# Maine Forestry Best Management Practices (BMP) Use and Effectiveness—Data Summary 2014-2015


**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 thank the following people for their careful review of and helpful comment on the draft report:

**Erik Carlson** – Consulting Forester **–** C&L Forestry

**Norm Marcotte** – Nonpoint Source Program Coordinator - Maine Department of Environmental Protection

**Anil Raj Kizha** - Assistant Professor of Forest Operations - University of Maine

**Pat Sirois** – Executive Director – Maine Sustainable Forestry Initiative

**Mike St. Peter** – Director - Certified Logging Professional Program

# 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 succeed, 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 1,700 loggers, foresters and landowners have attended MFS and partner water quality trainings over the last five years. MFS's key partner in training development and delivery is the Education Committee of Maine's Sustainable Forestry Initiative State Implementation 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 manuscript, 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 BMPs are used to help control nonpoint source (NPS) pollution. The MFS is statutorily responsible for the development of forestry BMPs (38 M.R.S. §410-J) in Maine and has published a BMP manual. As part of this mandate, MFS 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. In 2010 the publication cycle was changed from an annual to a biannual report. The objective of this ongoing effort is to assess the use and effectiveness of BMPs in Maine.

Landowners are required to notify the MFS before harvesting takes place. Approximately 5,000 timber harvest notifications are filed in Maine each year; samples were drawn from these notifications. This report presents an analysis of data collected on 134 timber harvesting sites from 2014-15. MFS continues this monitoring effort as a part of regular field activities and expects to generate subsequent biannual reports.

Data in this report were 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]

[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.

Assessing the overall effectiveness of a suite of BMPs rather than monitoring the installation of prescribed individual practices allows MFS to assess whether BMPs effectively protect water quality.  For example, simply finding that water bars 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.

BMPs are voluntary measures for silvicultural practices 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

- **Eighty-five percent of sites had BMPs applied appropriately on crossings and approaches, or crossings 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 4% of 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.
- **Ninety-two percent of opportunities evaluated for sediment input found no sediment entered a waterbody.** A major goal of BMPs is keeping sediment from reaching 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.
- **Ninety-eight percent of sites showed no evidence of chemical spills.** 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 is an important BMP, as is being prepared with a plan and the proper equipment if a spill occurs.

- **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 maintenance 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.
- **Ninety-six percent 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 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 either were avoided or effective BMPs were used to cross.** Wetlands are common in many parts of Maine. Crossing wetlands risks compromising their natural hydrology if not done properly. Ninety-four percent 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 (USDA), 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 MFS 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. Of approximately 5,000 notifications filed, 134 sites were monitored. The sample was stratified geographically by forest protection region (Southern, Central and Northern Regions) and by ownership size.

## Data Summary

The information in this data summary was compiled from a sample data set using measurements and observations from harvest sites containing **134** 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 4).

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).

## BMP Inspection sites

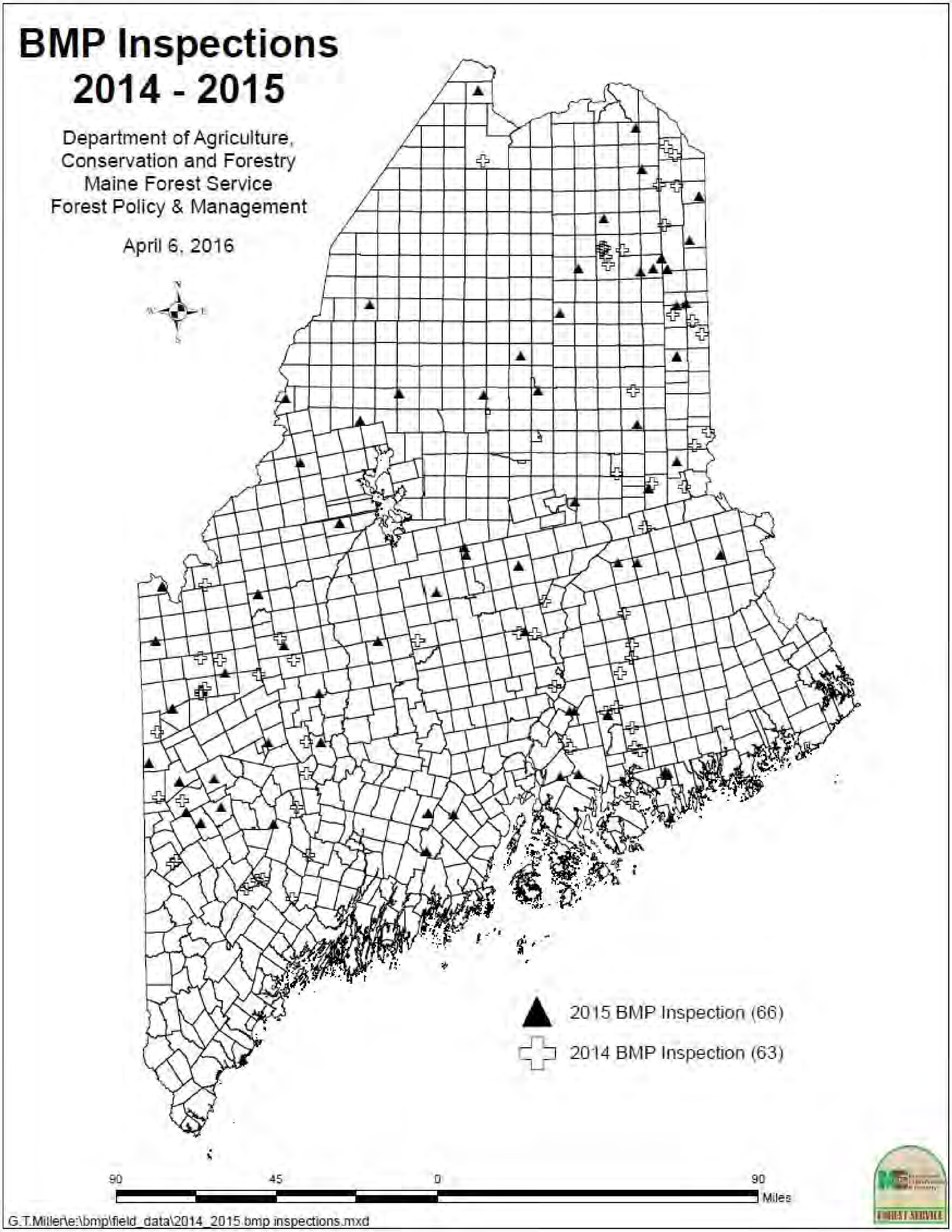



**Figure 1.** Locations of 2014-2015 BMP inspection sites.

# General Information

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 **134** new sample units were sampled.

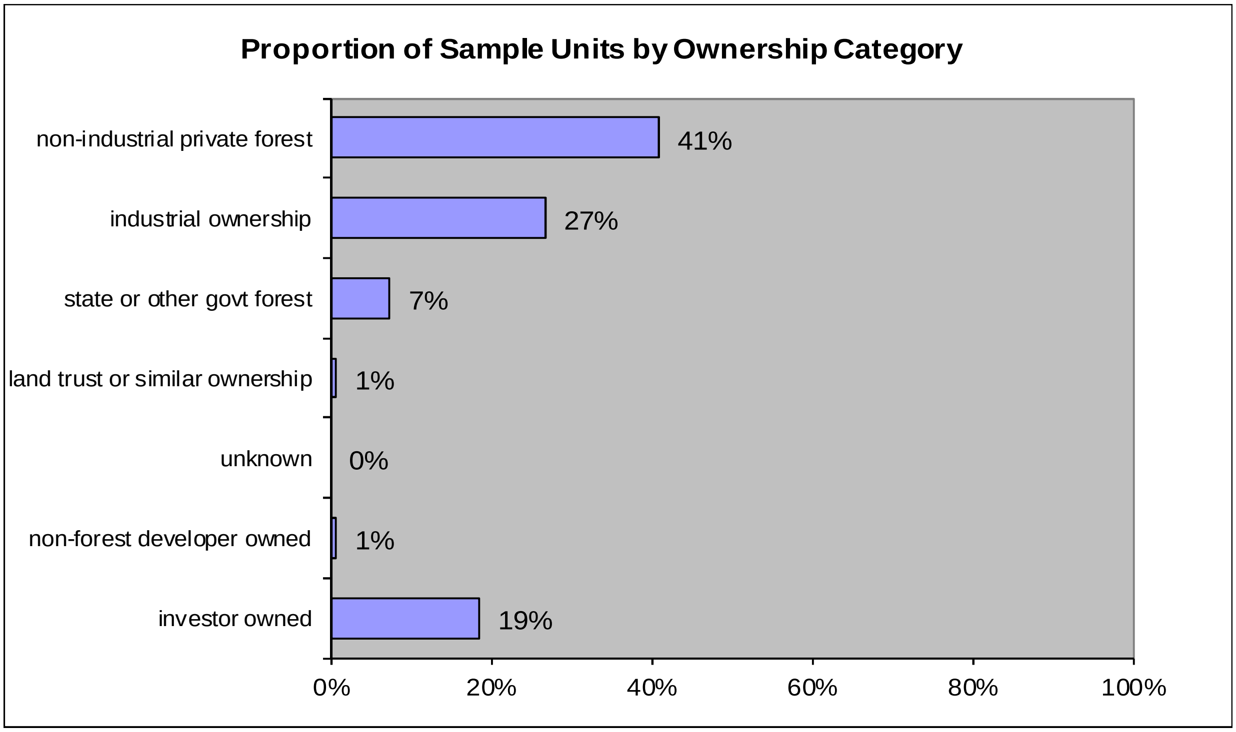



**Figure 2.** Proportion of Sample Units By category (n=134).

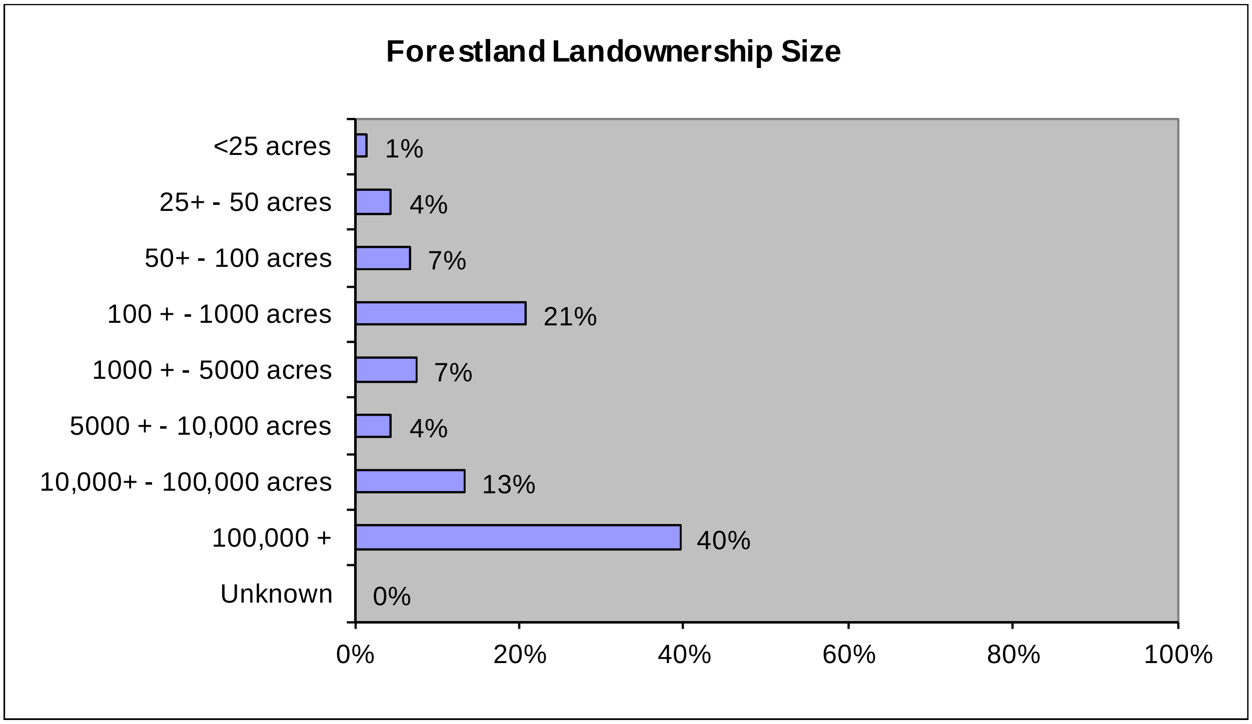



**Figure 3.** Ownership Size (n=134).

Monitoring efforts 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 crossings and their approaches were inspected for BMP implementation and effectiveness and the data was recorded for each sample unit as the water body was being crossed. The delineation of sample units and the features to be included within them are shown on figure 4.

