

Site-level Monitoring Program Review

A report to the Minnesota Forest Resources Council

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Introduction

This review focuses on the processes, outputs, and overall goals of the Department of Natural Resources (DNR)/Minnesota Forest Resources Council (MFRC) Site-level Monitoring Program. As information to determine the scope of the review accumulated, two important characteristics of the program became apparent and directed the course of the review:

- **implementation monitoring is widely viewed as absolutely essential to maintaining the integrity and viability of the voluntary guideline approach to forest management in Minnesota.** Field monitoring and reporting documents the use of practices designed to minimize the negative impacts of timber harvest and forest management. With this documentation, conflicts based on different ways of valuing forests can be managed by addressing the means of sustaining forests. The less productive alternative is prolonged conflict over the relative merits of the values themselves.
- **without regular, impartial documentation of the application of the guidelines based on field observations, it is likely that other less palatable approaches to minimizing the effects of timber management practices on the environment would be necessary.** Few forest stakeholders favor government regulation of forestry activities over less onerous approaches to accomplishing the same ends. Credible monitoring of the guidelines provides a rational basis for supporting voluntary guidelines.

Given these attitudes, this review identified opportunities for improvements in the current (well-designed) field-based monitoring approach, particularly those improvements that would contribute most to maintaining the credibility of the voluntary guideline system. It did not consider changes that might redirect monitoring efforts away from assessing and reporting on rates of guideline implementation. For example, the merits of dropping or significantly reducing investments in implementation monitoring in favor of increased effectiveness monitoring were not considered.

While improving guideline monitoring is the primary motivation behind this review other objectives include examining the possibilities of reducing program costs and combining this effort with other monitoring efforts

This review is intended to foster an open discussion that will evaluate the recommendations in this report, identify additional opportunities for improving the Site-level Monitoring Program, select the appropriate mechanisms for bringing those improvements about, and correct the shortcomings of the limited perspective expressed in this report.

The review is organized into the following sections:

- A description of the monitoring program, especially the relationships between its key processes and its goals (**Site-level Monitoring Program history** and **Program description** sections).
- Recommendations for improvements (in specific processes) and alternative approaches to meeting program goals (**Recommendations**).

- An examination of the potential for expanding the program to meet additional information needs (**Can guideline implementation monitoring serve multiple purposes?**).

Site-level Monitoring Program history

Table 1 summarizes significant events in the history of the Site-level Monitoring Program. Decisions associated with these events led to the current Site-level Monitoring Program and help explain the program's current configuration. As part of this history, several options for guideline monitoring were designed, put into practice, and evaluated. Some of the better and more useful approaches were subsequently incorporated into the current monitoring program. Because of this, past approaches are useful guides when proposing improvements to the current program.

The DNR published a guidebook of forestry best management practices for protecting water quality in 1989 (MN DNR 1989) and initiated BMP field audits in 1991. These BMPs and the field audits focused on satisfying federal and state regulations derived from the 1987 amendments to the Clean Water Act. In 1991-1993 interdisciplinary teams evaluated 261 sites for the application and effectiveness of 97 BMPs for road construction and maintenance, timber harvesting, mechanical site preparation, prescribed burning, and pesticide use (Phillips 1994). Field audits consisted of group-based subjective assessments of whether BMPs were applied correctly and effectively.

Also in 1989, the Minnesota Environmental Quality Board started preparation of the Generic Environmental Impact Statement (GEIS; Jaakko Poyry 1994) in response to general concerns about the cumulative effects of timber harvest and forest management in Minnesota. The GEIS was completed in 1994 and strongly influenced subsequent forest policy development.

Meanwhile, in 1994 DNR published a guidebook of forestry best management practices for visual quality and in 1995 revised the BMPs for protecting water quality and wetlands in response to the Wetland Conservation Act. Interdisciplinary field audits documented BMP compliance in 1995 and 1997.

