A REGIONAL PROTOCOL FOR EVALUATING THE EFFECTIVENESS OF FORESTRY BEST MANAGEMENT PRACTICES AT CONTROLLING EROSION AND SEDIMENTATION

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Abstract: 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 pollution. However, states' monitoring of BMP effectiveness often has been sporadic and anecdotal, and the procedures used have varied widely. Consequently, there are inconsistencies in the rigor used to evaluate BMP effectiveness, and thus, the objectiveness and accuracy of those evaluations. As a result of litigation questioning the "silvicultural exemption", the US Environmental Protection Agency has expressed interest in improving the monitoring of BMP effectiveness. Since 1990, several approaches for developing consistent BMP evaluations and reporting methodologies have had varying degrees of success, utility, and acceptance. Traditionally, monitoring has focused on individual BMP practices in terms of their prescriptive guidelines, which vary by state. But this approach has created an impediment both for developing a consistent methodology and for focusing on whether BMPs are actually effective at controlling erosion and sedimentation. To improve consistency and provide a more universal method of BMP monitoring while maintaining state control of BMPs, a protocol was developed that is based on the underlying principles of BMPs (e.g., controlling water in small amounts) and that focuses on the outcomes of those principles (e.g., did sediment reach the stream). Formal protocol development was funded by the USDA Forest Service and the US Environmental Protection Agency. The protocol was created cooperatively over a number of years with input by a wide variety of stakeholders, including state forestry and watershed agencies, industrial land owners, and university and federal scientists. The protocol was field tested by state forestry and industry personnel in 9 states across the northeastern United States in 2002-2003. This testing provided information for further improvements to wording of the questions and identified where additional questions were needed or where others could be deleted. Following these changes, the protocol again was field tested extensively in 7 northeastern states in 2004. Although testing has focused on states in the Northeast, because the protocol is based on BMP principles and examines outcomes, it is applicable to most of the physiographic and forest conditions nationwide.

INTRODUCTION

Water pollution in the United States is regulated by the US Environmental Protection Agency, primarily through the 1972 Clean Water Act (CWA) and its reauthorization in 1993. While much of the CWA deals with point source pollution, non-point source pollution is addressed in sections 404, 208 and 319. These sections exempt silvicultural and other forest operations from the permitting requirements associated with water pollution as long as best management practices (BMPs) are used. As a result, all states have adopted their own sets of forestry BMPs that are to be employed during and/or after road and landing construction, harvesting, and other forestry operations.

Critics of the silvicultural exemption argue that there is a general lack of evidence that BMPs effectively control non-point source pollution, especially in-stream sedimentation, from roading and harvesting operations. Much of this criticism is attributable to two factors: (1) many purported evaluations of BMP effectiveness are instead evaluations of BMP implementation (i.e., determining whether BMPs were used) and not a review of their effectiveness, and (2) many research studies that have evaluated BMP effectiveness have evaluated surrogates of BMP effectiveness and not the actual effectiveness of BMPs (Edwards 2004). The lack of a substantial body of rigorous evidence showing BMP effectiveness often is given as a reason that there should be no silvicultural exemption in the CWA. Litigation in California requesting that the US Environmental Protection Agency withdraw the silvicultural exemption has demonstrated the need to be able to document rigorously how effective forestry BMPs are at controlling non-point source pollution.

As a result, a joint effort was undertaken by the USDA Forest Service, Maine's Forest Service, and the US Environmental Protection Agency to develop a protocol that would allow credible, consistent, and scientifically-based evaluation of BMP effectiveness. The initial steps in protocol development and versions of the protocol itself actually originated from BMP training sessions for loggers and foresters in Maine and from the Maine Forest Service's intent to modify and improve the state's BMP implementation and effectiveness monitoring program (Ryder and Edwards 2005). Soon thereafter, the USDA Forest Service's Northeastern Watershed Team and the US Environmental Protection Agency became interested in Maine's developing approaches and provided funding to formalize the protocol and expand it to make it applicable to at least the 20 states in the US Forest Service's Northeastern Area and Virginia. This paper describes development and features of the protocol; more detailed information about the steps taken in protocol development is provided in Ryder and Edwards (2005).

UNIQUE CHARACTERISTICS OF THE REGIONAL PROTOCOL

In several ways, the Regional Protocol is unique compared to many past attempts at evaluating BMPs. First and foremost, this protocol is based on evaluating BMP performance, such as determining if sediment reached the channel, rather than focusing on whether prescriptive requirements in BMP manuals were followed (e.g., were cross drains installed on roads at required distances). This differentiation is important because implementation is not synonymous with BMP effectiveness. By focusing on BMP performance and not specific prescriptions, the Regional Protocol can be applied to most types of landscapes and conditions, across states or regions, and it inherently considers the outcomes of good planning, which many prescriptive-based procedures do not.

