CHAPTER 1. INTRODUCTION

1.1 PURPOSE OF GUIDANCE

This guidance is intended to assist state, regional, and local environmental professionals in tracking the implementation of best management practices (BMPs) used to control nonpoint source pollution generated by forestry practices. Information is provided on methods for sample site selection, sample size estimation, sampling, and result evaluation and presentation. The focus of the guidance is on the statistical approaches needed to properly collect and analyze data that are accurate and defensible. A properly designed BMP implementation monitoring program can save both time and money. For example, in 1993 forestry operators notified the State of Idaho of 5,890 forestry operations (Colla, 1994). The cost of determining the status of BMP implementation on each of those forestry operations would have exceeded the amount budgeted, and thus statistical sampling of sites was needed. This document provides guidance for sampling representative forestry operations to yield summary statistics at a fraction of the cost of a comprehensive inventory.

The focus of this guide is on the design of monitoring programs to assess forestry management measure and best management practice implementation, with particular emphasis on statistical considerations.

Some forestry nonpoint source projects and programs combine BMP implementation monitoring with water quality monitoring to evaluate the effectiveness of BMPs in protecting water quality (Curtis et al., 1990; Rashin et al., 1994; USEPA, 1993b). For this type of monitoring to be successful, the scale of the project usually must be small (e.g., a watershed of a few hundred to a few thousand acres). Accurate records of all the sources of pollutants of concern and a census of how all BMPs are operating are very important for this type of monitoring effort. Otherwise, it can be extremely difficult to correlate BMP implementation with changes in stream water quality. This guidance does not address monitoring the implementation and effectiveness of all BMPs in a watershed. This guidance does provide information to help program managers gather statistically valid information to assess implementation of BMPs on a more general (e.g., statewide) basis. The benefits of implementation monitoring are presented in Section 1.3.

1.2 BACKGROUND

Pollution from nonpoint sources—sediment deposition, erosion, nutrients, contaminated runoff, hydrologic modifications that degrade water quality, and other diffuse sources of water pollution—is the largest cause of water quality impairment in the United States (USEPA, 1995). Congress passed the Coastal Zone Act Reauthorization Amendments of 1990 (CZARA) to help address nonpoint source pollution in coastal waters. CZARA provides that each state with an approved coastal zone management program develop and submit to the U.S. Environmental Protection Agency (EPA) and National Oceanic and Atmospheric Administration (NOAA) a Coastal Nonpoint

Pollution Control Program (CNPCP). State programs must “provide for the implementation” of management measures in conformity with the EPA *Guidance Specifying Management Measures For Sources Of Nonpoint Pollution In Coastal Waters*, developed pursuant to Section 6217(g) of CZARA (USEPA, 1993a). Management measures (MMs), as defined in CZARA, are economically achievable measures to control the addition of pollutants to coastal waters, which reflect the greatest degree of pollutant reduction achievable through the application of the best available nonpoint pollution control practices, technologies, processes, siting criteria, operating methods, or other alternatives. Many of EPA's MMs are combinations of BMPs. For example, depending on site characteristics, implementation of the Road Management MM might involve use of the following BMPs: installing or regrading water bars; clearing road inlet and outlet ditches, catch basins, culverts, and road-crossing structures of obstructions; revegetating road surfaces; and inspecting closed roads.

CZARA does not specifically require that states monitor the implementation of MMs and BMPs as part of their CNPCPs. State CNPCPs must, however, provide for technical assistance to local governments and the public for implementing the MMs and BMPs. Section 6217(b) states:

> Each State program . . . shall provide for the implementation, at a minimum, of management measures . . . and shall also contain . . .
> (4) The provision of technical and other assistance to local governments and the public for implementing the measures . . . which may include assistance . . . to predict and assess the effectiveness of such measures . . . .

EPA and NOAA also have some responsibility under Section 6217 for providing technical assistance to implement state CNPCPs. Section 6217(d), Technical assistance, states:

> [NOAA and EPA] shall provide technical assistance . . . in developing and implementing programs. Such assistance shall include: . . .
> (4) methods to predict and assess the effects of coastal land use management measures on coastal water quality and designated uses.

This guidance document was developed to provide technical assistance as described in CZARA Sections 6217(b)(4) and 6217(d), but the techniques described can be used for other similar programs and projects. For instance, monitoring projects funded under Clean Water Act (CWA) Section 319(h) grants, efforts to implement total maximum daily loads developed under CWA Section 303(d), storm water permitting programs, and other programs could benefit from knowledge of BMP implementation.