The Sustainable Forest Resources Act (SFRA) of 1995 created the Minnesota Forest Resources Council and directed it to develop integrated forest management and timber harvesting guidelines. Previously published BMPs formed the core of the integrated guidelines. The SFRA also directed the DNR to monitor the application of those guidelines. Integrated voluntary guidelines took effect in 1998. The first field evaluations of guideline application in 2000 were summarized in a 2001 publication (Phillips 2001). Subsequent field evaluations occurred in 2001 and 2002. A 2002 publication summarized results of 2001 monitoring (Phillips and Dahlman 2002). Data from monitoring in 2000, 2001, and 2002 were combined and summarized in 2004 (Dahlman and Phillips 2004). Data from 2000-2002 constitute a pre-guideline adoption baseline with which to estimate the impact of guideline adoption on implementation rates. Post-guideline adoption field evaluations conducted in 2004, 2005, and 2006 were summarized in a 2008 report (Dahlman 2008).

Previously developed BMPs and monitoring procedures clearly influenced the current Site-level Monitoring Program. In addition, both SFRA mandates and the Council's direction shaped implementation monitoring. As directed by the SFRA, the Council in 1998 established guideline implementation goals for major categories of forestland owners (89A.05, Subd.3). These goals included targets for organizational support for and adoption of guidelines. No targets were set for implementation of specific guidelines largely because 'identifying specific goals for the application of the guidelines is premature without an understanding of the extent to which the recommended practices are currently applied' (Minnesota Forest Resources Council 1998). Following the Council's direction, the DNR's site-level monitoring focuses almost exclusively on estimating the rates of application of the general guidelines and those for timber harvesting and does not monitor several specific activities for which guidelines were developed (Table 2).

Many aspects of site-level monitoring, however, were not specified in legislation and were left to the discretion of the DNR and the Council. These include the frequency of monitoring, the frequency of reporting, and the content of monitoring reports. Specific use of the information derived from monitoring (other than "to recognize and consider forest resource issues, concerns, and impacts at the site and landscape levels" 89A.02) was left to any interested party.

Program description

Goals

MFRC and DNR documents do not explicitly articulate a set of goals for the Site-level Monitoring Program. The design of the monitoring protocols, descriptions of the program in summary reports, and the opinions of Site-level Committee members, Council members and other stakeholders, however, suggest that three goals are of paramount importance:

- The program should help maintain the credibility of a voluntary program of forestry best management practices by providing unbiased information on the rate of implementation of the guidelines and posing a threat of exposing "cheaters."
- The program should help foster use of the practices described by the guidelines by providing information with which to improve the guidelines and the education programs that promote their use.
- The program should satisfy the legislative directive to conduct monitoring in the SFRA.

Overview of data collection, analysis, and reporting

Figure 1 schematically depicts site-level monitoring. It emphasizes the primary participants and forest stakeholders and the relationships between them. On the left side of the figure, connected by downward arrows, are the events central to data collection, evaluation, and reporting. These begin with a decision by individual forestland owners and managers to harvest and end with an assessment of the how the guidelines contributed to minimizing the negative impacts of timber harvesting. On the right side of the figure a series of upward and horizontal arrows show the feedback loops that provide for continuous improvement in the guidelines and the rate at which they are implemented. Feedback takes many forms, from reports to landowners based on monitoring visits to their property to format and informal presentation of monitoring results to various audiences. The focus of improvements in the

processes of data collection and reporting should be on minimizing the time between harvest and summary report while maintaining the credibility of the data collected. The focus of improvements in the feedback mechanisms should be on identifying key audiences and improving the methods of communication with them.

