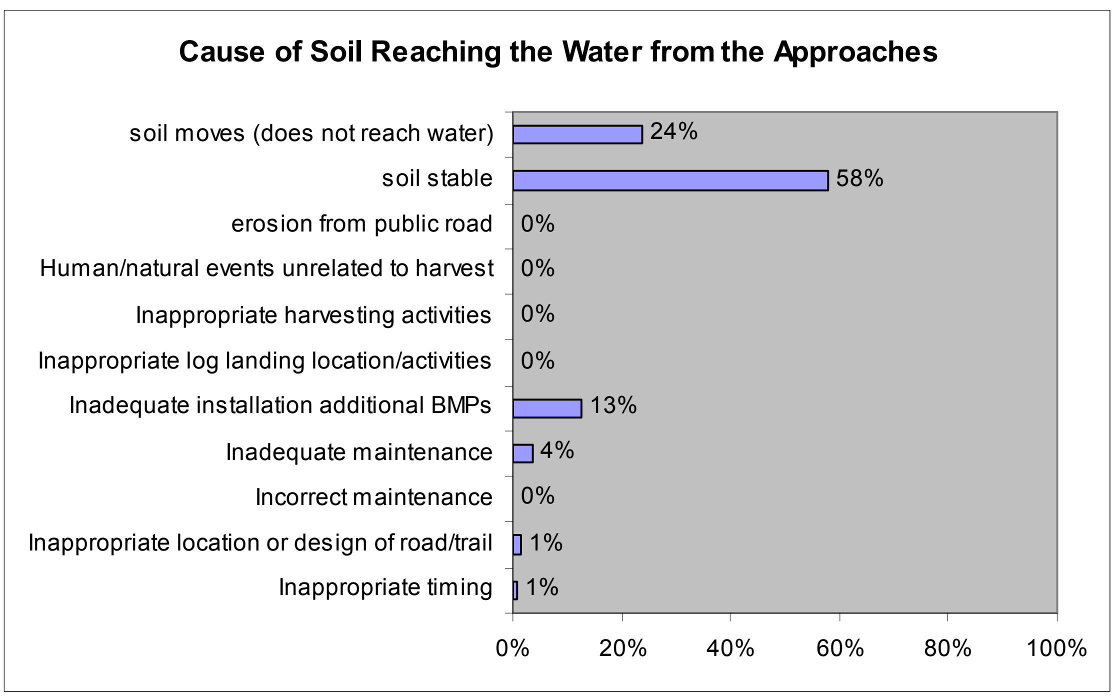


Figure 8 Causes of sedimentation from the approaches on sample units with crossings **(n=277).**

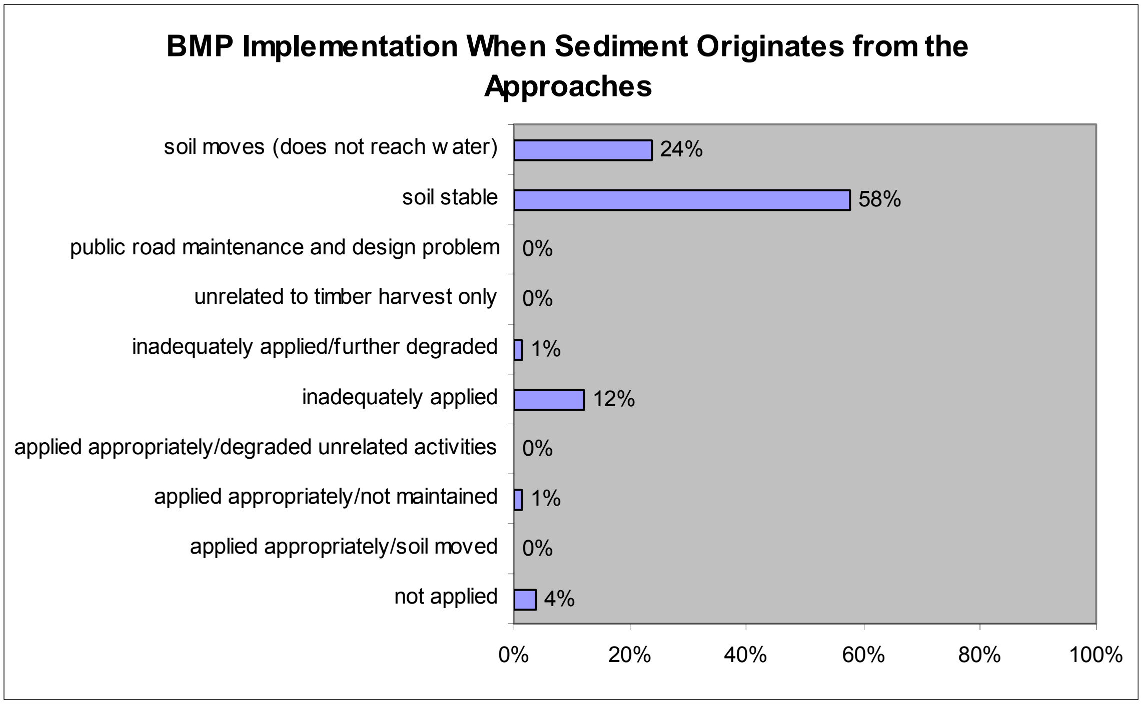


Figure 9 BMP implementation when sediment originates from the approaches on sample units with crossings **(n=277).**

BMPs should extend uphill from the crossing to the point at which a break in the road grade directs water away from the crossing. The road on the left has well designed approaches that direct water into a vegetated filter strip before if reaches the stream. In contrast the road on the right has no place for the water to go before reaching the waterbody. Grading to maintain the road crown, ditch turnouts and vegetated filter strips are some of the BMPs used on approaches.