Outcome-based evaluation is successful because it is founded on the underlying principles of BMPs which are based on the laws of physics and chemistry. For example, covering exposed soil to minimize initiation of soil movement by raindrop impact and retain infiltration rates, and maintaining/establishing root growth to retain infiltration and bind soil particles are well accepted principles of soil physics and soil chemistry (Schwab et al. 1993). Hence, mulching and re-vegetating exposed mineral soil are BMPs that have been developed from these underlying principles. But rather than focusing on whether mulching or revegetation was done according to a specific state's BMPs, the protocol evaluates the outcomes of soil protection, e.g.,

did soil movement occur or did sediment reach the stream. This point is important because every state has its own unique set of BMPs (Edwards and Stuart 2002), with hundreds and perhaps thousands of individual BMPs prescribed nationwide; thus, relying on underlying principles and outcomes allows the Regional Protocol to be applied much more universally than evaluation techniques that are designed around agency-specific or institution-specific prescribed BMPs. Focus on individual BMPs is one reason that many previous attempts at BMP effectiveness protocols have failed to be widely accepted or applied (Ryder and Edwards 2005).

Questions in the Regional Protocol are worded to avoid subjective or value-laden answers. Words, such as "acceptable", "excessive", "short-term", and "low-impact" were avoided, as these can be interpreted differently by different people, agencies, or organizations. Thus, typical questions about BMP effectiveness, such as "Is the BMP practice effective?" were replaced with questions like "Is a rill evident?". The answer to the latter question is much less subjective particularly since the definition of a rill is provided, and the evaluator can use measurements of width, length, and/or depth to determine if an erosion feature meets the definition of a rill. Similarly, a question such as "Is sedimentation on the stream bank and/or in the stream substantial?" can be reworded as "Are sediment accumulations on the stream bank and/or in the stream greater than or equal to [one of the defined answer choice categories or measurements]?" These types of quantifiable question/answer pairs not only reduce subjectivity but they also increase the repeatability of data collection, which is important for assuring data quality.

BMP effectiveness traditionally has been defined in terms of sediment reaching water bodies because in-stream conditions are the emphasis of the CWA; however, the Regional Protocol also identifies erosion and sediment transport problems on the hillside (e.g., in the buffer area around streams), even if sedimentation does not terminate in the stream channel. Identifying these hillside effects is important because erosion and soil movement may not be contributing to in-stream pollution at the time of evaluation, but sediment could reach the stream in the future. Thus, information about potential future problems can be obtained with the Regional Protocol for future follow-up, if desired.

The Regional Protocol also includes questions that address issues which represent more contemporary interpretations and applications of the CWA, including issues of chemical pollution prevention, occurrence of in-stream large woody debris, channel condition, and fish passage (i.e., through stream crossings). While these types of issues generally were not considered in the context of non-point source pollution in the past, many state and federal agencies now recognize and actively consider these issues in terms of the chemical, physical, and biological integrity of water bodies within their interpretations of the CWA.

PROTOCOL DEVELOPMENT

The Regional Protocol is a living document that has undergone multiple iterations based upon general comments, comments obtained during short-term field testing by a variety of end users and researchers, and comments resulting from extensive data collection by various state agency personnel responsible for evaluating BMP effectiveness. The first field testing was done in 9 northeastern states in 2002-2003 by state forestry and industry personnel. This testing provided information for further improvements to wording of the questions and identified where additional

questions were needed or where others could be deleted. Field testing and extensive data collection again occurred in 7 northeastern states in 2004. Participants in the various steps of protocol development included representatives from Maryland, West Virginia, Virginia, Pennsylvania, Ohio, Indiana, Wisconsin, Vermont, Massachusetts, New Hampshire and Maine, the New York City Watershed Council, Maine's Atlantic Salmon Commission, the Chesapeake Bay Project, US Environmental Protection Agency Washington Office Staff, American Forest and Paper Association, Master Logger Program of Maine, Master Logger Program of Maryland, Northeast Area State Foresters Association, Mead Westvaco, International Paper Company, a variety of independent foresters, and other interested stakeholders. To date, more than 250 individuals have seen and reviewed at least a portion of the protocol, and approximately 75 individuals have field tested the protocol. The shaded states in Figure 1 indicate those in which the protocol was tested and/or data were collected for one or more of the versions of the Regional Protocol.