For many guidelines, the difficulty of determining whether or not they were applicable and/or applied increases with time after harvest. Consequently, current monitoring processes are designed to minimize the time between timber harvest and the onsite visit (Table 3). Table 3 summarizes the sequence of steps involved in monitoring and the approximate time of the year when they are completed. In addition to the constraint imposed by a relative short summer field season, two steps in data collection are strongly tied to seasonal changes in the forest (italicized, Table 3). First, Resource Assessment identifies potential sample sites using a computer algorithm that detects changes in the forest canopy that may have resulted from forest harvest. This change detection procedure requires satellite images obtained during summer when trees are in full leaf. Second, Resource Assessment selects a random subset of disturbance sites for monitoring and photographs the sites from the air. These aerial photographs must be obtained after satellite image change detection and before snow obscures ground features. Based largely on visual interpretations of the satellite imagery and the aerial photographs, Resource Assessment eliminates many sites with canopy disturbances that are not timber harvests. The non-harvest sites that are not eliminated by Resource Assessment are subsequently eliminated when additional ground-based information is available.

Other steps in the process precede, follow or occur simultaneously with these time-sensitive steps in a logical sequence. Using current methods and staffing, a complete monitoring cycle, from site selection to distribution of a summary report, takes approximately 21 months. Two process improvements already underway will shorten the cycle. DNR has contracted with an outside consultant for a comprehensive database design to organize, store, and summarize monitoring data gathered in the field. As a follow-up to database design, a second contract will allow the physical database to be constructed, including 'smart' software for field-hardened laptops that will facilitate data collection in electronic form (instead of on paper forms that must then be manually entered) and perform basic quality control functions. If these improvements are implemented successfully, the outcome will be considerably less time spent transcribing paper forms and correcting inaccurate entries. In addition, data analysis in preparation for report writing will be easier and quicker. With these improvements, it is likely that the monitoring cycle could be 2-3 months shorter.

It may be possible to shorten the monitoring cycle by limiting the time allowed for the field data collection and handling provided under contract. Doing so while still visiting a large number of sites (approximately 90 sites in each of 2004, 2005, and 2006) each season likely would require the contractor to employ more field staff and may increase the cost of these services, decrease data quality, or both. Other steps in the process offer little opportunity to reduce the overall length of the monitoring cycle.

Reducing sample size (i.e., visiting fewer sites) has direct implications for both the program budget (via lower contractor costs) and reporting schedule (by shortening the time required for field data collection). It may be possible to expend less on monitoring and shorten the

time required for monitoring by visiting fewer sites. However, the reliability and utility of the estimated implementation rates likely would also decrease with smaller sample size. Figure 2 illustrates how the level of confidence in estimated implementation rates varies with sample size and implementation rate. The 95% confidence limits shown in Figure 2 correspond to the widely accepted 0.05 level used in scientific studies to designate significant differences between measurements of interest. For two implementation rates (one from the 2000-2002 monitoring period and one from the 2004-2006 period, say) to be significantly different at the 0.05 level, their 95% confidence intervals cannot overlap. Because detecting differences between implementation rates has not been a priority of the Site-level Monitoring Program, no statistical tests have been performed or reported. Confidence intervals, however, also help describe in a general but helpful way how accurate the estimates are. We can have less confidence that the estimate is accurate if the confidence interval is very large than if it is very small. Comparing expected confidence intervals that are calculated using different sample sizes helps inform the decision about how many samples to collect. If we want to be very certain about the estimate (or to be able to detect differences between two implementation rates), then more samples is better than fewer. Sample size decisions are often a compromise between desired accuracy and the cost of collecting samples. The Site-level Committee should review program goals and resources and determine sample size accordingly.

Feedback loops

Much of the benefit of monitoring derives from the feedback provided to individual landowners, DNR foresters and timber program managers, other natural resource professionals, the MFRC, and logger education programs. For example, feedback encourages loggers to improve their understanding and application of the guidelines on subsequent timber harvests; feedback helps DNR personnel to focus timber sale supervision most effectively and insure that guidelines are being appropriately applied on state lands; and feedback allows the MFRC to keep the guidelines relevant to current forest management goals, practices, and needs.

