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Maine Forestry Best Management Practices (BMP) Use and Effectiveness—Data Summary 2006 - 2007

Maine Forest Service
Forest Policy and Management Division

Maine Forestry Best Management Practices Use and Effectiveness 2006 - 2007

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

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Executive Summary

The 2006-2007 Maine Forest Service (MFS) report on the use and effectiveness of forestry Best Management Practices (BMPs) presents the second and third years of data collection and analysis utilizing "Best Management Practices Implementation Monitoring Protocol," an original project of the Northeastern Area Association of State Foresters' Water Resources Committee. Introduced in the 2005 BMP report, 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 approximately sixteen months of data collected between May 2006 and December 2007. 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.

This approach 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. Improved monitoring methods make it difficult to compare specific year to year data. However, MFS's evaluation of BMP use and effectiveness indicates continuous improvement.

BMPs were used appropriately at 41% of the monitored harvests in 2000. In 2006 and 2007, BMPs prevented sediment from reaching the waterbody at 77% of stream crossings and 89% of approaches to the crossings.

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

[1] Welsch D., Ryder R., Post T. 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.

- **Of the 1260 opportunities to observe soil conditions, 87% showed no sediment reached the waterbody a *4% improvement from the 2005 reporting period.***
- **Harvests with either no stream crossings or avoided stream crossings, and harvests with properly implemented BMPs accounted for 77% of the sample units where no impact to water resources was noted, a slight decrease from 79% in 2005.**
- **BMPs were not applied on 4% of crossings, the same level as 2005. On approaches BMPs were not applied at 2%, a slight decrease from 6% in 2005.**
- **Forty-one 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 on the ground can help identify sensitive areas, reduce skid trails, and avoid unnecessary stream crossings.**

The level of BMP usage that exists today in Maine is a testament to the efforts of Maine's professional logging community and associated organizations. The hard work of these people and organizations have greatly reduced the major water quality problems associated with timber harvesting that existed in Maine just a few decades ago.

The monitoring also identified areas that need improvement:

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

2 - Undersized crossing structures. Undersized crossings can lead to conditions that limit fish passage including increased flow velocities, perched outlets and accumulated debris barriers. Upgrading crossing structures so they do not restrict the stream channel can be costly. Therefore, prioritizing which structures should be considered for replacement is important. MFS currently is partnering with the US Fish and Wildlife Service on a stream crossing survey in the Penobscot River Watershed. This survey ranks 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 also be considered.

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

Acknowledgements

MFS obtained landowner permission prior to conducting BMP surveys. Often landowners, loggers, and foresters requested they 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 which 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 Imitative Coordinator, Andy Shultz, formerly of a.Forestry, and Kirby Ellis, of Ellis' Forestry Services, who acted as quality control teams assuring consistent application and interpretation of the monitoring protocol by MFS field staff.

Additional appreciation is expressed to **David Welsch USDA Forest Service Northeast Area Watershed Specialist** for assistance and training in running the standardized reporting system that 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

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Introduction

The Best Management Practices (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, USDA Forest Service, Northeastern Area State and Private Forestry, Watershed Team, or Keith Kanoti, Water Resources Forester with the Policy and Management Division of the Maine Forest Service.

Background

The BMP protocol project is a cooperative effort of the USDA Forest Service, and the Northeastern Area Association of State Foresters–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 the U.S. Forest Service, Northeastern Area State and Private Forestry (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

A stratified random sample of harvest sites (Figure 1) was selected 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 **252** sample units covering an estimated **24,718** acres. These sample units included **141** skid trail and haul road crossings on which **54,456** 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.

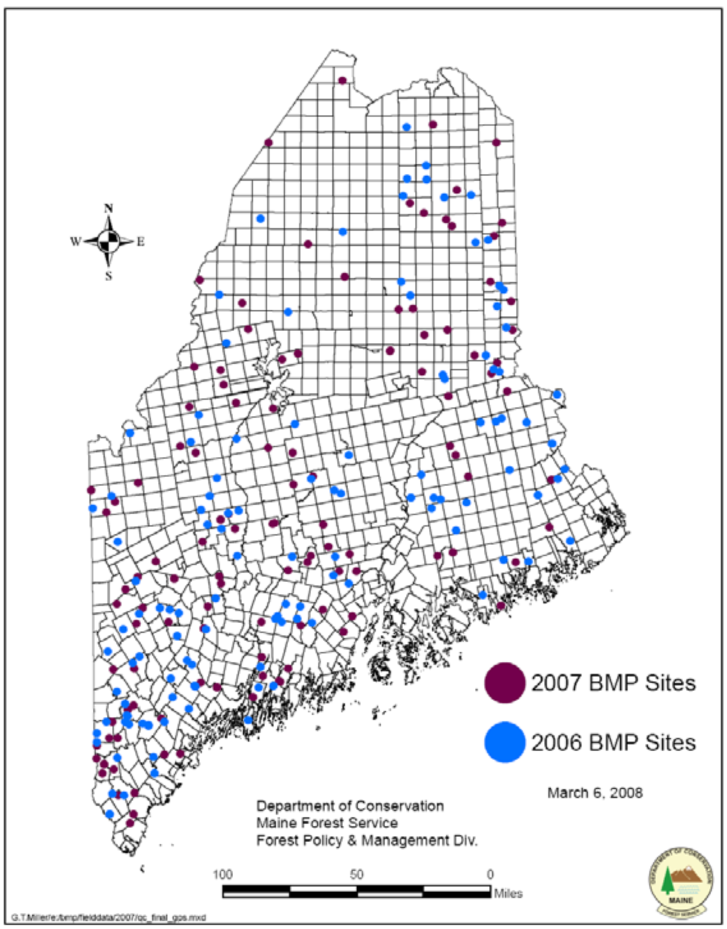

Figure 1 Location of 2006-2007 BMP Sample Sites

General Information

For each sample unit monitored 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 and 2007 allow distinction between family forests (non-industrial private forest -NIPF) and land retained as forest land for investment purposes. The 2005 report grouped these landowner types together. NIPF is defined as smaller family forests or groups not directly associated with primary forest industries. The investor owned category (17%) 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. 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).

