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Maine Forestry Best Management Practices (BMP) Use and Effectiveness—Data Summary 2013



Maine Department of Agriculture, Conservation and Forestry
Maine Forest Service
Forest Policy and Management Division
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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)

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We would also specifically like to thank the following people for their careful review and comment of the draft of report:

Amanda Mahaffey – Northeast Regional Director - Forest Guild

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Executive Summary

The Maine Forest Service (MFS) has worked closely with Maine's professional forestry community for many years to develop and refine forestry Best Management Practices (BMPs) to protect water quality. MFS BMPs stress a strong understanding of water quality protection principles needed to use the "toolbox" of BMP practices effectively. MFS prefers a flexible, voluntary BMP approach over prescriptive regulation. Voluntary BMPs based on water protection principles allow loggers and foresters to select efficient practices that result in the desired outcome; protection of water quality. For an outcome based BMP system to be successful, a strong training program must be in place as well as a monitoring system to ensure that BMPs are working on a statewide basis. Over 700 loggers, foresters and landowners have attended Maine Forest Service and partner water quality trainings over the last 2 years. MFS's key partner in training development and delivery has been Maine's Sustainable Forestry Initiative State Implementation Committee's Education Committee. The Certified Logging Professional Program, Qualified Logging Professional Program, Professional Logging Contractors of Maine, and the Northeast Master Logger Certification Program have all been instrumental in training program delivery. These public-private partnerships have advanced Maine's BMP educational efforts far beyond what they would be otherwise.

As of this writing, forestry operations do not have permitting requirements under the Clean Water Act because there is a "silvicultural exemption" given in that law, as long as best management practices (BMPs) are used to help control non-point source (NPS) pollution. The MFS is statutorily responsible for the development of forestry BMPs (38 M.R.S. §410-J) in Maine and has issued a BMP manual as required by United States Environmental Protection Agency (EPA). As part of this mandate, MFS also monitors and reports on the use and effectiveness of BMPs on harvest operations across the state.

MFS has conducted random, statewide monitoring of BMPs on timber harvesting operations since March 2000. The objective of this ongoing effort is to assess the use and effectiveness of BMPs in Maine. In 2010 the publication cycle was changed from an annual to a biannual report. Landowners are required to notify the MFS before harvesting takes place. Approximately 5,000 timber harvests notifications are filed in Maine each year; samples were drawn from these notifications. This report presents an analysis of data collected on 101 timber harvests during 2013. Originally 106 harvest sites were selected, but due to staffing shortages five sites were not visited, and these were dropped from the sample. MFS continues this monitoring effort as a part of regular field activities and expects to generate subsequent biannual reports.

Data in this report was collected and analyzed using the "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

Assessing the overall effectiveness of the suite of BMPs used rather than monitoring the installation of prescribed individual practices allows MFS to assess whether BMPs effectively protect water quality. For example, simply finding that waterbars were installed does not indicate whether they were effective in directing water into the filter area and keeping sediment out of the waterbody. 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 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.

Key findings

- **83% of crossings and approaches had BMPs applied appropriately or were avoided.** Stream crossings and their associated approaches represent a high risk area for sedimentation of surface waters. MFS BMPs emphasize planning harvests to minimize the number of crossings by avoiding crossing streams whenever practicable. When stream crossings are needed, properly applying BMP principles (such as minimize and stabilize exposed soil, control water flow, protect the integrity of the waterbody) when installing BMP practices (such as mulch and seed, slash stabilization, water diversions etc.) will minimize risk to the waterbody.
- **BMPs were not applied on 8% stream crossings and approaches.** When BMP principles and practices are not applied the risk of damage to waterbodies greatly increases. Monitoring in Maine and elsewhere has shown that if BMPs are not applied sediment reaches waterbodies much more frequently than when BMPs are applied.
- **91% of opportunities evaluated for sediment input found no sediment entered a waterbody.** A major goal of BMPs is keeping sediment from reaching

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.

waterbodies. It is essential that the BMPs chosen effectively achieve this goal. In other words, the outcome is more important than the BMP practice used.

- **There was no evidence of chemical spills on any of the harvests evaluated.** Large amounts of potentially toxic chemicals, including fuel, hydraulic and lubricating oils and greases are often present at logging operations. Properly securing and storing these chemicals and being prepared with a plan and the proper equipment if a spill occurs is an important BMP.
- **When applied appropriately BMPs were effective at preventing sedimentation from entering waterbodies.** Sedimentation events were strongly correlated with inadequate application of BMPs, or lack of BMPs. When BMPs were applied appropriately the risk of sediment entering a waterbody was very low, this finding is consistent with many studies from around the country.
- **The number of haul road stream crossings that spanned the bankfull width of the stream channel has steadily increased since 2005.** Improving installation of haul road crossings to permit fish passage through the crossing has been a major focus of training over the past several years. Crossings that are at least as wide as the natural stream channel are much more likely to permit passage of fish than ones that constrict the channel.
- **95% of sites had no haul road or landing in the waterbody buffer/filter strip.** Active haul roads and log landings typically have large amounts of exposed soil associated with them. BMPs call for an unscarified filter strip along waterbodies where the forest floor is kept intact and mineral soil is not exposed. Keeping new haul roads and log landings out of these areas is an important BMP. Relocating legacy roads and landings when possible away from waterbodies is also important.
- **Wetlands were either avoided or effective BMPs were used to cross.** Wetlands are very common in many parts of Maine. Crossing wetlands risks compromising their natural hydrology if not done properly. 91% of sample sites had no wetland crossing. Avoiding wetland crossings when at all possible is an important BMP. The majority of wetlands that were crossed had BMPs used to limit rutting to less than 6" deep, indicating effective use of BMPs. Wetland crossing BMPs focus on increasing the bearing strength of the soil by techniques such as limiting operations to frozen conditions and the use of corduroy, slash, timber mats or other measures.

Protocol Background

The BMP protocol project was a cooperative effort of the Forest Service, U.S. Department of Agriculture, and the Northeastern Area Association of State Foresters–Water Resources Committee (NAASF–WRC). The project 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 S&PF). The NA S&PF proposed the method to the NAASF–WRC and the EPA for development as a

potential regional protocol. After the withdrawal of the Maine Forest Service from the committee, David Welsch served as the project coordinator through the development, testing, and implementation of the project.

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 U.S. Forest Service Northern Research Station and NA S&PF have collaborated in the development and testing of the BMP protocol.

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Sample Selection

Landowners are required to notify the Maine Forest Service before starting a commercial timber harvest. Sample locations were randomly selected from Forest Operations Notifications that indicated the harvest was taking place within 250 feet of a waterbody. 101 sites were monitored out of approximately 5,000 notifications filed. Unlike previous years, the sample was not geographically stratified or stratified by ownership size, so caution must be used when comparing these results to those in previous reports. We expect to return to a stratified sample in the future.

Data Summary

The information in this data summary was compiled from a sample data set using measurements and observations from harvest sites containing **101** sample units. On most harvest sites one sample unit was sampled, however a few harvests had two or more units sampled. For a diagram of sample unit delineation see Figure 3.

The data collection procedure 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.

Data summary generation, quality control, risk analysis, and statistical sample design information are described in *Best Management Practices (BMP) Monitoring Manual—Desk Reference: Implementation and Effectiveness for Protection of Water Resources* (NA–FR–02–07).

General Information Feature

This report presents the results of data gathered for the BMP protocol project on new sample units for the State of Maine.

- A total of **101** new sample units were sampled, most harvest sites contained one sample unit, and on a few sites two or more units were sampled.

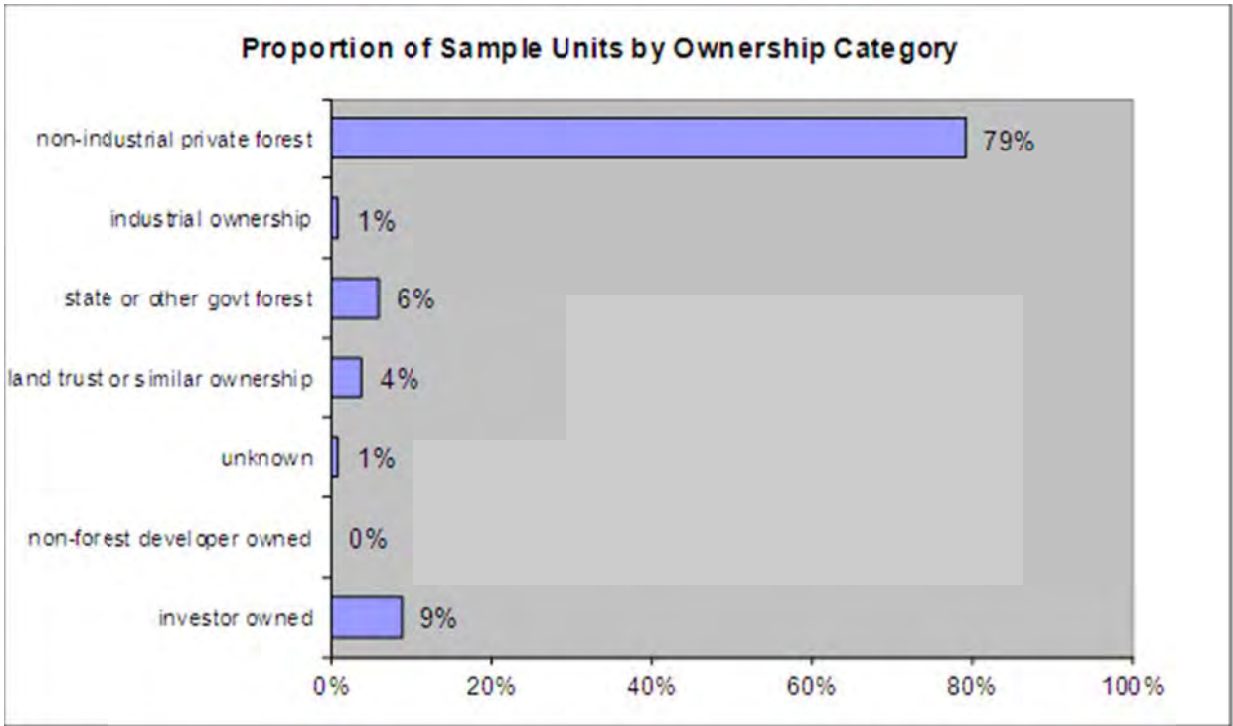


Figure 1 Proportion of Sample Units By category (n=101)

Acres Monitored

Total number of acres monitored: **5,893**

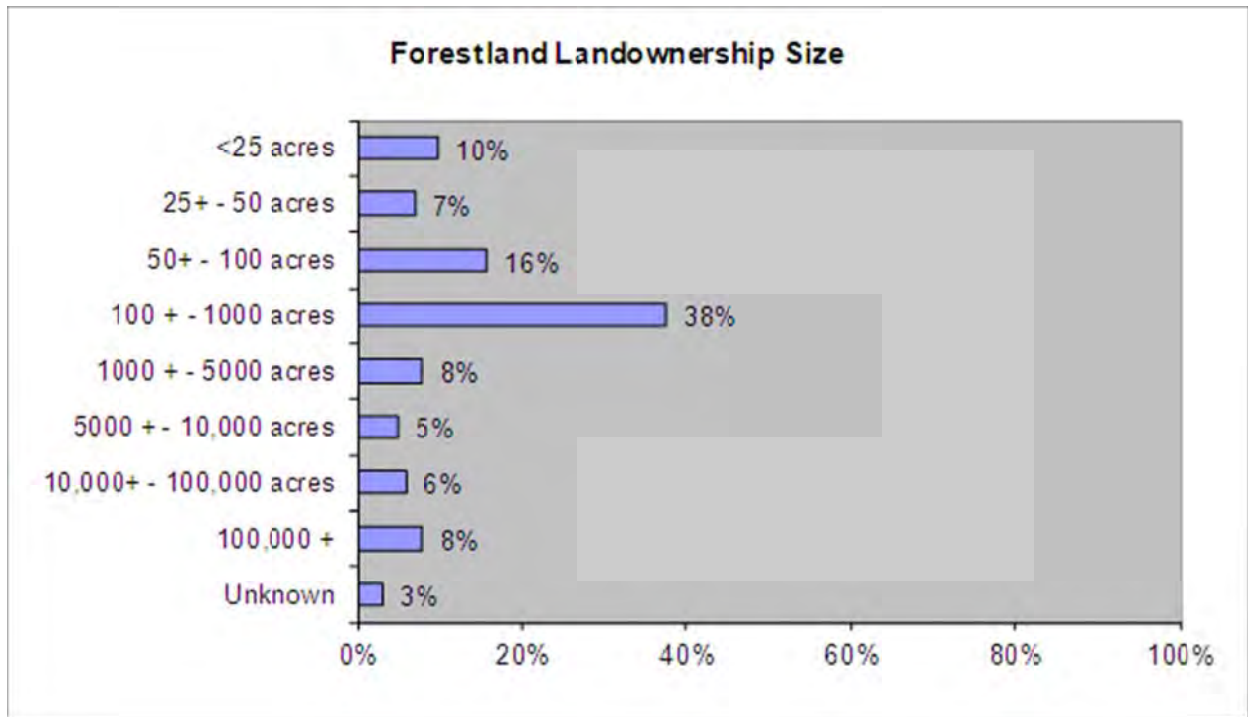


Figure 2 Ownership Size (n=101)

The total number of acres monitored equates to the area sum of all sample units where data was collected. One or two sample units were chosen at each harvest monitored. MFS personnel focused on recently harvested areas adjacent to surface water. Sample units were delineated by cutting boundaries, ownership boundaries, and by the crossing of natural perennial and intermittent streams. The crossing and its approaches were investigated and the data recorded in the sample unit being entered as the water body was being crossed. The delineation of sample units and the features to be included within them are shown on the following illustration. Because of the way method used to select samples for this survey, a higher percentage of samples were from smaller ownerships than was true for previous surveys where the sample was stratified by ownership size.

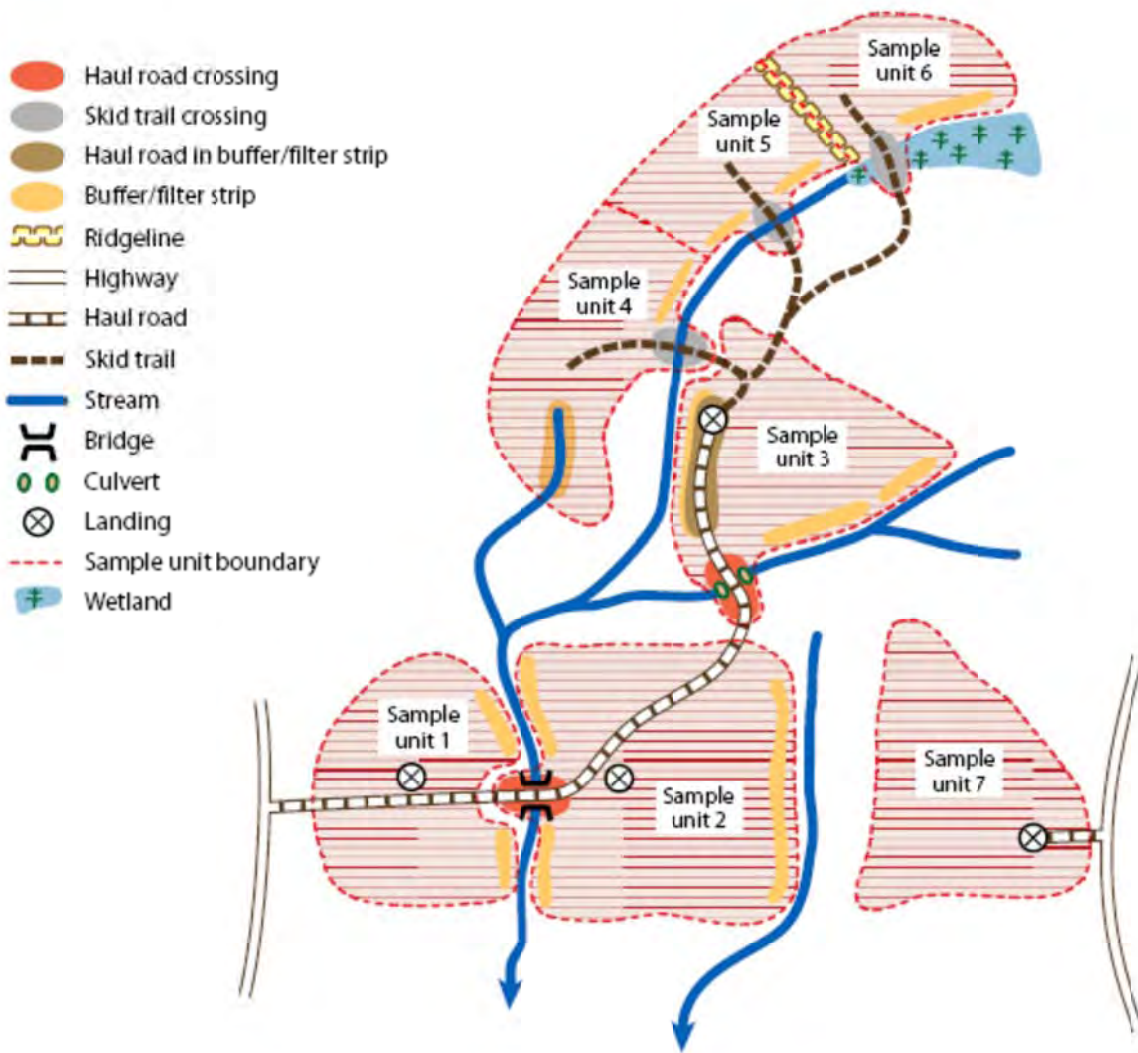


Figure 3 Sample Unit delineation

BMP Principle: Pre-Harvest Planning



Laying out the harvest on the ground can help identify sensitive areas, reduce skid trails, and avoid unnecessary stream crossings.