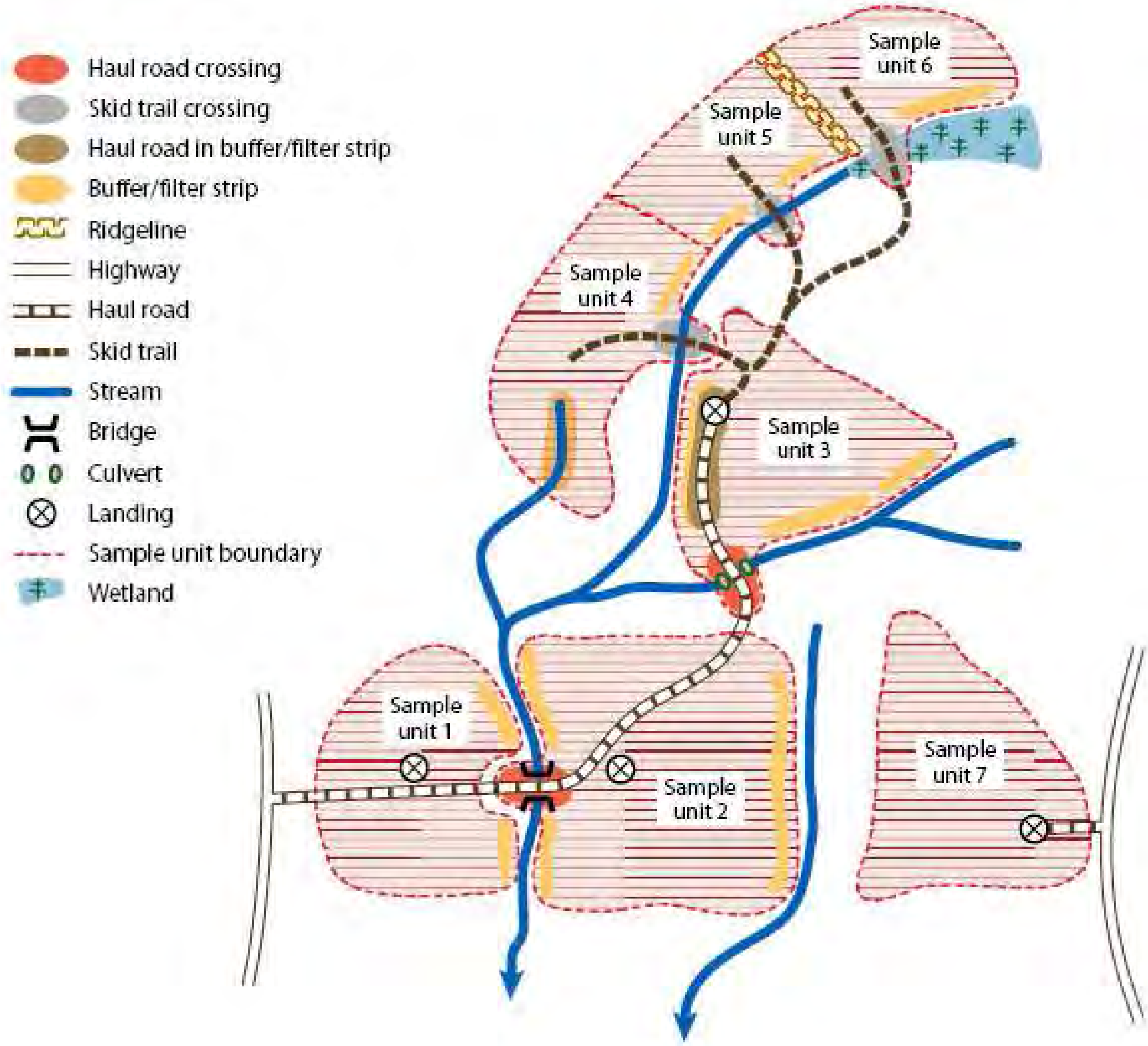



**Figure 4.** Sample Unit Delineation.

## ***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**

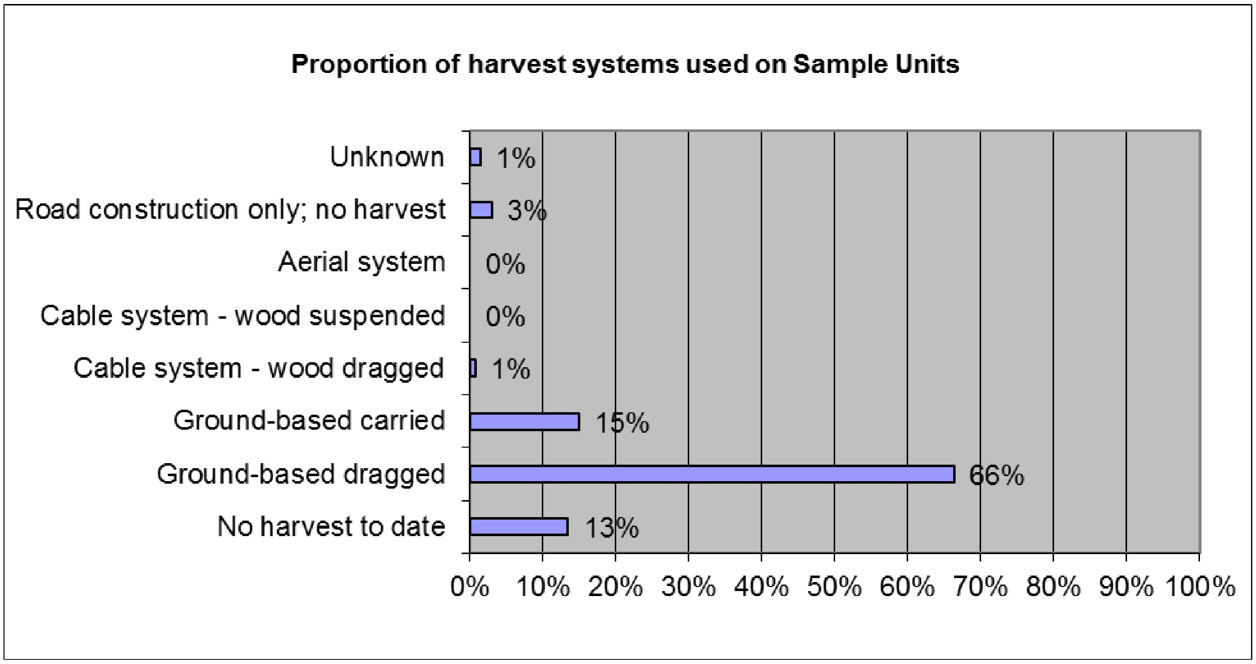



**Figure 5.** Harvest Systems (n=134).

**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 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

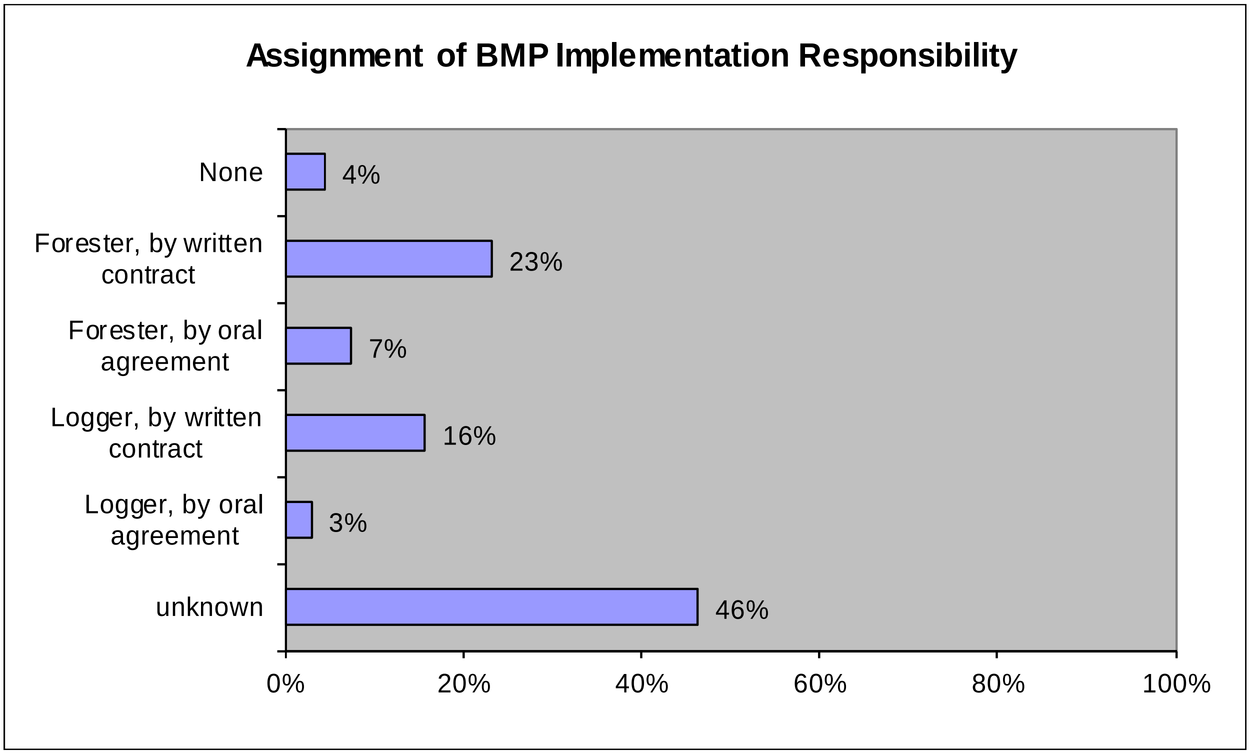



**Figure 6.** Assignment of BMP Responsibility (n=134).

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

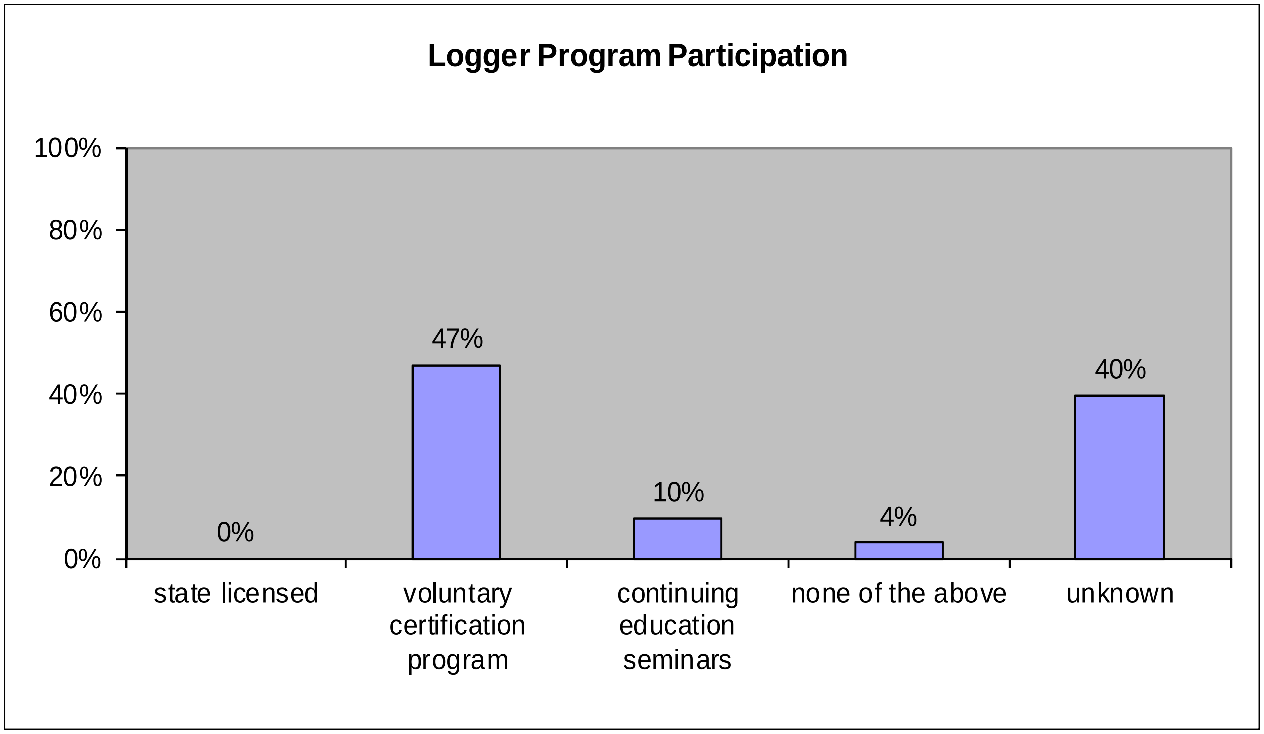



**Figure 7.** Logger certification program participation for the respondents in the study (n=134).

**Discussion**

Many loggers voluntarily participate in second and third party certification programs in Maine such as 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. The 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. However, the state of Maine does not require loggers to be licensed.

# Soil Movement, Sedimentation, and Stabilization

There were **five** opportunities to observe the occurrence of soil movement, sedimentation, or stabilization for each sample unit. They were at 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. **Proportions in this section are 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, this is intended to

> The protocol defines 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.

give an overall picture of harvest impacts on water quality, since many harvests were 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.

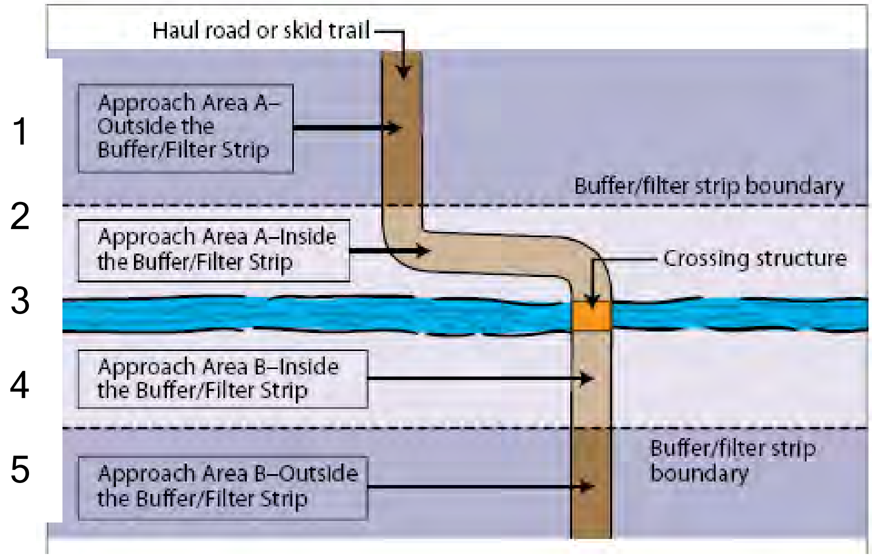



**Figure 8.** Diagram showing five opportunities to observe soil movement at any typical haul road or skid trail stream crossing

For the 134 new sample units, there were 670 opportunities to observe soil conditions.

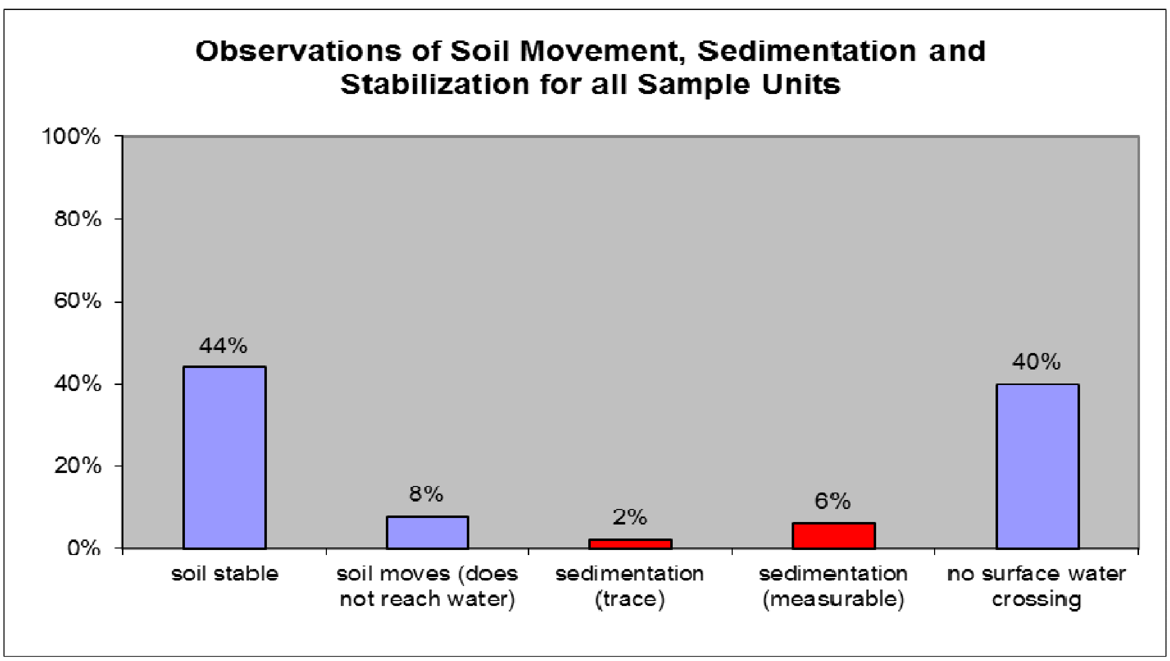



**Figure 9.** Proportions are based on the total number of opportunities to observe soil conditions in the protocol (n=670). Note: measurable sediment is considered a volume of sediment greater than one cubic foot.