Crossing Structure

MFS Staff evaluated **68** crossing structures. For the purposes of the protocol the crossing structure includes any portion of the road that lies within the bankfull width of the channel (See appendix A). Crossings were identified as either a haul road or skid trail. A haul road is a forest access system designed to transport harvested forest products to a location or facility for resale, sorting or processing into value added forest products. Skid trails primarily bring trees that have been harvested to a concentration point for further preparation for transport on a haul road or public transportation route.

Crossing Structure Types

Across all sample units culverts were the most common type of crossing structure encountered (Figure 10). Single and multiple culverts were the most common type of structure encountered on haul roads while fords (both unimproved and pole and brush fords) and removed structures were the most common encountered on skid trails (data not shown).

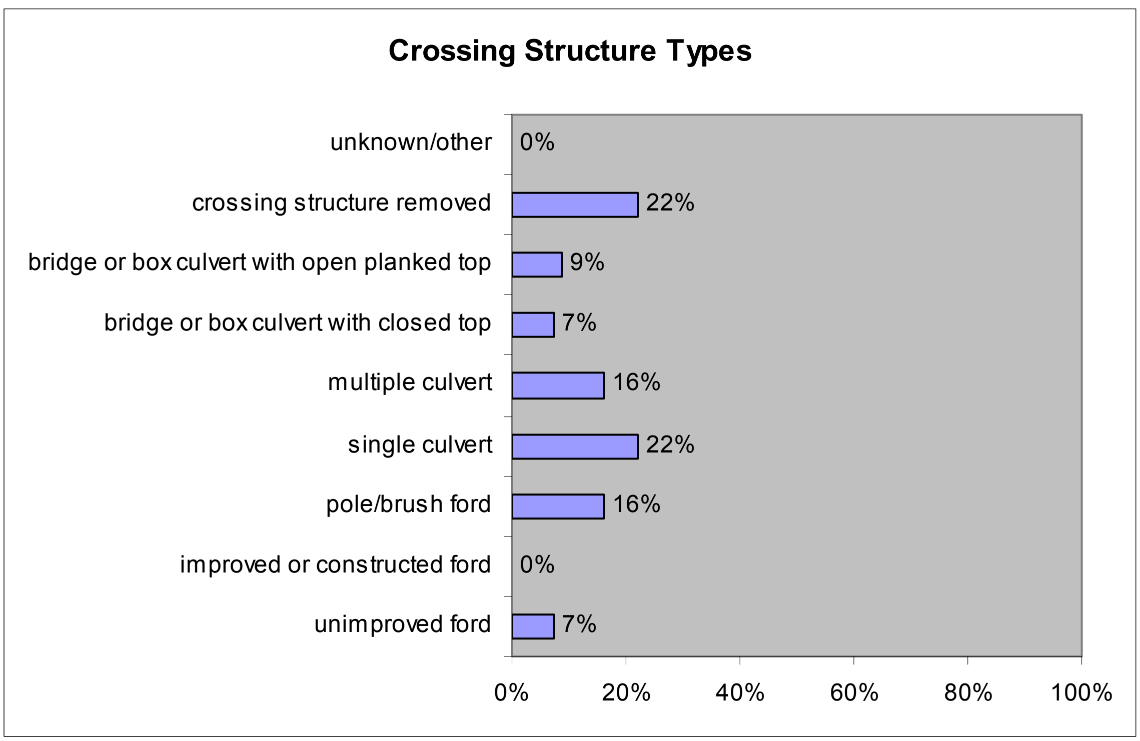


Figure 10 Crossing structure types **(n=68)**.

Well designed temporary crossings can be very cost effective and minimize disturbance to the waterbody. Pictured is the same crossing during use and after removal. Note that slash has been left on the approach to the crossing to stabilize any exposed soil. No sediment was deposited below the bankfull elevation of the channel.

Soil Stabilization and Sedimentation from the Crossing Structure

In MFS observations of waterbody crossings, 44% were successfully stabilized, while 56% had soil movement, which in many cases (44%) reached the waterbody. This is a 6% increase in sedimentation rate over the 2006-2007 level. *The classification of measurable sedimentation was 28%, the same as 2006-2007* (Figure 10). Measurable sedimentation is defined as $\geq$ 1 cubic foot of sediment below the bankfull elevation of the channel. Many times portions of a crossing structure must come in contact with the waterbody. It is extremely difficult to keep all soil from reaching the waterbody, but siltation and sedimentation can be minimized to the point that the biological activity of the associated waterbody is not affected. While it is not known in how many cases the amount of sediment introduced was substantial enough to cause harm to the waterbody the fact that more than one quarter of crossings introduced measurable amounts of sediment is cause for concern.