Harvest Systems Used

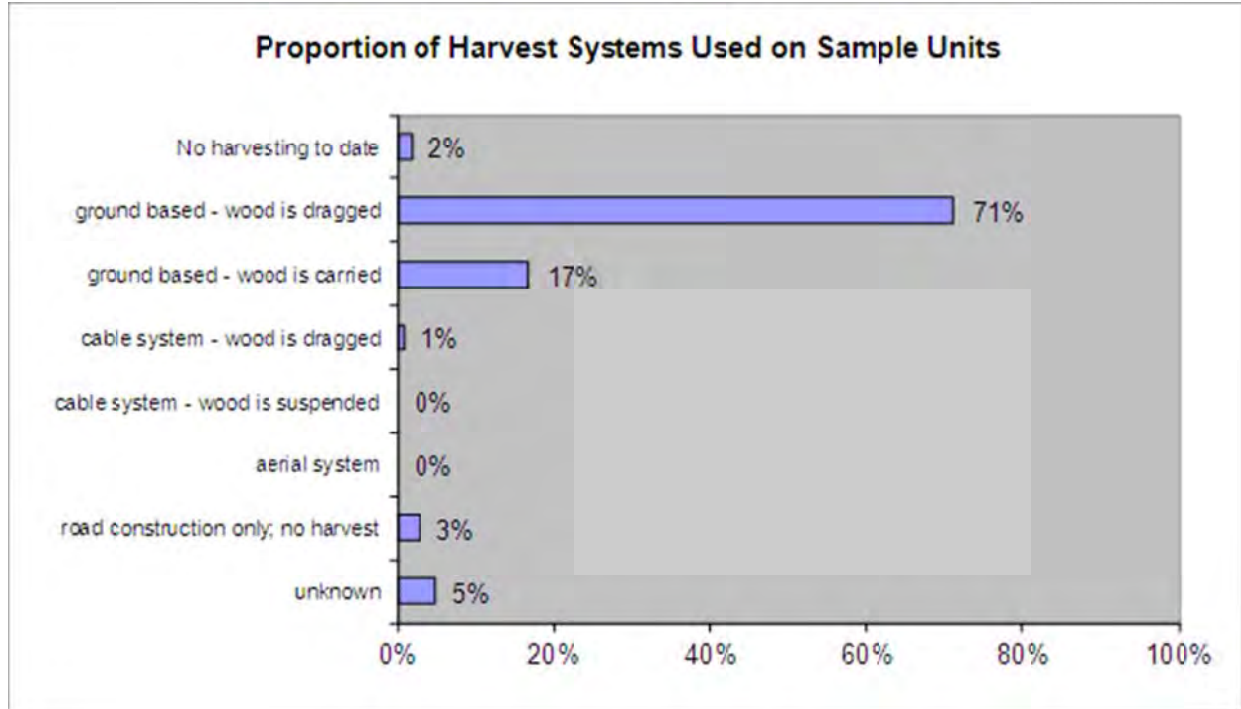


Figure 4 Harvest Systems (n=101)

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. When ground conditions are susceptible to disturbance, such as under unfrozen conditions, harvests that are primarily ground based dragged typically result in greater amounts of exposed soil. **Ground based - carried** harvesting systems generally result in less exposed soil and hence can reduce environmental risk. Trees are typically cut to length in the woods and then carried or “forwarded” to the landing for further processing, sorting, or loading for off-site transport.

Cable - dragged or suspended and aerial harvesting systems common in western mountain states are rare in Maine. Prolonged steep slopes and naturally occurring unstable soils generally do not occur in Maine to the same extent as out West.



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 together with proper planning are critical to good results.

BMP Implementation

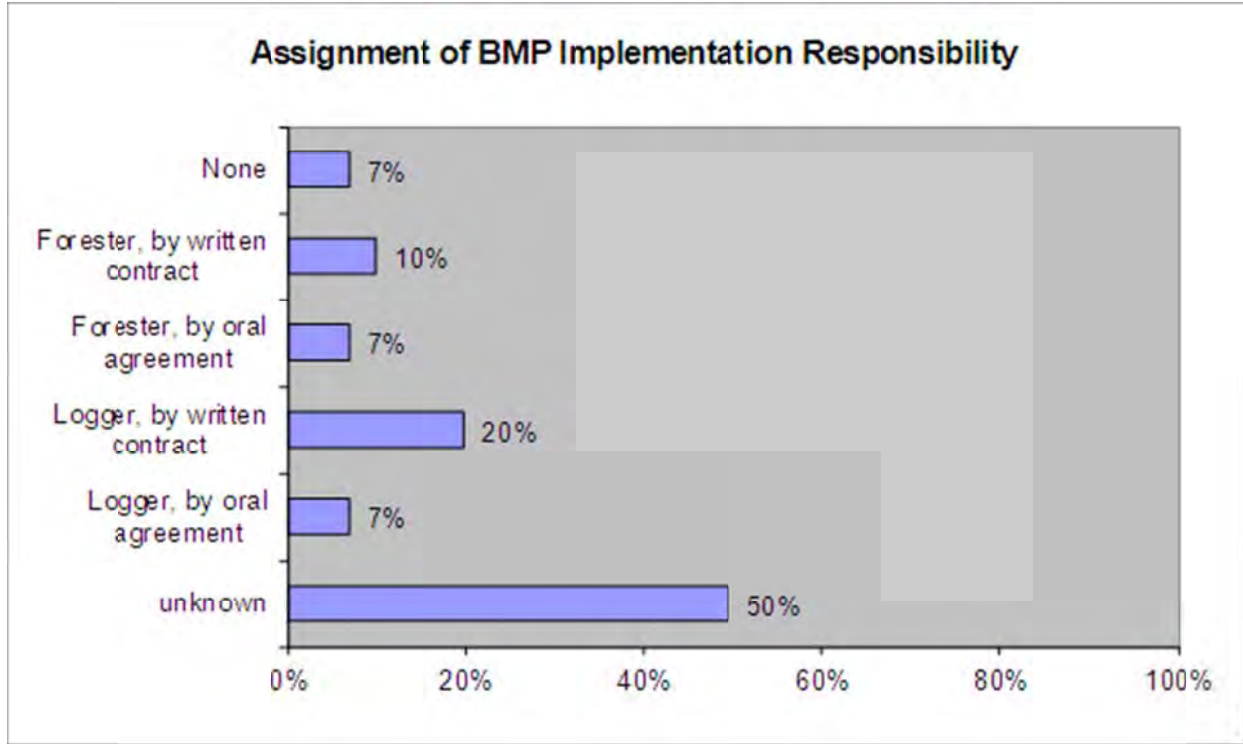


Figure 5 Assignment of BMP Responsibility (n=101)

The Maine Forest Service recommends identifying who is responsible for BMP implementation within a written timber sale agreement that clearly explains landowner, logger, and forester expectations. The Maine forest service provides BMP training to loggers, foresters and landowners. Foresters must be licensed to practice in Maine in Maine.



BMP Principle: Define objectives and responsibilities

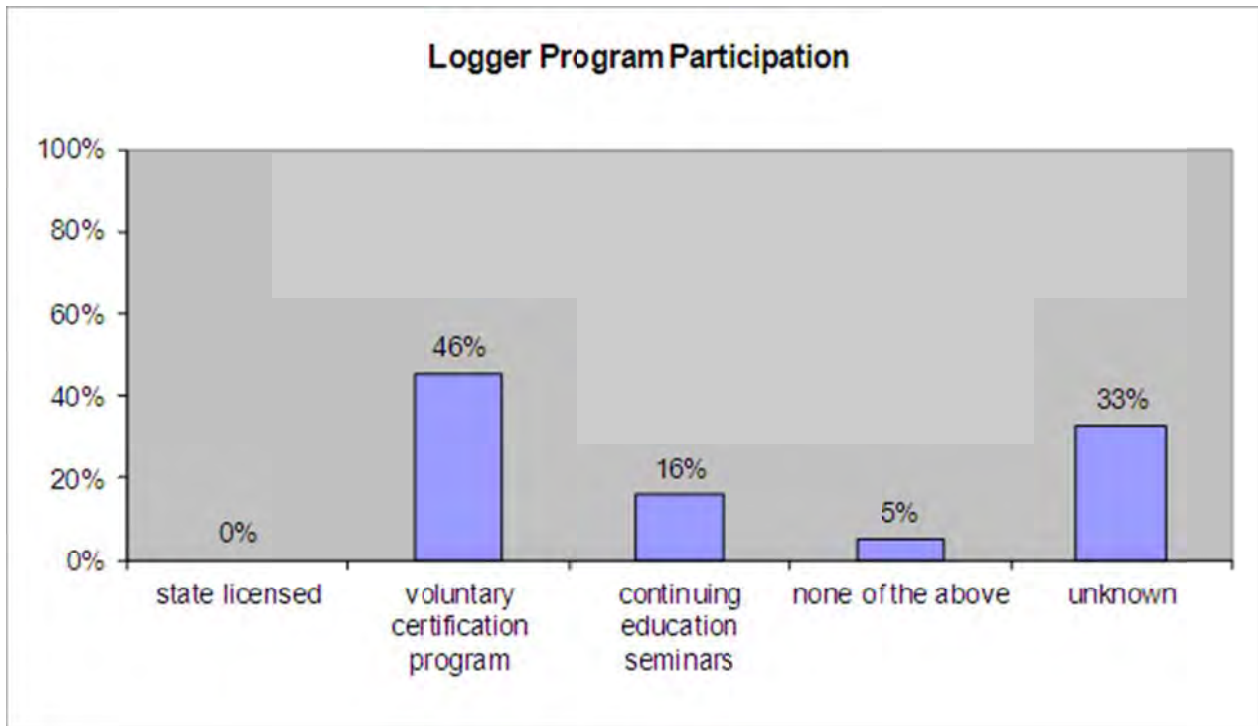


Figure 6 Logger program participation (n=101)

Discussion

Many loggers voluntarily participate in second and third party certification programs in Maine; Certified Logging Professional (CLP), Qualified Logging Professionals (QLP) and the Northeast Master Logger Certification Program. CLP with assistance from many partners has certified over 5,000 loggers since 1991, and there are currently over 100 Northeast Master Logger Certified companies in Maine. CLP along with other logger certification programs require continuing education credits and periodic field auditing on active timber harvests. Maine logger programs have significantly reduced logger worker compensation costs by promoting safety and accident prevention. Maine does not have state-level logger licensing.

Soil Movement, Sedimentation, and Stabilization on all Sample Units

There were 5 opportunities to observe the occurrence of soil movement, sedimentation, or stabilization for each sample unit: Approach Area A–Outside the Buffer/Filter Strip, Approach Area A–Inside the Buffer/Filter Strip, the crossing structure, Approach Area B–Inside the Buffer/Filter Strip, and Approach Area B–Outside the Buffer/Filter Strip (Figure 7). **Proportions in this section were based on the total number of opportunities to make observations about soil conditions, including sample units that did not have a crossing.** Including sites without crossings in here is intended to give an overall

The protocol defines as buffer or filter strip as “A state designated width of land adjacent to surface where logging activities affecting shade, basal are or erosion and sedimentation are regulated to protect waterbodies.” In Maine, regulatory buffers range from 25’ to 250’ or wider depending on the type of waterbody and regulatory jurisdiction.

picture of harvest impacts on water quality, since many harvests are planned such that they never interact with a waterbody. Subsequent sections (Approaches, Crossing Structure) give a more detailed analysis of just sample units that had crossings. Wetland Crossings, Haul Roads in the Buffer and Chemical Pollution are not included here and are treated separately in their own sections.

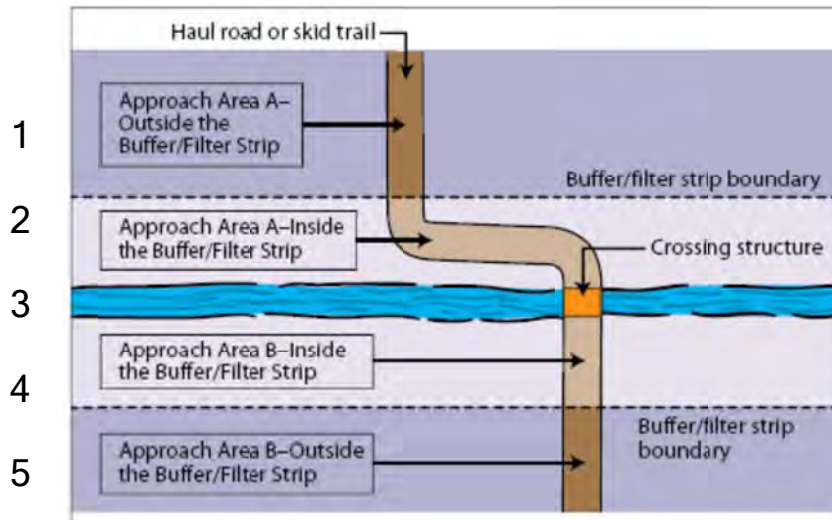


Figure 7 Showing 5 opportunities to observe soil movement at any typical haul road or skid trail stream crossing

For the **101** new sample units, there are **505** opportunities to observe soil conditions.

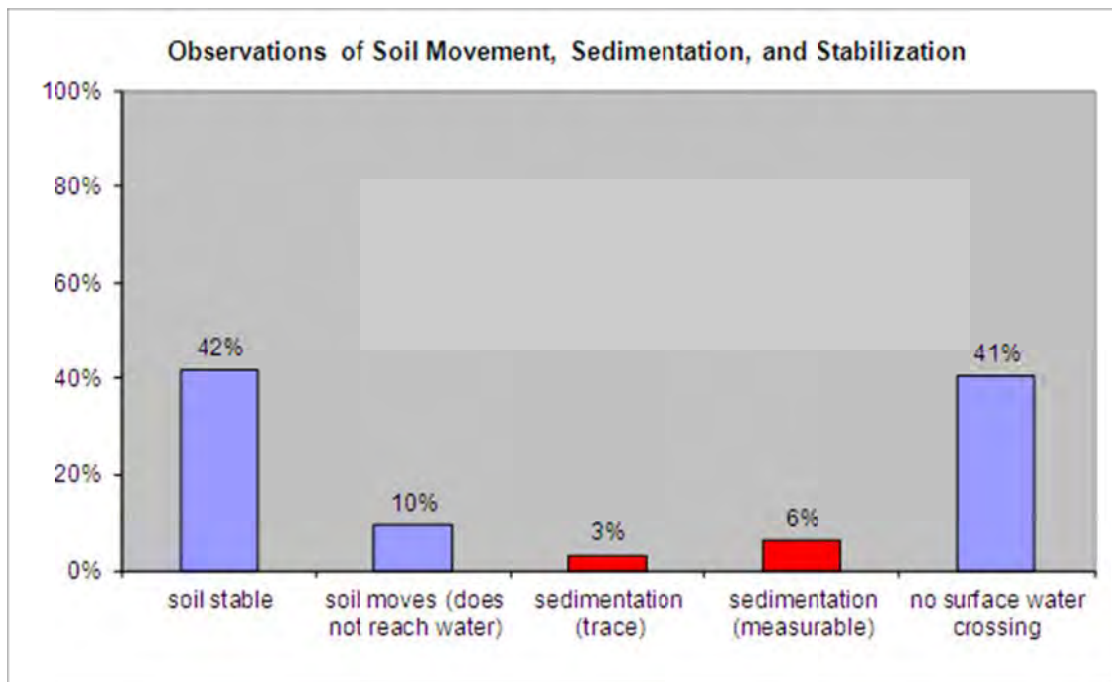


Figure 8 Proportions are based on the total number of opportunities to observe soil conditions in the protocol n=505. Note: measurable sediment is considered a volume of sediment greater than 1 cubic foot.

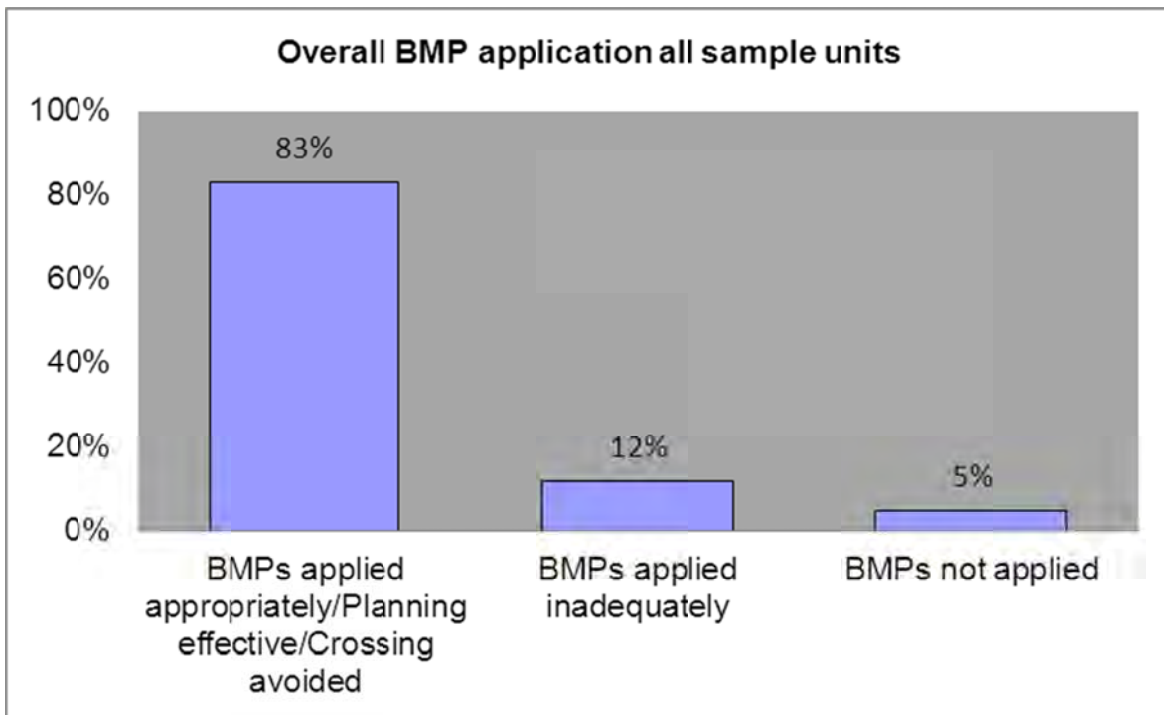


Figure 9 Overall applications of BMPs at stream crossings.