The monitoring program provides several forms of feedback. Informal, but very effective feedback, occurs when forestry and education professionals assess the results of monitoring in published reports and incorporate what they learn into their everyday work. Results of informal feedback include development and improvement of educational programs and materials that more effectively communicate the value and specifics of the guidelines.

Formal feedback to landowners includes the reports of site visits provided to landowners by the contractors. The improvements to field data collection methods that are currently underway will increase the usefulness of those reports. Future reports will include more accurate data and maps of the harvest site that include delineations of infrastructure, crossings, leave trees, and other features addressed by guidelines. The DNR's BMP Program Coordinator and the MFRC Site-Level Monitoring Program Manager give presentations, conduct training sessions, and provide educational materials in response to requests from interested stakeholders. Formal feedback also includes distribution of monitoring reports to the Legislature on a periodic basis in fulfillment of statutory requirements.

Despite the importance of feedback to increasing the effective use of the guidelines, more effort could be directed to identifying and targeting particular audiences. The primary

mechanisms for reaching many natural resources professionals are well-prepared training programs provided by MLEP and the University of Minnesota. For most other audiences, however, the irregularly published formal report is the primary source of information. For most audiences, this report likely requires more effort than they are willing to expend to learn about the role of guidelines in forest management. For example, *Baseline Monitoring for Implementation of the Timber Harvest and Forest management Guidelines on Public and Private Forest Land in Minnesota: Combined Report for 2000, 2001, and 2002* (Phillips and Dahlman 2004), is 43 pages of tables, graphs, and text that describe the rate at which the guidelines were implemented on timber harvest sites on public and private lands. Only readers already very familiar with the guidelines will find the document informative without considerable effort.

Communicating effectively requires delivering the message an audience needs to hear in a format that suits its learning style. It is unrealistic to expect that one method of communication (a periodic technical report, for example) will be effective in communicating a complex message to all audiences. Targeting specific messages to important stakeholders via appropriate media would increase the effectiveness of the Site-level Monitoring Program.

MFRC-DNR relationship

The MFRC and the DNR define their roles in site-level monitoring based on the Sustainable Forest Resources Act, and in particular Minnesota Statutes Chapter 89A.07, Subd. 2:

SFRA 89A.07, Subd. 2. Practices and compliance monitoring. The commissioner shall establish a program for monitoring silvicultural practices and application of the timber harvesting and forest management guidelines at statewide, landscape, and site levels. The Council shall provide oversight and program direction for the development and implementation of the monitoring program. To the extent possible, the information generated by the monitoring program must be reported in formats consistent with the landscape regions used to accomplish the planning and coordination activities specified in section 89A.06.

In principle, the relative roles of the Council and the DNR in implementation monitoring are clear and distinct, with the DNR responsible for monitoring and the Council providing advice and guidance and serving as a primary audience for periodic reports. In practice, however, the organizations interact in convoluted ways that cause unnecessary friction regarding budget and staffing.

Budget – The MFRC funds most of the non-personnel costs for monitoring; the staff position responsible for monitoring is supported by the DNR. Past monitoring costs are not well documented; Figure 3 shows best-available estimates of monitoring costs, exclusive of personnel costs. The approximate current cost for one complete monitoring cycle is about \$175,000 with this amount being expended over 20-22 months. Producing a monitoring report each year requires enough funds to support portions of two monitoring cycles simultaneously, which is equivalent to allocating \$175,000 per year. Costs for monitoring are paid from money allocated to the MFRC with occasional supplements from other sources. Before FY2007, DNR annual budgets included \$50,000 for guideline monitoring. In FY2008

and subsequent years, these funds were added to the budget of the MFRC. The MFRC's Site-level Monitoring Program manager administers the monitoring budget that the DNR BMP Program Coordinator uses for monitoring.

Decision-making that involves reallocation of funds among MFRC programs, and changes in the budget for monitoring specifically, do not include the DNR BMP Program Coordinator. The uncertainty about the budget for monitoring that results from reallocation within the MFRC budget and inconsistent legislative funding from year to year contribute to monitoring program instability and pose a significant challenge to both the DNR and the MFRC.