With several years of monitoring data now in hand we see that the rate of measurable sediment input at crossings has remained consistently high. Sedimentation at crossings is clearly an area that MFS and its partners should concentrate educational, technical and, where appropriate, financial assistance efforts. Private logger training efforts such as Certified Logging Professional, Qualified Logging Professional and the Northeast Master Logger Certification Program should also consider increasing education efforts targeted at proper stream crossing installation techniques. In addition to educational efforts the monitoring protocol needs to evaluate the *amount* of sediment that is being introduced at crossings. 2009 Monitoring will include data to quantify the amount of sediment delivery; this will allow a better assessment of the potential biological impact of sedimentation associated with crossings.

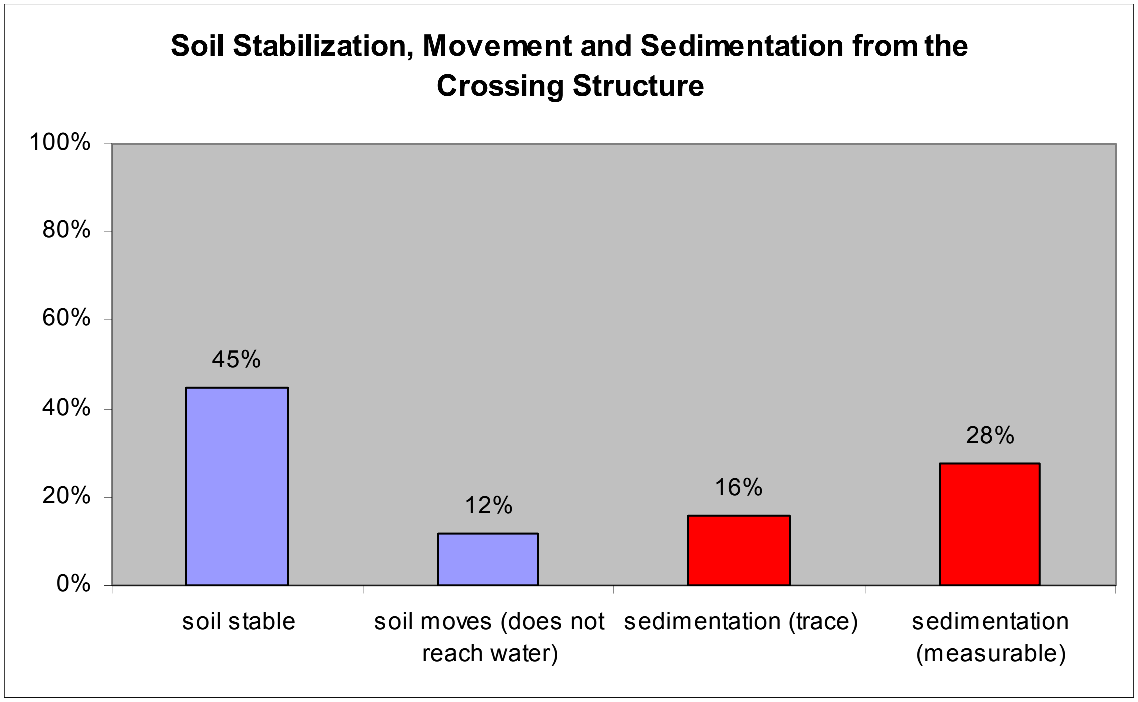


Figure 11 Soil stabilization movement and sedimentation from crossing structures **(n=68)**.

Structure Type Associated with Sedimentation

Single culverts were the crossing structure most often associated with the addition of trace (trace is defined as <1 cubic foot) (Figure 12) amounts of sediment to the waterbody. Pole or brush fords were the structures most often associated with measurable sedimentation entering the waterbody (Figure 13) MFS recommends the use of temporary bridges, particularly at skidder crossings. Bridges can often protect stream banks more effectively than fords, thus minimizing sedimentation.