Discussion

Of the 505 opportunities to observe soil conditions, 9% showed either trace or measurable amounts of sediment reached the waterbody. 41% of harvests avoided water crossings, avoiding a crossing, when operationally practicable, is always considered preferable to installing a crossing that needs BMPs to control erosion and sedimentation. Excluding avoided water crossings, sediment reached the waterbody on 15% of observations. BMPs were judged to be applied appropriately on 83% of sites and not applied at 5% of sites. These percentages include sites where crossings were avoided. If sites without crossings are not included BMPs were not applied at 8% of crossings.

Sedimentation by Area of Origin

There were **47** observations of sediment reaching the surface water body or deposited within bankfull channel width of the water feature.

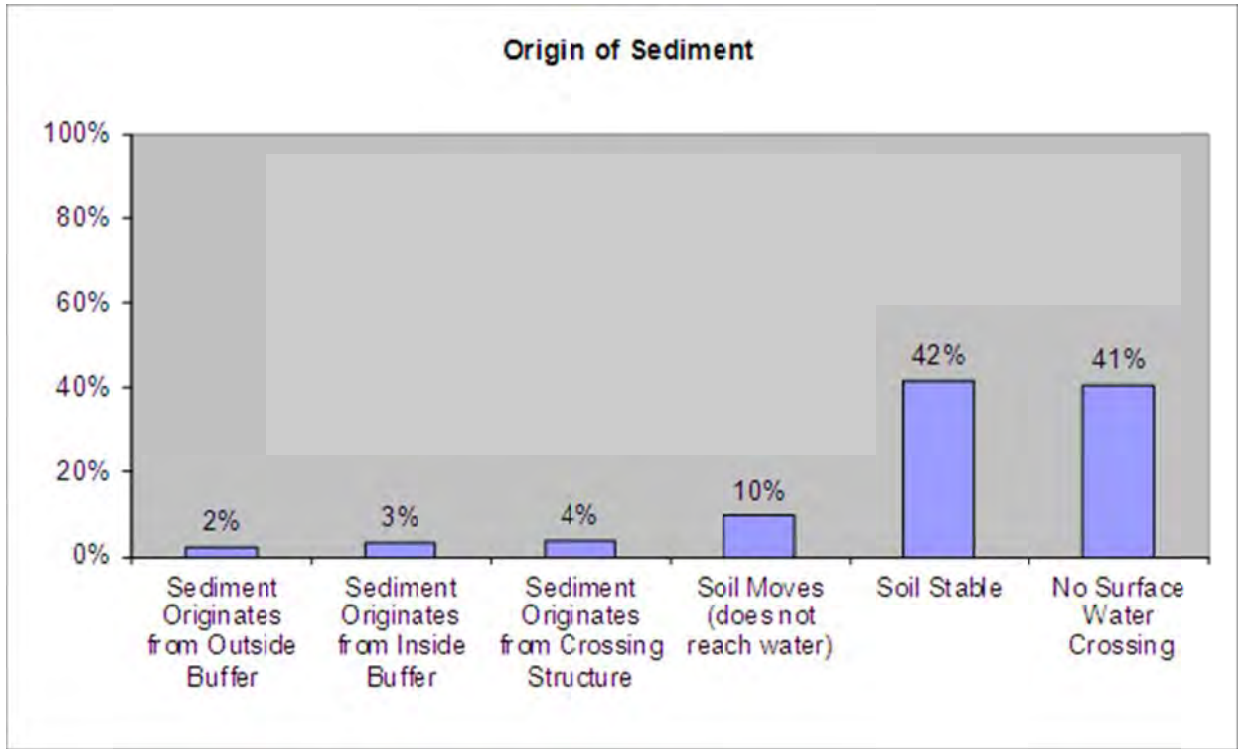


Figure 9 Origin of Sediment (n=505)

Trace and Measurable Sediment by Area of Origin

The following charts compare observations of trace amounts of sediment by area of origins to observations of measurable amounts of sediment by area of origin.

There were **16** observations of trace amounts of sediment reaching the surface water body or deposited within bankfull channel width of the water feature.

There were **31** observations of measurable amounts sediment reaching the surface water body or deposited within bankfull channel width of the water feature.

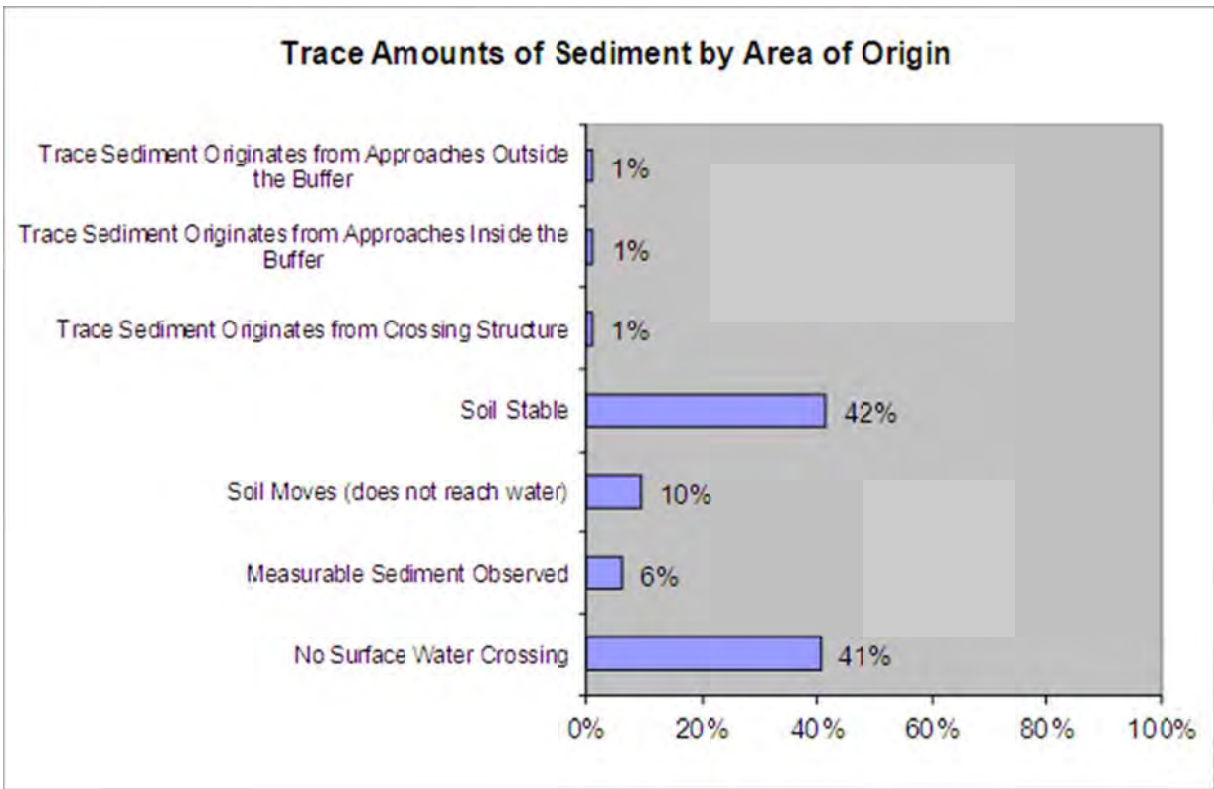


Figure 10 Trace amounts of sediment by origin (n=505)

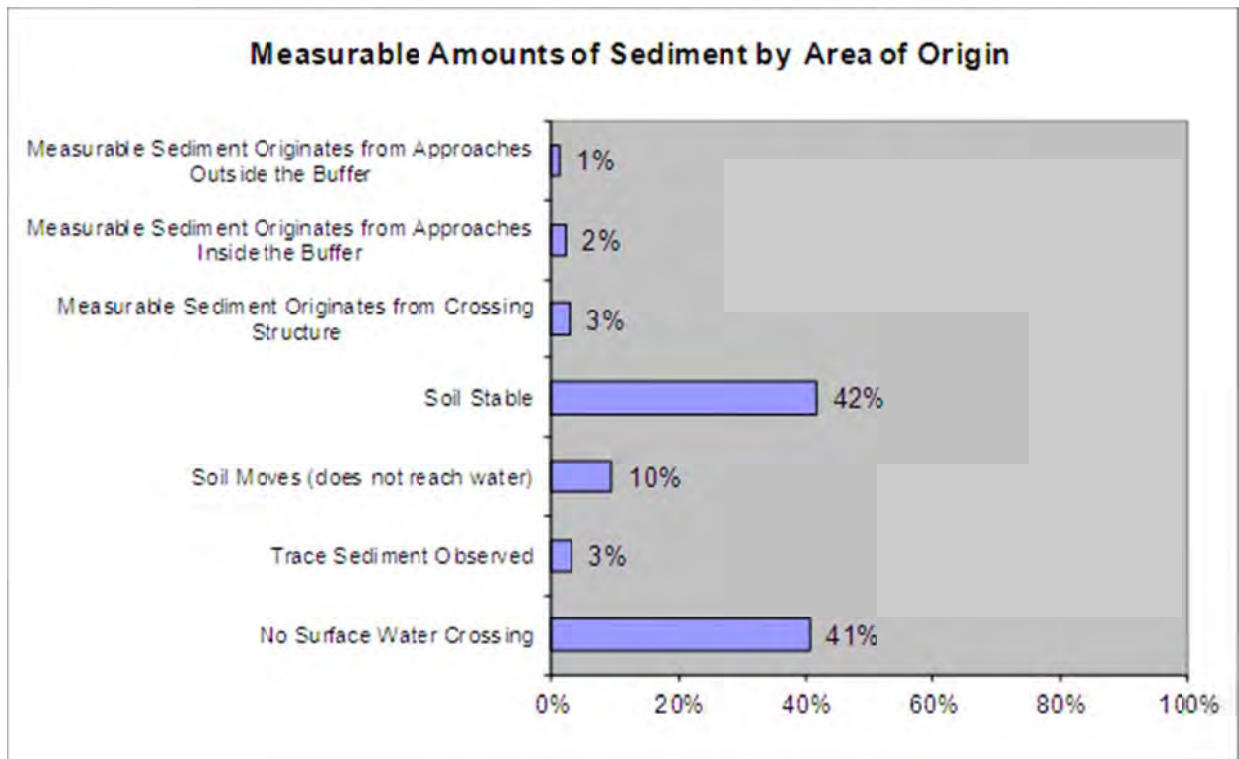


Figure 11 Measurable amounts of sediment by origin (n=505)

BMP Principle: *Minimize and Stabilize Exposed Soil*



Discussion

Measurable sediment was most likely to reach the waterbody from the crossing structure and inside the buffer/filter strip, this is not surprising since these are the areas closest to the waterbody. Sediment did also reach waterbodies from the approaches outside of the filter strip on some sites. **This highlights the importance of extending BMPs far enough up the slope to be able to handle the anticipated amount of runoff from areas beyond the filter area.** It is also critical to have a plan for installing additional BMPs in the approaches if the initial ones are not adequate.

The amount of exposed soil is directly correlated to amount of water quality risk associated with timber harvesting. The Maine Forest Service recommends minimizing exposed mineral soil adjacent to water bodies and stabilizing immediately if it occurs. Follow recommended filter area widths in MFS's Best Management Practices for Forestry: Protecting Maine's Water Quality adjusting for percent slope and distance to waterbody.

Approaches to Water Crossing

There were **4** opportunities to observe the occurrence of soil movement, sedimentation, or stabilization from the approaches to a surface water crossing: Approach Area A—Outside the Buffer/Filter Strip, Approach Area A—Inside the Buffer/Filter Strip, Approach Area B—Inside the Buffer/Filter Strip, and Approach Area B—Outside the Buffer/Filter Strip. **Data reported in this section contains information only from sites that had surface water crossings.**

For the **101** new sample units there were **61** crossings evaluated, with 4 opportunities to observe soil movement in the approaches there were **244** total opportunities to observe soil conditions at approaches.

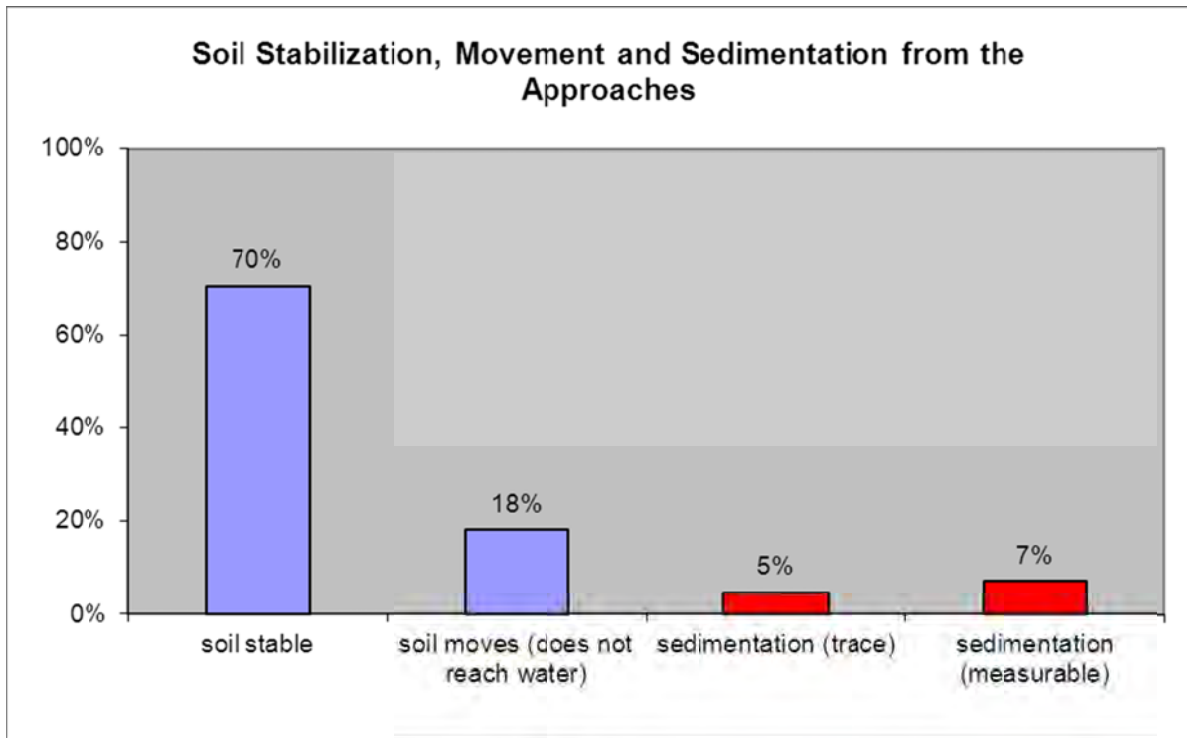


Figure 12 Observations of soil stabilization, movement and sedimentation at the approaches (n=244)

Discussion

Excluding avoided stream crossings (41%), there were 244 opportunities to observe soil conditions in the approaches to the 61 crossings. Sediment reached the waterbody from the approaches at 12% of observations. In 18% of cases in which soil moved but did not reach the waterbody. BMPs are not designed to eliminate all soil movement, rather to reduce it to levels that the BMP system can manage without it impacting the waterbody.

Sediment from the Approaches

There were **11** observations of trace amounts of sediment reaching the surface water body or deposited within bankfull channel width of the water feature.

There were **17** observations of measurable amounts of sediment reaching the surface water body or deposited within bankfull channel width of the water feature.

The following table compares volumes of measurable amounts of sediment.

Table 1 Volume of sedimentation at approaches (cubic feet). Table reflects the mean (average), median, and maximum sediment volumes 1 cubic foot or greater. Rill and gully volumes are measurements of the volume displaced from the rill or gully and may be larger than the volume actually entering the bankfull channel. Sediment evident in the water body is a measure of the sediment attributable to the logging activity and present in the channel when the observation is made; it cannot account for sediment washed away prior to observation. Thus, there is a high probability that the actual volume of sediment reaching the bankfull channel of the water body is between these two estimates.