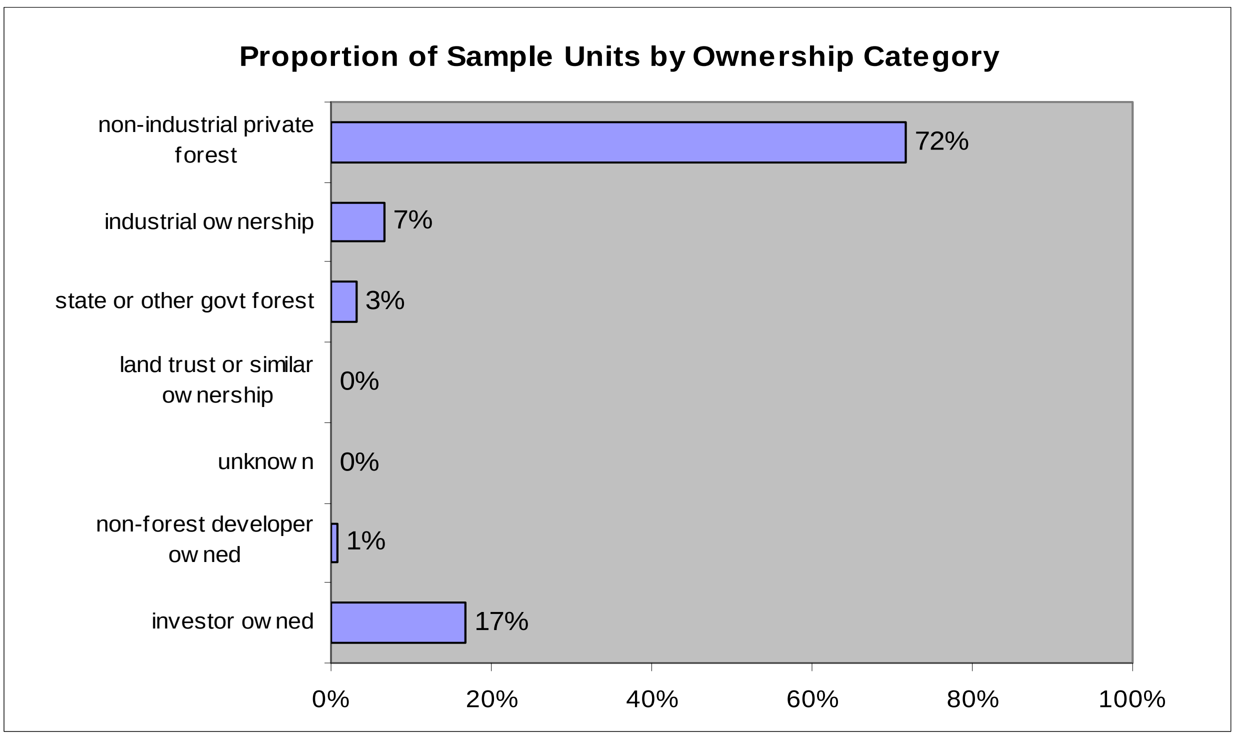

Figure 2 Ownership category of sample units. **(n=252)**

Harvest Systems Used

Ground based harvesting is by far the most common type of system in Maine. **Ground based - dragged** harvesting systems usually require use of cable or grapple skidders where trees are harvested individually or pre-bunched mechanically and dragged to the landing for further processing, sorting, or loading for off-site transport. Harvests that are primarily ground based dragged 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. Trees typically are cut to length in the woods and then carried or “forwarded” to the landing for further processing, sorting, or 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.

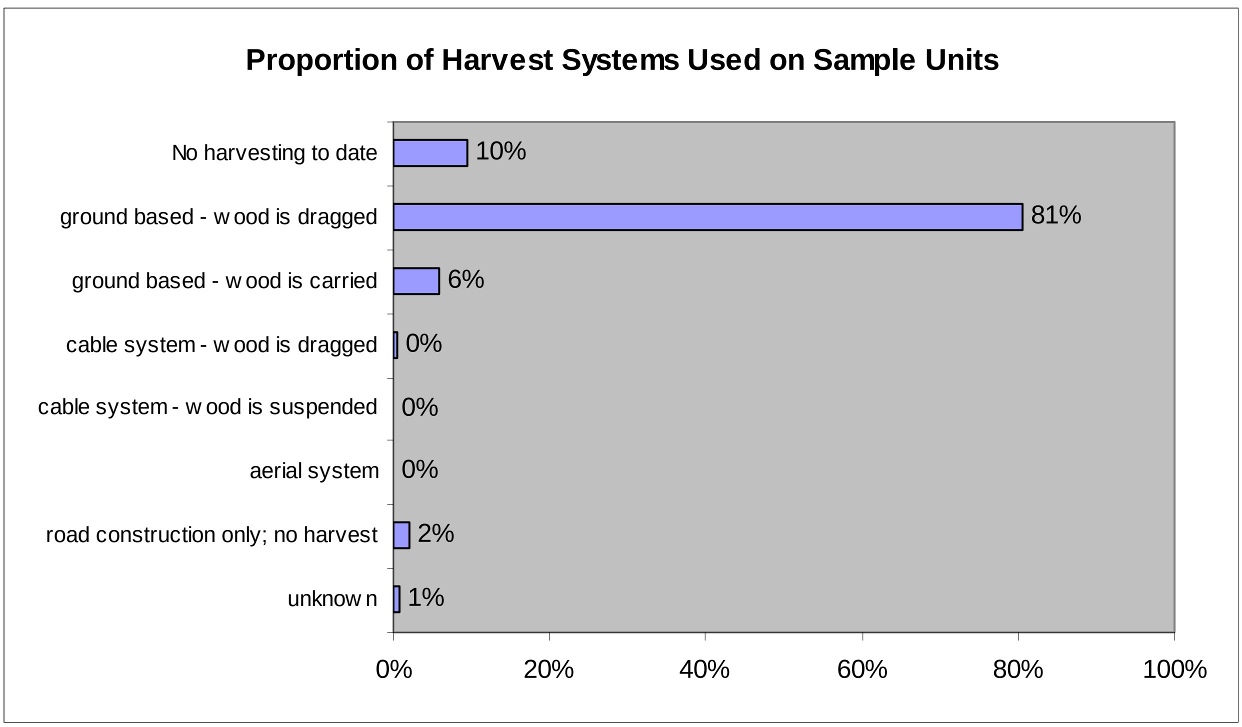

Figure 3 Harvest systems used on evaluated sample units. **(n=252)**

BMP Responsibility

BMPs are voluntary in Maine. However, mandatory BMPs may be resultant of additional 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 are also mandatory under many of the third party certification systems used to certify forestland in Maine.

The Maine Forest Service recommends identifying by name the person responsible for BMP implementation within a written timber sale agreement that clearly explains landowner, logger, and forester expectations. Where assignment of responsibility for BMPs by oral or written agreement was known, 88% of harvests evaluated had BMP responsibility assigned. This suggests a general knowledge among the forestry community of BMPs and their importance. 2006 – 2007 also showed what appeared to be a slight increase in written contracts for both loggers and foresters from 2005, 29% to 36% respectively.