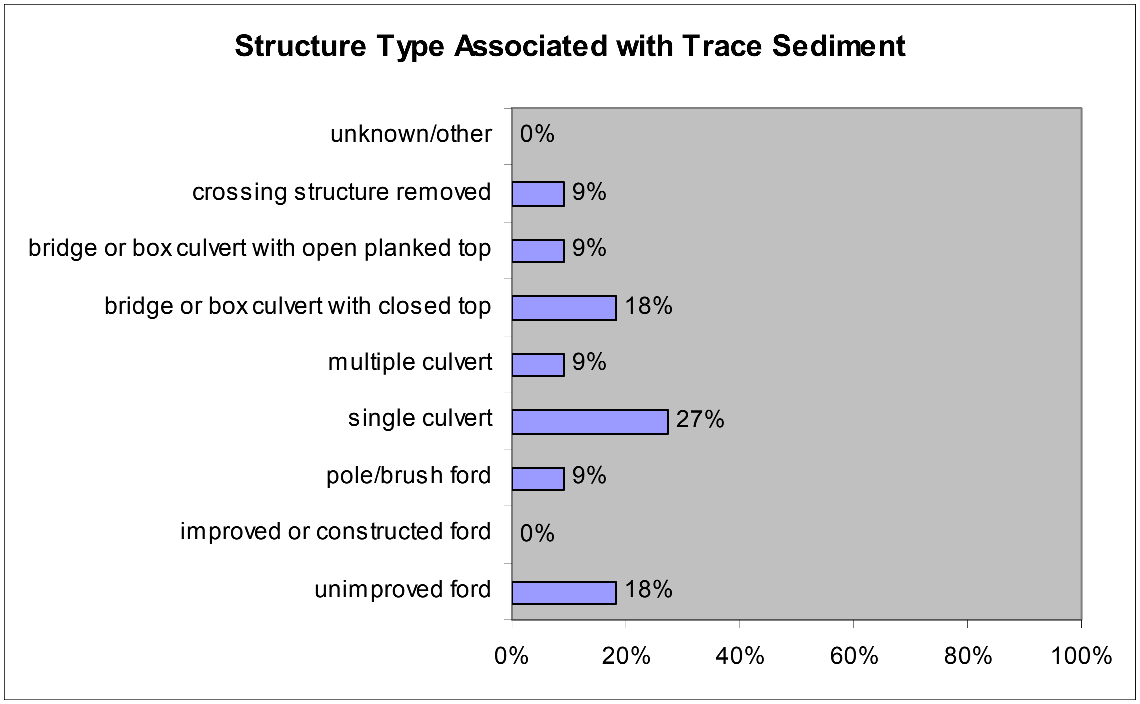


Figure 12 Structure type associated with trace sedimentation **(n=11)**.

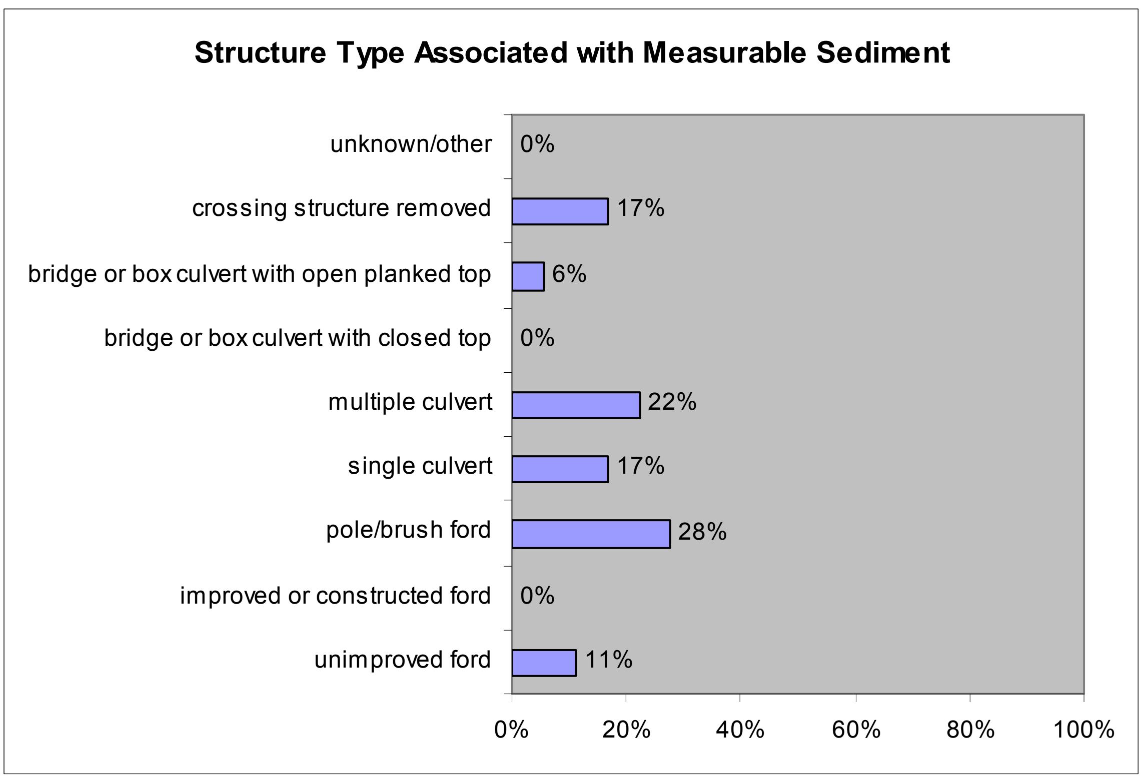


Figure 13 Structure type associated with measurable sedimentation **(n=18)**.

BMP Implementation at crossings

When sediment reached a waterbody at a crossing structure, the most common cause was the inadequate application of BMPs (Figure 14). This is consistent with observations at the approaches.