	Approaches Outside the Buffer/Filter Strip (ft ³)		Approaches Inside the Buffer/Filter Strip (ft ³)	
	Rill or gully	Sediment evident in water body	Rill or gully	Sediment evident in water body
Mean	52	6	53	3
Median	11	5	10	2
Maximum	267	24	267	7

Specific Cause of Sedimentation from the Approaches

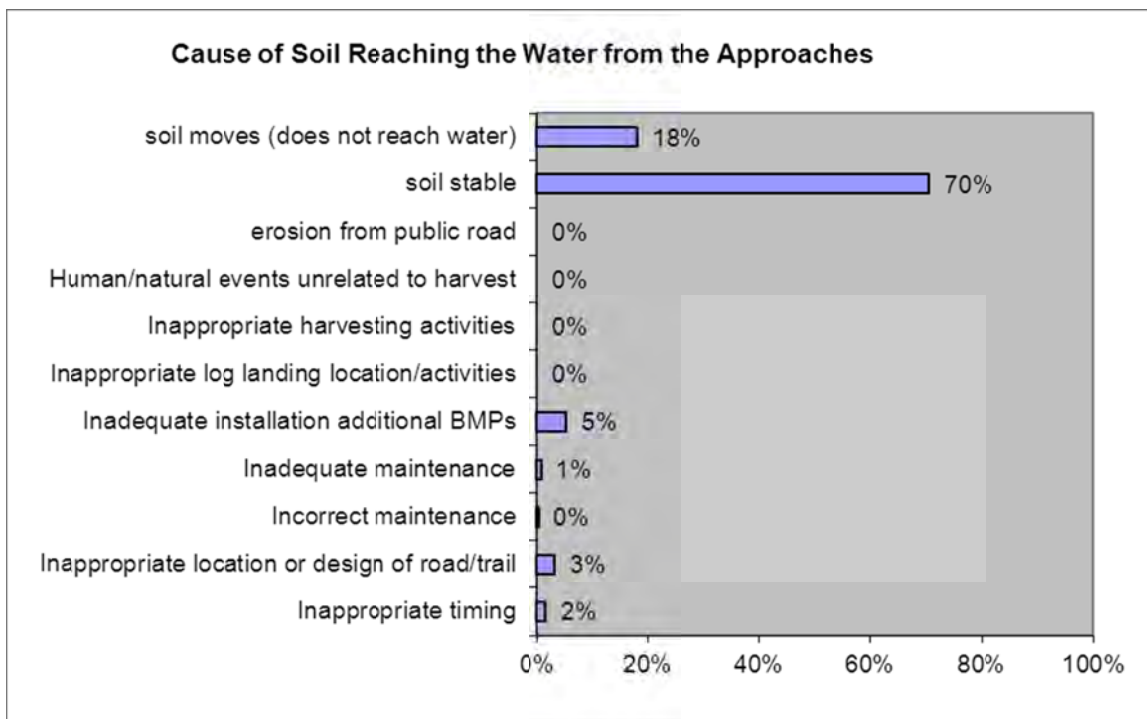


Figure 13 Cause of soil reaching the water from the approaches (n=244)

BMP Maintenance refers to reshaping or reinforcing installed BMPs to compensate for wear from use or erosion or in anticipation of seasonal shutdown or extreme weather events. Inadequate installation of additional BMPs or incorrect BMP maintenance are the primary causes for sediment reaching the water from the approaches. This finding is consistent with previous years and should continue to be stressed in trainings.

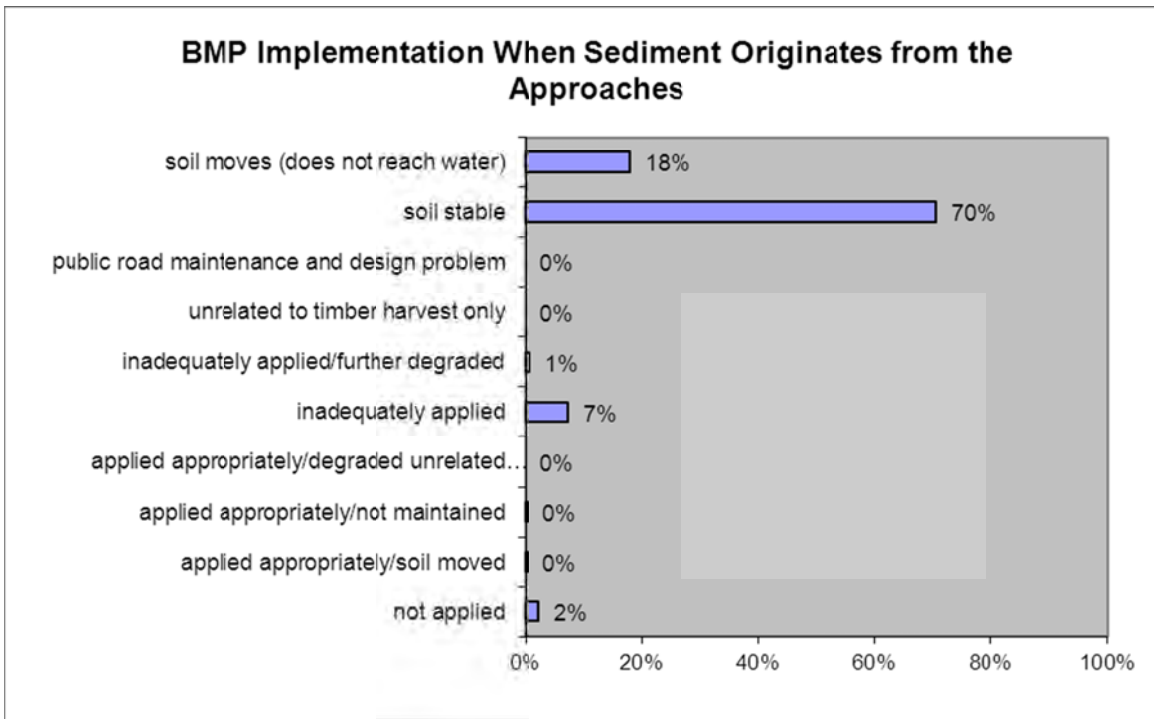


Figure 14 BMP implementation at approaches (n=232)

Discussion

Where crossings were present, sediment was kept from reaching the waterbody from the approaches in 88% of cases. When soil did reach the waterbody it was most likely to do so when BMPs were either not applied or applied inadequately or incompletely. In a few cases BMPs were applied appropriately, but soil still reached the waterbody.

There are four equally important phases of BMP implementation;

- 1) Plan ahead - avoid water crossings, locate access roads, landings and trails properly, and time operations appropriately
- 2) Build it right - adequately apply initial BMP installations
- 3) Maintain it - monitor, repair and add additional BMPs as necessary during the active portion of the harvest
- 4) Close it out properly- identify long-term maintenance and monitoring needs, successfully establish soil stabilization, and anticipate activities unrelated to timber harvesting that may degrade final stabilization efforts.



Crossing Structure

There was 1 opportunity to observe the occurrence of soil movement, sedimentation, or stabilization from the crossing structure. **Data reported in this section contains information only from sites that had surface water crossings.**

Crossing Structure Specifications

A total of 101 new sample units were sampled.

- 61 sample units had surface water crossings.

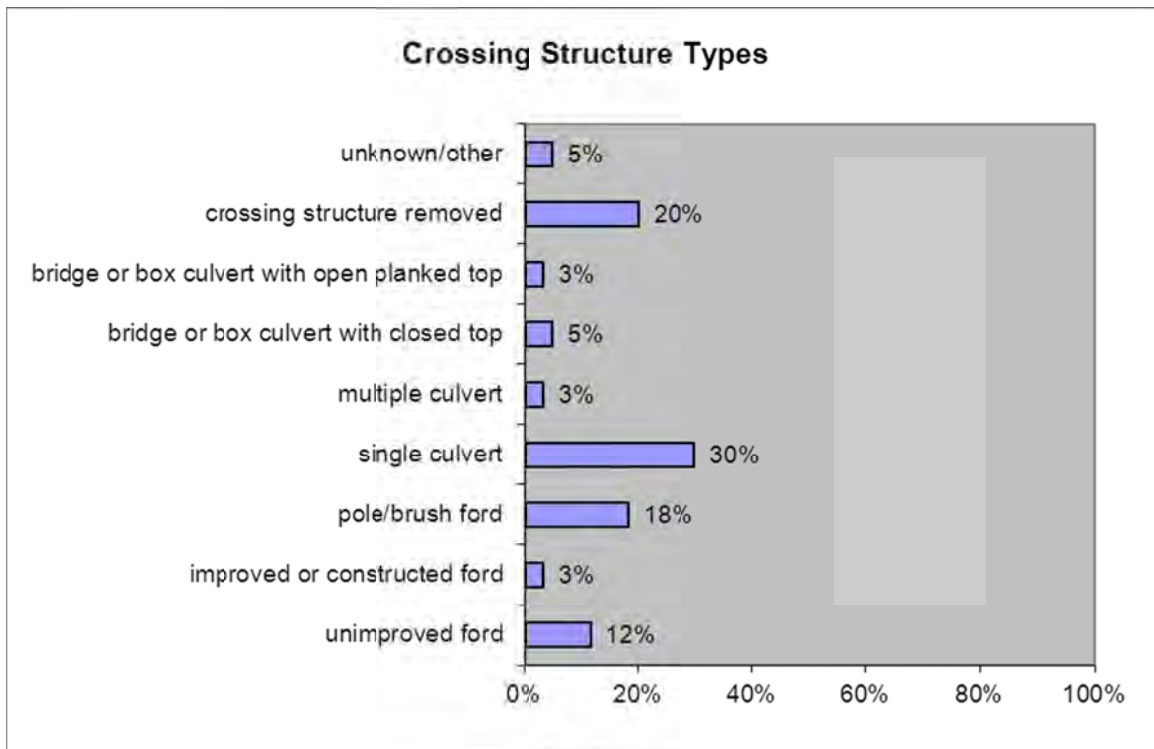


Figure 15 Crossing structure types (n=61)

Structure Type by Road Type

- There were 37 sample units with a skid trail at the water crossing.
- There were 24 sample units with a haul road at the water crossing.

The following charts compare crossing structure types by road type at the water crossing.

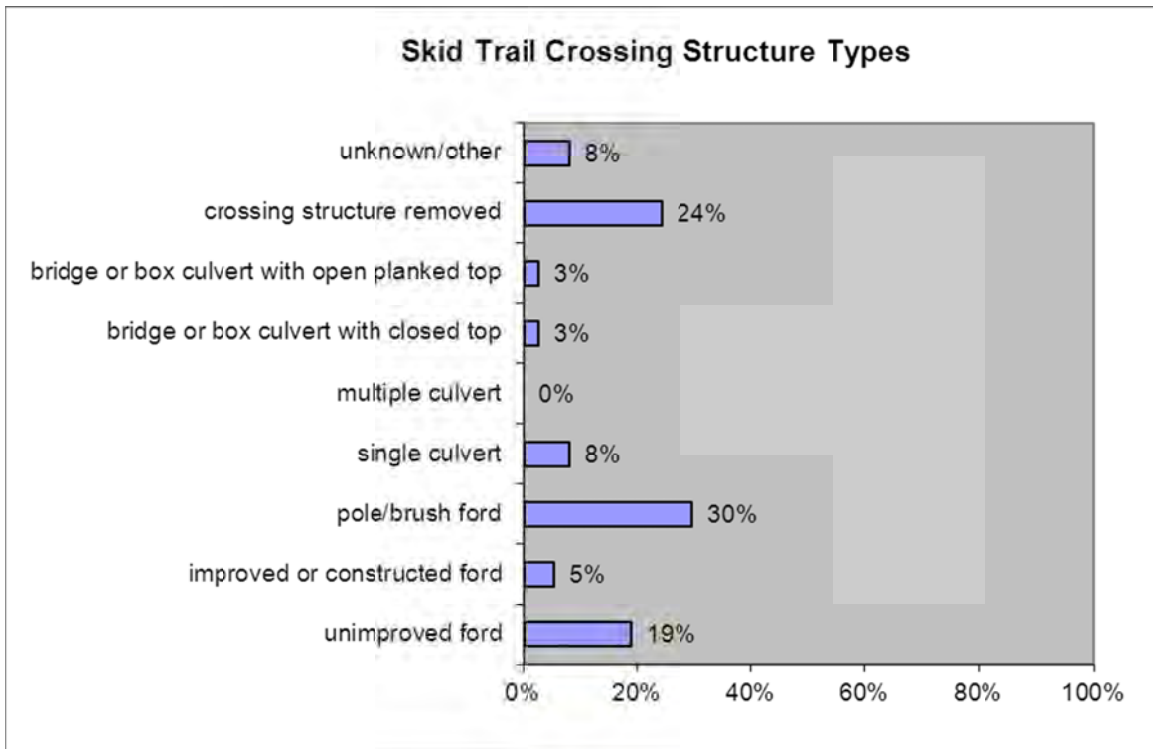


Figure 16 Structure type associated with skidder crossing (n=37)

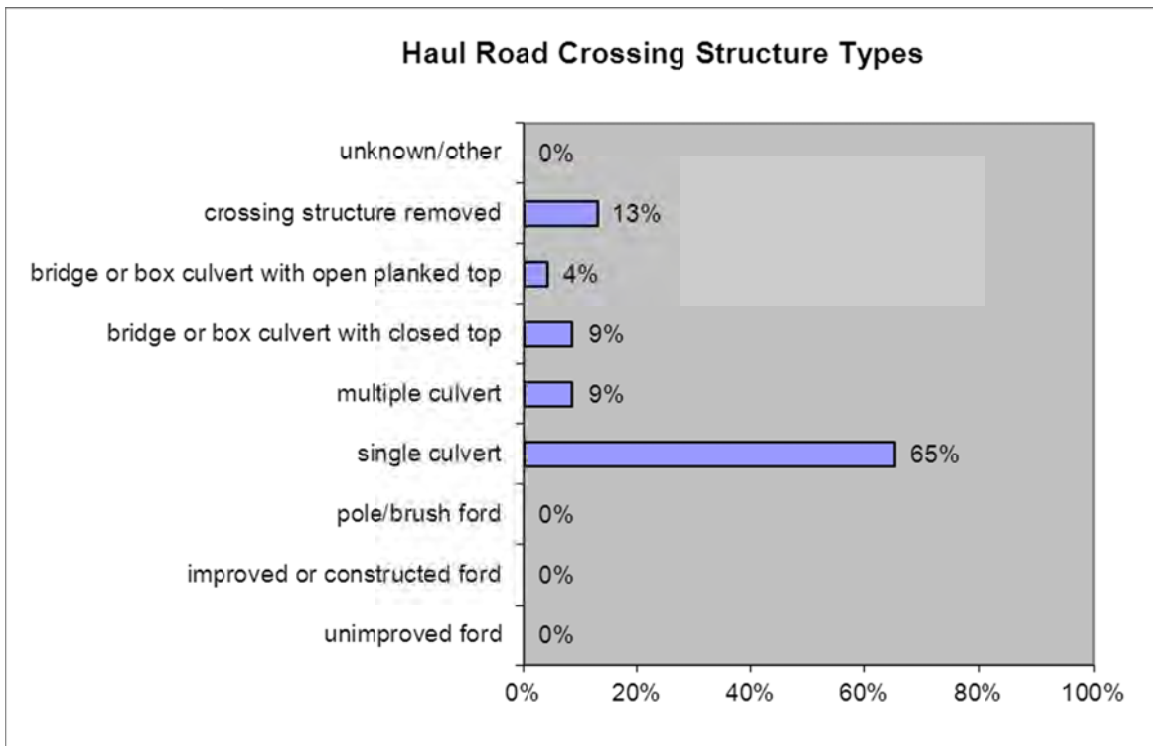


Figure 17 Structure type associated with haul road crossing (n=24)

Discussion

Sixty-one crossings were identified as either haul road or skid trail; 24 haul road and 37 skid trail. A haul road may be defined as 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 are travel routes to bring trees that have been harvested to a concentration point directly associated with the forest operation notification for either further preparation for transport on a haul road or public transportation route. Haul road stream crossings were evaluated if they were directly associated with the sample unit. Haul road crossings associated with multiple harvests or large amounts of acreage not directly associated with harvest were not evaluated.



Haul Road



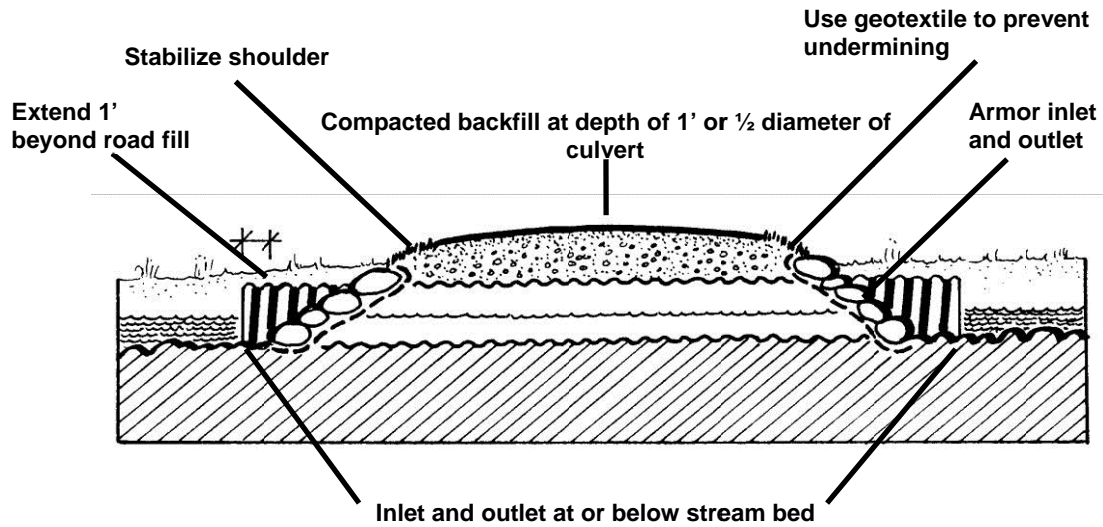
Skid Trail

Structure Type Associated With Water Body Type

- There were **36** crossings associated with a perennial water feature.
- There were **19** crossings associated with an intermittent water feature.
- There were **5** crossings associated with an ephemeral water feature.

It is very important that permanent structures be designed and installed to meet or exceed minimum standards and BMP recommended guidelines. Proper installation maximizes the useful life of the crossing structure thus reducing maintenance and unnecessary replacement costs due to premature failure.

When installing permanent crossings:



For the **101** new sample units, there were **61** opportunities to observe soil conditions at the crossing structure.