Site-level Monitoring Program funding over the past 10 years has not kept up with inflation and other increases in costs associated with changes in program procedures (e.g., the shift from DNR staff and volunteers to third party auditors for field data collection). Consequently, funding the Site-level Monitoring Program, the Council's top priority, has reduced the funds available for other MFRC programs, especially the Landscape Planning Program. The recurring need to supplement MFRC Site-level Monitoring Program funding can be a significant challenge to the DNR, especially in years when budgets are constrained.

Allocating funds for monitoring exclusively to the MFRC instead of the DNR (as the agency responsible for monitoring) has a significant benefit. When budgets are inadequate to support all activities, lower priority activities like monitoring are often the first to be abandoned. Given the DNR's broad range of responsibilities compared to the more limited responsibilities of the MFRC, it is more likely that monitoring funds would be diverted to other purposes if allocated to the DNR than if allocated to the MFRC. The current arrangement has kept the Site-level Monitoring Program viable for 13 years, though some observers suggest that the quality of the program may have suffered relative to comparable programs in other states and provinces.

Staffing – The DNR Division of Forestry's BMP Program Coordinator is responsible for all aspects of guideline implementation monitoring, from site selection to hiring and training of contractors to writing and publishing periodic reports. In addition, this position coordinates the Division's interactions with state and federal water quality regulatory agencies and has other duties. The Coordinator gets occasional assistance from MFRC or DNR professional staff and works closely with the MFRC's Site-level Monitoring Program manager. As part of an informal arrangement, the MFRC Site-level Monitoring Program manager prepared annual performance evaluations of the BMP Program Coordinator on behalf of the Coordinator's official DNR supervisor. This arrangement led to conflicting supervisory direction and was a consistent source of irritation for the BMP Program Coordinator. The position now reports directly to the Division Director, an arrangement that may work better than the previous one.

The MFRC Site-Level Monitoring Program manager consults with the DNR BMP Program Coordinator and acts as a liaison between the BMP Program and the MFRC. The purpose of this position is to provide technical expertise to the forest resources management community on site-level guideline development, implementation, and monitoring and to provide expertise on environmental issues related to soil, air, and water resources. The position was located in the DNR central office while most of the MFRC staff was and is located on the University of Minnesota St. Paul campus. This resulted in less interaction with other MFRC staff and University of Minnesota researchers than would be the case if the position's primary location

was on the campus but allowed close interaction with the DNR BMP Program Coordinator. The late Dr. Michael Philips last filled the position and was an Adjunct Professor in the University's Department of Forest Resources.

Recommendations

The following recommendations are based on two related assumptions.

- It is in everyone's best interest to maintain and enhance the integrity of the system of voluntary guidelines.
- Producing regularly scheduled, unbiased reports on current rates of guideline implementation is essential to maintaining the integrity of the system.

The recommendations address the strategic direction of the program and improvements to specific monitoring methods.

Strategic direction of the program

1) Articulate the purpose(s) of implementation monitoring and the intended use(s) of the information it generates.

Firmly established and clearly articulated goals for the program and in particular for the use of the information gathered will help ensure that the program maintains focus and accomplishes its mission. Documenting the overall rate at which each guideline is being implemented in the state is a worthwhile goal for the program and one that the program accomplishes well. However, if there are other goals that should also be accomplished, or other uses of the data that are collected, they should be clearly articulated to insure that data collection and reporting methods are appropriate for accomplishing those goals.

2) Establish and maintain a regular schedule for monitoring and reporting.

The integrity of the voluntary guideline system rests in large part on the monitoring program's ability to substantiate that regulatory enforcement of forest management practices is not needed. Regular, unbiased reporting of guideline implementation rates help do just that. Given that guideline implementation rates are relatively high and given the preferences expressed by a broad range of forest stakeholders as input to this report, it is important that reports are available on a regular, predictable schedule.