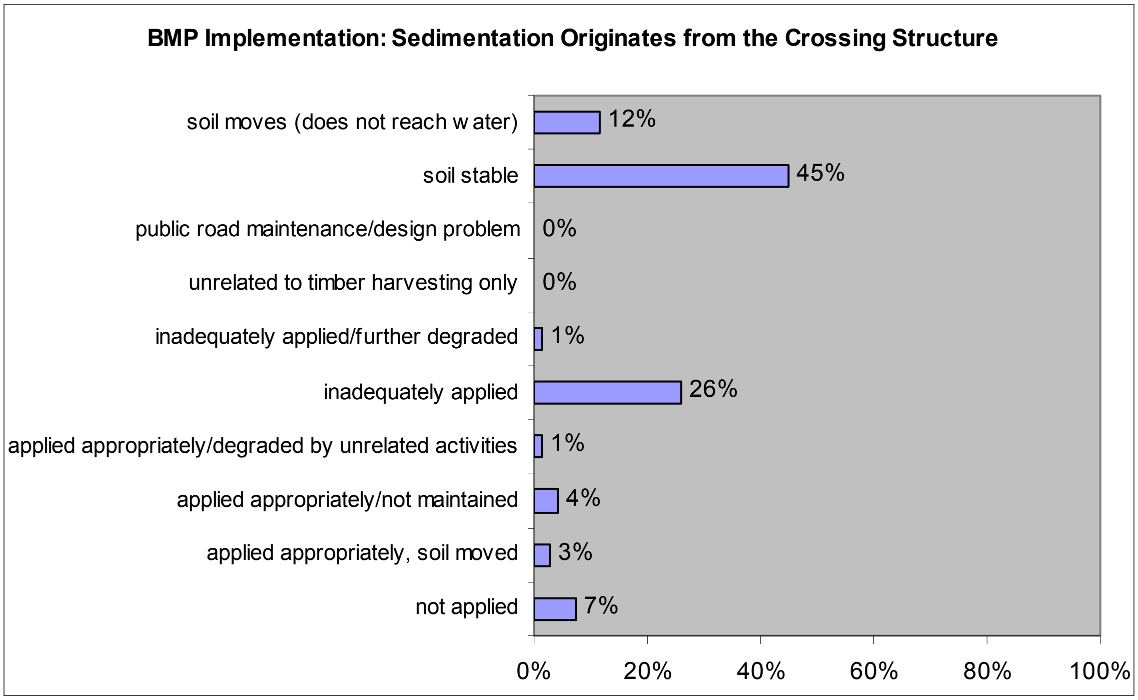


Figure 14 BMP Implementation when sediment reached the waterbody from the crossing structure. **(n=68)**

Fish Passage

Stream crossings that prevent fish from passing under or through them can reduce the amount of stream habitat available, or the ability of some species to spawn. Permanent structures least likely to impede fish and macroinvertibrate passage are those in which the natural stream bottom is accessible and undisturbed such as bridges and bottomless arch culverts. If closed bottom culverts are used they should be embedded so that a natural stream bottom substrate is present and continuous through the culvert. Properly constructed crossings that protect fish passage are also often the easiest to maintain and the least likely to fail or become damaged, thus reducing long term costs. Where closed bottom structures must be used temporary structures have less impact on fish habitat, depending on the type of crossing, the season(s) of use and the type of stream.

Crossing Structure Sizing

In Maine legal requirements for structure opening size vary depending on the jurisdiction. However, properly sized structures typically should also be *at least* equal to the bankfull width of the channel. Maine Forest Service BMPs recommend that temporary crossings and permanent structures that will be regularly maintained be sized to accommodate a 10 year flood event (2.5 times the cross sectional area of the stream channel at bankfull). BMPs recommend permanent crossings that will not be regularly maintained be sized to accommodate a 25 year flood event (3.5 times cross sectional area).Undersized crossings can lead to conditions that limit fish passage including increased flow velocities, perched outlets and accumulated debris barriers. Undersized structures are also at increased risk of being unable to handle high water flows and therefore are more likely to experience catastrophic failures leading to large sediment inputs. *55% of the crossings evaluated did not span the bankfull width of the channel.* This is an 11% decrease from the 2006-2007 level of 66%. Additional years of data will be required to see if the improvement in the numbers of crossings that span the stream channel represents a trend (Figure 15).

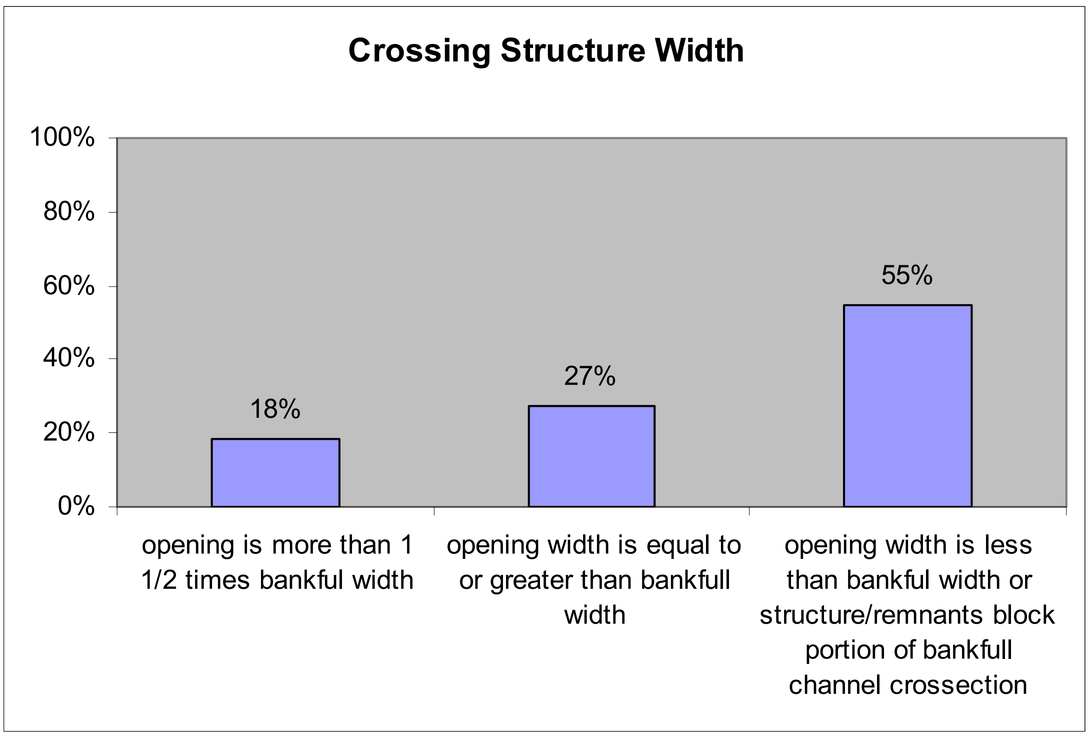


Figure 15 Width of crossing structure in relation to waterbody width at pre structure bankfull elevation. **(n=68)**