Soil Stabilization, Movement, and Sedimentation from the Crossing Structure

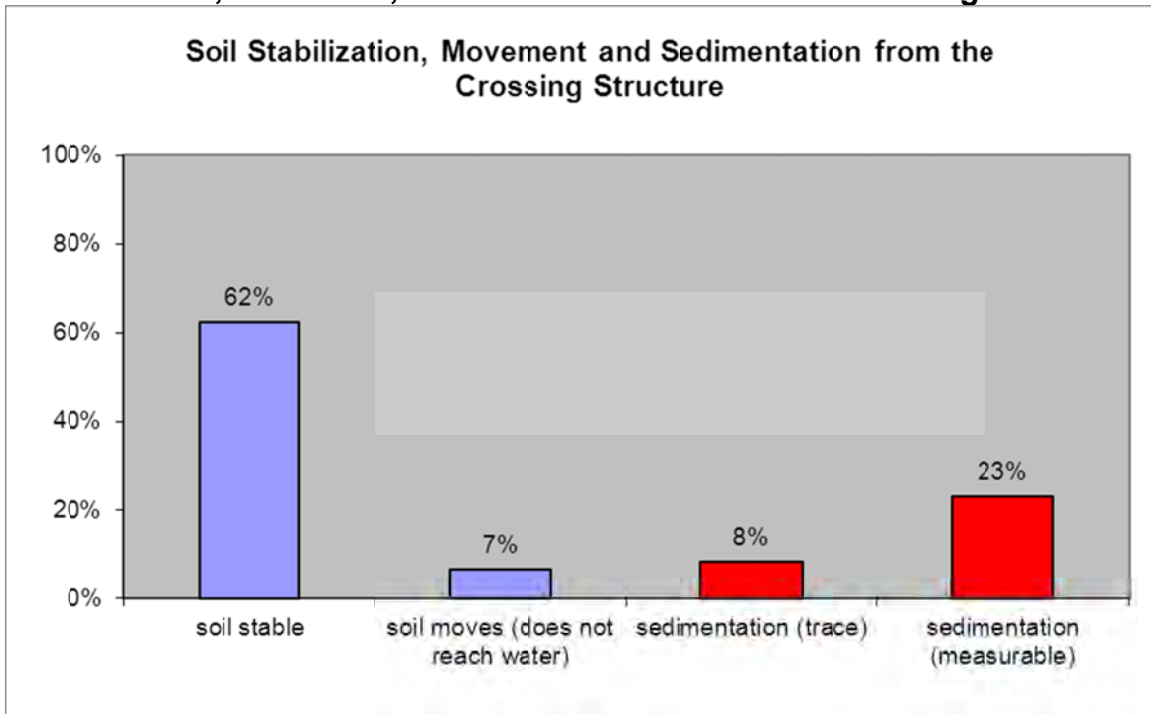


Figure 18 Observations of soil stabilization, movement and sedimentation from the crossing structure. (n=61).

Discussion

Excluding avoided crossings, 31% of crossings had sediment enter the waterbody. 23% of all observations showed measurable soil movement into the waterbody originating from the crossing; this is an increase of 6% over the level reported in 2011-2012.

Portions of the summer of 2013 were very wet, and the increase in measurable events over the previous monitoring period may be attributable to what would normally be small issues becoming larger issues with increased rain fall. If this is the case it **reinforces to need to install and maintain BMPs so that significant weather events do not turn what could be a minor problem into a major one.** It should also be kept in mind because of the difference in sample selection this year a greater proportion of non-industrial ownerships were selected. Regardless of the cause, measurable sediment events at crossings should be watched closely in future monitoring efforts.

Sedimentation from the Crossing Structure

There are **5** observations of trace amounts of sediment reaching the surface water body or deposited within bankfull channel width of the water feature.

There are **14** observations of measurable amounts of sediment reaching the surface water body or deposited within bankfull channel width of the water feature.

Table 2 Volume of Measurable Sediment Observed in the Water and Attributable to the Crossing Structure (cubic feet)

	Sediment evident in water body (ft³)
Average	36
Median	4
Maximum	320

Discussion

The average volume of sediment entering the water for crossings was 36 cubic feet. This average was skewed by a two large sedimentation events, related to structure failures. One of these events was due to instability of the structure due to failure of old bridge abutments, the second was due to poor choice of structure type. These events demonstrate the importance of proper crossing structure design; sizing and maintenance since crossing failures have the potential to lead to large sediment inputs. Because of the influence of these two events the median value of 4 cubic feet value is probably more useful in determining the impact of sedimentation occurring at “typical” crossings (Table 2).

Structure Type Associated With Sedimentation

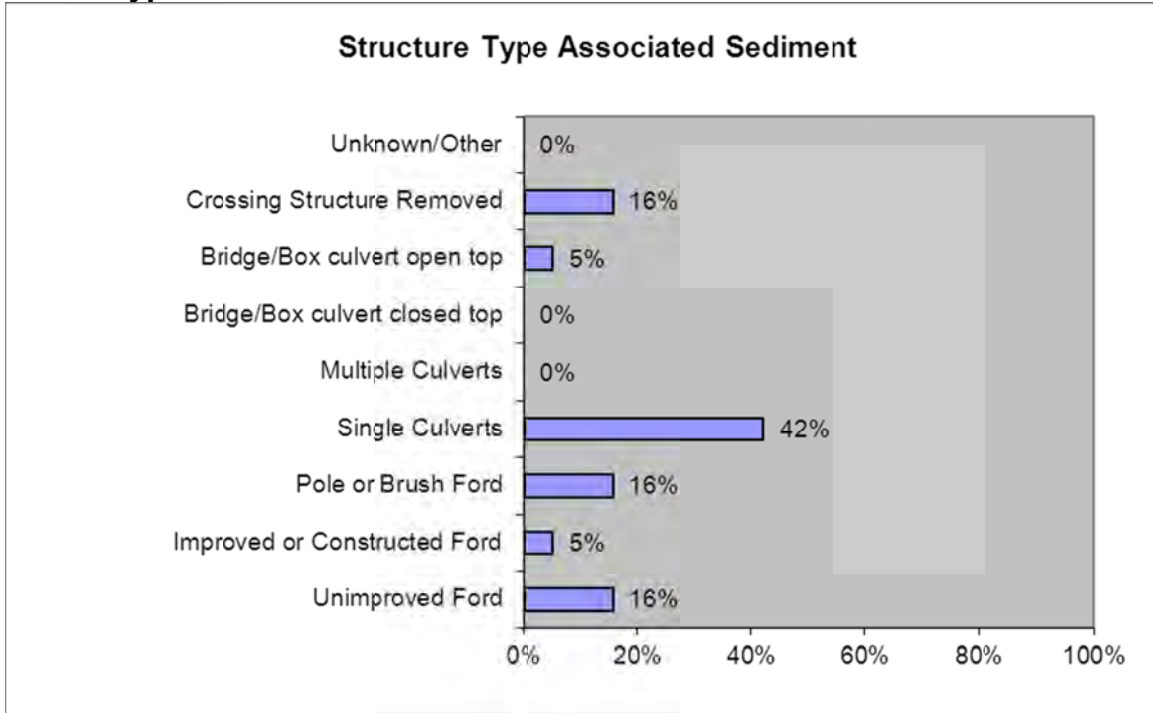


Figure 19 Structure type associated with sedimentation (n=61)

Likelihood of Structure Type Being Associated With Observations of Trace Sediment or Measurable Sediment

When measurable sedimentation was observed at the crossing, the structure present was most often a single culvert. However this does not indicate the relative risk of sedimentation occurring since single culverts were also the most commonly evaluated structure. To assess this risk, each structure type was analyzed separately to see how often sedimentation occurred for that type.

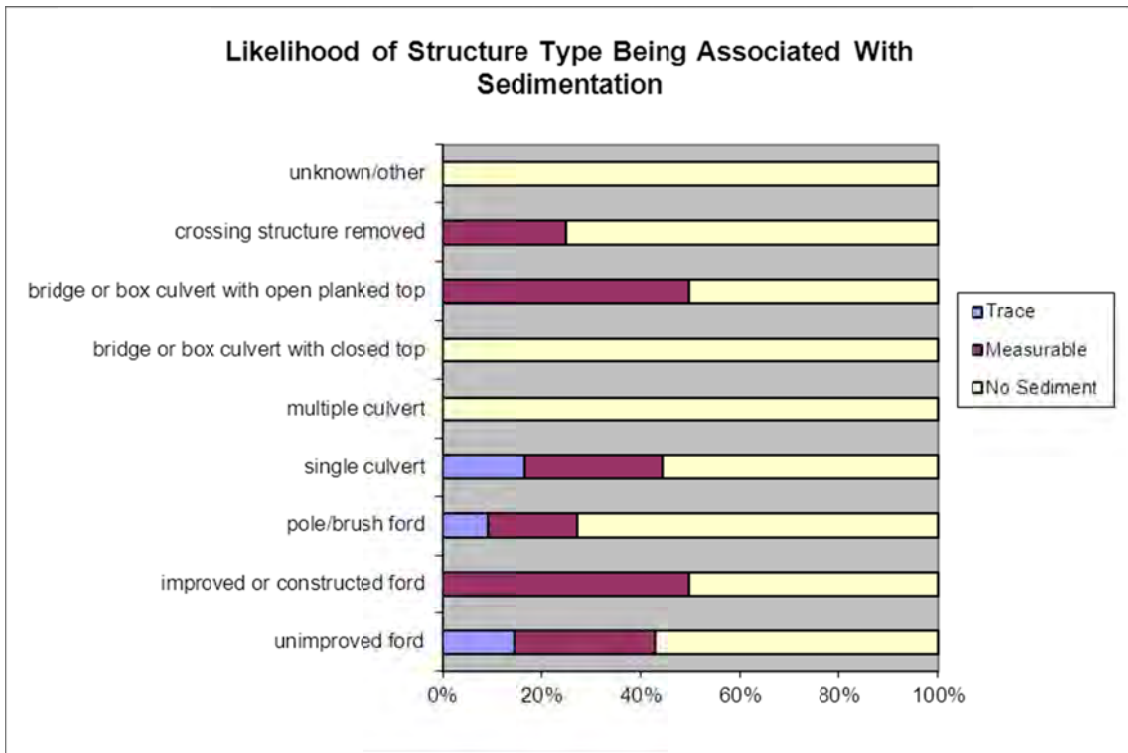
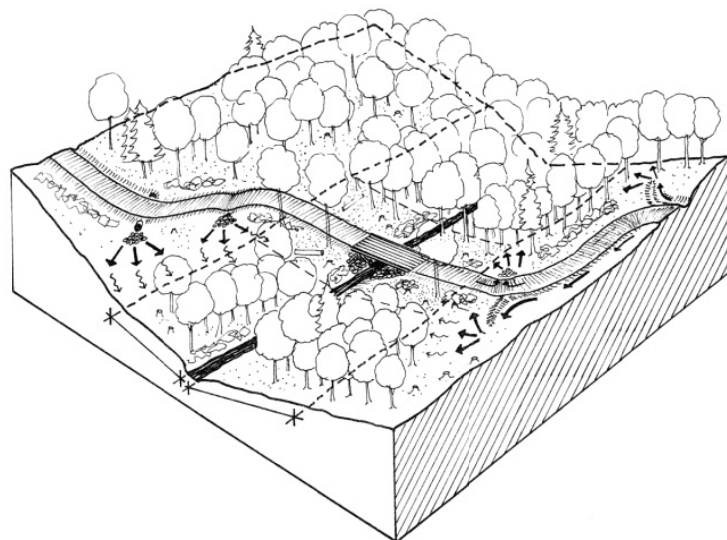


Figure 20 Likelihood of structure type being associated with sedimentation

Elevated crossing structures, crossings not at the lowest point in the road profile, divert storm flow into adjacent filter areas. By elevating the approaches inside the buffer/filter strip, storm water can be easily diverted away from the crossing structure. Crossings located at the lowest point of the road profile can fail prematurely from side embankment erosion immediately adjacent to the structure.



Activities Related to Sedimentation

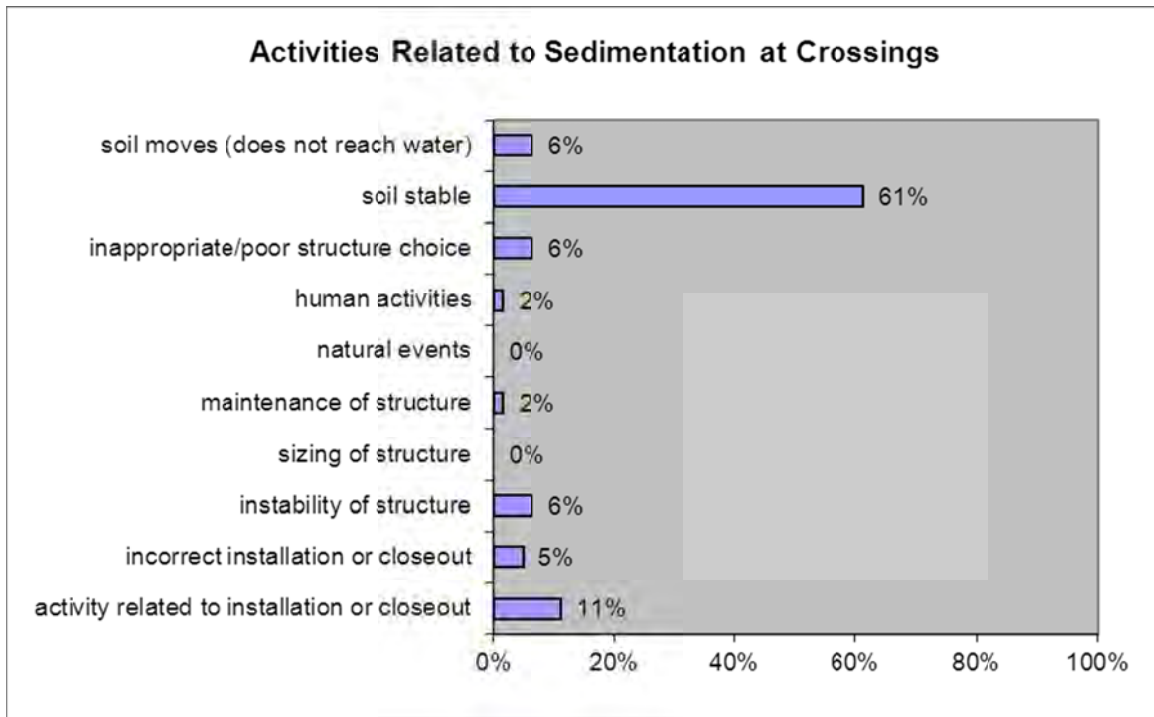


Figure 21 Activities related to sedimentation at crossings (n=61)

Table 2 Quantities of Sedimentation by Crossing Structure Type

	Sediment Volumes (ft ³)		
	Average	Median	Maximum
Unimproved ford	161	161	320
Improved/constructed ford	4	4	4
Pole/brush ford	2	2	3
Single culvert	6	5	12
Multiple culvert	N/A	N/A	N/A
Bridge/box culvert, closed top	N/A	N/A	N/A
Bridge/box culvert, open top	200	200	200
Structure removed	4	2	9
Unknown/other	N/A	N/A	N/A

N/A values indicate that no volume measurements were recorded

Discussion

BMPs are designed to be reasonable measures to minimize the amount of sedimentation that occurs. Installation or closeout of crossings was the most common causes of sediment entering the waterbody from the crossing structure. It is very difficult to install or remove a crossing without some level of sedimentation occurring. A small, one-time input of sediment from a crossing removal or installation is often of less biological importance than ongoing, chronic sediment inputs. **Use of stabilization BMPs after removal or installation are critical to ensure that chronic sedimentation inputs are avoided.**

Effectiveness of BMP Principles and Practices at crossing structures

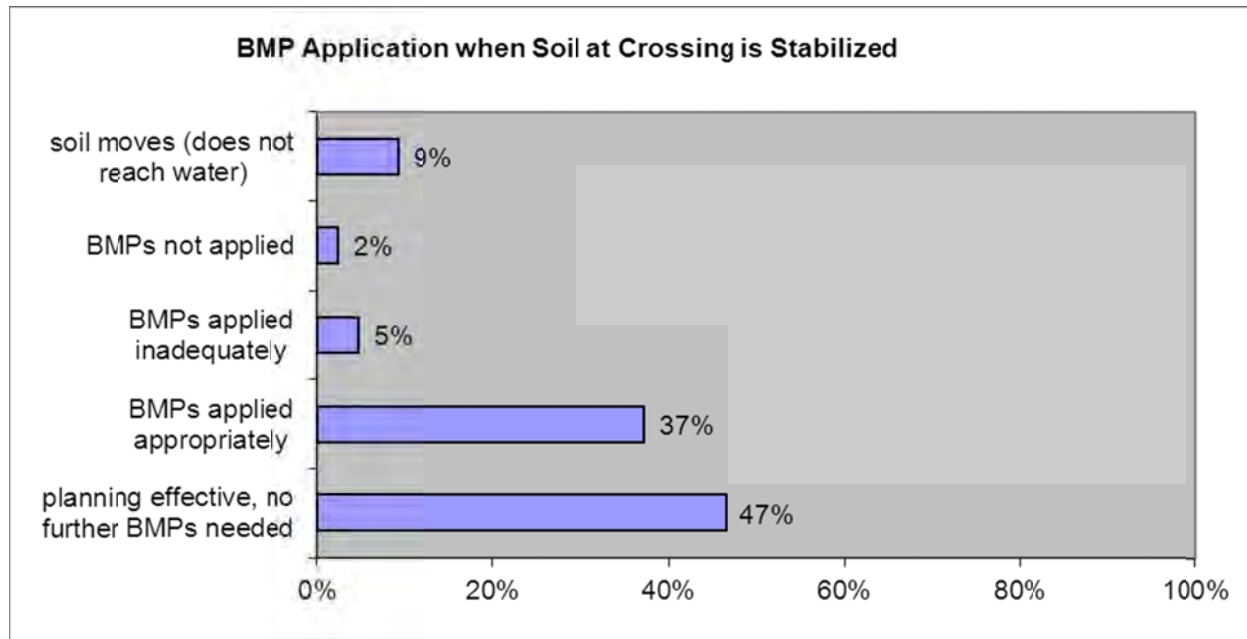


Figure 22 BMP application when no sediment entered the waterbody from the crossing structure. (n=42).