Methods to assess the implementation of MMs and BMPs, then, are a key focus of the technical assistance to be provided by EPA and NOAA. Implementation assessments can be done on several scales. Site-specific assessments can be used to assess individual BMPs or MMs, and watershed assessments can be used to look at the cumulative effects of implementing multiple MMs. With regard to "site-specific" assessments, individual BMPs must be assessed at the appropriate scale for the BMP of interest. For example, to assess the implementation of MMs and BMPs for forest roads at harvest sites, only the roads at timber harvesting sites would need to be inspected. In this example, the scale would be a timber harvest area and the sites would be active and inactive roads at the harvest areas. To assess MM and BMP implementation at streamside management areas (SMAs), the proper scale might be a harvest area larger than 10 acres and the sites could be areas encompassed by buffer areas for 200-meter stretches of stream. For site preparation and forest regeneration, the scale and site might be an entire harvest site. Site-specific measurements can then be used to extrapolate to a watershed or statewide assessment. It is recognized that some studies might require a complete inventory of MM and BMP implementation across an entire watershed or other geographic area.

1.3 TYPES OF MONITORING

The term *monitor* is defined as "to check or evaluate something on a constant or regular basis" (Academic Press, 1992). It is possible to distinguish among various types of monitoring. Two types, implementation and trend (i.e., trends in implementation) monitoring, are the focus of this guidance. These types of monitoring can be used to address the following goals:

- Determine the extent to which MMs and BMPs are being implemented in accordance with design standards and specifications.
- Determine whether there has been a change in the extent to which MMs and BMPs are being implemented.

In general, implementation monitoring is used to determine whether goals, objectives, standards, and management practices are being implemented as detailed in implementation plans. In the context of BMPs within state CNPCPs, implementation monitoring is used to determine the degree to which MMs and BMPs required or recommended by the CNPCPs are being implemented. If CNPCPs call for voluntary implementation of MMs and BMPs, implementation monitoring can be used to determine the success of the voluntary program (1) within a given monitoring period (e.g., 1 or 2 years); (2) during several monitoring periods, to determine any temporal trends in BMP implementation; or (3) in various regions of the state.

Trend monitoring involves long-term monitoring of changes in one or more parameters. As discussed in this guidance, public attitudes, land use, or the use of different forestry practices are examples of parameters that could be measured with trend monitoring. For example, the State of Idaho, Department of Lands, tracks trends in the number of forestry operations and enforcement actions (Colla, 1994). In addition, to isolate the impacts of MMs or BMPs on water quality, it is necessary to track their implementation over time.

Because trend monitoring involves measuring a change (or lack thereof) in some parameter over time, it is necessarily of longer duration than implementation monitoring and requires that a baseline, or starting point, be established. Any changes in the measured parameter are then detected in reference to the baseline.

Implementation and the related trend monitoring can be used to determine (1) which MMs and BMPs are being implemented, (2) whether MMs and BMPs are being implemented as designed, and (3) the need for increased efforts to promote or induce use of MMs and BMPs. Data from implementation monitoring, used in combination with other types of data (e.g., water quality data), can be useful in meeting a variety of other objectives, including the following (Hook et al., 1991; IDDHW, 1993; Schultz, 1992):

- To evaluate BMP effectiveness for protecting soil and water resources.
- To identify areas in need of further investigation.
- To establish a reference point of overall compliance with BMPs.
- To determine whether landowners/ forestry operators are aware of BMPs.
- To determine whether landowners/ forestry operators are using the advice of forestry BMP experts.
- To identify any BMP implementation problems specific to a land ownership category.
- To evaluate whether any forestry practices cause environmental damage.
- To compare the effectiveness of alternative BMPs.

MacDonald et al. (1991) describe additional types of monitoring, including effectiveness monitoring, baseline monitoring, project monitoring, validation monitoring, and compliance monitoring. As emphasized by MacDonald and others, these monitoring types are not mutually exclusive and the distinction between them is usually determined by the purpose of the monitoring.

Effectiveness monitoring is used to determine whether MMs or BMPs, as designed and implemented, are effective in meeting management goals and objectives. Effectiveness monitoring is a logical follow-up to implementation monitoring. It is essential that effectiveness monitoring include an assessment of the adequacy of the design and installation of MMs and BMPs. For instance, the objective of effectiveness monitoring could be to evaluate the effectiveness of MMs and BMPs *as designed and installed*, or to evaluate the effectiveness of MMs and BMPs *that are designed and installed adequately or to standards and specifications*. Effectiveness monitoring is the subject of another EPA guidance document, *Nonpoint Source Monitoring and Evaluation Guide* (USEPA, 1996).