Stream Bed Conditions Under and in Crossing Structures

Crossing structures properly designed and installed to allow fish passage incorporate either natural or simulated natural stream bed substrate in the bottom of the structure. Open bottom structures such as bridges and arch culverts allow natural stream bed substrate to be maintained. Closed bottom structures such as round culverts, box culverts and pipe arches can also incorporate substrate by being embedded in the stream bottom or being sized large enough to allow bed load substrate to accumulate in their bottoms over time. **45%** of the crossing structures were open to the natural stream bed. *No closed bottom structures had* *continuous substrate in the structure bottom.* **25%** of closed bottom structures had perched outlets. Perched outlets can be severe impediments to fish passage (Figure 16). Perched outlets can result from improper initial installation and/or undersized structures. Undersized structures accelerate flows which leads to down stream scouring, which in turn lowers the elevation of the downstream streambed. This can result in a culvert that was formerly at grade becoming perched. The Maine Forest Service, in cooperation with many partners, has conducted numerous training efforts for operators and foresters on proper installation techniques for fish friendly crossings.

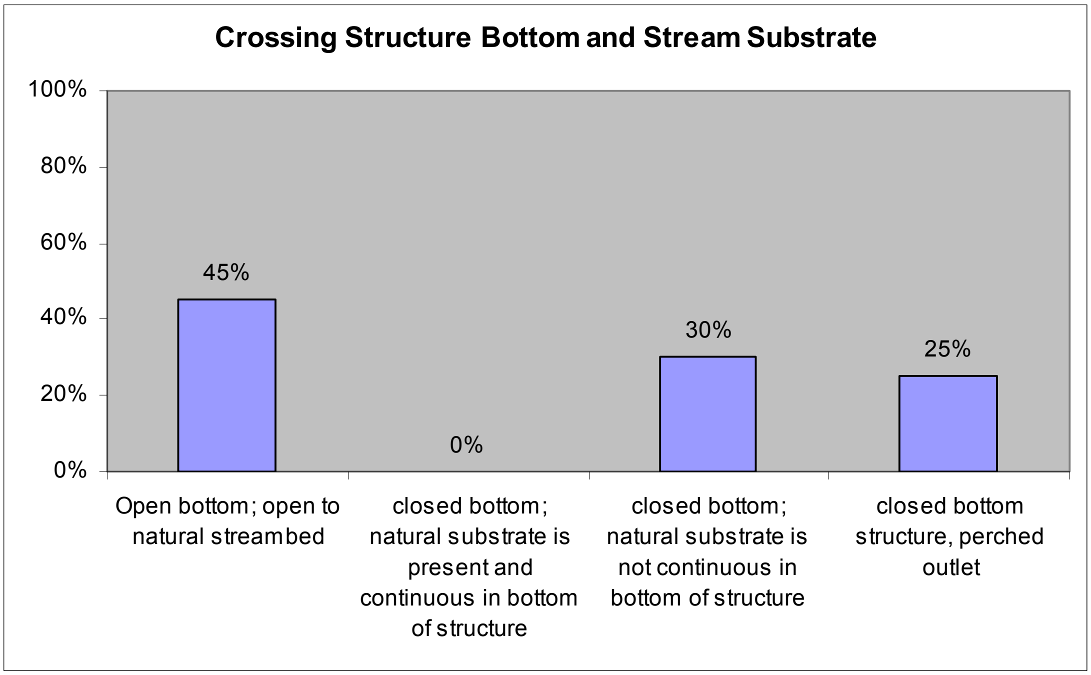


Figure 16 Presence of substrate in crossing structures. **(n=40)**

Crossing structures that are open to the natural stream bottom allow for fish passage. Closed bottom structures that do not span the stream channel or are improperly installed can become perched, making it difficult for fish to move upstream.

Chemical Pollution Prevention

Loggers and foresters generally take seriously the importance of keeping chemical pollutants out of water supplies. Observations of chemical pollutants in sample units were limited to a few cases of minor dripping from machines and occasional empty containers left at woodyards (Figures 17 and 18). There were no cases of chemical pollutants entering the water recorded (data not shown). Although no chemical pollutants made it to the waterbody, contamination remains a concern, particularly in areas where groundwater may serve as private or public drinking water sources.