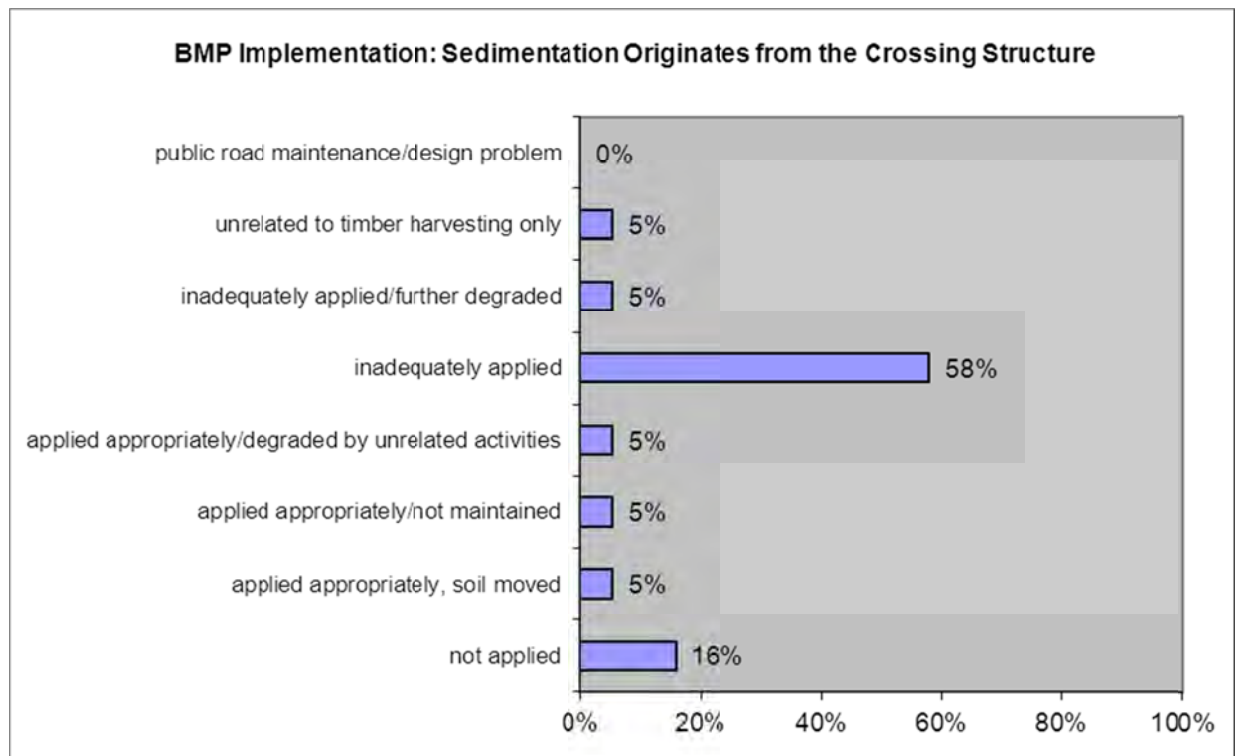


Figure 23 BMP application when sediment (both trace and measurable) originating from the crossing structure entered the waterbody (n=19).

Discussion

When a crossing was present, 31% of all observations showed soil movement into the waterbody originating from the crossing. Comparing BMP application when sediment does not enter the water (Figure 23) to BMP application when sediment does enter the water (Figure 24) gives a measure of how effective BMPs are. For example, if a high percentage of sites with BMPs applied appropriately had sediment enter the water the BMPs would be judged to be largely ineffective. On the contrary, the data here show that in the vast majority of cases when BMPs practices were applied appropriately or planning was effective (a valid BMP principle) sediment did not enter the water (Figure 23). On the other hand when sediment reached a waterbody it was due to BMPs being inadequately applied or not applied at all (Figure 24). In only a few cases were BMPs applied adequately but sediment reached the water. Inadequate application of BMPs, rather than no BMPs led to the largest number of sedimentation events. **Being sure that BMPs are installed correctly to achieve the intended outcome appears to be an area to focus further training.** This illustrates that it is not just sufficient to install a BMP; rather that BMP needs to be installed adequately to achieve its intended outcome.

Fish Passage



Foresters and loggers discuss the effects of crossing installation using the SFI stream table model during a Maine Forest Service – Maine Sustainable Forestry Initiative fish passage training in Whitneyville.

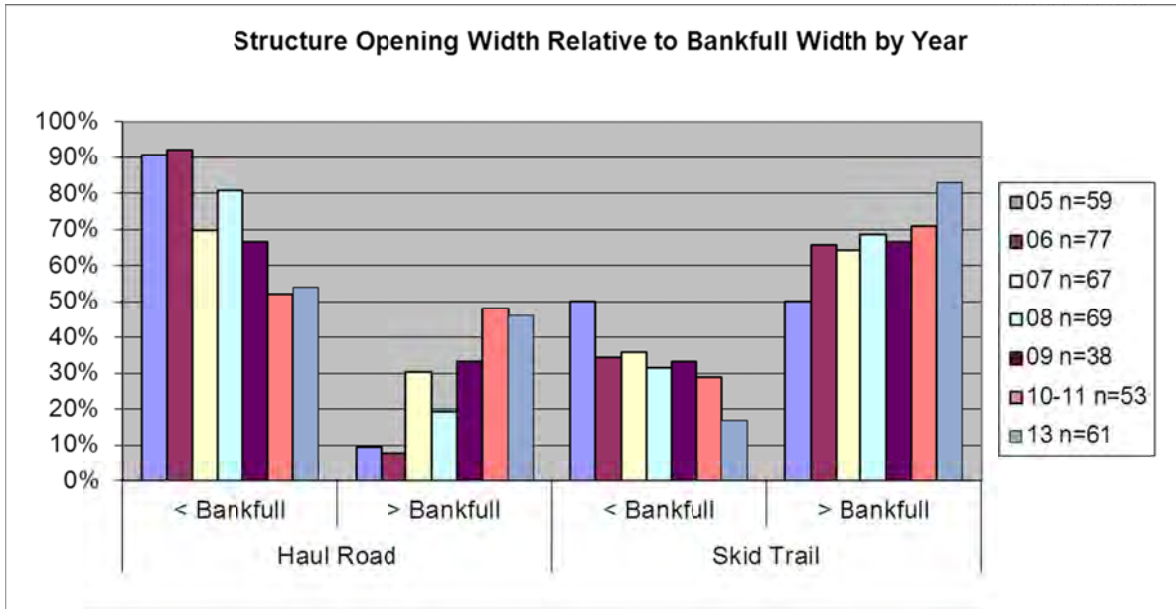


Figure 24 Crossing structure widths relative to bankfull width. Data includes remnant structure width for structures that have been removed prior to the monitoring field visit.

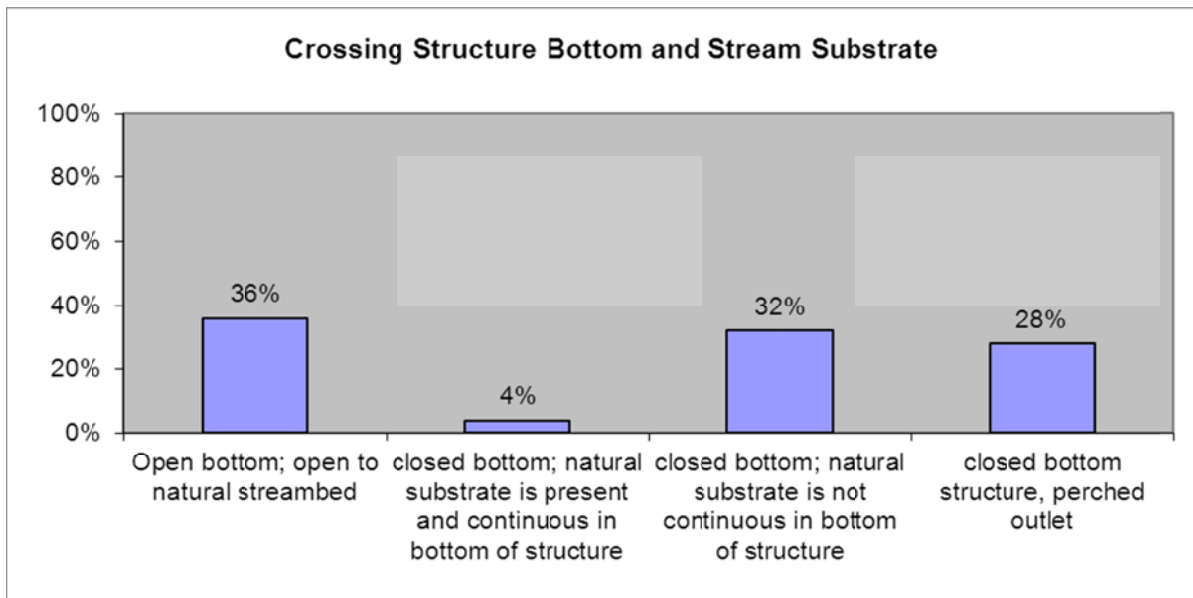


Figure 25 Crossing structure bottom condition for crossings where fish or macroinvertebrates were present and the structure was to be in place for more than 3 months (n=25).

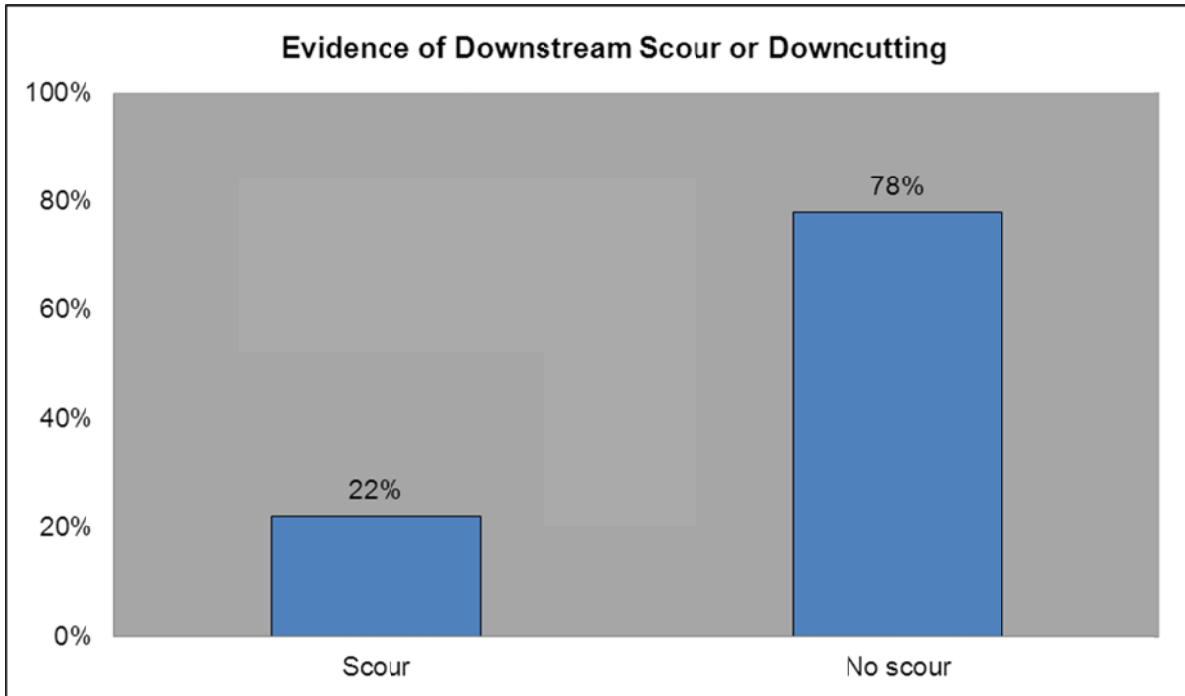


Figure 26 Evidence of scouring or downcutting within 100' of the crossing outlet n=61.

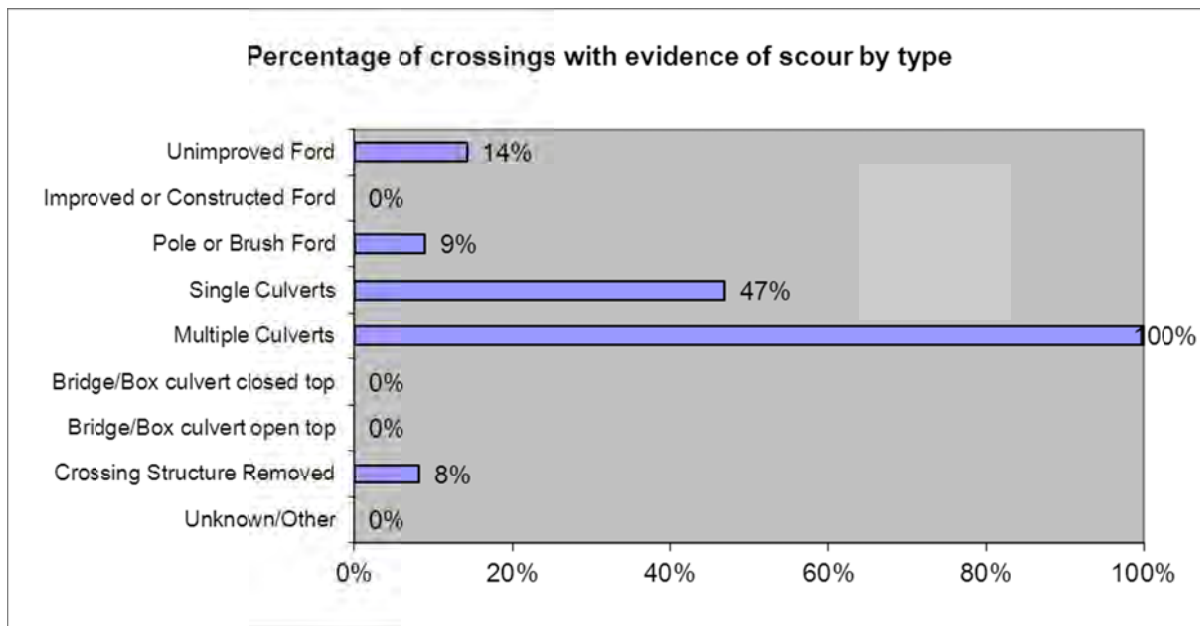


Figure 27 The percentage of crossings of each type where scour or downcutting was observed within 100' of the outlet. "n" is variable by structure type.

Discussion

Improving the performance of crossings to permit fish passage has been a major focus of training over the past five years. Training is based on a set of four principles that when incorporated into crossing design should permit fish passage under most conditions: 1) Span the stream; 2) Set the crossing at the right elevation; 3) Slope of the

crossing matches the slope of the stream: and 4) Substrate stays in the crossing structure. Since 2005 there has been a positive trend in the percentage of crossings that are equal to or greater than bankfull width (i.e. spanning the stream) (Figure 25). This is particularly important for haul roads where the crossings are more often permanent, rather than temporary like on skid trails, because a poorly installed crossing can have long lasting impacts. Although monitoring during 2013 still found that over half the crossings on haul roads did not span the stream, the trend of larger percentages spanning the stream over time is encouraging. At crossings where fish or macroinvertebrate were likely present 40% had substrate in the crossing structure and 28% had a perched outlet indicating a problem with the elevation of the installation or a scour issue resulting in a perched culvert (Figure 26). 22% of crossings had scour downstream of the crossing. Scour can result from flow accelerating through an undersized crossing and eroding the stream bed downstream (Figure 27). Single and multiple culverts were the most common types to exhibit scour, whereas open bottom structures such as bridges were much less likely to have scour associated with them (Figure 28).

Haul Road or Log Landing in the Buffer/Filter Strip

There was **1** opportunity to observe the occurrence of soil movement, sedimentation, or stabilization from the haul road or log landing inside the buffer/filter strip. **Proportions were based on the total number of opportunities to make observations about soil conditions at the haul road or log landing inside the buffer/filter strip.**

For the **101** new sample units, there were **101** opportunities to observe soil conditions at the haul road or log landing inside the buffer/filter strip.

- **5** sample units had a haul road or log landing located within the buffer/filter strip that was not associated with a crossing.