Reporting frequency will necessarily acknowledge staff and funding limitations but should not be determined solely by those limits. A program purpose that articulates information needs well and a monitoring and reporting schedule designed to satisfy those needs are sufficient justification for requesting an appropriate allocation. For the current combination of available staff and monitoring cycle length, annual reporting on all guidelines each year does not appear to be feasible. Based on monitoring results obtained thus far, annual reports are also hard to justify scientifically. The change in implementation rates between 2000-2002 and 2004-2006 was relatively small. Will small changes in implementation rates, annual reporting would most often provide little new, useful information. Even particularly successful logger and land manager education programs likely will not produce detectible increases in implementation rates immediately. Decreases in implementation rates will also likely occur slowly.

It seems reasonable to ensure the production of regular reports by limiting either the frequency or the scope of the reports. Consider two scenarios. First, producing an implementation report every two years (based on field monitoring of the most recent harvests) may be sustainable under the current staffing level. In addition, some savings would be realized because the purchase and analysis of satellite imagery and aerial photography for site selection would be proportionately reduced. Second, producing an implementation report every year but limiting the scope to either a subset of the guidelines or a geographic portion of the state also may be sustainable under the current staffing levels. This is because data analysis and report writing are time consuming activities; limiting the data to a subset of guidelines or a portion of the state may facilitate timely reporting. Cost savings would be less than in the first scenario because sites would be identified and selected every year. The first scenario (estimates of guideline implementation rates for all guidelines every other year) likely would better satisfy the information needs of more forest stakeholders than the second scenario. A third scenario would be to do field monitoring for two consecutive field seasons, then deferring data collection for one season so that a thorough report could be written at least once every three years based on two consecutive years of monitoring. This scenario may require an increase in funding, but would have the advantages of more frequent field monitoring and may be more acceptable to environmental, forest industry, and other interests than the first two scenarios.

3) Strengthen the role of the MFRC in guideline monitoring by placing full responsibility for monitoring with the Council, along with appropriate staffing and funding.

The MFRC is a more appropriate organization to be responsible for guideline monitoring than is the DNR. As the largest forestland manager in the state and an organization that has officially adopted the guidelines and incorporated them into all operations, DNR has significant interest in the outcomes of guideline monitoring. Employing contractors to collect field data on guideline implementation and a statewide, randomized system of monitoring site selection helps limit the amount DNR might bias results. However, contractors are under contract to the DNR and DNR employees store, analyze, and report on data. With MFRC responsible for monitoring guideline implementation, the potential for and appearance of conflict of interest is less. The multiple interests that make up the MFRC provide the diverse perspective and scrutiny that help prevent bias.

DNR Forestry's land management responsibilities are diverse, demanding, and often sub-optimally funded. In addition, given the political nature of natural resource management, the Division often must divert staff time from long-term responsibilities to current or controversial issues. A recent example is the effort devoted to managing OHVs on public lands. If guideline implementation monitoring is not a very high priority for the Division, there is a good probability that field data collection and reporting would be delayed or postponed to accommodate other activities. Note the delay between the most recent data collection efforts (in 2004-2006) and the publication of the results of those efforts (2008). The delay can in part be attributed to the diversion of staff time to other priorities. With the relatively limited focus of the MFRC and the high priority given to guideline implementation monitoring by the MFRC, such delays are less likely. In addition, the organizations represented on the Council are more readily rallied in support of Legislative funding through the Council than by the DNR.