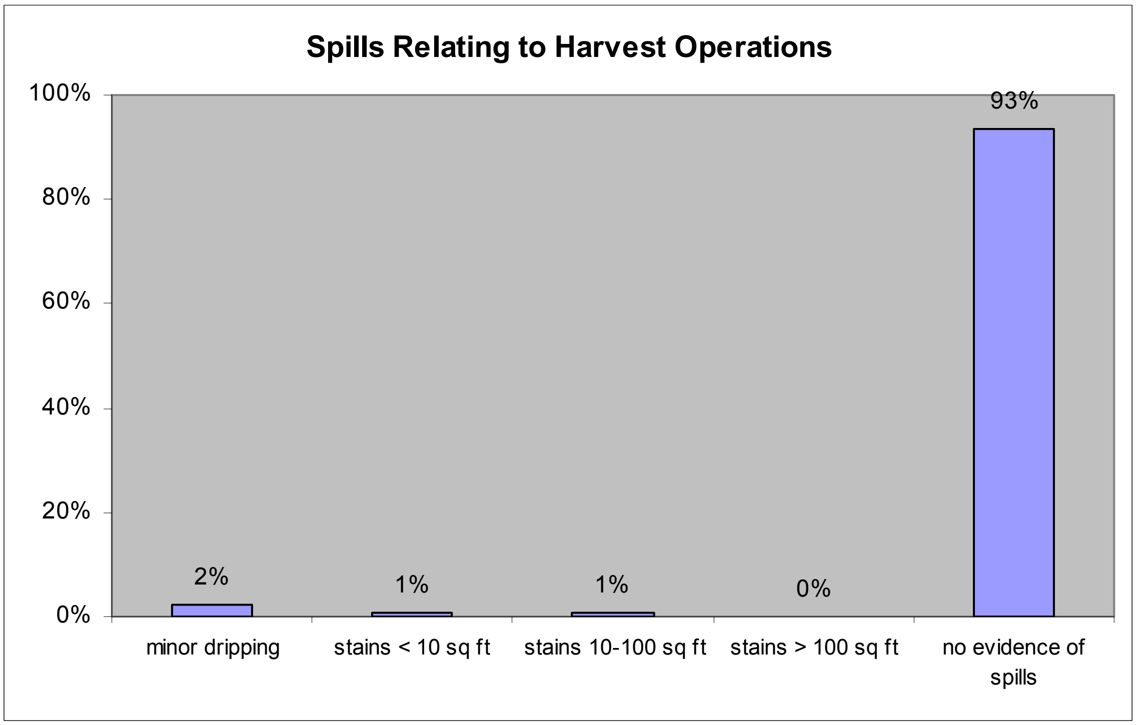


Figure 17 Spills relating to harvest Operations **(n=122)**

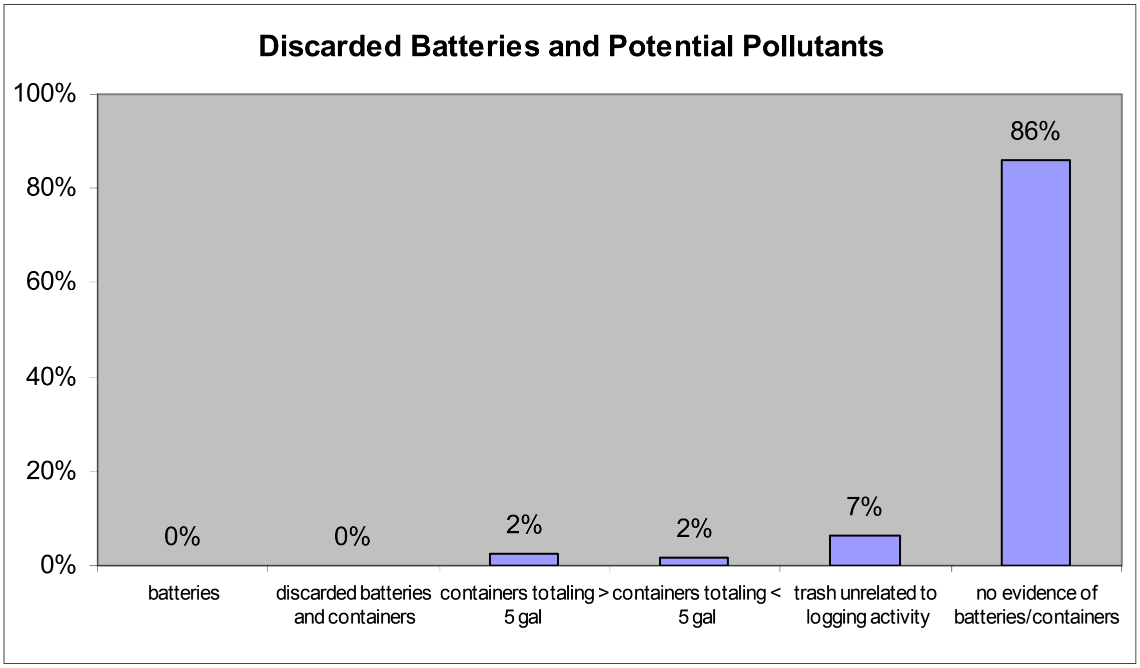


Figure 18 Discarded batteries and other pollutants. **(n=122)**

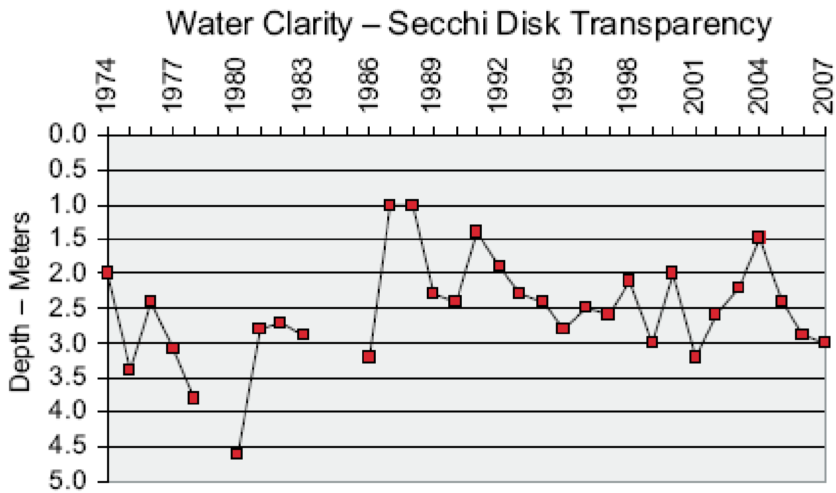
Conclusions

The 2008 BMP monitoring showed some small but important changes in environmental understanding on the part of the logging industry. Use of channel spanning crossing structures and planning for crossing avoidance are real and important improvements. These improvements give an indication that the training in efforts of the Maine Forest Service and its industry partners including Maine's Sustainable Forestry Initiative, the Certified Logging Professional and Qualified Logging Professional programs, are paying off. They also indicate the level of professionalism displayed by Maine's loggers today. The fact that 87% of cases evaluated showed no sedimentation and only 4% of crossings did not have BMPs applied indicates that most foresters and loggers understand the importance of maintaining water quality and know what steps to take to protect it.

As stated in the executive summary Maine has come a long way in it efforts to protect water quality on timber harvests. Although the first formal attempts to quantify BMP usage did not begin until the 1990's, antidotal reports from the 1970's and 1980's indicate that there has been a vast improvement in efforts to protect water quality.

Actual improvements in water quality that have been observed over this time period that are attributable to increased use of forestry BMPs are often difficult to separate from the effects of mitigation of other non-point pollution sources, particularly those associated with development. One example from a heavily forested watershed where improvement in Forestry BMPs is thought to have contributed to improvement in lake water quality is Madawaska Lake.

Located in Aroostook County, Madawaska Lake experienced declining water quality beginning in the 1980s when increased timber harvesting, road building and shoreland development in the watershed contributed excess phosphorus and sediment to the lake. As a result, Maine Department of Environmental Protection (MDEP) added Madawaska Lake to the state's 1988 Clean Water Act section 303(d) list of impaired waters. The lake's water quality began improving in the mid-1990s, due to changes in statewide forestry standards, improved regulatory oversight of development and the implementation of forestry BMPs. MDEP removed Madawaska Lake from its section 303(d) impaired waters list in 2006.[5]



Water clarity in Madawaska Lake abruptly declined in 1987. From 1987 to 1992 the lake suffered four nuisance algae blooms (SDT < 2.0 meters). Since 1993 water clarity has improved, and the lake has been free of algae blooms for 14 of the past 15 years. (Note: no data were collected in 1979, 1984 and 1985.)