Soil Stabilization, Movement, and Sedimentation

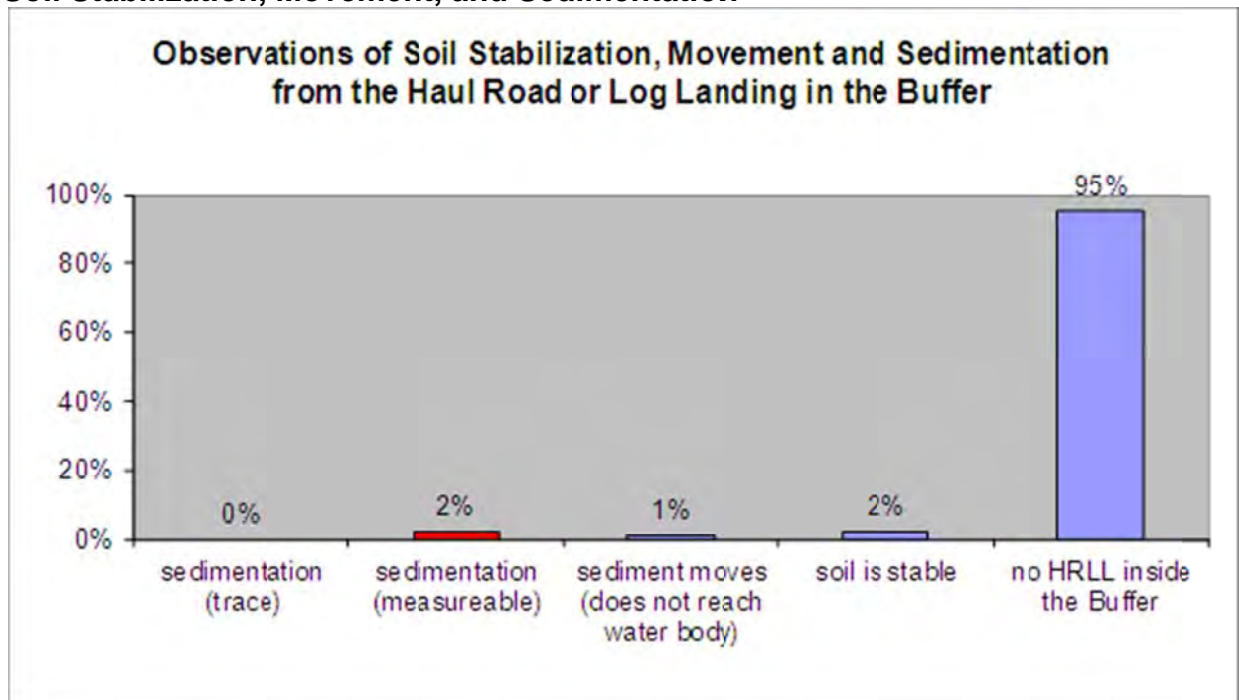


Figure 28 Observations of soil movement, stabilization and sedimentation from haul road or log landing in the buffer (n=101)

Table 3 Cubic feet of sediment entering waterbodies from haul roads located in the buffer. Table reflects the mean (average), median, and maximum of sediment volumes 1 cubic foot or greater. Rill and gully volumes are measurements of the volume displaced from the rill or gully and may be larger than the volume actually entering the bankfull channel. Sediment evident in the water body is a measure of the sediment attributable to the logging activity and present in the channel when the observation is made; it cannot account for sediment washed away prior to observation. Thus, there is a high probability that the actual volume of sediment reaching the bankfull channel of the water body is between these two estimates.

	Calculated volume of soil removed from rill or gully terminating within bankfull channel width (ft ³)	Sediment evident in water body or within bankfull channel width (ft ³)
Average	22	13
Median	22	13
Maximum	22	24

Discussion

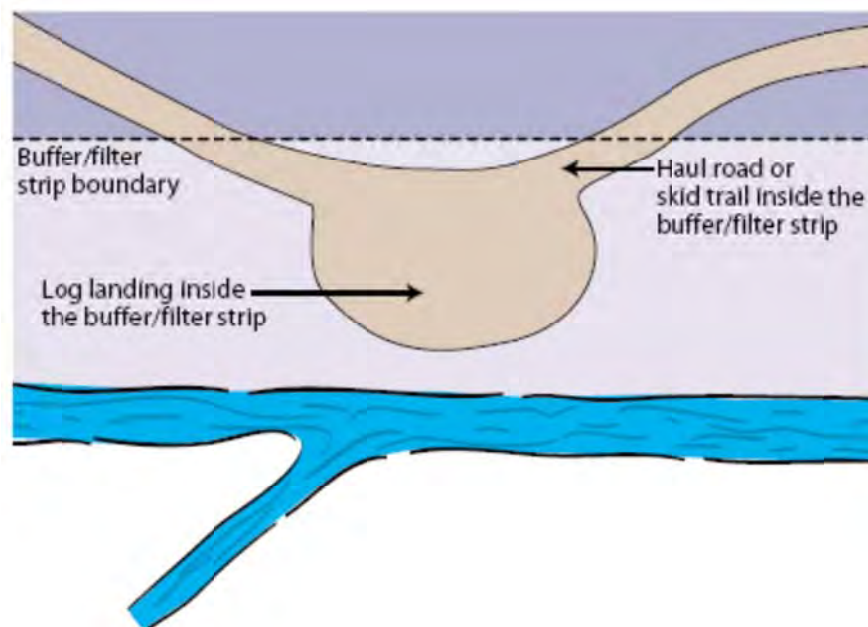
Areas of prolonged exposed soil exposure during a given timber harvest are typically located on haul roads and landings. These locations pose the greatest risk to adjacent water resources from soil movement and potential chemical contamination from fuel oil and maintenance fluid use and storage. Locating haul roads and landings outside buffer filter strip, significantly reduces environmental risk and BMP implementation costs.

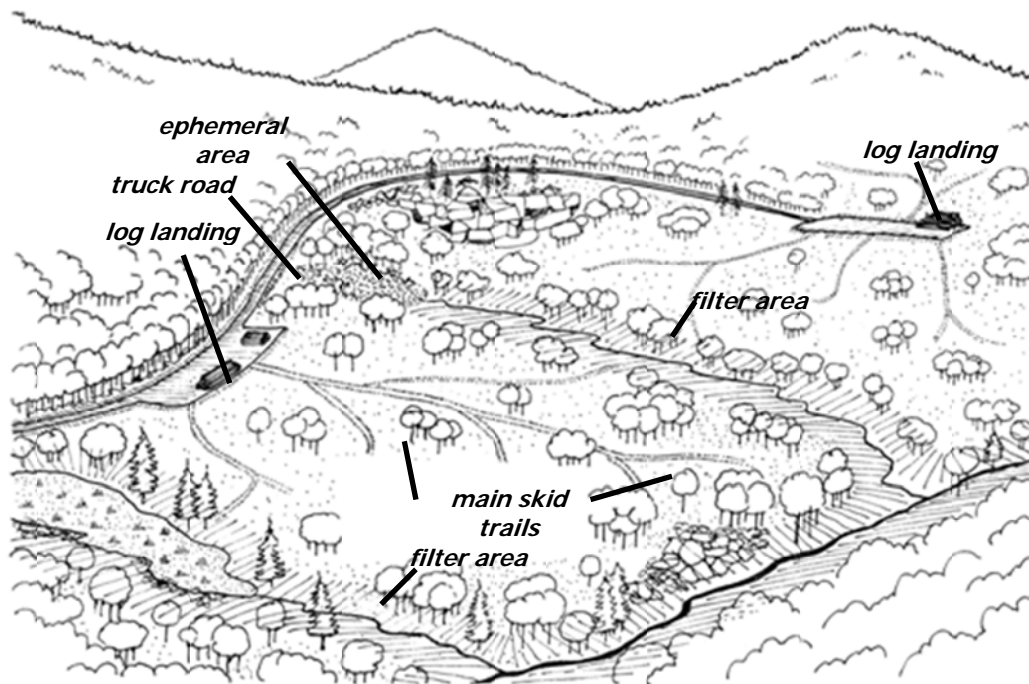
At timber harvests monitored 95% did not have landings or haul roads within the buffer. None the less, measurable sediment entered the waterbody in 2 out of 5 cases where

haul roads or yards were located in the buffer indicating the high environmental risk roads in these locations pose. New construction typically avoids placing these forest access systems within these sensitive areas. **Practitioners should routinely scrutinize appropriateness of reuse when accessing historical haul roads, yards and skid trails to regain access to areas that have not been harvested in recent years. It is also critically important that BMPs on legacy roads located in buffers be maintained to ensure they continue to function as designed.**

As with other findings, analysis shows when BMPs are applied, negative impacts to forested water resources are greatly reduced. Locating haul roads and landings outside the buffer during the pre-harvest planning is an effective BMP commonly implemented by Maine forest practitioners.

Haul Road and Log Landing in a Buffer Filter Strip





Selecting haul road and landing locations carefully can minimize risk to sensitive areas

Chemical Pollutants

101 new sample units were sampled.

Evidence of Potential Pollutants

- **No** sample units had evidence of lubricant, fuel, hydraulic fluid, and/or anti-freeze spillage resulting from harvest operations.
- **2** sample units had evidence of discarded batteries and/or other potential pollutant containers present.

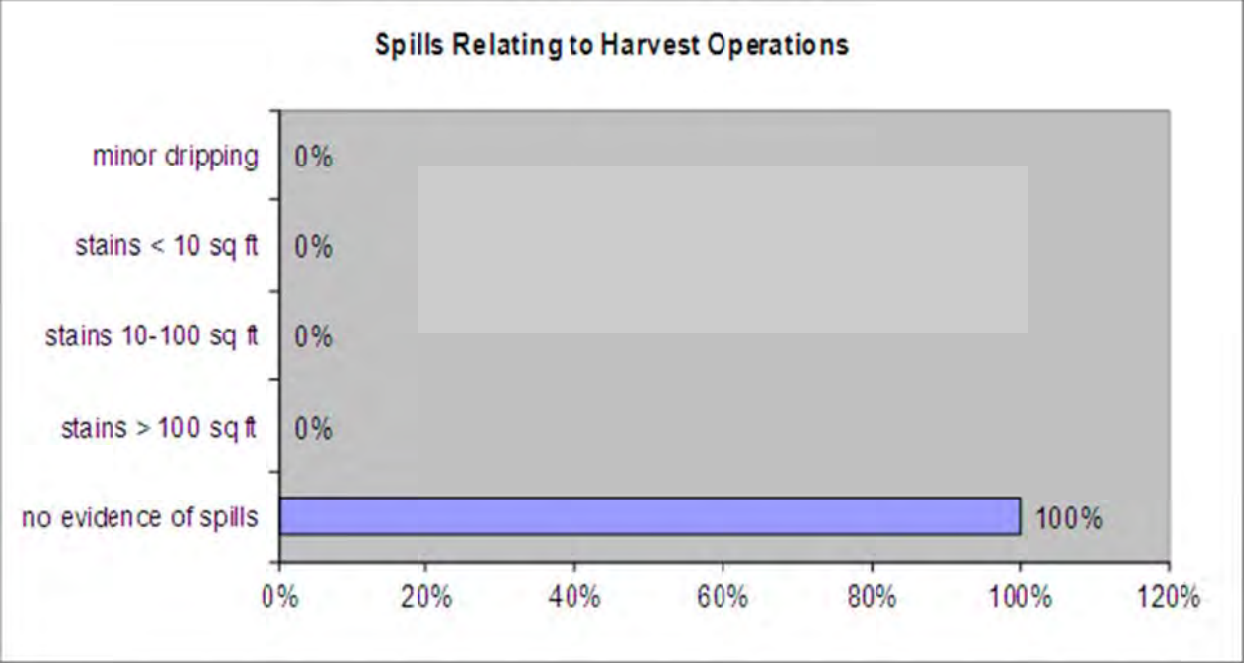


Figure 29 Spills relating to harvest operations (n=101)

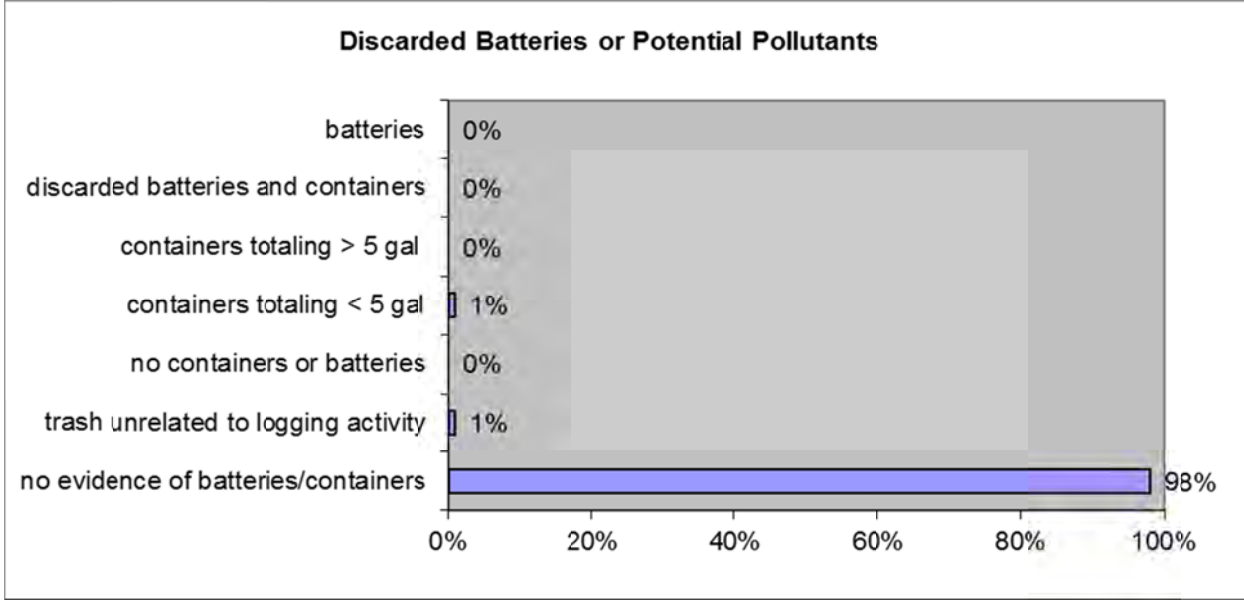


Figure 30 Discarded batteries and other pollutants (n=101)

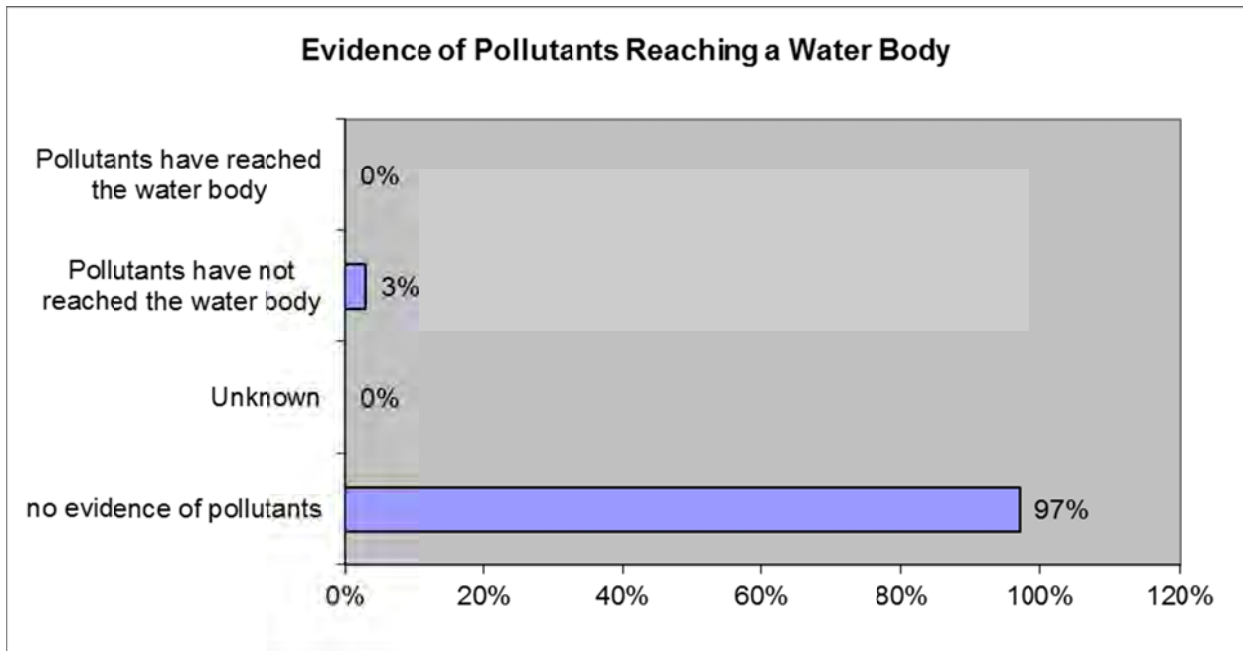


Figure 31 Evidence of pollutants reaching a waterbody (n=101)

Discussion

Forest practitioners should take great care handling and disposing fuel oil, ant-freeze, hydraulic fluid, and batteries. These common items are considered hazardous when not used and stored properly. **The fact that there was no evidence of chemical pollution recorded shows that this BMP is taken seriously.**

Hazardous Materials BMP Practices

- Use appropriate containers for collecting and storing oils, fuels, coolants, or hazardous wastes
- Maintain and repair all equipment outside filter areas
- Have spill kits or other absorbent materials for mopping up spills readily available
- If a spill occurs keep it from flowing off the yard and into surface waters
- Know state agency phone to call in case of an emergency
- Collect trash and dispose of properly



Wetland Crossings

101 new sample units were sampled.

- **9** sample units had a wetland crossing.