The current approach to guideline implementation monitoring includes interpersonal and inter-organizational relationships that can be problematic and could be avoided if MFRC were responsible for guideline monitoring. Decisions about the budget for monitoring are made by the MFRC largely without input from the DNR that relies on that budget for monitoring. For many years, the MFRC's Site-level Monitoring Program manager unofficially supervised the DNR's BMP Program Coordinator. The DNR's Director of the Division of Forestry, however, is now his official supervisor. In addition, the BMP Program Coordinator must respond to directives (in the form of advice) about the monitoring program from the MFRC Site-level Committee, whether or not they are delivered via his official supervisor. If the BMP Program Coordinator (and his guideline monitoring responsibilities) were transferred to the MFRC, supervisory and management relationships would function more smoothly.

The advantages of transferring responsibility for guideline monitoring to the MFRC may be greater than the disadvantages. Fears that the MFRC will cease to exist and take the monitoring program with it warrant serious consideration. However, every demonstration of the value of the MFRC to the Governor's Office and the Legislature as a forum for cooperation strengthens the MFRC. If the Legislature or the Governor's Office sees no need for continuing support of the MFRC, it is likely that more serious problems than can be addressed by forest management guidelines will be the root cause. In this case, a monitoring program that had been retained by the DNR Division of Forestry would likely fare no better than it would under the MFRC. There is no reason to believe that technical expertise on monitoring and budget and project management skills in the DNR are significantly better than those in the MFRC. The same can be said for technical writing and data analysis skills. If MFRC staff maintain good working relationships with and access to the expertise of colleagues in the DNR differences in expertise are not a reason for favoring one organization over the other.

The advantages to the monitoring program of close ties between the BMP Program Coordinator and the Division's other programs should not be overlooked. The working relationships between the BMP Program Coordinator and other DNR employees and his involvement in other water quality and BMP issues that arise within the DNR help keep the monitoring program current and relevant. Locating the BMP Program Coordinator in the DNR office but transferring supervision to the MFRC may be an appropriate compromise that takes advantage of the working relationships while removing problematic aspects of the MFRC-DNR relationship.

Some MFRC members have suggested that locating the MFRC Site-level Monitoring Program manager in the Division's central office in St. Paul helps blur the distinctions between the MFRC and the DNR and limits his interaction with other MFRC staff. To address these concerns, the primary location of the MFRC Site-level Monitoring Program manager could be the MFRC office on the University of Minnesota St. Paul campus. This would facilitate communication with his or her supervisor, other MFRC staff, and University of Minnesota faculty. In addition, working part-time at the DNR central office would foster more effective working relationships with DNR and other state agency staff.

4) Use information more effectively

Communication is more effective if the message is well tailored to the target audience. A one-size-fits-all strategy for conveying complex information fails more often than not. In addition to increased attention to basic effective communication practices, the MFRC and/or the DNR should develop reports that focus on specific audiences and/or specific practices.

In 1998, the Council postponed setting implementation goals for specific guidelines in part because it lacked information that would help determine realistic goals (MFRC 1998). The MFRC now has information on timber harvest practices before and 6-8 years after the guidelines were adopted. From this information it should be possible for the Council to agree on realistic but challenging implementation goals for at least a portion of the guidelines. Setting implementation goals would emphasize the importance of using the guidelines and help focus the energies and attention of forest resource managers.

Current data collection efforts focus largely on determining which guidelines were applicable and if applicable guidelines have been implemented. Information on the reasons why guidelines are not implemented likely would be useful in a variety of ways: in improving the guidelines themselves; in increasing awareness of the guidelines by targeting specific audiences; or providing lower-cost alternatives, to give a few examples.

It is likely that the implementation monitoring database contains information that would be useful in focusing research on the effectiveness of the guidelines. To date, however, examination of the empirical relationships within the monitoring database had not been done largely because there has been insufficient staff time to do so.

In 1998, MFRC recognized the importance of the support of public and private organizations for the guidelines and their application and set a goal of obtaining statements of support (Minnesota Forest Resources Council 1998). Actively maintaining such information over time provides an opportunity to promote the use of the guidelines and reinforce their value as forestland ownership and management objectives change.