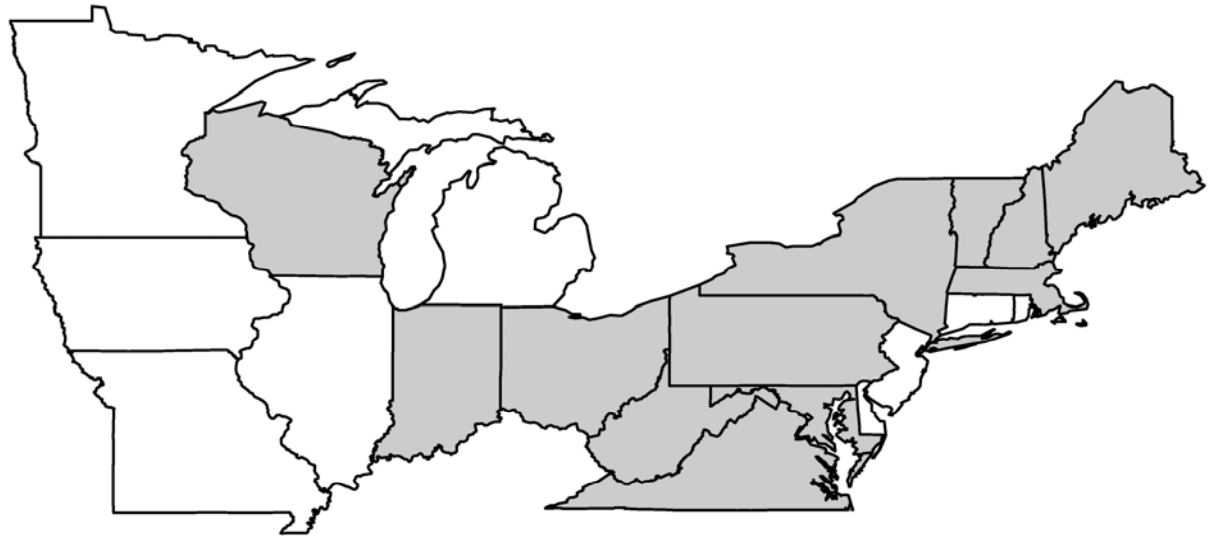

Figure 1 States shown are the 20 states in the US Forest Service's Northeastern Area and Virginia. Shaded states indicate those in which data collection for and testing of the various versions of the Regional BMP Effectiveness Protocol occurred.

PROTOCOL DESIGN

The protocol contains multiple sections: (1) general information, which includes socially focused questions, such as landowner types, harvest unit acreage, and involvement with state stewardship programs, logger training, and certification programs; (2) water body crossings (i.e., haul roads and skidder crossings) and associated approaches; (3) haul roads located within a riparian or buffer area; (4) chemical pollution prevention; and (5) riparian or buffer areas. Where relevant, each section (e.g., a water body crossing) has a subsection with questions about site attributes, such as slope of the land and specific soil information.

The Regional Protocol is structured like a dichotomous key, with each question having associated answer options. The answer for a question determines the subsequent sequence of

questions. Initially the questions and answer choices were programmed into Trimble GEO3 GPS units, but now Palm Pilots™ with Windows®-based pocket PC software are used.

The areas evaluated for BMP effectiveness in each forest operation are those most likely to contribute or control sediment or act as a conduit for sediment delivery to water bodies, influence shading of water bodies, or alter the hydraulics of water (i.e., stream crossings). Consequently, the focus is on the water bodies themselves or areas in close proximity to water bodies – the area immediately outside the riparian buffer, the riparian buffer, and the water body crossing. Together, these areas comprise the sample unit (Figure 2) in the Regional Protocol.

By definition, a sample unit is a "contiguous harvest unit that includes either or both a riparian zone or a water body crossing. It is bounded by any combination of water bodies, the boundary of the harvest area, or a land ownership boundary. The sample unit starts when a water body is crossed or a riparian area is entered [assumes entrance by a road or trail]. A new sample unit begins each time a water body is crossed and ends at the next water body, the edge of the harvest area, or the land ownership boundary, whichever is encountered first." The outer boundary of the sampling area is defined (in feet) by the length of the slope distance outside the riparian buffer where there is greater than a 5 percent change in slope for a minimum distance of 25 ft.

REPEATABILITY OF DATA COLLECTION

Precision and repeatability are important components of the Regional Protocol. One of the goals of having objective questions is to ensure that the answer to each question by different evaluators for a given sample unit will be the same. However, repeatability can be assessed only by the inclusion of duplicate evaluations. Consequently, both "hot checks" and repeated evaluations are a suggested part of protocol use. Hot checks are duplicate evaluations of a subset of sample units performed by a team or individual at the same time but independently of the principal evaluator. Repeated evaluations are done independently by a separate team or individual at a subset of sample units at a later time than the initial evaluation. These latter evaluations must be done within a timely manner after the initial evaluation to ensure that external changes (natural or human) that might affect answers have not occurred (Ryder and Edwards 2005).