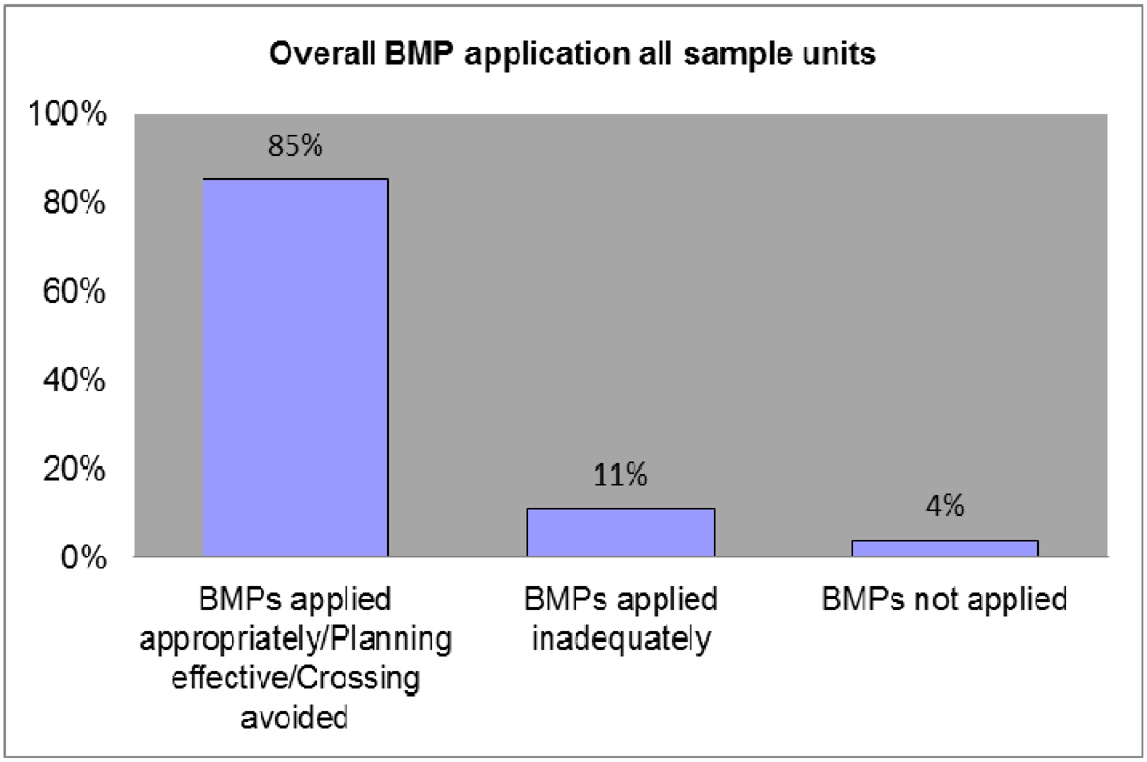


**Figure 10.** Overall applications of BMPs at stream crossings.

**Discussion**

From the soil samples observed, 8% showed either trace or measurable amounts of sediment reached the waterbody (n=670). Forty percent of the harvests monitored avoided water crossings. Avoiding a crossing, when operationally practicable, is always considered preferable to installing a crossing that will need BMPs to control erosion and sedimentation. Excluding avoided water crossings, sediment reached the waterbody on 14% of observations. BMPs were judged to be applied appropriately on 85% of sites and not applied at 4% of sites. These percentages include sites where crossings were avoided. If sites without crossings are not included BMPs were not applied at 7% of crossings.

### Sedimentation by Area of Origin

There are **55** observations of sediment reaching the surface water body or deposited within the bankfull channel width of the water feature.

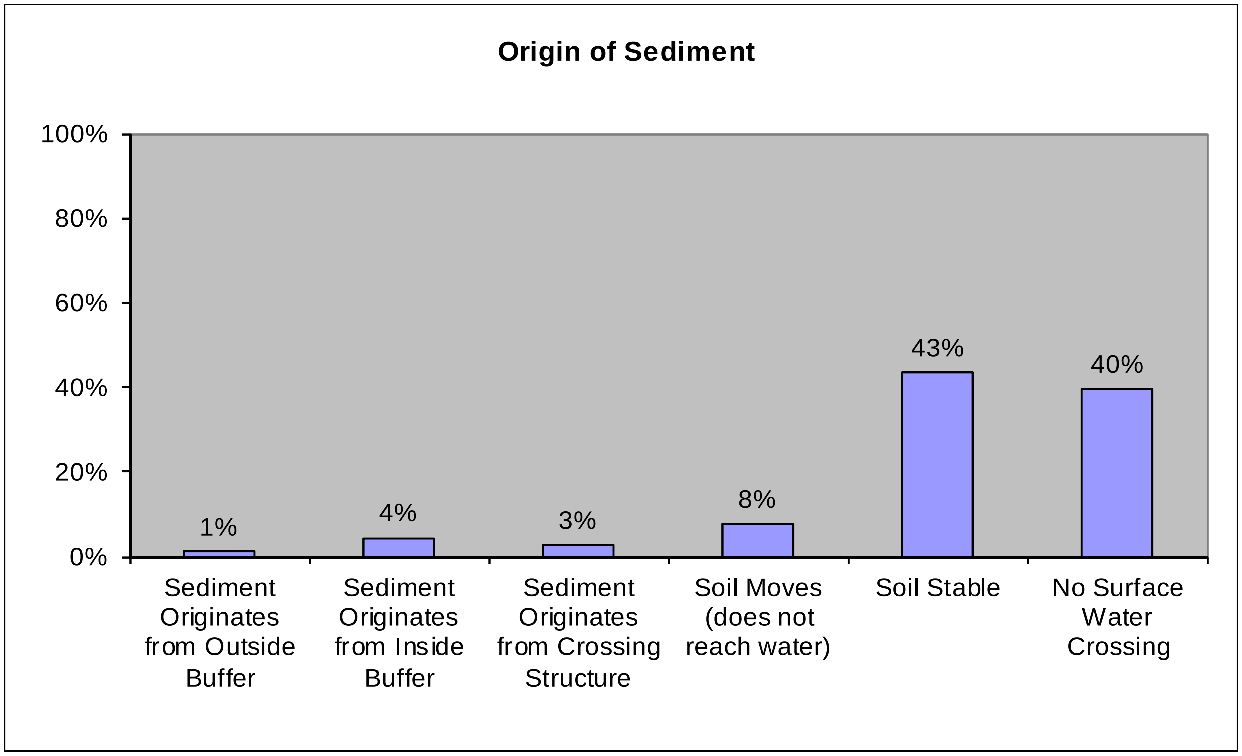



**Figure 11.** Origin of Sediment (n=670).

### 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 **15 and 40** observations of trace and measurable amounts of sediment reaching the surface water body or deposited within bankfull channel width of the water feature respectively.

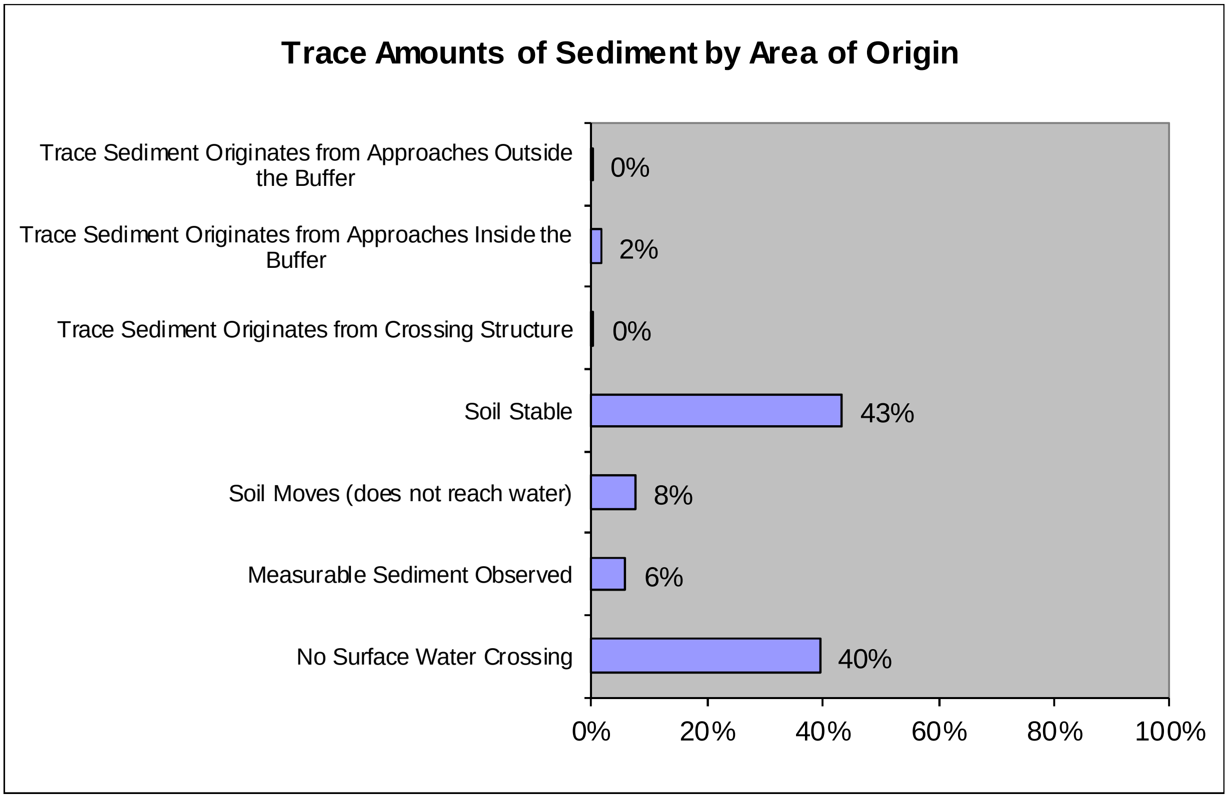



**Figure 12.** Trace amounts of sediment by origin. Proportions are based on the total number of opportunities to observe soil conditions.

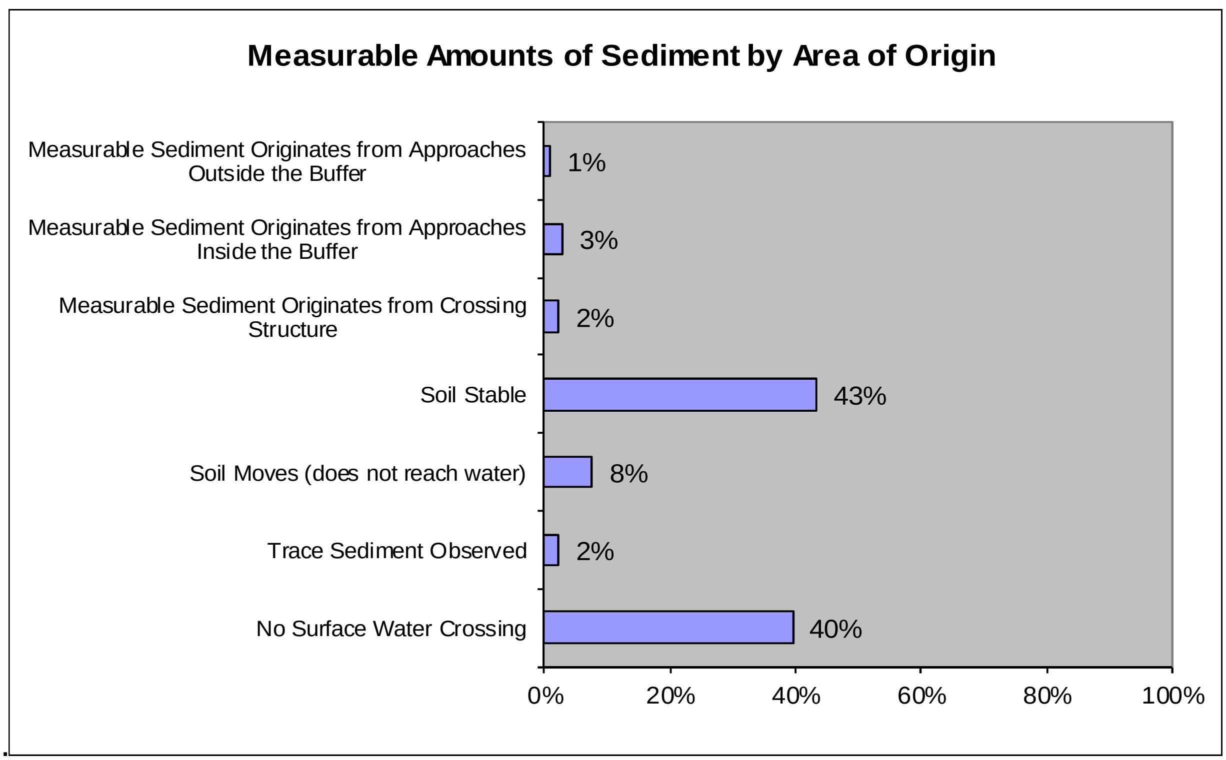
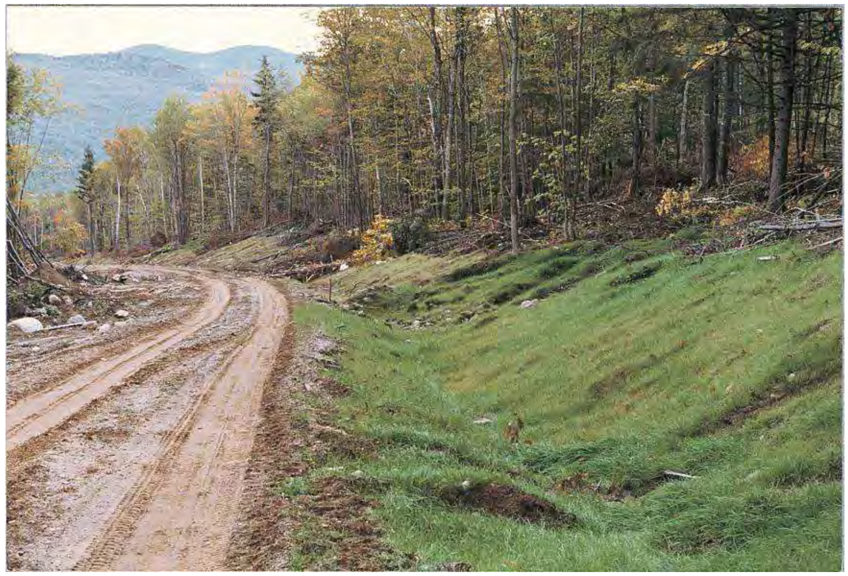



**Figure 13.** Measurable amounts of sediment by origin Proportions are based on the total number of opportunities to observe soil conditions (n=670).

***BMP Principle**: Minimize and Stabilize Exposed Soil*



**Discussion**

Measurable sediment was most likely to reach the waterbody from inside the buffer/filter strip and from the crossing structure. This was expected as these were the areas closest to the waterbody. Sediment also reached 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 anticipated 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. MFS recommends minimizing exposed mineral soil adjacent to water bodies and stabilizing immediately if it occurs. MFS's *Best Management Practices for Forestry: Protecting Maine's Water Quality* provides recommended filter area widths adjusted for percent slope and distance to the waterbody[2].

# Approaches to Water Crossing

There were **4** sections at each sample unit to observe the occurrence of soil movement, sedimentation, or stabilization from the approaches to a surface water crossing, classified as: 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. **Proportions are based on the total number of opportunities to make observations about soil conditions at the approaches.**

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[2] Maine Department of Agriculture, Conservation and Forestry, Maine Forest Service. *Best management Practices for Forestry: Protecting Maine's Water Quality.* 2004.

From the **134** sample units, there were **81** crossings evaluated. With 4 opportunities to observe soil movement in the approaches, there were **324** total opportunities to observe soil conditions at approaches.

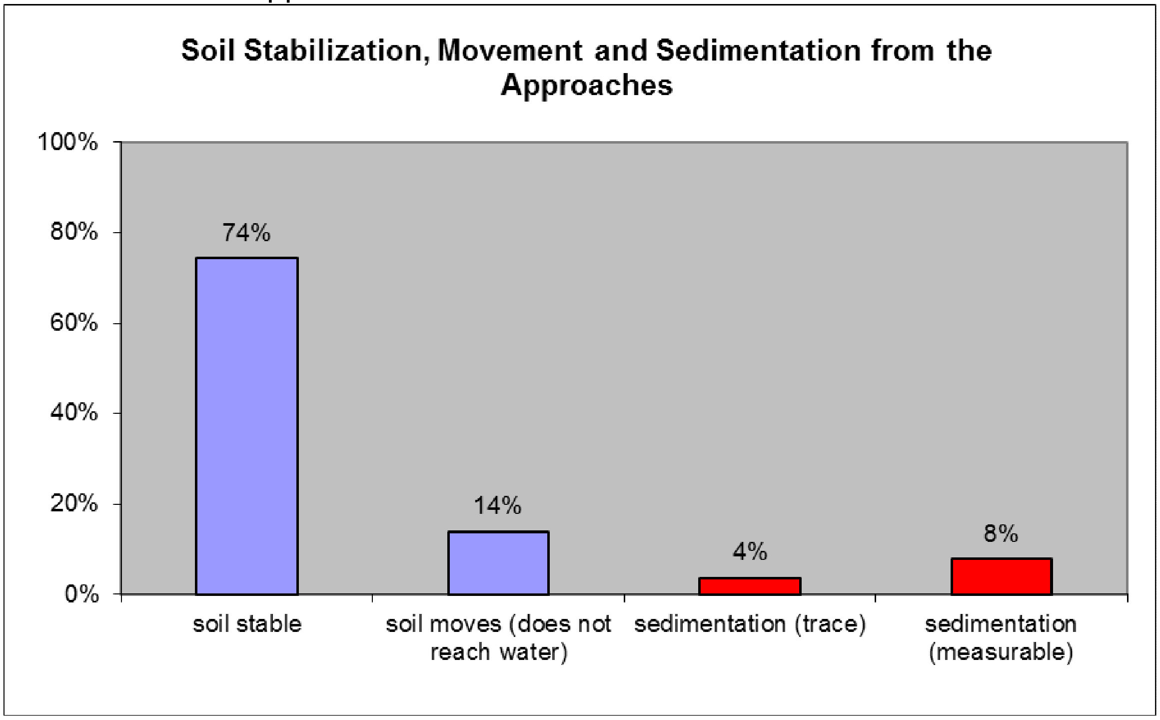



**Figure 14.** Observations of soil stabilization, movement and sedimentation at the approaches. Proportions are based on the total number of opportunities to observe soil conditions at the approaches (n=324).