Monitoring, education and training is key to sustaining the progress that has been made with Forestry BMPs and will allow Maine's forestry community to continually improve as we move into the future. With continual improvement in mind the monitoring identified two problem areas where training and education efforts can be concentrated.

1 - Sedimentation associated with crossing structures. The 2008 data show that sedimentation from crossing structures continues to be a problem. As seen in previous years, sedimentation results from the failure to reinforce, maintain or install additional BMPs as conditions change rather than the failure to install BMPs. MFS and its partners must increase educational and technical assistance efforts in these areas.

2 - Undersized crossing structures. The increase in the number of crossings that span bankfull elevation is encouraging, but there is still much work to be done. Upgrading crossing structures so they do not restrict the stream channel is costly; therefore, prioritizing which structures should be considered for

[5] Hoppe, K., and N. Marcotte. 2008. Improved Forestry Practices Help Restore Lake. 319 Nonpoint Source Program Success Stories. U.S. Department of Environmental Protection. EPA 841-F-08-001Y, 2p.

replacement is important. MFS currently is partnering with the US Fish and Wildlife Service on a stream crossing survey in the Penobscot River watershed. Several other organizations are working on related surveys in other parts of the state. These surveys rank crossing structures based on their potential to impede passage of fish, position in the stream, and the amount of habitat that would be opened above the structure were it to be upgraded. Efforts to secure funding to assist willing landowners to upgrade critical crossings should be considered.

Appendix A

What is Bankfull Elevation and Width?

The terms bankfull elevation and bankfull width are used throughout this report. Since this is a relatively new term used for BMP monitoring, further explanation is provided below.

Bankfull elevation may be defined as the point of demarcation between the stream channel and the floodplain. The bankfull elevation is at the elevation of the lowest depositional flat immediately above the channel and is often identified by the deposition of fine sediments indicated by the first depositional flat above the channel.

Bankfull width is the channel width from the bankfull elevation on the one side of the channel to the bankfull elevation on the other side of the channel.

Figure 19 Bankfull indicators visible at low flow. The bankfull elevation is indicated by the first depositional flat above the channel. On very confined channels, the bankfull elevation may only be evident as the discontinuous flat depositional areas shaded on the photo.