Effectiveness monitoring for forestry BMPs is also addressed in a U.S. Forest Service document, *Evaluating the effectiveness of forestry best management practices in meeting water quality goals or standards* (Dissmeyer, 1994).

1.4 Quality Assurance and Quality Control

An integral part of the design phase of any nonpoint source pollution monitoring project is quality assurance and quality control (QA/QC). Development of a quality assurance project plan (QAPP) is the first step of incorporating QA/QC into a monitoring project. The QAPP is a critical document for the data collection effort inasmuch as it integrates the technical and quality aspects of the planning, implementation, and assessment phases of the project. The QAPP documents how QA/QC elements will be implemented throughout a project's life. It contains statements about the expectations and requirements of those for whom the data is being collected (i.e., the decision maker) and provides details on project-specific data collection and data management procedures that are designed to ensure that these requirements are met. Development and implementation of a QA/QC program, including preparation of a QAPP, can require up to 10 to 20 percent of project resources (Cross-Smiecinski and Stetzenback, 1994), but this cost is recaptured in lower overall costs due to the project being well planned and executed. A thorough discussion of QA/QC is provided in Chapter 5 of EPA's *Nonpoint Source Monitoring and Evaluation Guide* (USEPA, 1996).

1.5 Data Management

Data management is a key component of a successful MM or BMP implementation monitoring effort. The data management system that is used—which includes the quality control and quality assurance aspects of data handling, how and where data are stored, and who manages the stored data—determines the reliability, longevity, and accessibility of the data. Provided that the data collection effort was planned and executed well, an organized and efficient data management system will ensure that the data can be used with confidence by those who must make decisions based upon it, the data will be useful as a baseline for similar data collection efforts in the future, the data will not become obsolete (or be misplaced!) quickly, and the data will be available to a variety of users for a variety of applications.

Serious consideration is often not given to a data management system prior to a data collection effort, which is precisely why it is so important to recognize the long-term value of a small investment of time and money in proper data management. Data management competes with other agency priorities for money, staff, and time, and if the importance and long-term value of proper data management is recognized early in a project's development, the more likely it will be to receive sufficient funding. Overall, data management might account for only a small portion of a project's total budget, but the return on the investment is great when it is considered that the larger investment in data collection can be rendered virtually useless unless data is managed adequately.

Two important aspects of data that should be considered when planning the initial data collection effort and a data management system are data life cycle and data accessibility. The data life cycle can be characterized by the following stages: (1) Data is collected; (2) data is checked for quality; (3) data is entered into a data base;

(4) data is used, and (5) data eventually becomes obsolete. The expected usefulness and life span of the data should be considered during the initial stages of planning a data collection effort, when the money, staff, and time that are devoted to data collection must be weighed against its usefulness and longevity. Data with a limited use and that is likely to become obsolete soon after it is collected is a poorer investment decision than data with multiple applications and a long life span. If a data collection effort involves the collection of data of limited use and a short life span, it might be necessary to modify the data collection effort—either by changing its goals and objectives or by adding new ones—to increase the breadth and length of the data's applicability. A good data management system will ensure that any data that are collected will be useful for the greatest number of applications for the longest possible time.

Data accessibility is a critical factor in determining its usefulness. Data attains its highest value if it is as widely accessible as possible, if access to it requires the least amount of staff effort as possible, and if it can be used by others conveniently. If data are stored where those who might need it can obtain it with little assistance, it is more likely to be shared and used. The format for data storage determines how conveniently the data can be used. Electronic storage in a widely available and used data storage format makes it convenient to use. Storage as only a paper copy buried in a report, where any analysis requires entry into an electronic format or time-consuming manipulation, makes data extremely inconvenient to use and unlikely that it will be used.

The following should be considered for the development of a data management strategy:

- *What level of quality control should the data be subject to?* Data that will be used for a variety of purposes or that will be used for important decisions should receive a careful quality control check.

- *Where and how will the data be stored?* The options for data storage range from a printed final report on a bookshelf to an electronic data base accessible to government agencies and the public. Determining where and how data will be stored therefore also requires careful consideration of the question: *How accessible should the data be?*

- *Who will maintain the data base?* Data stored in a large data base might be managed by a professional data manager, while data kept in agency files might managed by people with various backgrounds over the course of time.

- *How much will data management cost?* As with all other aspects of a data collection effort, data management costs money and this cost must be balanced with all other costs involved in the project.