## Discussion

Excluding avoided stream crossings (40%), there were 324 opportunities to observe soil conditions in the approaches to the 81 crossings. Sediment reached the waterbody from the approaches at 12% of observations. In 14% of cases, 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 **12** observations of **trace** amounts of sediment reaching the surface water body or deposited within bankfull channel width of the water feature and **25** observations of **measurable** amounts of sediment reaching the surface water body or deposited within bankfull channel width of the water feature.

### Specific Cause of Sedimentation from the Approaches

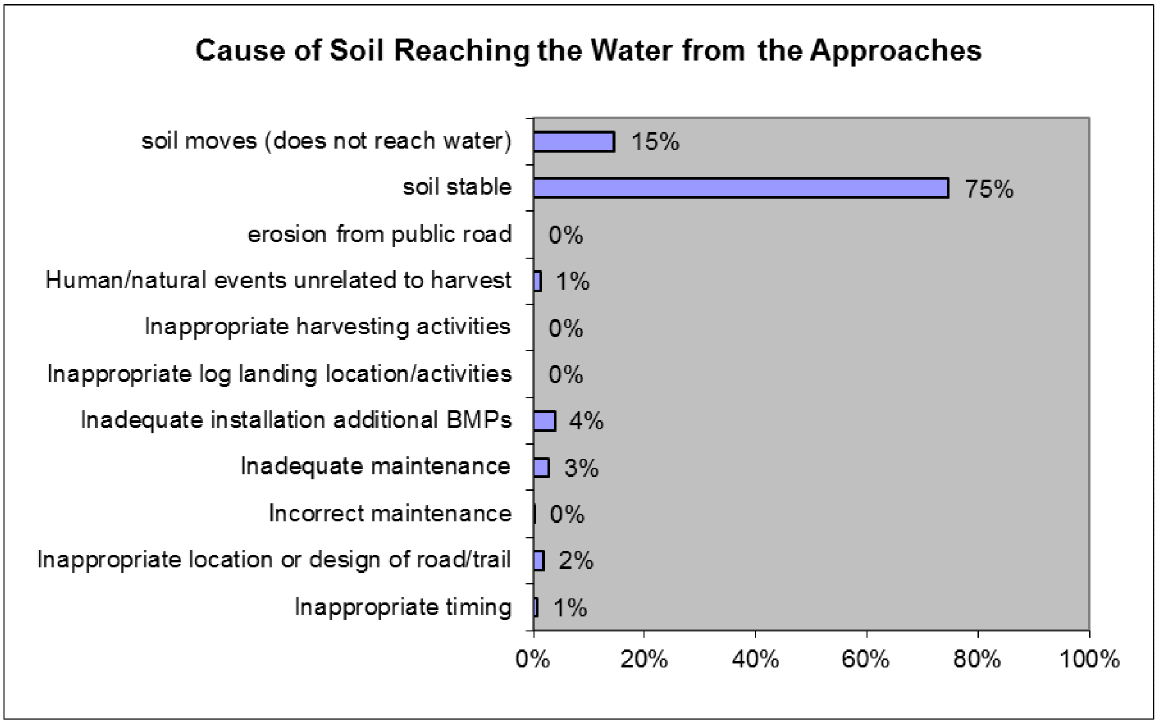



**Figure 15.** Cause of soil reaching the water from the approaches (n=324).

BMP Maintenance refers to reshaping or reinforcing installed BMPs to compensate for wear from use, erosion or in anticipation of seasonal shutdown or extreme weather events. Inadequate installation of additional BMPs and 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.

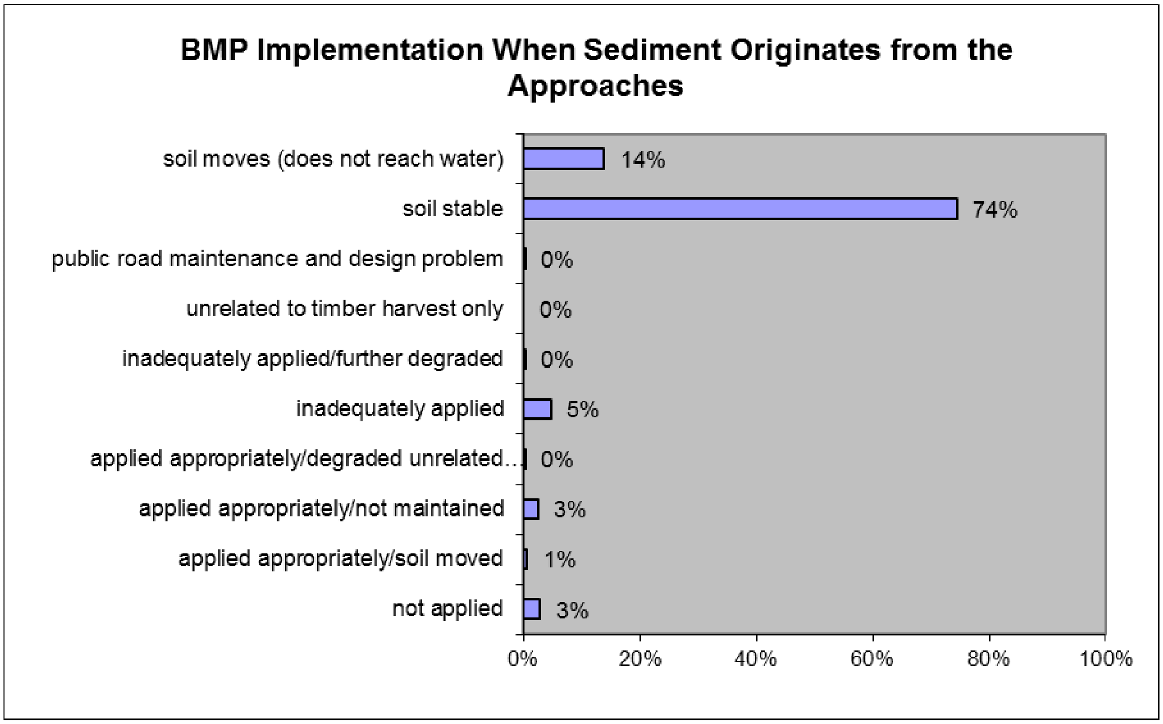



**Figure 16.** BMP implementation at approaches (n=324).

**<u>Discussion</u>**

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 **only one** 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 **134** new sample units were sampled.

- **81** sample units have surface water crossings.

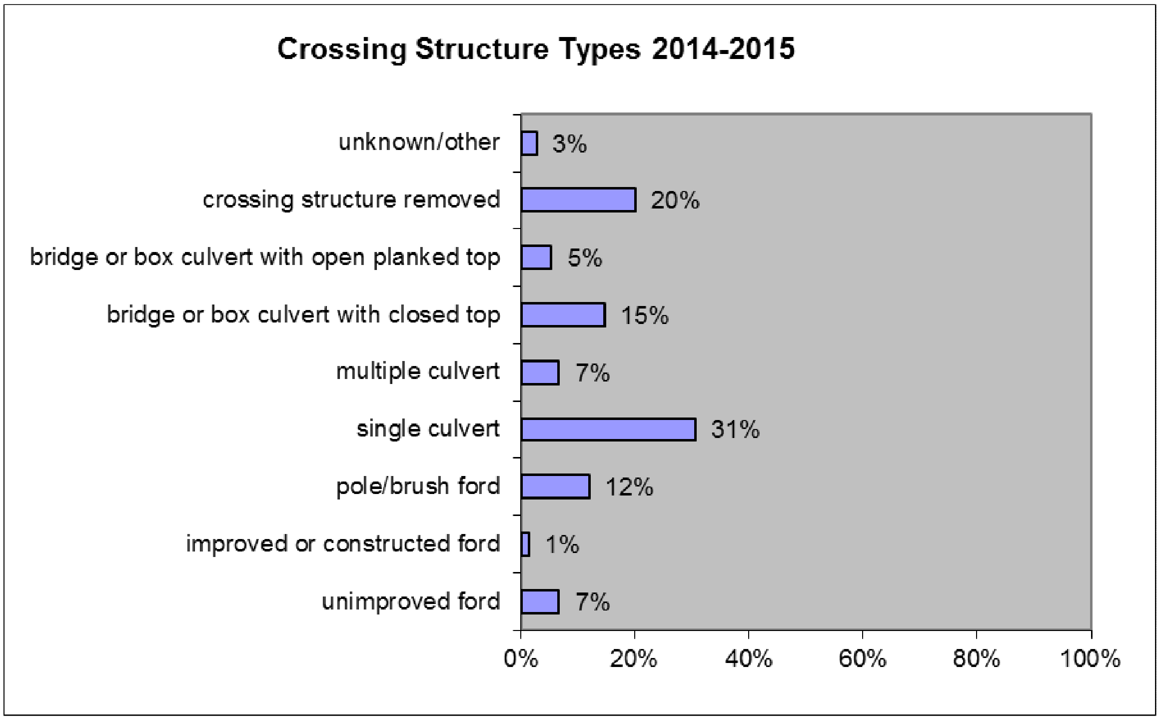



**Figure 17.** Proportions are based on the total possible number of crossing structures (n=81).

### Structure Type by Road Type

- There were **33** sample units with a skid trail at the water crossing and **48** sample units with a haul road at the water crossing.

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

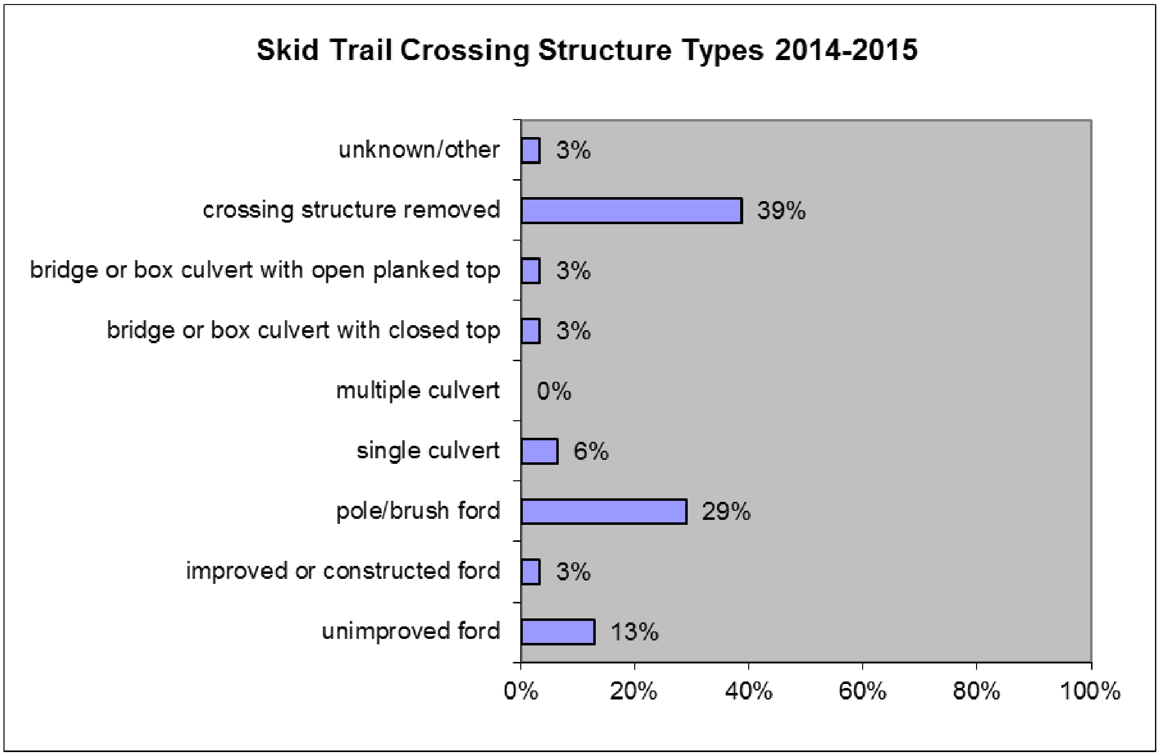



**Figure 18.** Structure type associated with skidder crossing. Proportions are based on the total possible number of crossing structures (n=33).

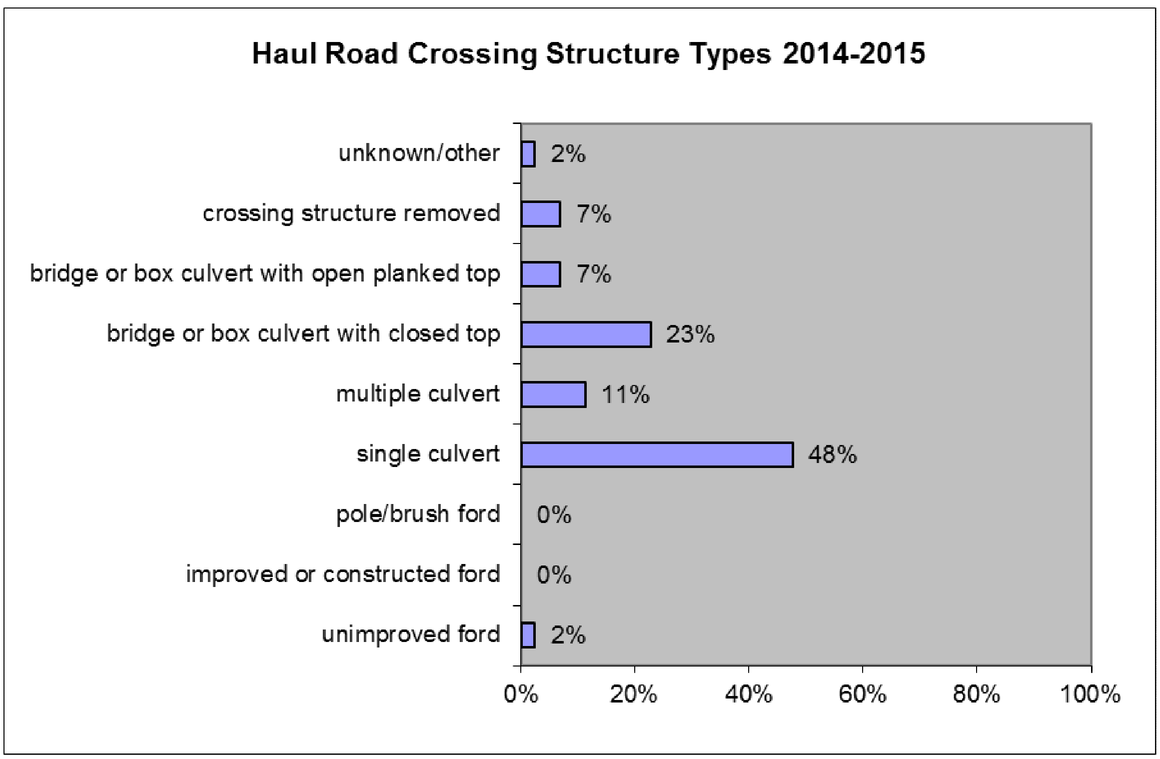



**Figure 19.** Structure type associated with haul road crossing. Proportions are based on the total possible number of crossing structures (n=48).