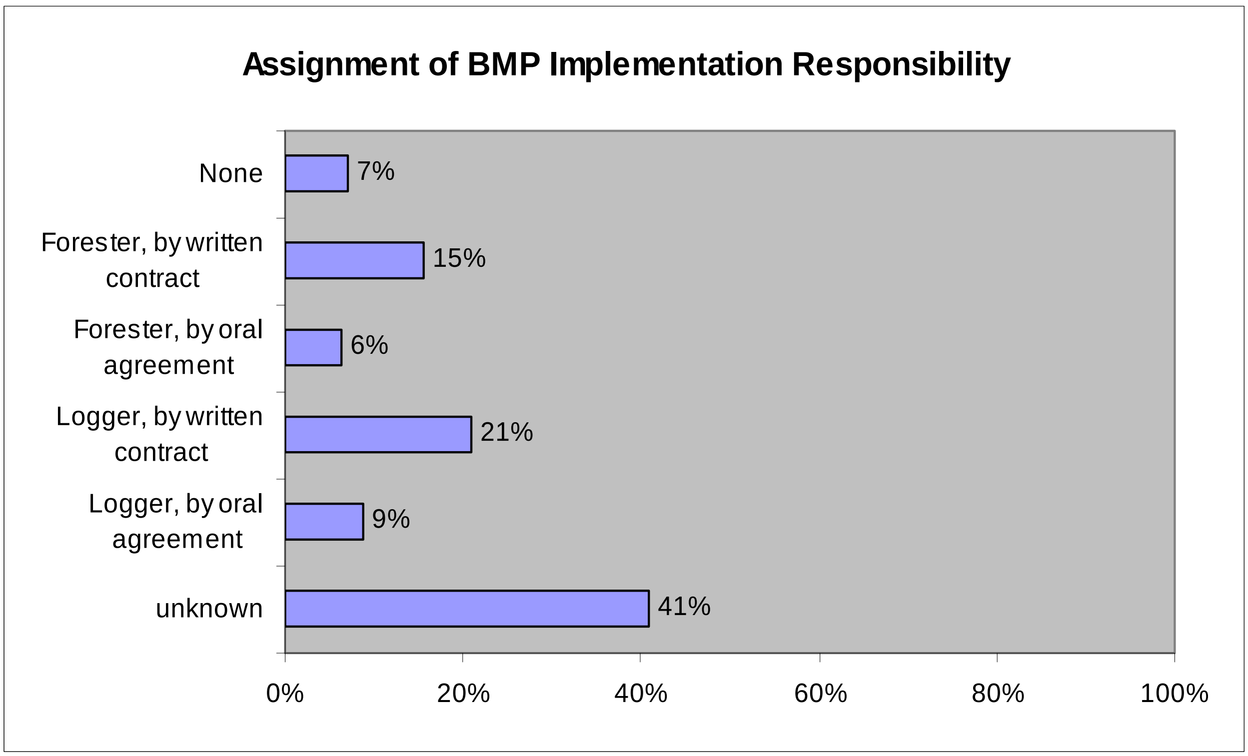

Figure 4 Assignment of BMP responsibility on evaluated sample units. **(n=252)**

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 2006-2007 sample units that did not have BMPs assigned had the lowest rates of sedimentation (Table 1). During 2005 harvests where BMPs were not assigned had much higher rates of sedimentation than harvests where responsibility was assigned. The reason for this change is unclear and but may be due to natural variability in the data. Larger samples taken from the Northeast Region have shown lower levels of sedimentation when BMP responsibility is assigned to a particular person[2].

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=72)	32%	11%	3%	1%	56%
Forester (by contract n=156)	54%	13%	5%	3%	21%
Logger (by contract n=212)	45%	13%	5%	8%	28%

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 fish spawning habitat; increases turbidity, and alters the chemical properties of rivers, streams, lakes and wetlands. BMPs are designed to be simple 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 **252** new sample units, there were **1260** opportunities to observe soil conditions.

Of the 1260 opportunities to observe soil conditions *87% showed no sediment entering the waterbody, a 4% improvement from the 2005 reporting period.* Of the remaining 13% of opportunities to evaluate soil movement 6% showed trace and 7% showed measurable amounts of sediment reached the waterbody (Figure 5).

Forty-one percent of the sample units did not have water crossings. This may be due to the absence of water or the purposeful avoidance of stream crossings through pre-harvest planning. Laying out the harvest on the ground can help identify sensitive areas, reduce skid trails, and avoid unnecessary stream crossings. When accounting for no surface water crossed, 83% of the observations at steam crossings showed no sediment entering the water. Prior to 2006 the protocol did not differentiate between harvests where there was no

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

water and harvests where water crossings were avoided by planning. The protocol has since been modified to account for water crossings avoided by planning.

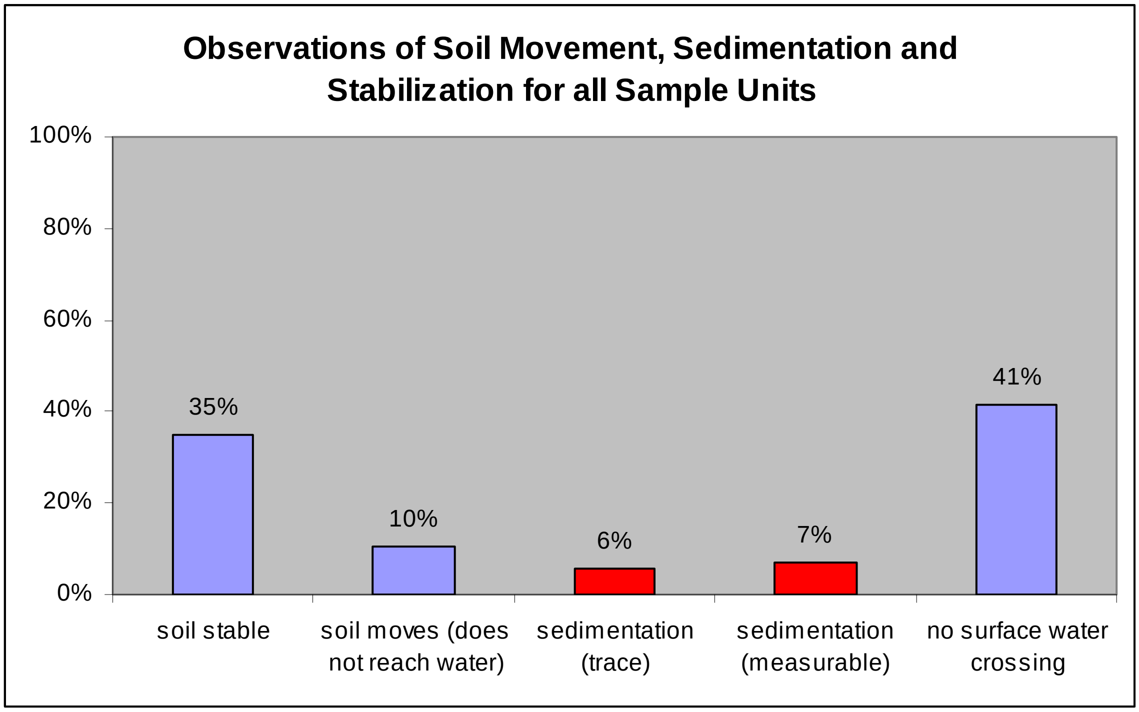

Figure 5 Observations of soil movement, sedimentation and stabilization as a proportion of total opportunities to observe soil conditions in the protocol **(n=1260)**

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 78% 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 22% of the observations where sediment did reach 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. 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.

Because of the small sample size we are not able to say anything definitive about how the origin of the sediment (crossing structure vs. approaches) relates to the amount of sediment delivered (trace vs. measurable) to the waterbody. Percentages of sediment originating from each area were similar to 2005 data with a possible slight reduction in measurable sediment delivered from the approaches. As BMP use increases, one would expect to see a decrease in measurable sedimentation relative to trace sedimentation.