The technical team, who has been largely responsible for developing the Regional Protocol, would like an overall answer replication rate of 90 percent, though it is not known from the testing and use that have happened to date if this goal is attainable. In the Regional Protocol's first phase of use, 30 percent of the sample units were revisited for repeated evaluations. There were 620 questions that were replicated in this repeated evaluation, and 71 percent of the replicated questions had identical results from two independent evaluations. Additional improvements to the Regional Protocol are being made to reconcile differences and improve replication in the future.

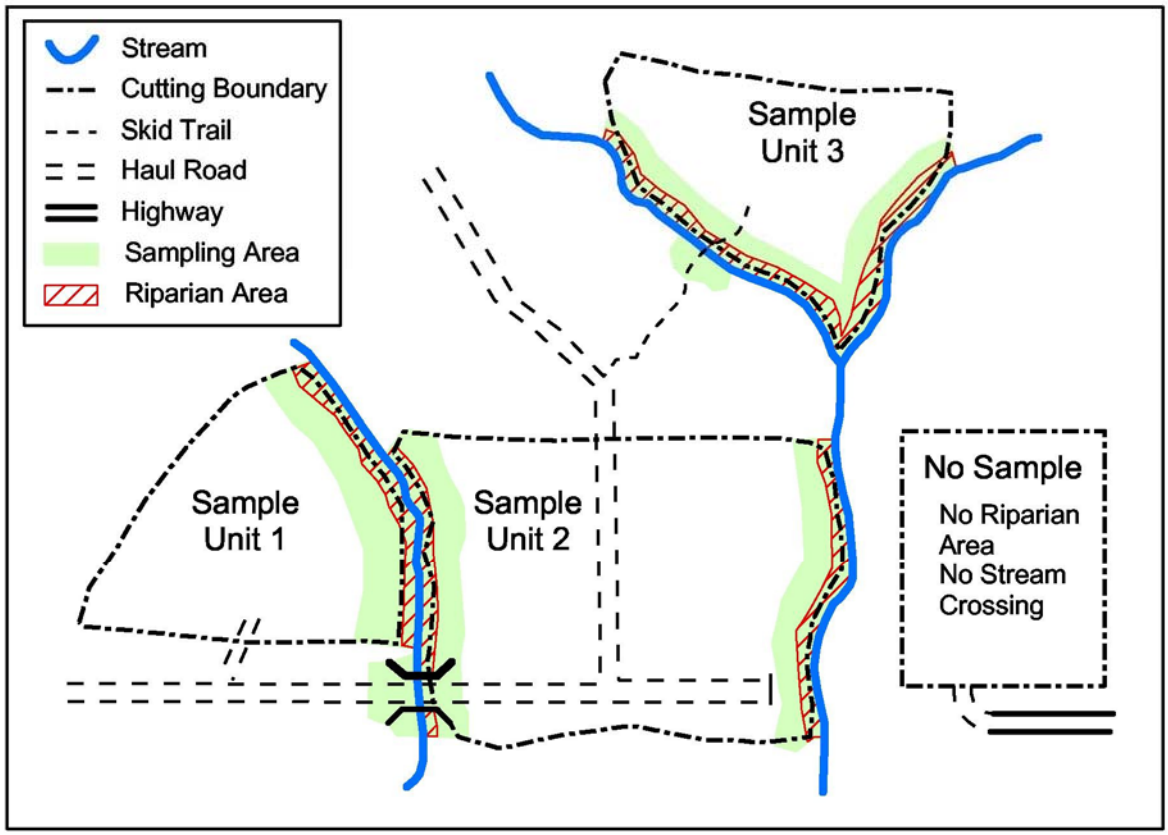

Figure 2 Examples of sample unit boundaries in the Regional BMP Effectiveness Monitoring Protocol.

The shaded sampling area includes the riparian buffer width plus a defined slope distance outside the riparian buffer. Sample Unit 1 has only a riparian buffer and the boundaries of the harvest to delineate the sample unit and no water crossing; Sample Unit 2 has a water crossing and two riparian buffers and the boundaries of the current harvest to delineate the sample unit; Sample Unit 3 has a water crossing, a riparian buffer and the boundaries of the current harvest to delineate the sample unit. When a water body crossing is part of a sample unit, the entire water crossing and the associated approaches are considered part of and evaluated as a component of the water crossing, though one side of the approach may be outside the sample unit.

SUMMARY

A protocol was developed out of the need to be able to objectively evaluate the effectiveness of forestry BMPs. Questions in the protocol are in the form of a dichotomous key, largely with quantitative or objective answer choices. The protocol was developed and tested over several years throughout much of the northeastern United States to ensure broad applicability over the region's many physiographic conditions and myriad of forest operations. Rather than focusing on specific BMPs, this protocol is grounded in the physical and chemical principles from which BMPs have been developed and it focuses on the outcomes of BMPs, such as evaluating whether

in-stream sedimentation occurred. As a result, while the protocol has been developed in the Northeast, it has wide application for much of the nation.

ACKNOWLEDGMENTS

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