**Discussion**

Eighty-one crossings were identified as either haul roads or skid trails; 48 haul roads and 33 skid trails. 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 are primarily 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.

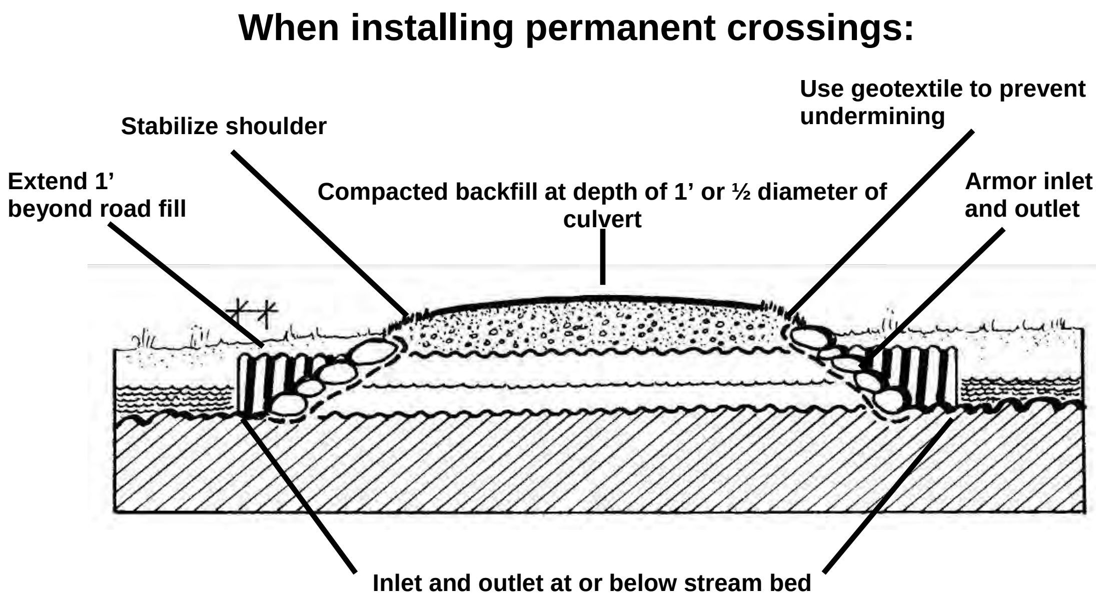
Haul Road

Skid Trail

**Structure Type Associated With Water Body Type**

- There were **60** crossings associated with a perennial water feature, **8** crossings associated with an intermittent water feature, and **9** 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.




For the **134** new sample units, there were **81** opportunities to observe soil conditions at the crossing structure.

### Soil Stabilization, Movement, and Sedimentation From the Crossing Structure

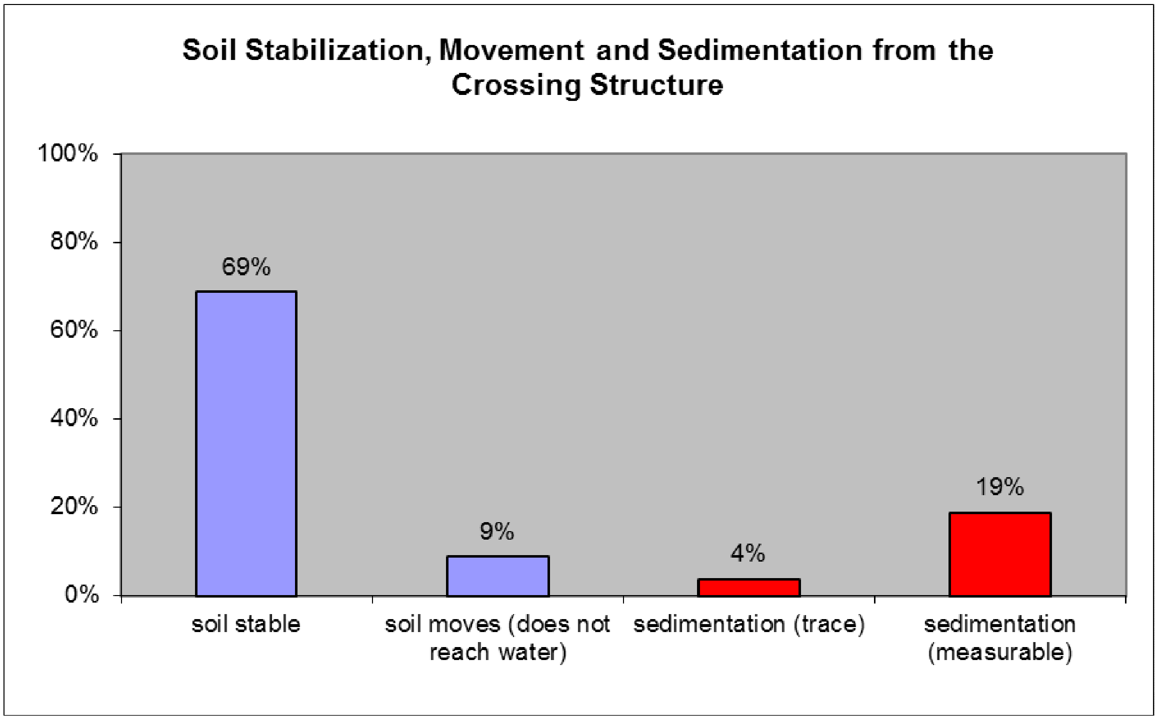



**Figure 20.** Observations of soil stabilization, movement and sedimentation from the crossing structure. Proportions are based on the total number of opportunities to make observations about soil conditions at the crossing structure (n=81).

**Discussion**
Excluding avoided crossings, 23% of crossings had sediment enter the waterbody. This is significantly lower than an average of 35% reported between 2005 to 2013. Nineteen percent of all observations showed measurable soil movement into the waterbody originating from the crossing; down from an average of 23% between 2005 and 2013.

**Sedimentation from the Crossing Structure**

There are **3** observations of trace amounts of sediment reaching the surface water body or deposited within bankfull channel width of the water feature.

There are **12** observations of measurable amounts of sediment reaching the surface water body or deposited within bankfull channel width of the water feature.

**Table 1** Volume of Measurable Sediment Observed in the Water and Attributable to the Crossing Structure (cubic feet).

| | Sediment evident in water body |
|---|---|
| **Average** | 16 |
| **Median** | 7 |
| **Maximum** | 70 |

**Discussion**
Sedimentation originating from the crossing structure has been identified as a problem area in previous reports. In response to this issue, MFS and its partners including Maine SFI, the Certified Professional Logging Program and others have provided targeted water quality trainings.  Over 1,700 foresters, land owners and logging professionals over just the last two years. MFS also continues to provide portable skidder bridges available for loan to loggers across the state.

**Structure Type Associated With Sedimentation**

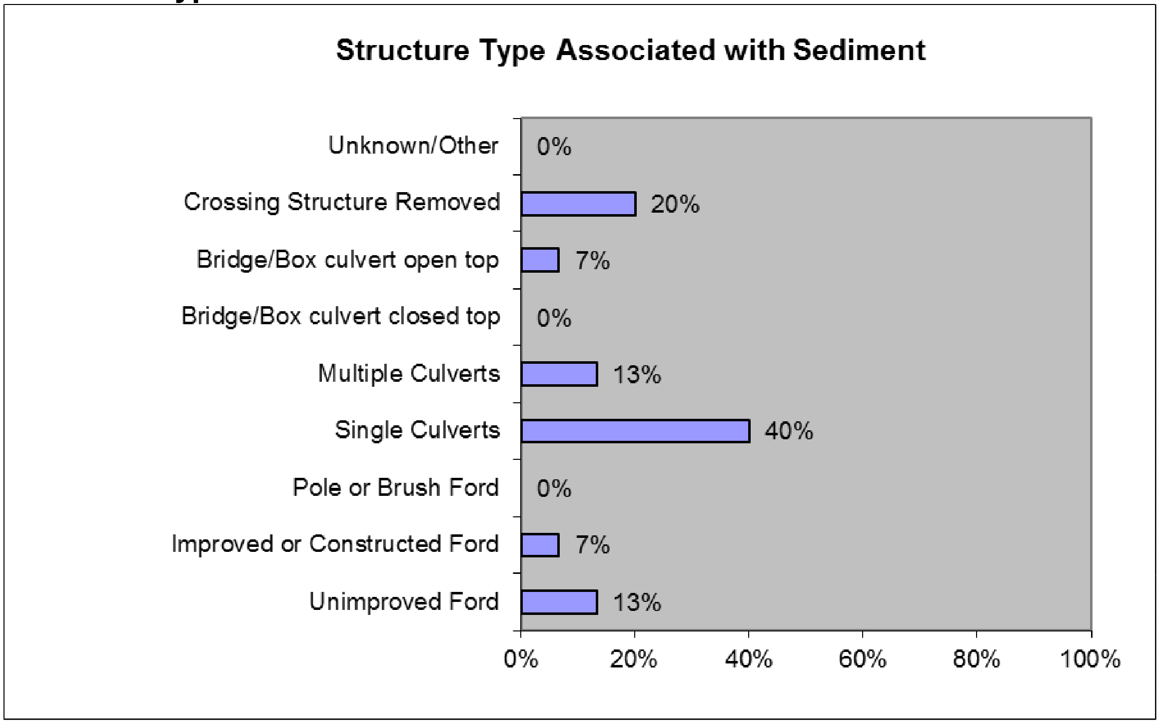



**Figure 21.** Structure type associated with sedimentation (n=15).

## 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.

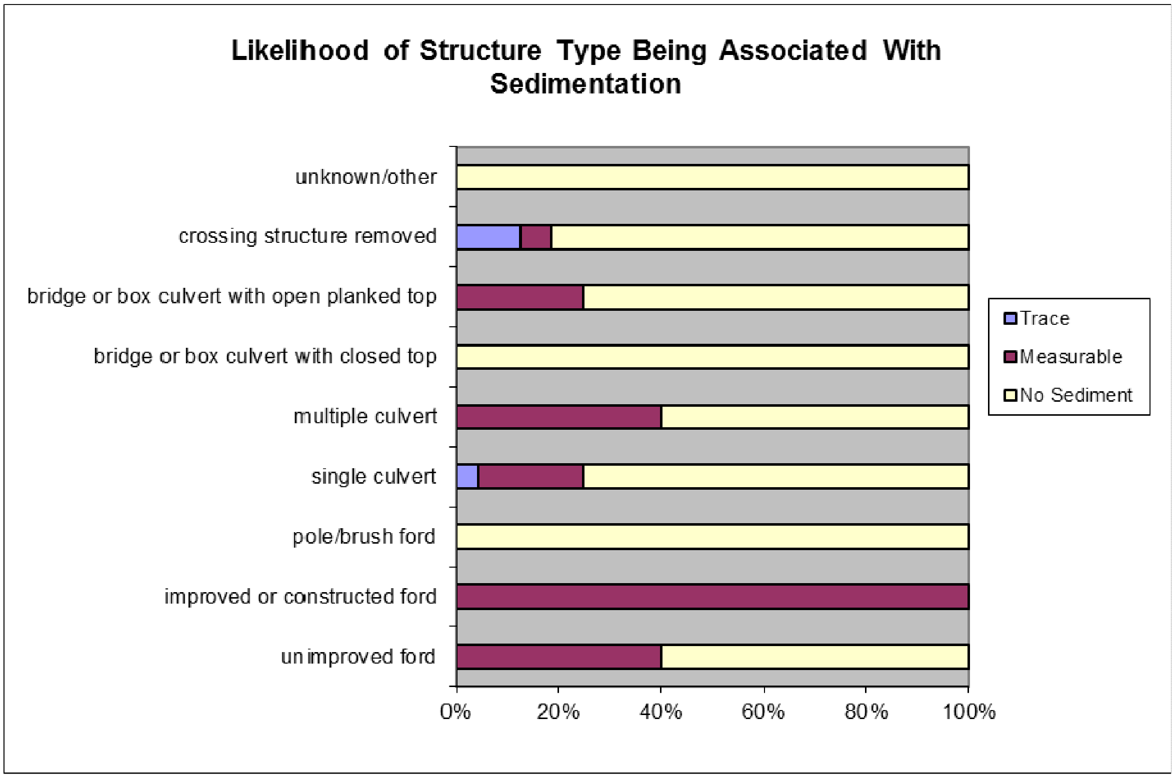
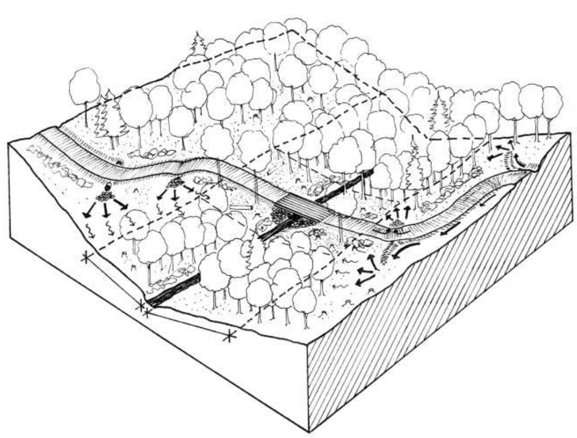



**Figure 22.** Likelihood of structure type being associated with sedimentation.

In Figure 20 above, the likelihood of a structure to contribute to sedimentation is directly related to the occurrence of the structure during our monitoring efforts. For instance, improved or constructed ford was observed only 7% of the time. However, measurable amounts of sediment were reported during this rare occurrence, resulting in a high likelihood of this structure type being associated with sedimentation. Figure 20 suggests that it is best to avoid using multiple culverts, constructed fords or unimproved fords to cross streams. Please reference Figure 19 to view the occurrence of each structure.