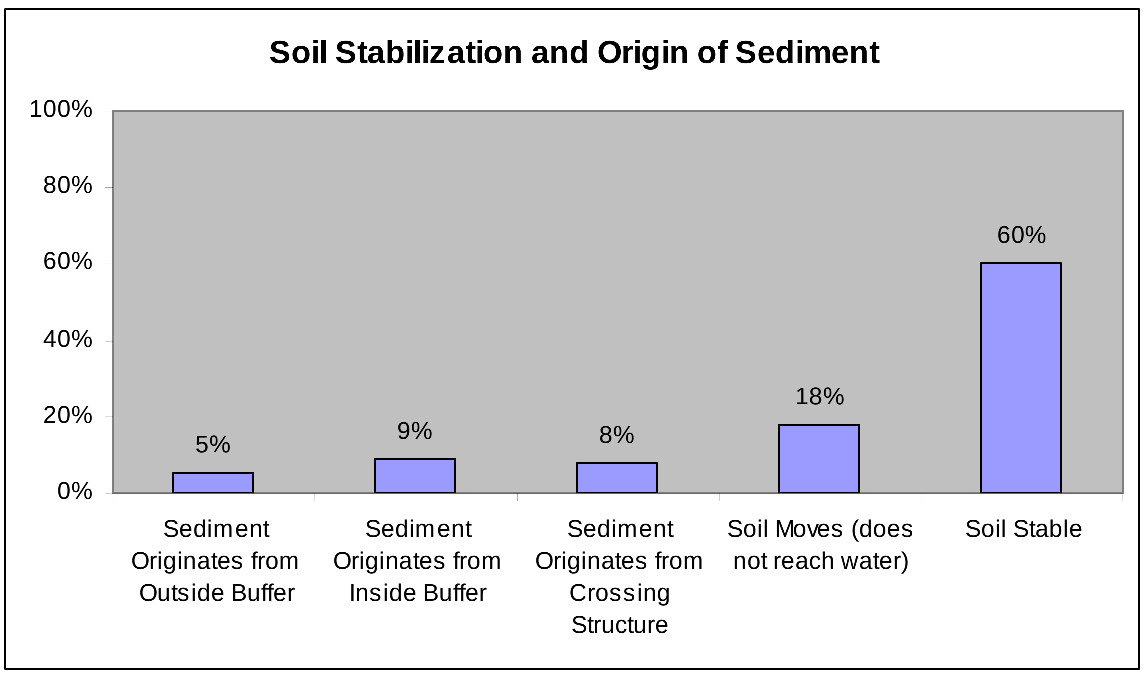

Figure 6 Soil stabilization and origin of sediment from sample units with water crossings **(n=732)**.

Approaches

Soil Stabilization and Sedimentation from the Approaches

During 2006-2007 MFS Field Staff evaluated **54,456** feet of water crossing approaches. At each water crossing there were four opportunities to evaluate approaches, one inside the buffer and one outside the buffer on each side of the crossing. On the sample units with crossings there were a total of **585** opportunities to evaluate soil conditions.

In 82% of the cases no soil reached the water body from the approaches (Figure 7). This indicates that planning and implementation of BMPs are keeping sediment from entering the water in most cases. Analysis of the18% of cases where sedimentation did occur from the approaches indicates the majority of sedimentation was due to inadequate maintenance or inadequate installation of additional BMPs (Figure 8). Assessment of BMP application when sedimentation occurred indicates that in most cases BMP implementation was either inadequate or BMPs were not applied (Figure 9). 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* is likely to improve the installation and maintenance of BMPs. These educational efforts should also stress the importance of proper closeout of operations since returning to a site to fix a problem after a harvest is completed represents an additional cost.

About 15% of cases (3% of total observations) of sedimentation were due to events unrelated to the harvest (Figure 8). This may indicate an opportunity to educate others (likely recreational user groups) of the importance of staying off of roads during inappropriate times of year.

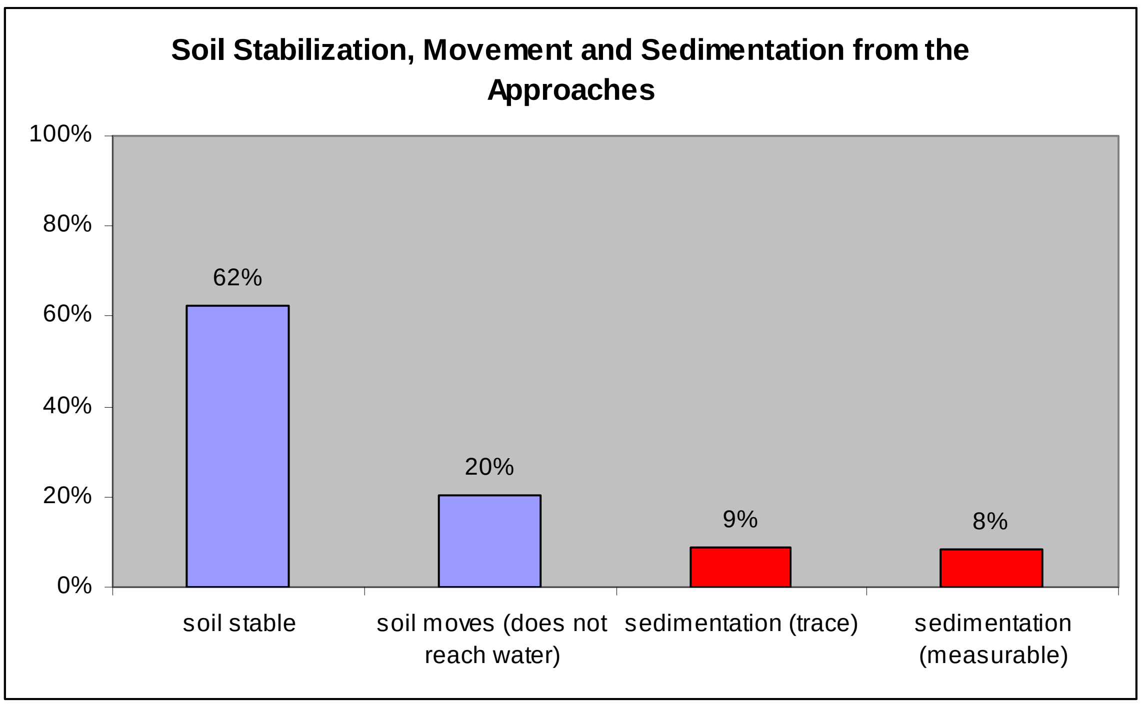

Figure 7 Soil stabilization, Movement and Sedimentation from the Approaches **(n=585)**.

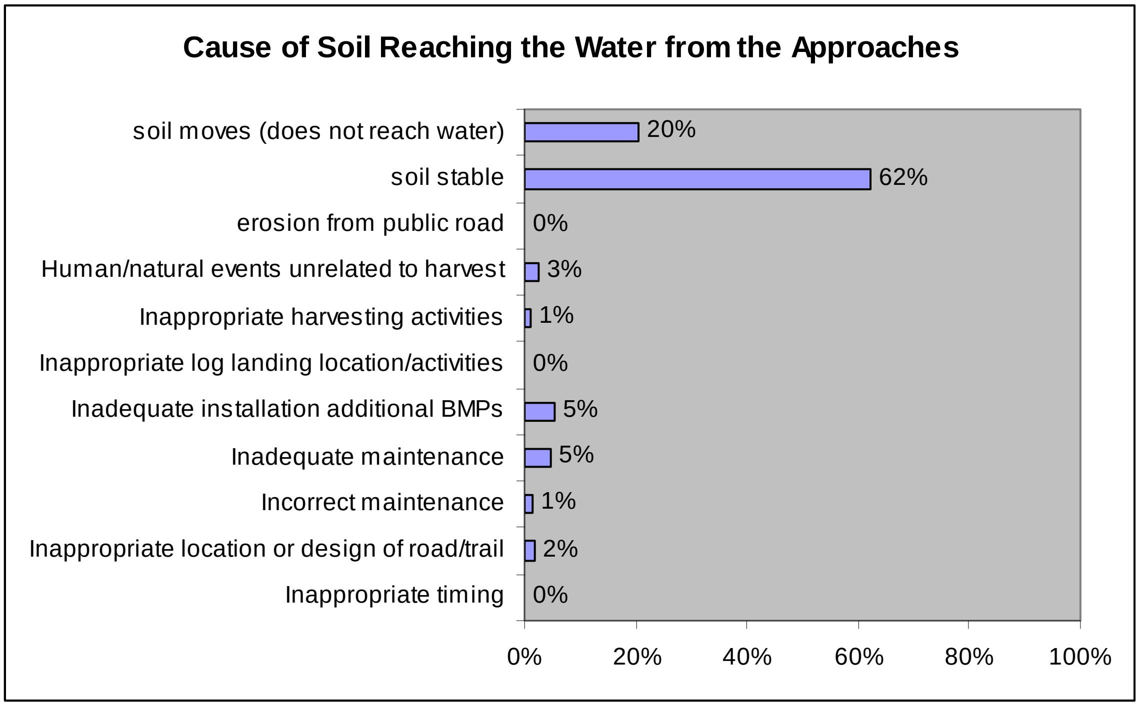

Figure 8 Causes of sedimentation from the approaches on sample units with crossings **(n=585).**