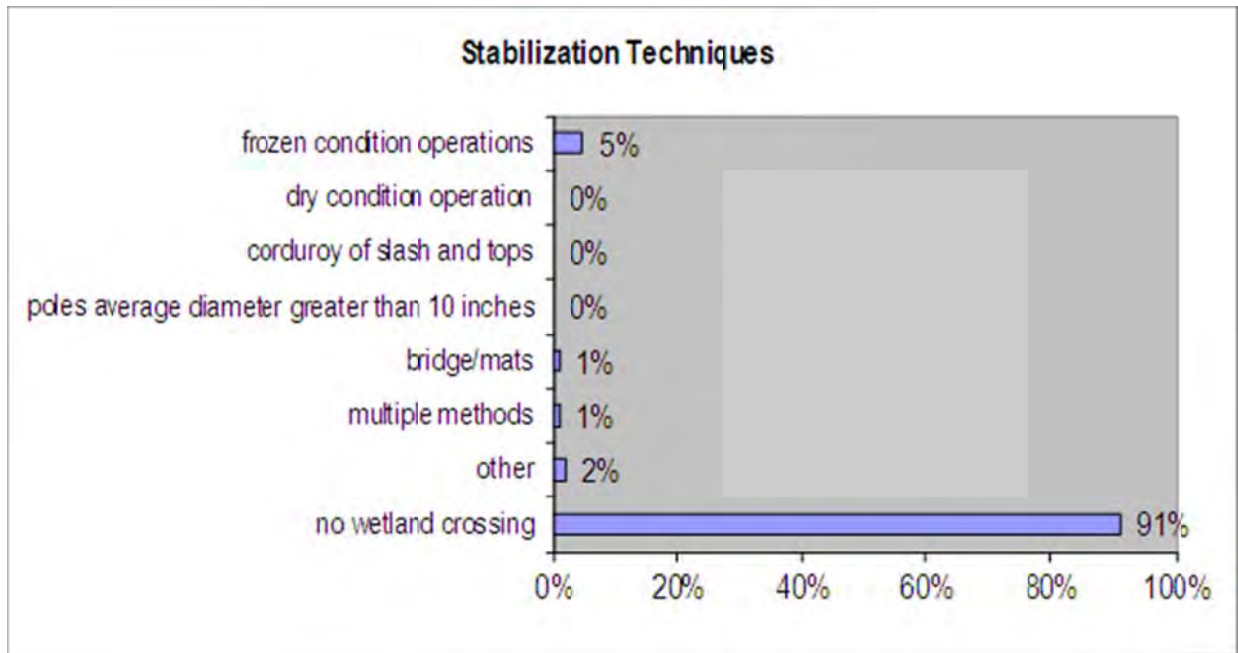


Figure 32 Wetland crossing stabilization techniques (n=101)

Table 4 Wetland Crossing Length from Upland to Upland

	Length (feet)
Average	137
Median	100
Maximum	450

Rutting Depth and Sedimentation

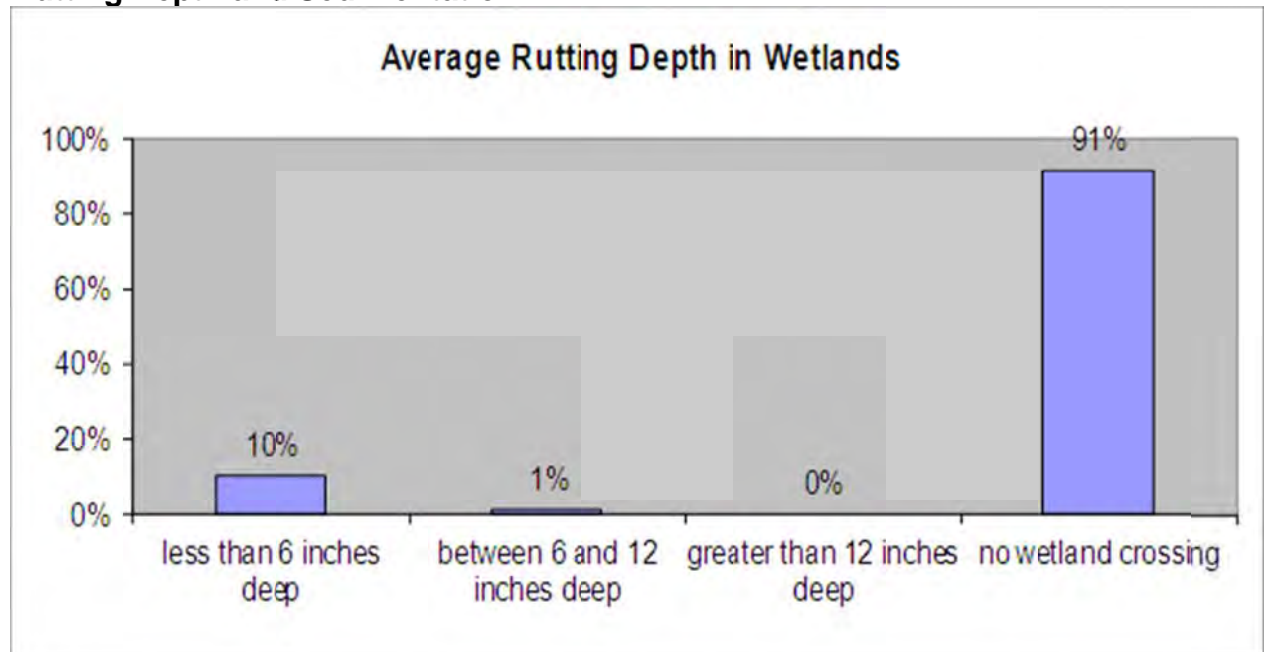


Figure 33 Average rutting depth in wetlands (n=101)

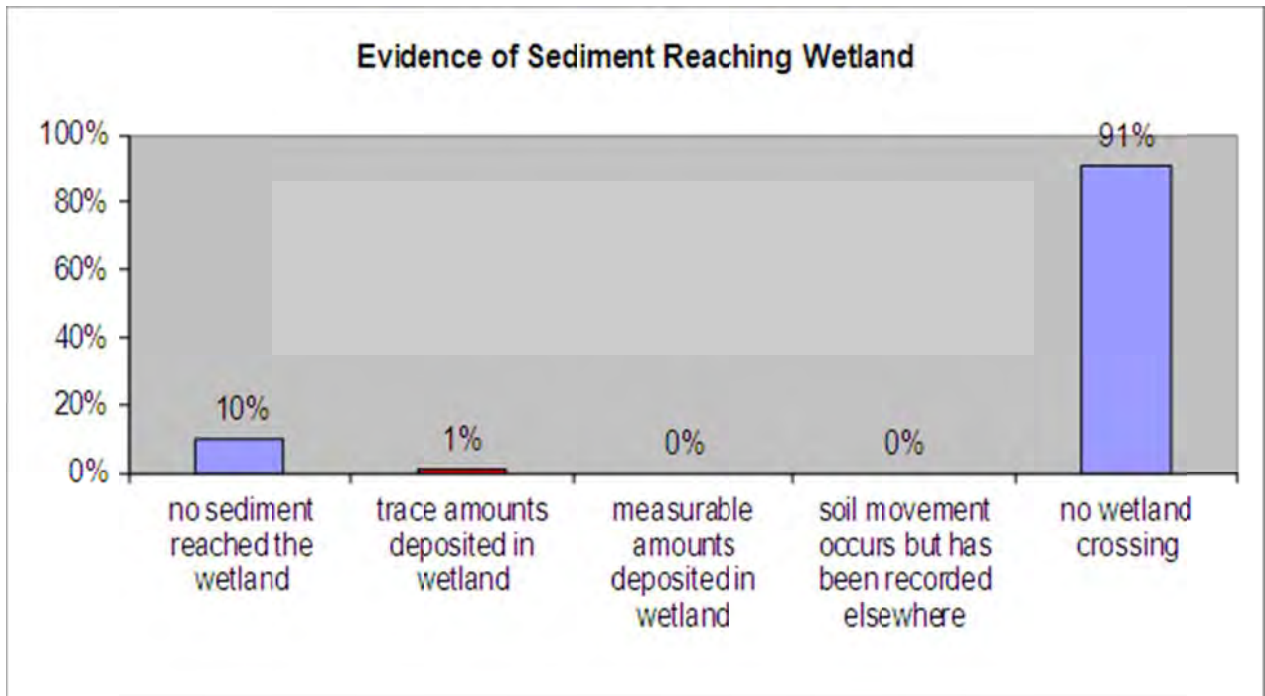


Figure 34 Evidence of sediment reaching wetlands (n=101)

Discussion

BMPs recommend avoiding wetland crossings whenever possible. Wetland crossings included crossings of both forested and non-forested wetlands. Forested wetlands are often managed for timber in Maine. With 91% of the samples having no wetland crossings it is evident that this BMP is commonly practiced in Maine. When wetlands do need to be crossed, adequate cross drainage must be installed so water flow is not inhibited. On skid trails BMPs are designed to minimize rutting by increasing the bearing capacity of the inherently weak wetland soils, the most common BMP used was operating under frozen conditions. Ruts in wetlands can interfere with the natural hydrology of these systems. The majority of wetland crossings monitored had ruts less than 6" deep, indicating effective use of BMPs crossing these sensitive areas.

Conclusions

The creation of the Northeast Regional Forestry BMP protocol and the effort of the MFS and its partners to collect data in a consistent manner on an ongoing basis, allows us to quantify trends in BMP performance. Previous BMP monitoring efforts tended to occur in a periodic fashion and often used different protocols making direct comparisons difficult. The Northeast Regional Forestry BMP Protocol allows an objective assessment of the continual improvement process.

The 2013 BMP monitoring results are generally consistent with the past few years and continue to show a general acceptance of the use of effective BMPs by the state's forestry and logging communities.

Although there is still work to be done, the trend of improved crossing design to achieve fish passage principles is encouraging.

As has been well documented by previous monitoring reports and numerous studies from around the country, when BMPs are applied they worked to achieve the objective of protecting water resources. Conversely, when not applied or applied inadequately the risk of detrimental impacts greatly increases. Although representing only a small percentage of total cases, the uptick in the percentage of crossing structures associated with measurable sedimentation in this monitoring period and number of cases where BMPs were not applied is worth noting. This reinforces the fact that continued monitoring, education, and training are key to sustaining the progress that has been made with forestry BMPs and will allow Maine's forestry community to continually improve in the future.

Appendix A

The Seven BMP Fundamentals

Most BMP techniques are based on a few basic principles. This section provides an overview of these fundamental BMPs and how they protect water quality. Understanding these principles will enable you to select or adapt the BMPs that are the most appropriate and effective. Think of these principles as goals. Any single practice or combination of practices that effectively achieves one or more of these key goals could be considered an appropriate BMP.

1. DEFINE OBJECTIVES AND RESPONSIBILITIES

- **Determine the harvest objectives with the landowner, forester, and logger.** The first step in planning, prior to beginning work, is to communicate with everyone involved what the harvest objectives are. Discuss what's going to be cut, where, and the desired condition of the remaining forest.
- **Decide who is responsible for BMPs.** You will want to agree in advance (and in a written contract) who is responsible for implementing the BMPs, including deciding when to operate, locating streams, laying out the operation, and planning and maintaining the BMPs.
- **Find out what legal requirements apply to waterbodies in the harvest area.** The basic legal requirement in Maine is to keep pollution—including mud, silt, rock, soil, brush, or chemicals—out of the water. When working near waterbodies, find out what town, state, or federal standards apply, and if permits are needed.

2. PRE-HARVEST PLANNING

Pre-harvest planning is good business practice and avoids many problems. Planning will help reduce costs, make the job more efficient, protect roads and trails that will stay in place after the job, leave the job looking better, *and* protect water quality.

- **Determine the harvest area limits and property boundaries on the ground. Know whose responsibility it is to identify the property boundaries correctly.** While not essential to protecting water quality, locating property boundaries is common sense and good planning. There may be survey pins, blazes, wire fences, or stone walls that mark boundaries or property corners. Forest type maps, soil or topographic maps, or aerial photos help, too.
- **Identify streams, lakes or ponds, wetlands, and other features on maps and on the ground.** Maps and aerial photographs can help identify features like waterbodies, steep slopes, or poorly drained soils. Walking the property to locate important features on the ground is essential. If possible, do your planning on bare ground in wet seasons when surface water is visible.
- **Identify the areas where you need BMPs.** Forest harvesting BMPs are most critical in and immediately next to waterbodies including intermittent and perennial streams, lakes or ponds, wetlands and coastal areas—wherever direct impacts to surface water may occur. You may also need to use BMPs in other areas of the watershed where flowing water could be substantially altered or carry sediment into these waterbodies.
- **Lay out the harvest operation on the ground.** Harvest planning includes determining where operational features such as roads, stream crossings, landings, cut-and-fill areas, main skid trails, and particular BMPs will be needed. While on-site, make sure everyone involved in the harvest operation is aware of the layout—especially roads, skid trails, and filter areas next to waterbodies.
- **Choose BMPs that are appropriate to the site conditions.** Most sedimentation occurs during short periods of heavy rain or snowmelt. How much rain falls during a storm, how much water streams carry, how stable the soils are, and what type of vegetation is present are all conditions that vary. BMPs that are sited, designed, and installed to anticipate adverse conditions work best.
- **Decide on BMPs for the entire harvest area and for closeout before beginning work.** BMP systems need not be complicated, but they require planning across the entire harvest area and over the entire duration of the operation, including closeout. Applying BMPs in one location can sometimes solve problems elsewhere on the site, or prevent problems after the operation is complete. When you understand the natural drainage system in the watershed, often you can use a combination of simple BMPs that are more effective—and cheaper—than more complex or expensive techniques.
- **Consider the needs of future operations on the same property.** Will roads, trails and landings be used again in five years, 15 years, or longer? Are there other areas of the property that can be accessed using the same roads? If you need to access the lot in the future, plan roads and trails accordingly. Otherwise, consider restricting vehicle access after the harvest. Because of the possibility of extreme weather conditions, it is important to design and close

out roads properly. Identify which structures—such as culverts—will be left in place, and which will be removed. Considering the future can avoid problems and costly solutions.

3. ANTICIPATE SITE CONDITIONS

- **Time operations appropriately.** Harvesting under frozen, snow-covered, or dry conditions can minimize the need for additional BMPs. At the same time, a range of BMPs that are appropriately chosen, installed, and maintained can extend the harvest season. Use extra caution during fall and spring when streams are high and the ground is typically wetter—you may need to use additional BMPs to control the larger volume of water.
- **Determine whether previous operations in the harvest area created conditions that are impacting—or could impact—water quality.** Old roads, log landings, and skid trails can be reused or upgraded. However, in some situations, avoiding or retiring them is a better choice. Using old roads, landings, and trails may be cheaper in the short run, but may be more costly to fix or maintain later. Pre-existing conditions may also influence your choice of BMPs.
- **Plan to monitor, maintain, and adjust BMPs as needed, especially to deal with seasonal or weather-related changes.** After installation, many BMPs require maintenance or modification. Conditions—such as the amount of water flowing in streams, soil moisture, or the depth of frost—can change quickly, even with one storm. Take into account how conditions may change, and maintain or install additional BMPs as needed. Determine who will be responsible for this work. In many instances, the landowner will want to periodically check and maintain BMPs that have been installed after harvesting is done. This often prevents washouts and a loss of access while protecting water quality at the same time.

4. CONTROL WATER FLOW

- **Understand how water moves within and around the harvest area, and decide how water flow will be controlled.** Concentrated flows of water on roads, skid trails, landings, and in drainage systems develops more force and a greater ability to erode soil and carry sediment. It is easiest and most effective to control small volumes of water, before they converge and accumulate into concentrated flows.
- **Slow down runoff and spread it out.** Many BMPs work by directing small amounts of water into areas of undisturbed forest floor where it can be absorbed.
- **Protect the natural movement of water through wetlands.** Wetlands play an important role in the environment by storing water in wet periods and slowly releasing it back into the surrounding ground and streams. Logging roads and trail crossings can affect the flow of water within or through a wetland. This changes how much water the wetland stores, the degree of flooding that occurs, and the rate at which water leaves the wetland. Such impacts can affect the health of the wetland and waterbodies downstream.

5. MINIMIZE AND STABILIZE EXPOSED SOIL

Limiting soil disturbance and stabilizing areas where mineral soil is exposed are among the most important BMPs for preventing erosion. These practices are most critical in and around filter areas—forest areas bordering waterbodies. Generally speaking, there are two major objectives:

- **Minimize disturbance of the forest floor, especially in filter areas.** The forest floor absorbs water and filters out sediment and other pollutants. Exposed soil, on the other hand, can erode very rapidly. Most of the sediment that ends up in streams near managed forests comes from exposed soil on roads, landings, and skid trails. Know where the filter areas are and how to protect their capacity to absorb and filter runoff.
- **Stabilize areas of exposed soil within filter areas and in other locations where runoff has the potential to reach filter areas.** Use BMPs during or immediately after the harvest to prevent exposed soil or fill from eroding. These techniques and materials can be used near waterbodies, at stream crossings, road cut-and-fills, ditches, landings, and skid trails. In some situations, you may need to seed and/or plant vegetation in order to stabilize the soil.

6. PROTECT THE INTEGRITY OF WATERBODIES

- **Protect stream channels and banks.** Blocking or altering streams (with slash, for instance) may keep fish from swimming past the blockage. Damaged stream banks erode quickly, causing sedimentation and siltation. By protecting the physical integrity of streams, BMPs prevent these problems.

- **Leave enough shoreland vegetation to maintain water quality.** BMPs maintain the benefits that nearby trees and plants provide waterbodies. Streamside vegetation shades the water, minimizing temperature changes. Live roots stabilize the banks and maintain the soil's physical and chemical properties. Trees along the banks drop leaf litter and woody debris that supply nutrients and become habitat for plants and animals in the stream. Shoreland vegetation plays an important role in maintaining water quality.

7. HANDLE HAZARDOUS MATERIALS SAFELY

- **Be prepared for any emergency.** Keep an emergency response kit and contact information at the site for fuel, oil, or chemical spills. Remember that fertilizers, herbicides, pesticides, and road chemicals (calcium chloride, road salt, etc.) are hazardous materials, too. Know whom to call for help with unexpected erosion, accidents, or other emergencies. Having a backup plan and being prepared for unexpected and special situations can help avoid or minimize negative impacts to water quality. Industry groups, equipment suppliers, and local and state government agencies all have specialists available to help.
- **Use and store hazardous materials properly.** The best way to avoid accidental spills of hazardous materials is to store and handle them so that the chance of these types of emergencies occurring is minimized.