Elevated crossing structures, located above 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

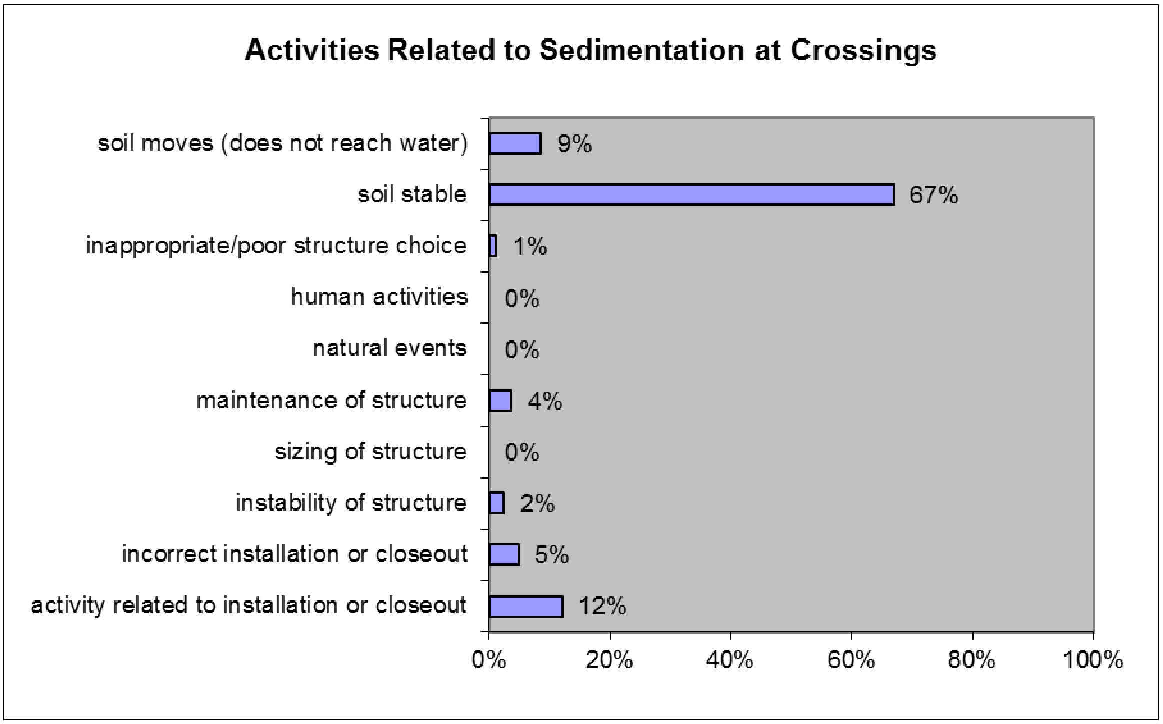



**Figure 23.** Activities related to sedimentation at crossings (n=15).

**Table 2.** Quantities of Sedimentation by Crossing Structure Type.

| | Sediment Volumes (cubic feet) | | |
|---|---|---|---|
| | **Average** | **Median** | **Maximum** |
| Unimproved ford | 13 | 13 | 25 |
| Improved/constructed ford | N/A | N/A | N/A |
| Pole/brush ford | N/A | N/A | N/A |
| Single culvert | 7 | 6 | 15 |
| Multiple culvert | 25 | 25 | 45 |
| Bridge/box culvert, closed top | N/A | N/A | N/A |
| Bridge/box culvert, open top | 70 | 70 | 70 |
| Structure removed | 1 | 1 | 1 |
| 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 is critical to ensure the avoidance of chronic sedimentation inputs.**

## Effectiveness of BMP Principles and Practices at crossing structures

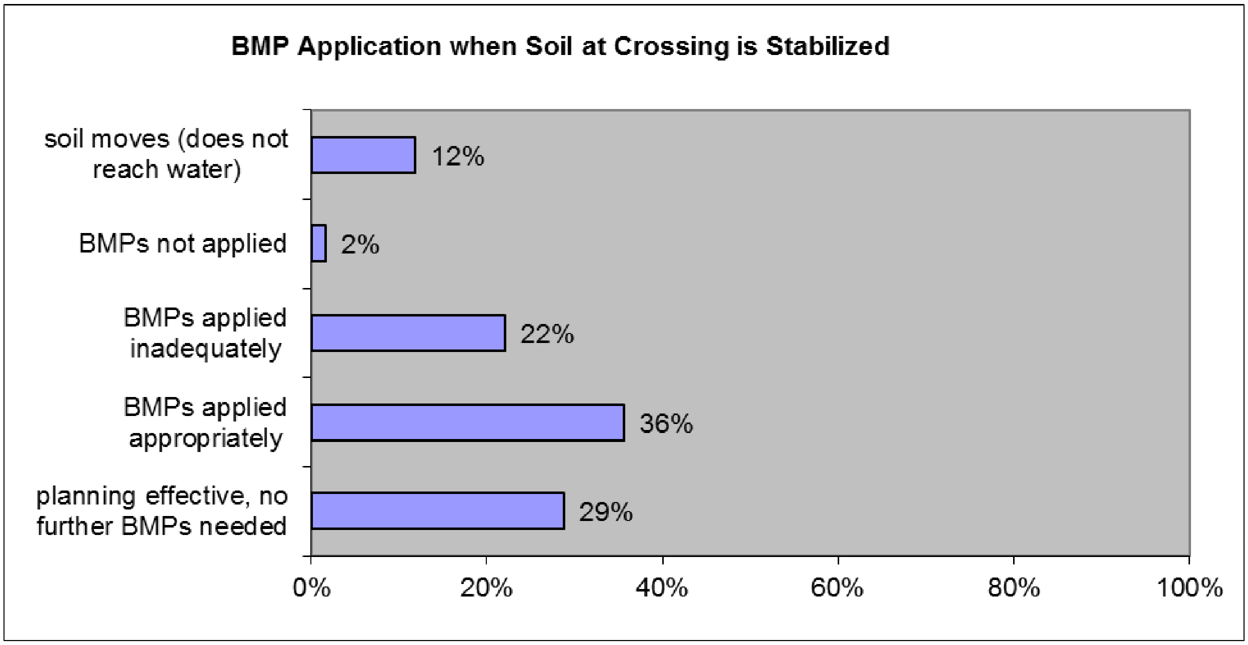



**Figure 24.** BMP application when no sediment entered the waterbody from the crossing structure (n=66).

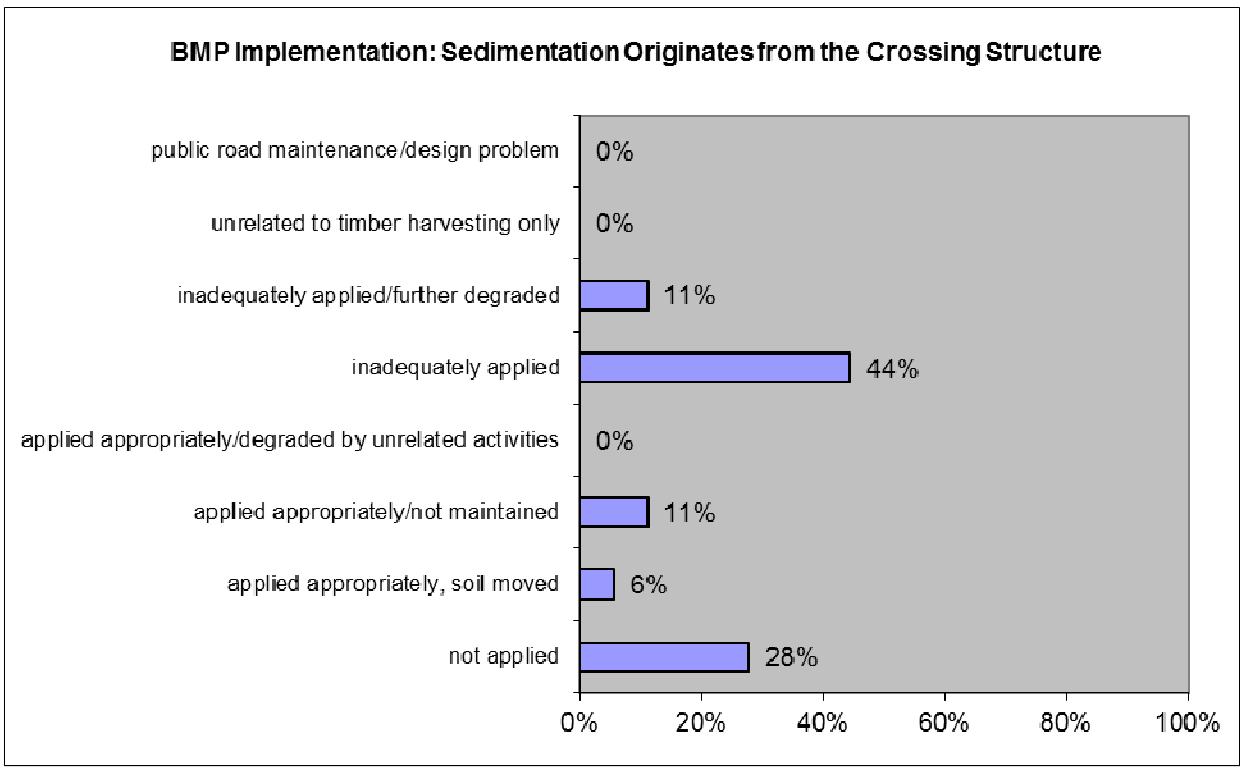



**Figure 25.** BMP application when sediment (both trace and measurable) originating from the crossing structure entered the waterbody (n=15).

**<u>Discussion</u>**

When a crossing was present, 23% of all observations showed soil movement into the waterbody originating from the crossing (Figure 18). Comparing BMP application when sediment does not enter the water (Figure 22) to BMP application when sediment does enter the water (Figure 23) 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 22). On the other hand when sediment reached a waterbody it was due to BMPs being inadequately applied, not maintained or not applied at all (Figure 23). 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. **Ensuring the correct installation of BMPs 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 BMPs need to be installed correctly to achieve their intended outcomes.

# Fish Passage

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

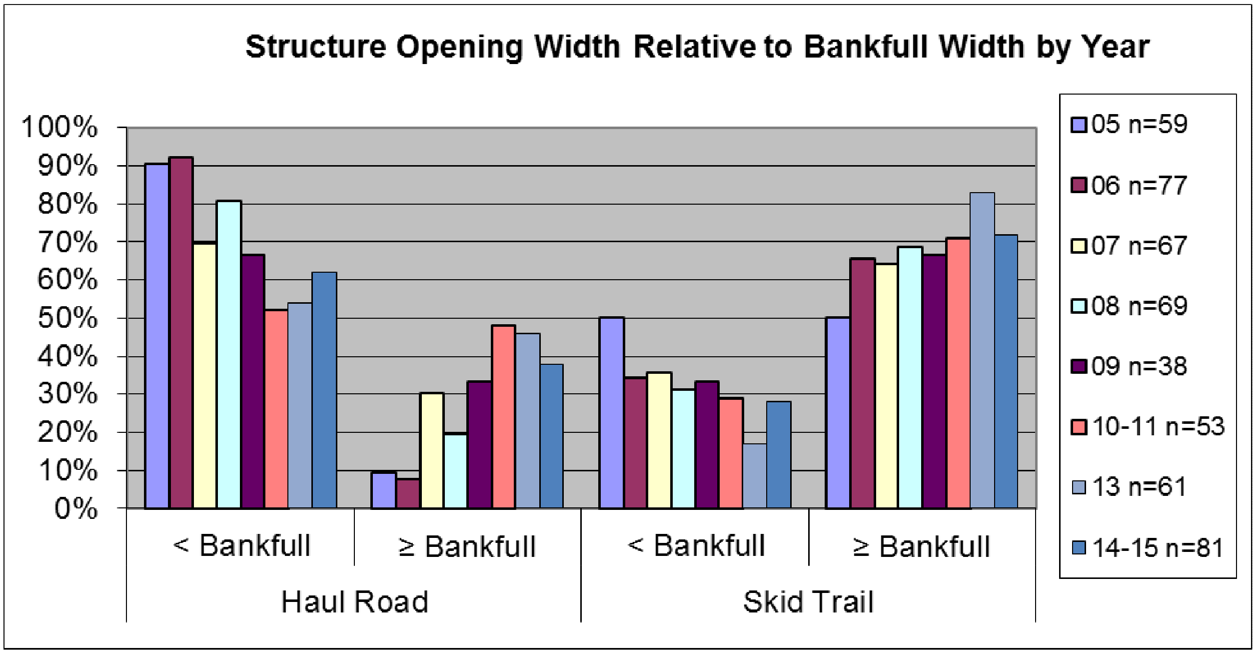



**Figure 26.** Crossing structure widths relative to bankfull width. Data includes remnant structure width for structures that have been removed prior to the monitoring field visit.

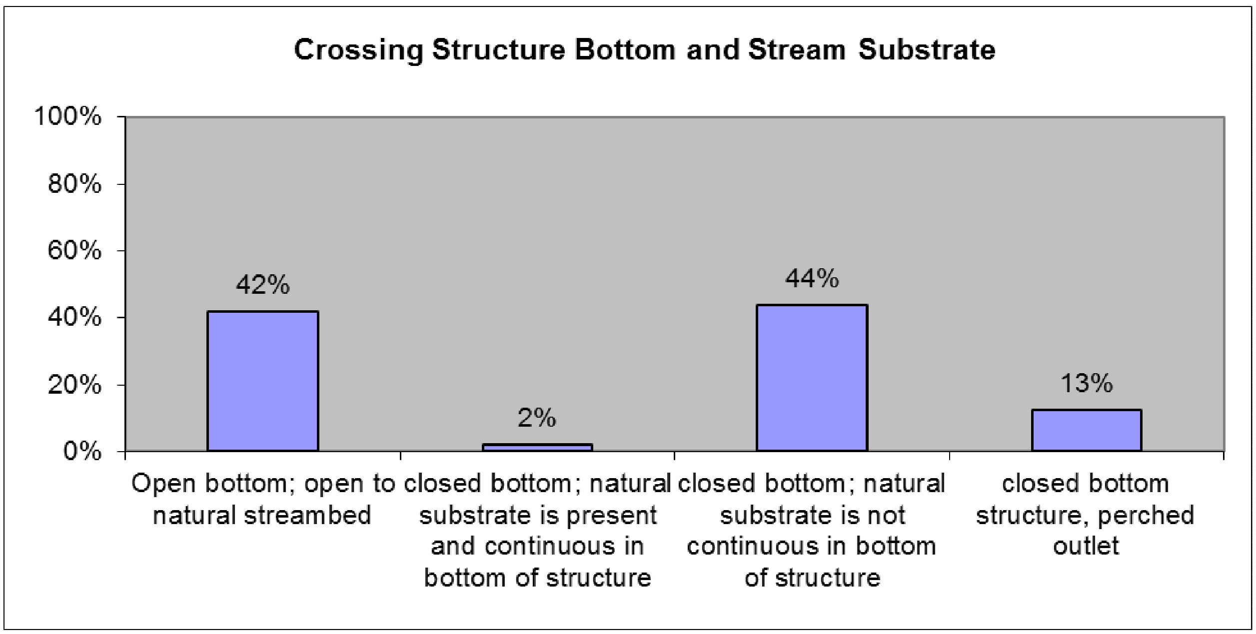



**Figure 27.** Crossing structure bottom condition for crossings where fish or macroinvertebrates were present and the structure was to be in pace for more than 3 months (n=48).