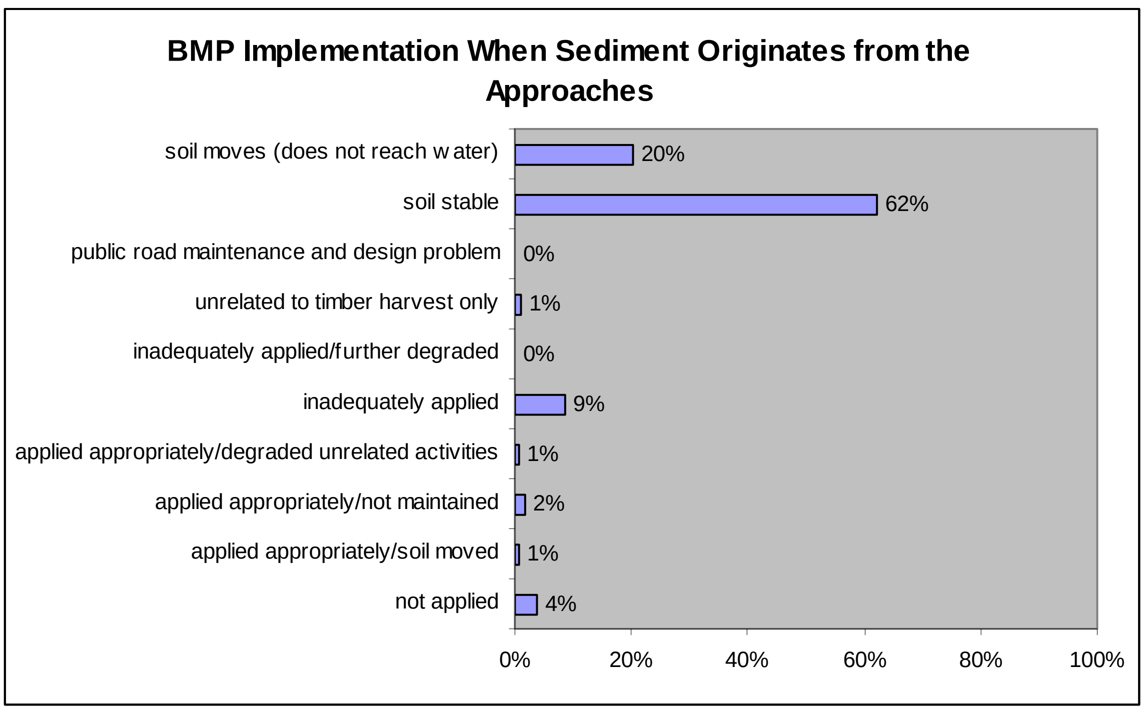

Figure 9 BMP implementation when sediment originates from the approaches on sample units with crossings **(n=585).**

Crossing Structure

MFS Staff evaluated **141** 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 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 single 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).

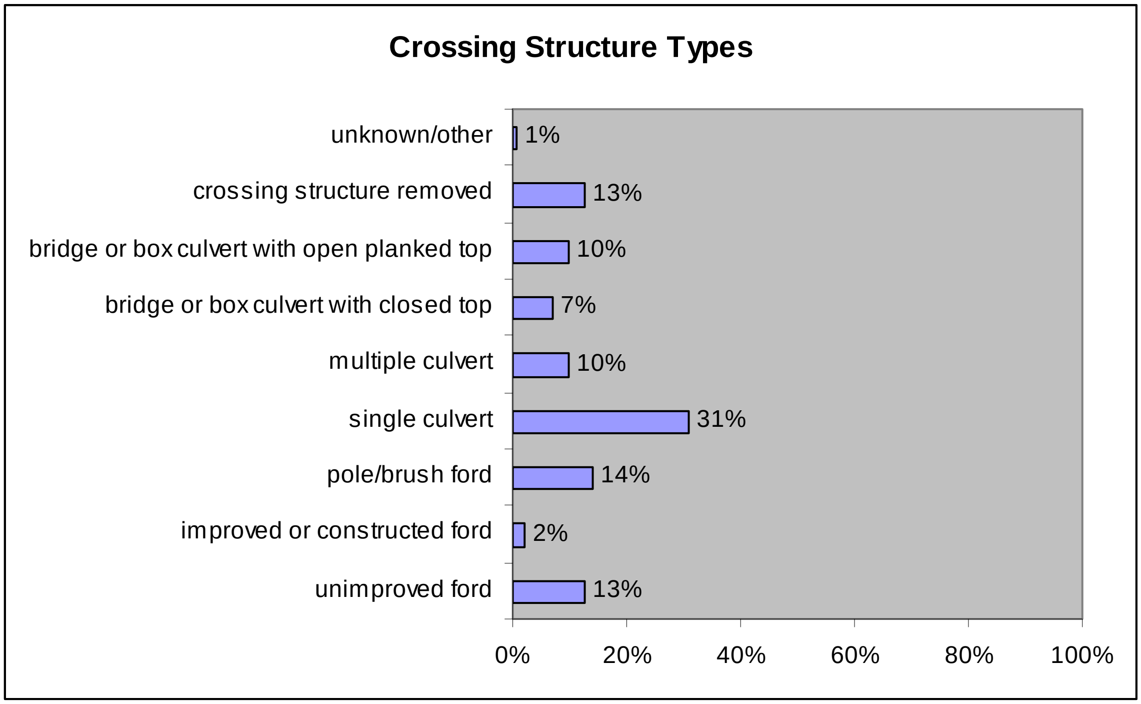

Figure 10 Crossing structure types **(n=141)**.

Soil Stabilization and Sedimentation from the Crossing Structure

In MFS observations of waterbody crossings 52% were successfully stabilized, while 48% had soil movement, which in many cases (39%) reached the waterbody. *27% of the observed crossings showed measurable sedimentation* (Figure 10). 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 they do not affect the biological activity of the associated waterbody. 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. Proper selection, sizing, installation and close out of crossing structures clearly represent areas that MFS 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 installations.