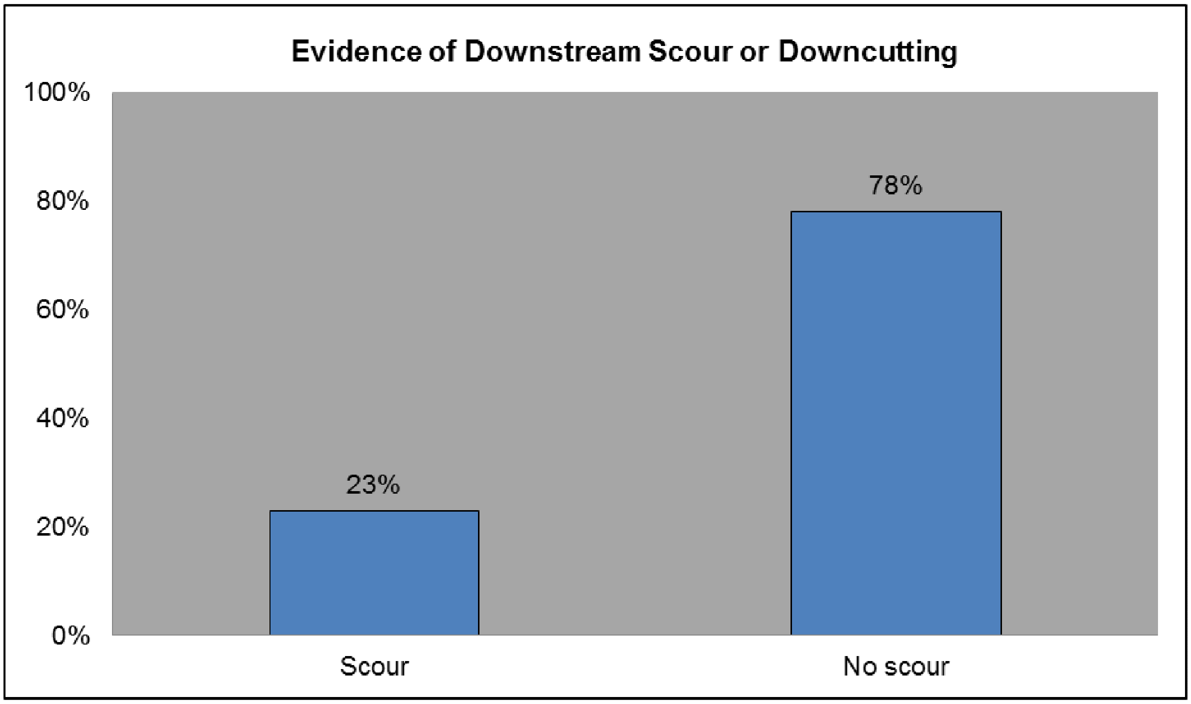


**Figure 28.** Evidence of scouring or downcutting within 100' of the crossing (n=76).

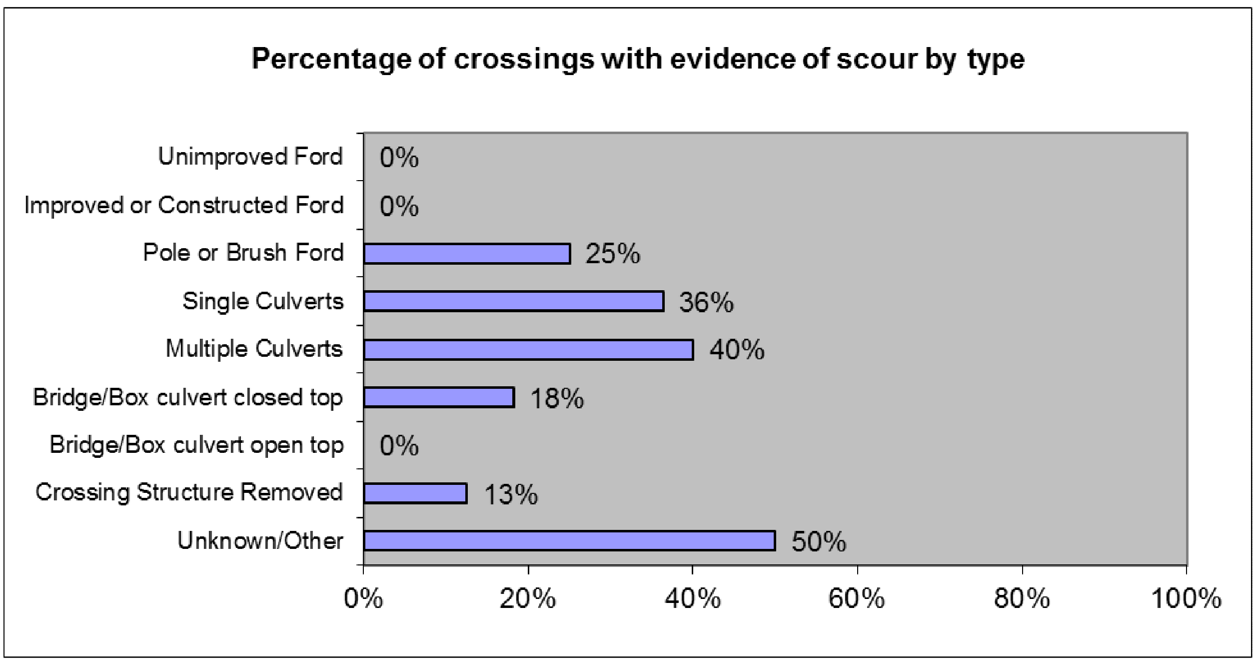


**Figure 29.** The percentage of crossings of each type where scour or downcutting was observed within 100' of the outlet. "n" is variable by structure type.

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## Discussion

Improving the performance of crossings to permit fish passage has been a major focus of training over the past seven 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 mostly positive trend in the percentage of crossings that are equal to or greater than bankfull width (i.e. spanning the stream) (Figure 24). This is particularly important for haul roads where crossings are more often permanent, rather than temporary like on skid trails, because a poorly installed crossing can have long lasting impacts. Monitoring during 2014-2015 found that 64% of the crossings on haul roads did not span the stream, an increase by 8% from the previous year, but not a significant detractor from the prevailing trend over the last 8 years.

It was found that 13% of stream crossings had a perched outlet, indicating a problem with the elevation of the installation or a scour issue (Figure 25). 23% 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 26). Single and multiple culverts were the most common types to exhibit scour, whereas open bottom structures such as bridges were less likely to have scour associated with them (Figure 27).

# Haul Road or Log Landing in the Buffer/Filter Strip

There is **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 are 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 **134** new sample units, there are **134** opportunities to observe soil conditions at the haul road or log landing inside the buffer/filter strip.

- **none of the** sample units have a haul road or log landing located within the buffer/filter strip.

### Soil Stabilization, Movement, and Sedimentation

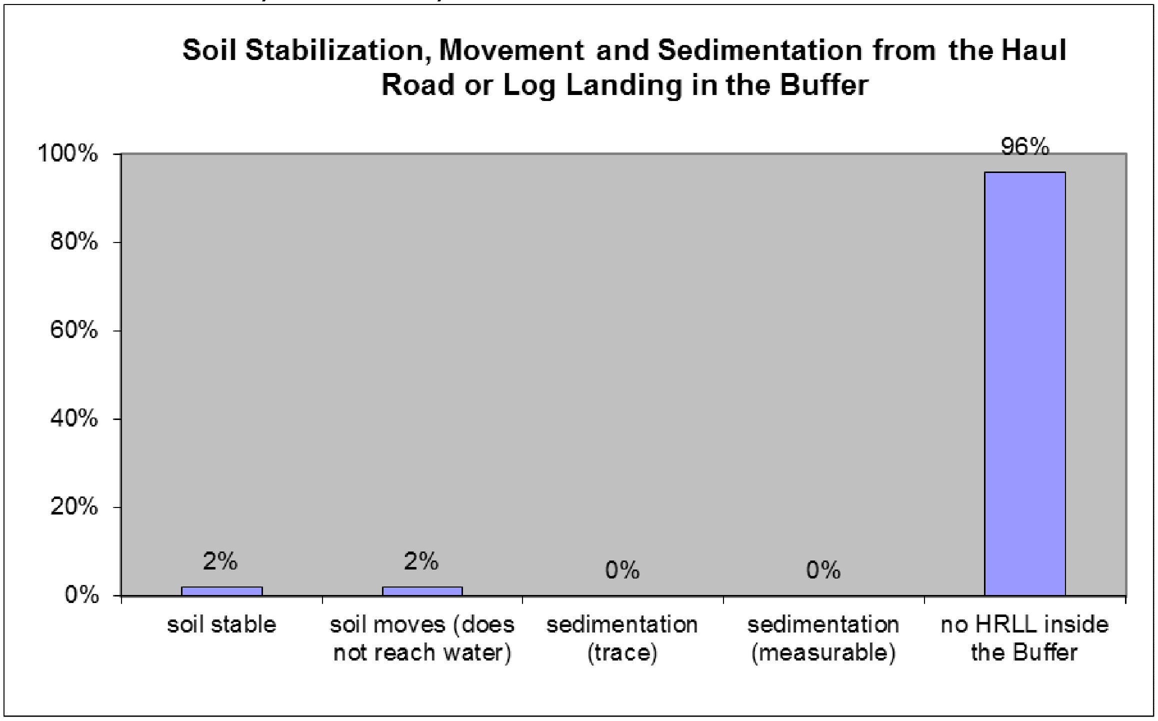



**Figure 30.** Proportions are based on the total number of opportunities to make observations about soil conditions at haul roads or log landings inside the buffer/filter strip (n=134).

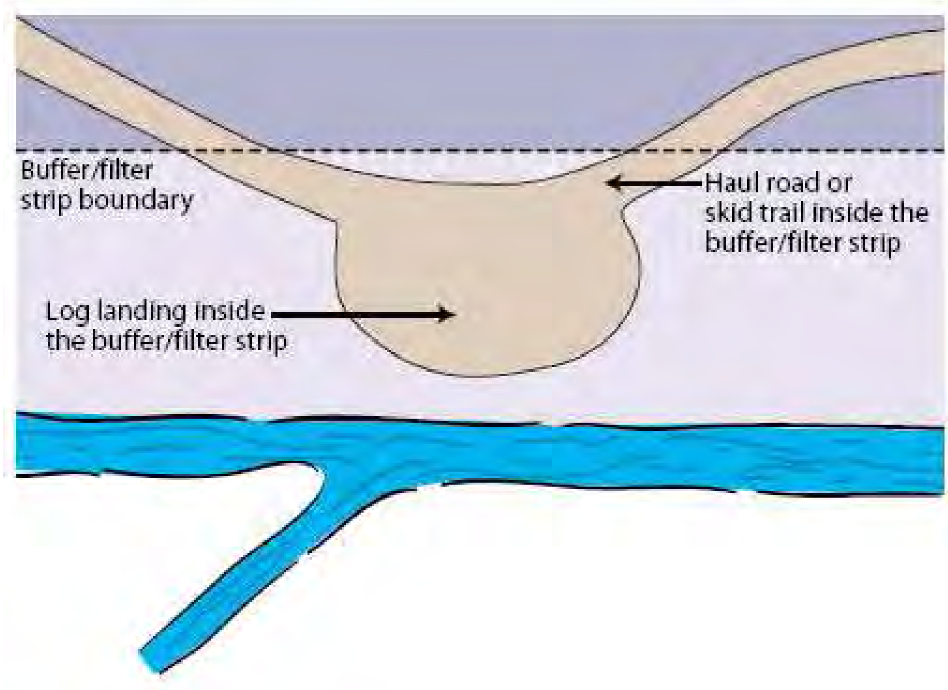
## Discussion

Areas of prolonged soil exposure during a timber harvest typically are 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 the buffer filter strip significantly reduces environmental risk and BMP implementation costs.

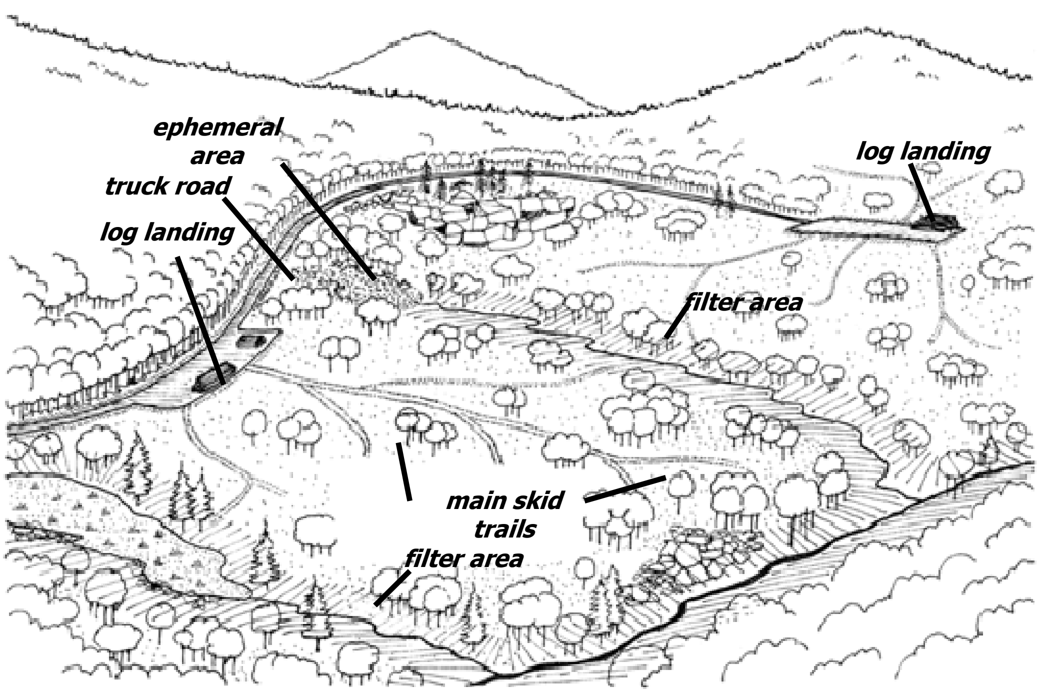
Ninety-six percent of timber harvests monitored did not have landings or haul roads within the buffer. New construction typically avoids placing these forest access systems within these sensitive areas. **Practitioners should routinely scrutinize appropriateness of reuse when accessing historical haul 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 that when BMPs are applied, negative impacts to 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

**134** new sample units were sampled.

### Evidence of Potential Pollutants

- **3** sample units had evidence of lubricant, fuel, hydraulic fluid, and/or anti-freeze spillage resulting from harvest operations.

- **10** sample units had evidence of discarded batteries and/or other potential pollutant containers present.

- **none of the** sample units had evidence of chemical spills as well as discarded batteries and/or other potential pollutant containers present.