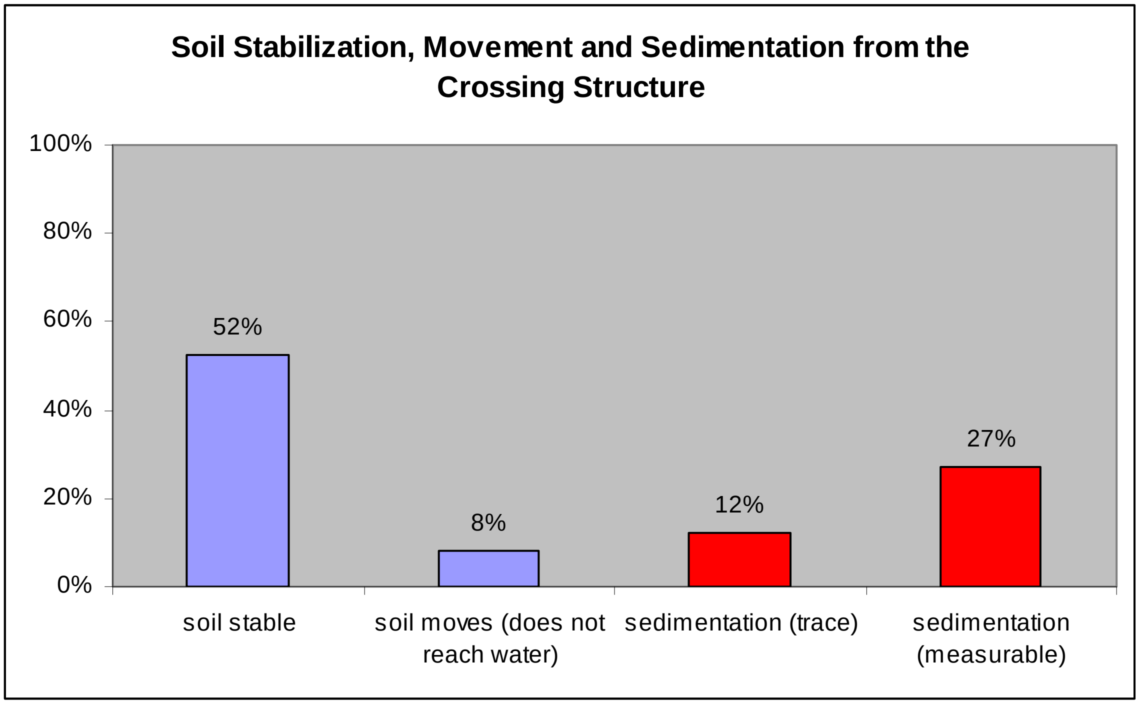

Figure 11 Soil stabilization movement and sedimentation from crossing structures **(n=141)**.

Structure Type Associated with Sedimentation

Single culverts were the type of structure most often associated with the addition of both trace (Figure 12) and measurable (Figure 13) amounts of sediment to the waterbody. This was due at least in part to the fact that single culverts were the most common type of structure encountered. When the data are normalized to account for the frequency of each structure, multiple culverts were the structure type that had the highest risk of being associated with sedimentation (Figure 14).

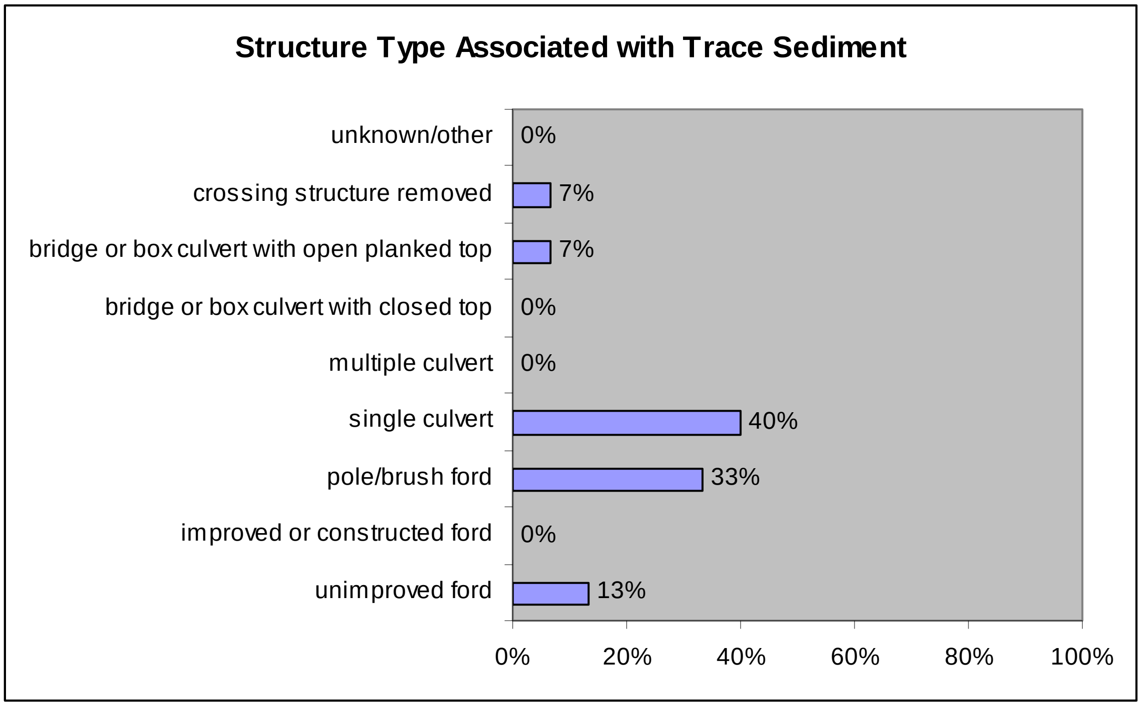

Figure 12 Structure type associated with trace sedimentation **(n=15)**.

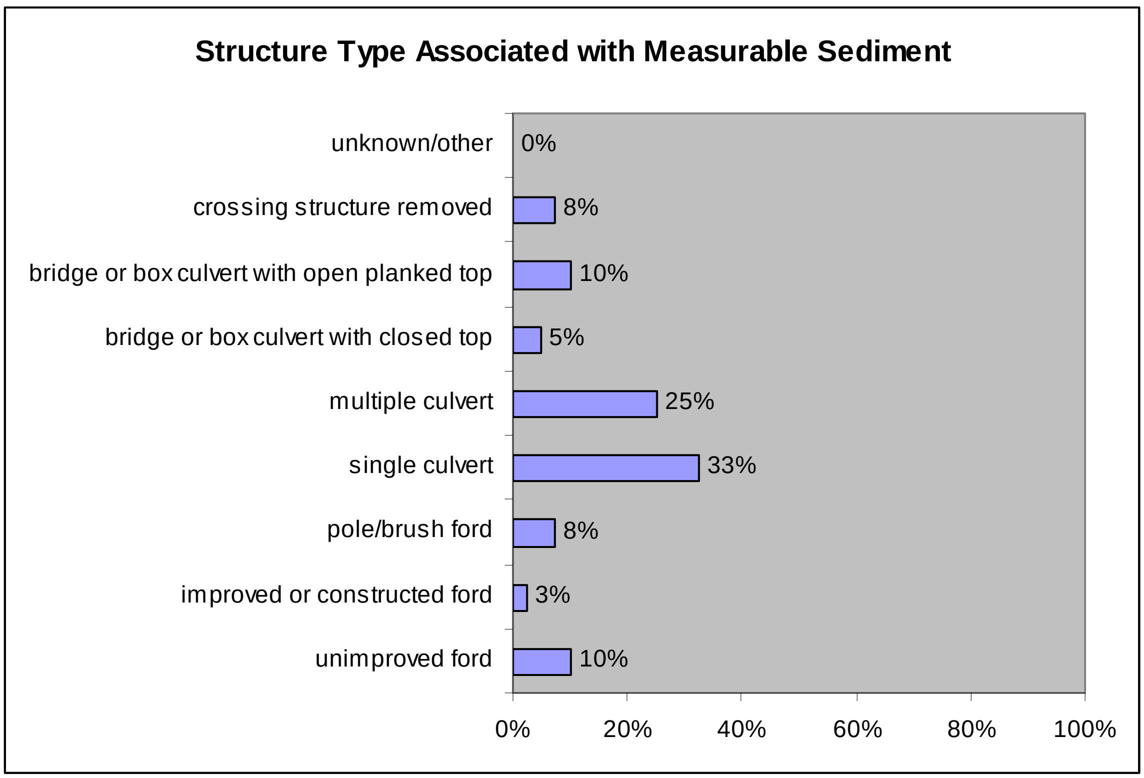

Figure 13 Structure type associated with measurable sedimentation **(n=40)**.