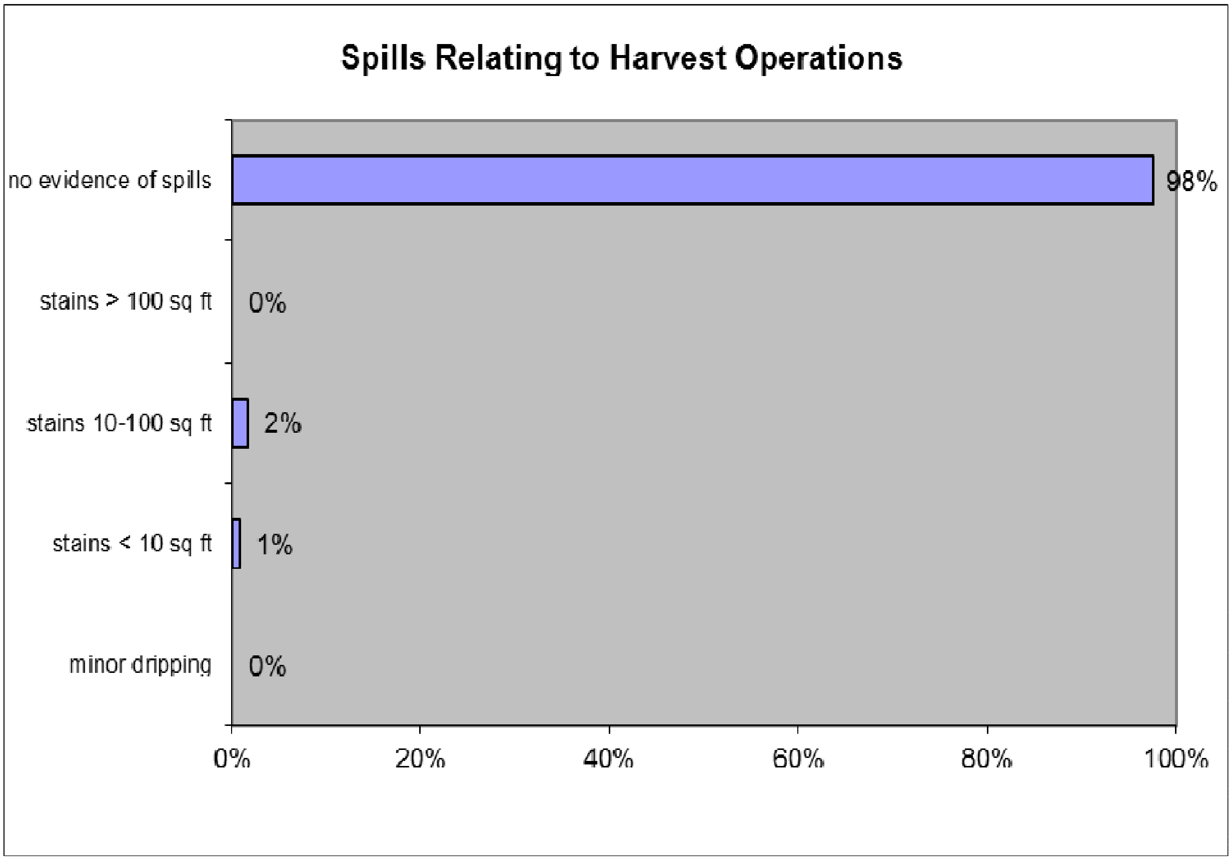



**Figure 31.** Spills relating to harvest operations (n=134).

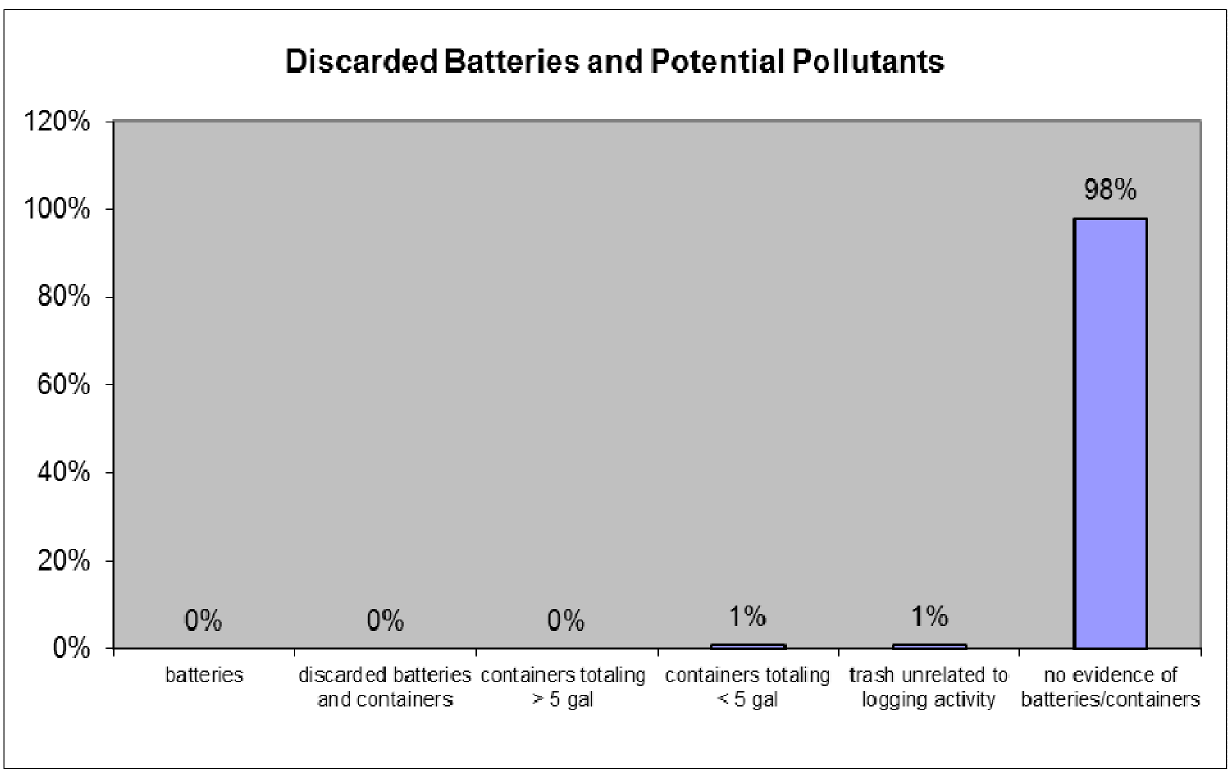



**Figure 32.** Discarded batteries and other pollutants (n=134).

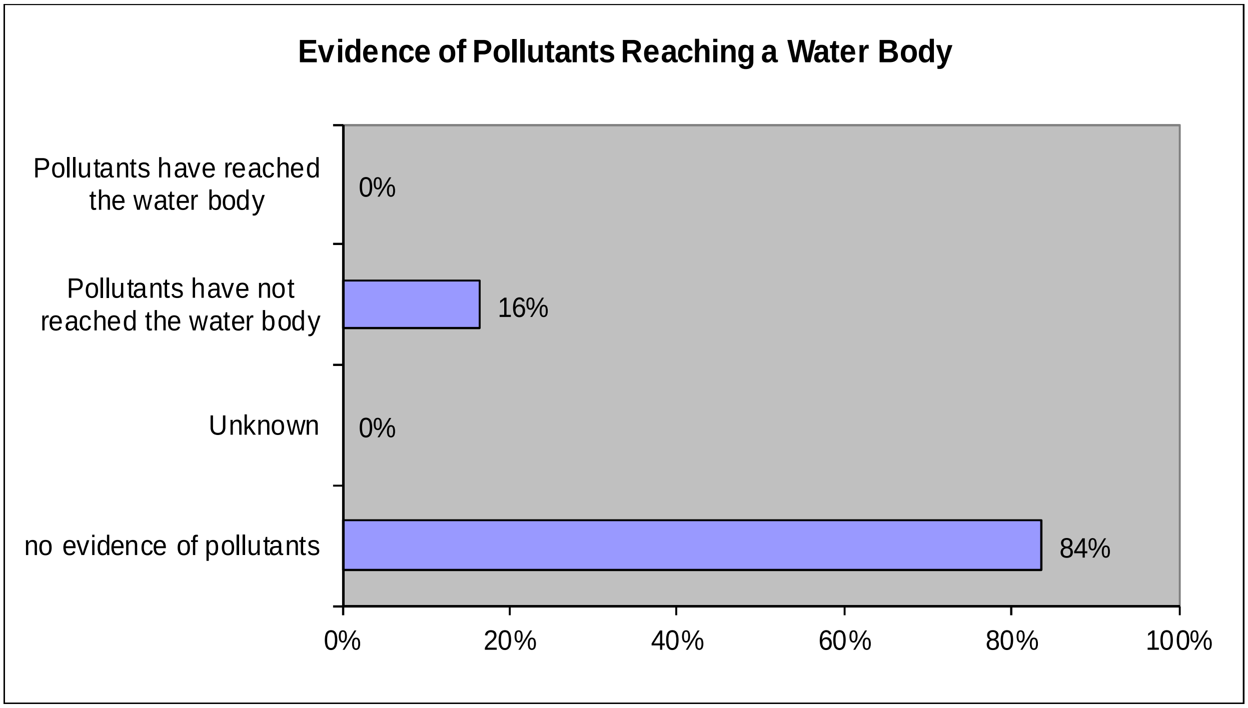


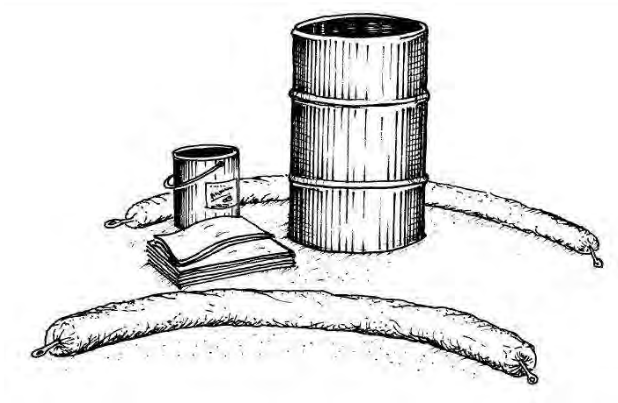
**Figure 33.** Evidence of pollutants reaching a waterbody (n=134).

## 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 for 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

**134** new sample units were sampled.

- **8** sample units have a wetland crossing.

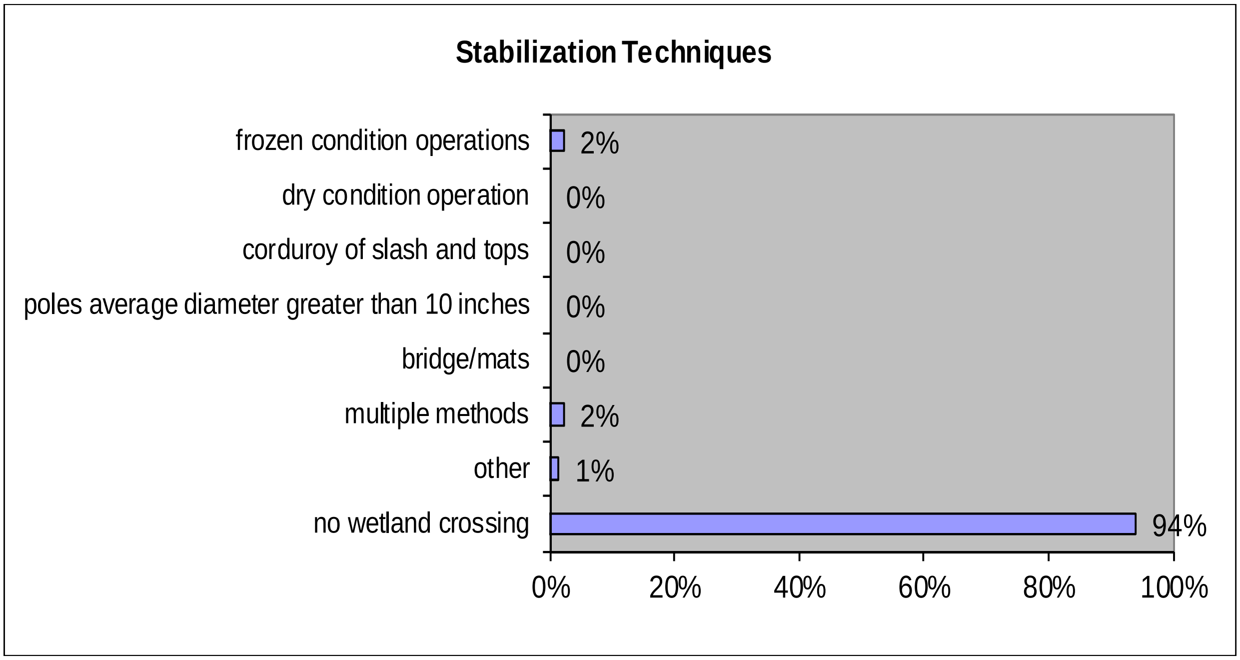



**Figure 34.** Wetland crossing stabilization techniques (n=134).

**Table 3.** Wetland Crossing Length from Upland to Upland.

| | **Length (feet)** |
|---|---|
| **Average** | 310 |
| **Median** | 283 |
| **Maximum** | 650 |

## Rutting Depth and Sedimentation

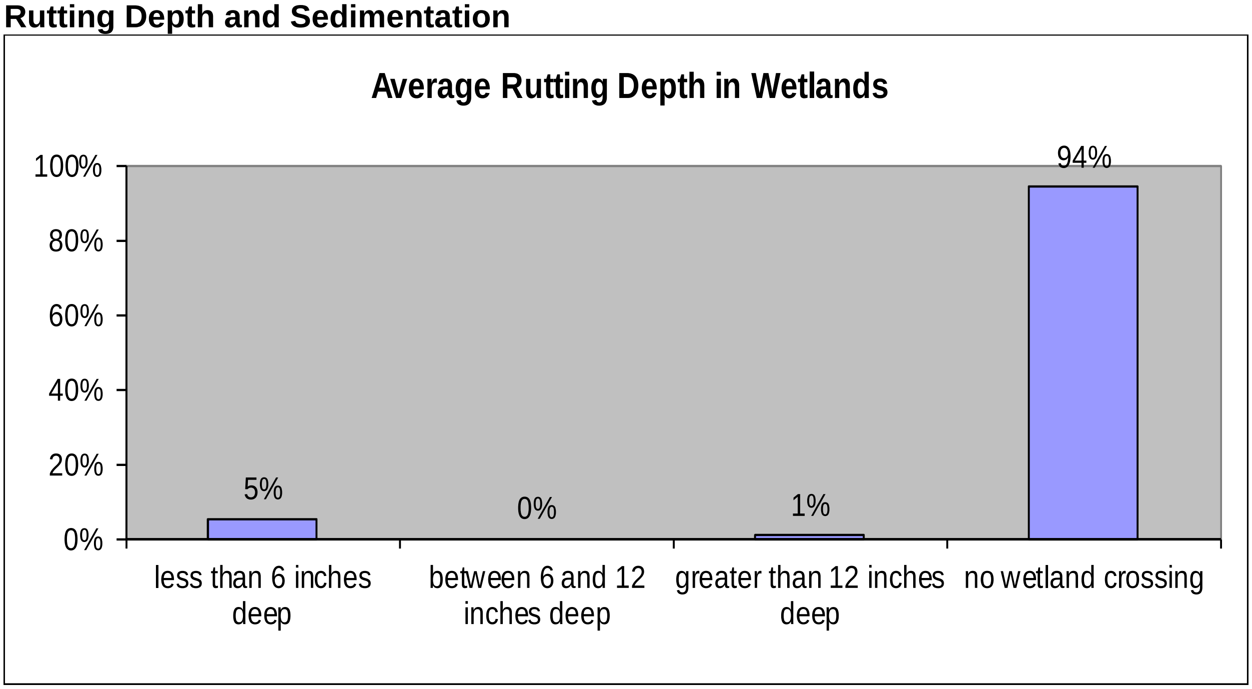



**Figure 35.** Average rutting depth in wetlands (n=134).

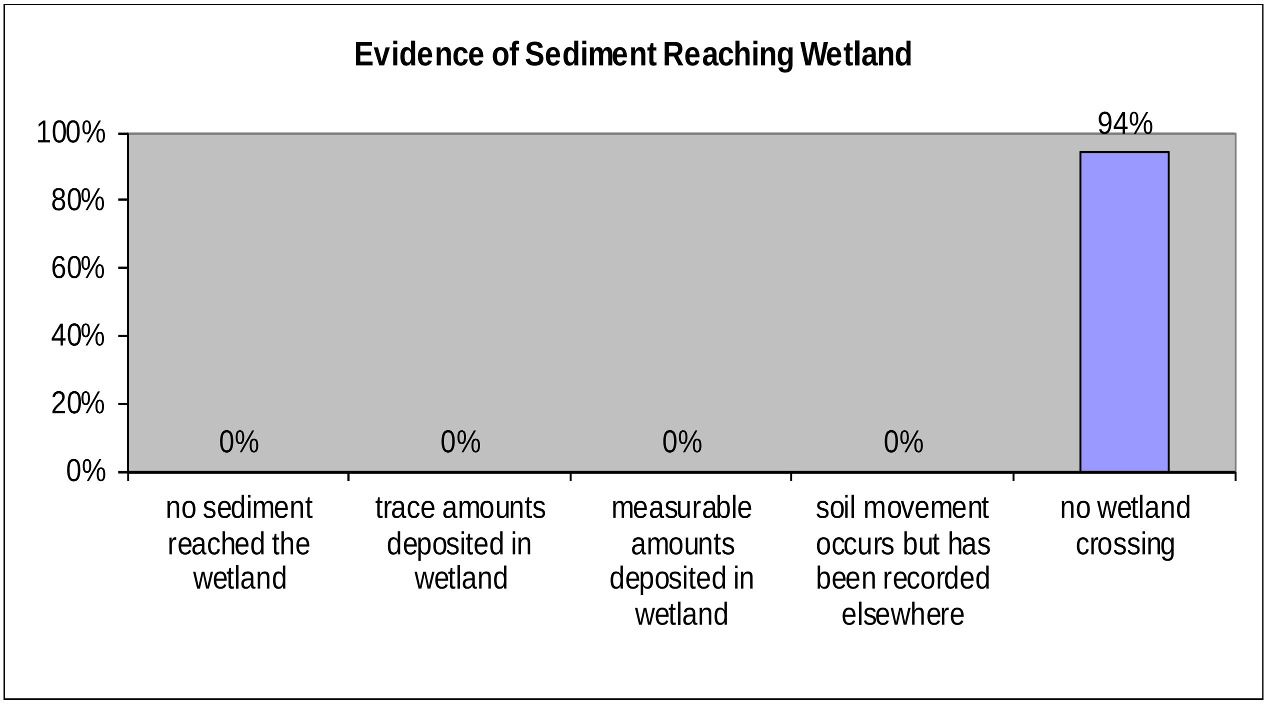



**Figure 36.** Evidence of sediment reaching wetlands (n=134).

**<u>Discussion</u>**

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 94% 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 BMPs used were operating under frozen conditions and the use of multiple stabilization techniques. 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 2014-15 BMP monitoring results are generally consistent with the past few years and continue to show effective use of BMPs by the state’s forestry community. Although sedimentation from crossing structures remains a particular concern this monitoring period, there was a slight reduction in the percentage of crossing structures associated with measurable sedimentation, from about 23% between 2005 and 2013 to 19% during this monitoring period. Instances in which BMPs were inadequately applied was the most prevalent BMP deficiency when sedimentation originated from the crossing structure between 2005 and present (44% during this monitoring period, slightly higher than an average of 42% between 2005 and 2013).

As has been well documented by previous monitoring reports and numerous studies from around the country, when BMPs are applied correctly, they achieve the objective of protecting water resources. Conversely, when not applied or applied inadequately the risk of detrimental impacts increases. Continued monitoring, education, and training are key to sustaining the progress that has been made with forestry BMPs.

# 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.