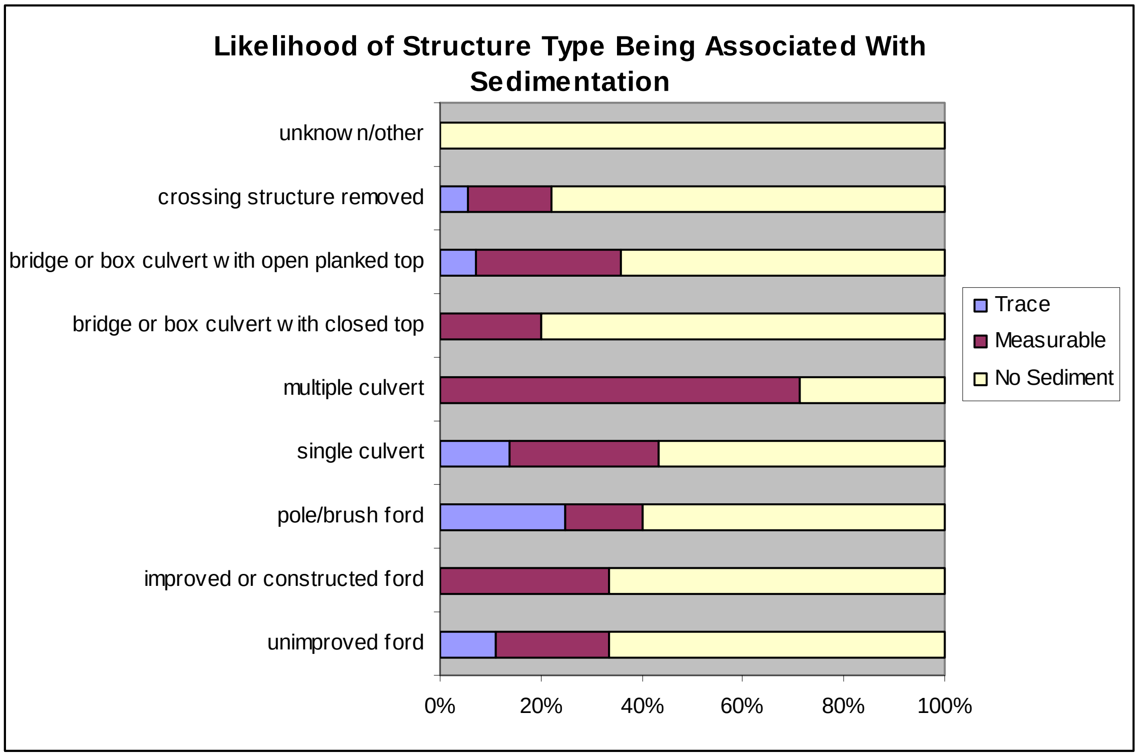

Figure 14 Likelihood of structure type being associated with sedimentation **(n=55)**.

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. 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). Properly sized structures typically should also be *at least* equal to the bankfull width of the channel. 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. *67% of the crossings evaluated did not span the bankfull width of the channel* (Figure 15).

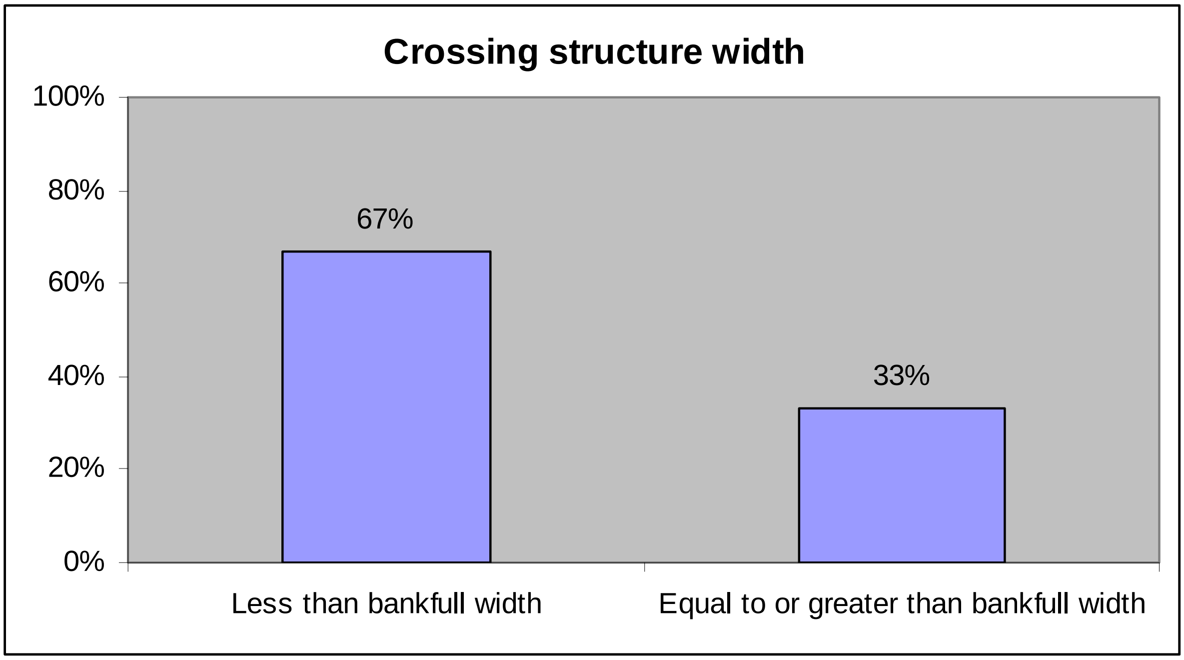

Figure 15 Width of crossing structure in relation to waterbody width at pre structure bankfull elevation. **(n=141)**

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. **52%** of the crossing structures were either open to the natural stream bed or had continuous substrate in the bottom of the structure. The majority of structures with substrate were open bottom structures rather than closed bottom ones with substrate in the bottom (Figure 16).

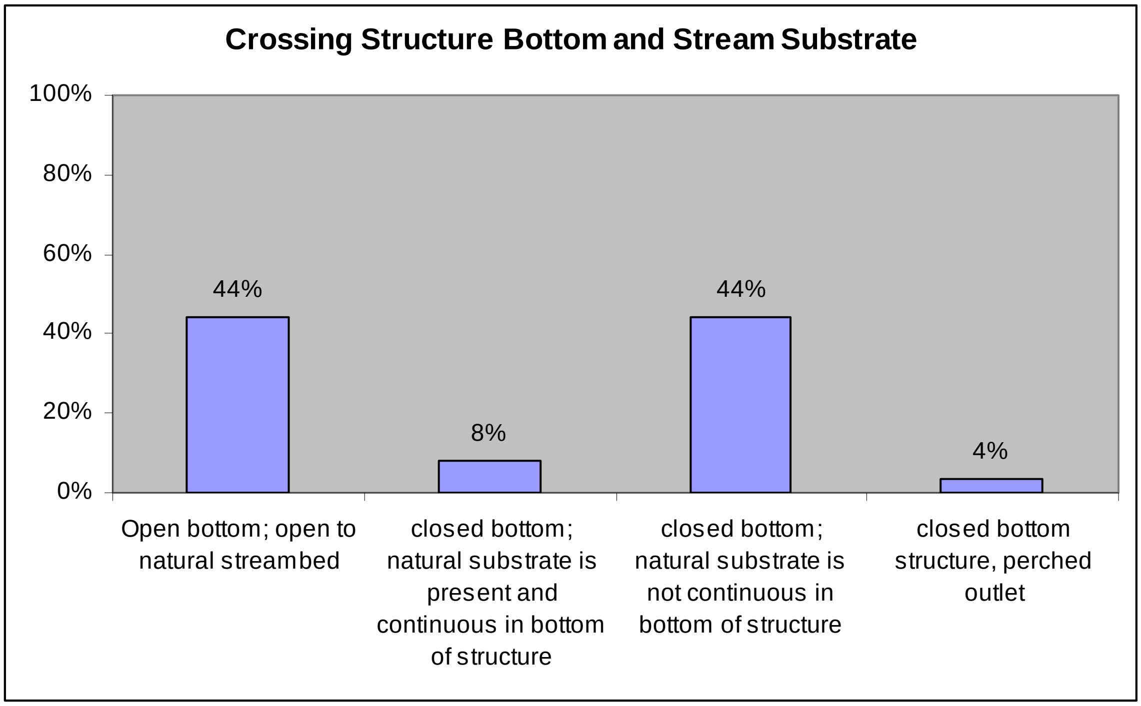

Figure 16 Presence of substrate in crossing structures. **(n=109)**

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.

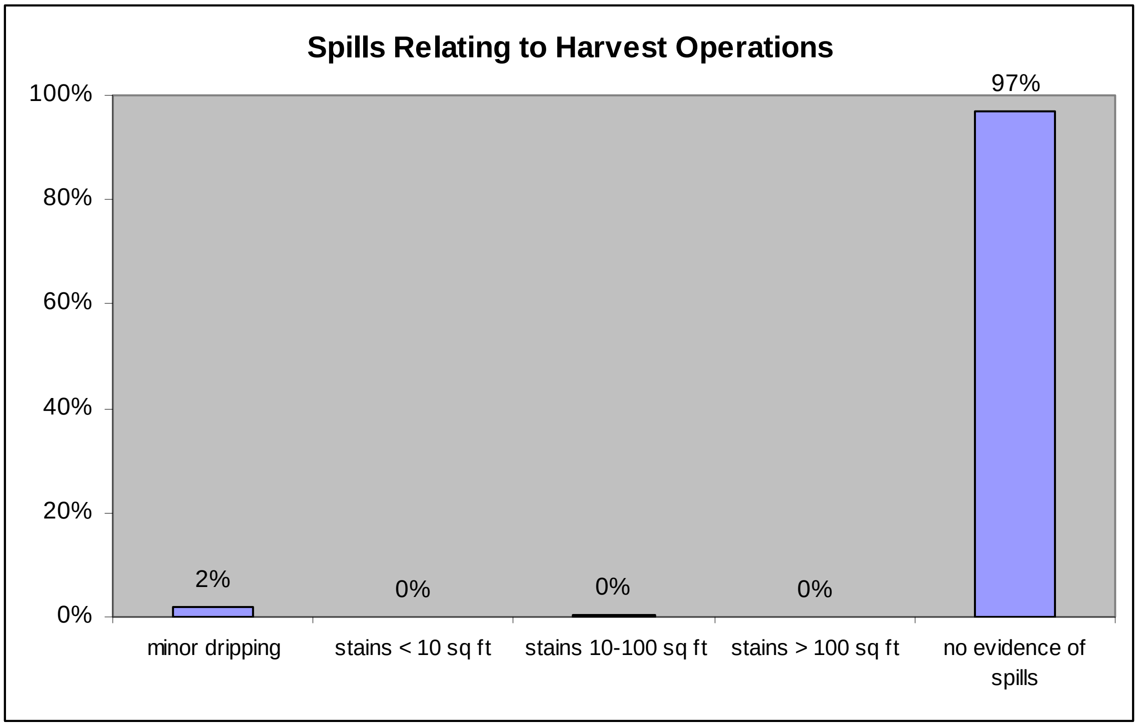

Figure 17 Spills relating to harvest Operations **(n=240)**

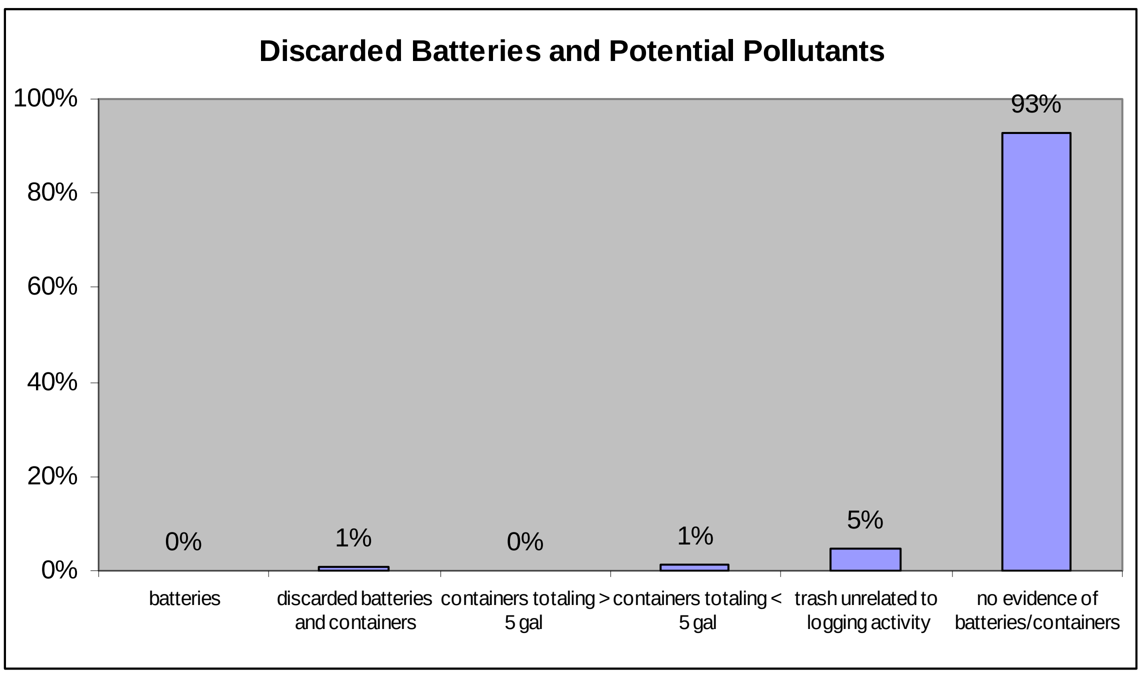

Figure 18 Discarded batteries and other pollutants. **(n=237)**

Conclusions

The 2006-2007 BMP monitoring showed improvement over 2005 in the number of harvests where sediment entered a waterbody. 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.

The monitoring also identified areas that need improvement:

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

2 - Undersized crossing structures. Upgrading crossing structures so they do not restrict the stream channel can be costly. Therefore, prioritizing which structures should be considered for replacement is important. MFS currently is partnering with the US Fish and Wildlife Service on a stream crossing survey in the Penobscot River Watershed. This survey ranks 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 also be considered.

APPPENDIX 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.