Poor access to information on the visual quality sensitivity of potential harvest sites limits the use of and benefits from the visual quality guidelines. Maps of the visual quality sensitivity of roads in 16 northern counties, created in the early 1990s, are available on the DNR website (www.dnr.state.mn.us/forestry/visual_sensitivity/index.html). Information for rivers, lakes, and recreational trails in some of these counties is available, but may be too general to be helpful. Visual quality sensitivity information for other counties is not available. Updated information for all counties should be made available in accessible formats.

Monitoring methods

1) Improve data collection and handling

Two projects recently initiated by the DNR will significantly improve data collection and handling. The first project is the design and construction of a relational database for storing and processing monitoring data. The database design reflects the logical relationships

between harvest site features (e.g., streams, RMZs, landings, harvest area, crossings and approaches) and the guidelines. For example, for monitored harvest sites crossed by a stream, the database will link descriptors of the stream (trout vs. non-trout, width), data on the RMZ (basal area, width), and site number to facilitate subsequent data queries and summaries. The second project will replace the paper-and-pencil forms used for recording information in the field with computerized data loggers. Data logger programs will provide appropriate prompts and perform error checks to insure that all required data are captured correctly. This will minimize the staff time spent correcting errors and transcribing data into electronic formats, one of the most time consuming aspects of the current process. In addition, the data loggers will include geographic information system functions that allow field personnel to view maps and aerial photography and save geographic descriptions of site features and guideline practices while in the field.

2) Review field measurement techniques for agreement with guideline intent

Current field measurement protocols may inaccurately report the implementation of a two guidelines where land managers are choosing to meet the guidelines in ways not described by the guidelines. For example, the guidelines recommend retaining leave trees in clumps of at least 5 percent of the harvest area or as scattered individual trees at the rate of 6-12 trees per acre. Current monitoring protocols consider the guideline to have been implemented if at least one of these recommendations is fully met. Combinations of clumps and scattered trees, if neither recommendation is fully met independently, are not considered to be implementation of the leave tree guideline, though it appears that land owners are attempting to meet the intent of the guideline with a combination of clumps and scattered trees. For RMZ width and residual basal area recommendations, it appears that some landowners are interpreting the guideline differently than the interpretation used to measure implementation. In both cases, the intent of the guideline should be clarified, including the actions that will satisfy that intent. If necessary, the monitoring protocols should be modified to agree with guideline recommendations.

3) Ensuring an adequate sample of NIPF landowners

Under-representation of NIPF sites in the monitoring sample likely biases statewide estimates of guideline implementation. Modifications of current site selection methods may be necessary to increase the NIPF sample. Far more NIPF owners refuse to allow access to their property for monitoring than do other owners. Starting with a larger initial pool of sites may result in an appropriate NIPF sample size despite the higher rate of non-participation but will entail higher costs for aerial photography acquisition and interpretation. If a smaller sample size is deemed adequate (see sample size discussion above) the current initial pool may be adequate.

Alternatively, consider incentives for participating and disincentives for refusing to participate in guideline monitoring. Incentives might include direct payments, cost-share assistance, free technical assistance, state nursery stock at a discount, a reduction in property tax rate, or public recognition for participating. Disincentives for refusing might take the form of fines (based on new statutory authority) or loss of eligibility for reduced property taxes.

Can guideline implementation monitoring serve multiple purposes?

Despite the opportunities for improvement identified in this report, the Site-level Monitoring Program is well designed to fulfill its primary objective of providing affordable, unbiased estimates of the rates of implementation of the MFRC's timber harvesting and forest management guidelines on forestlands in Minnesota. Its methods are appropriate and reflect the complexity of the task. The estimates it provides are believable and scientifically defensible. The program has these characteristics in large part because it is narrowly focused on its objective, essentially designed for a single, limited purpose.

The decision to use site-level monitoring in lieu of or to supplement other ongoing monitoring efforts (such as monitoring required for non-point source pollution management or forest certification) should be based on consideration of how such use would impact the program and its ability to satisfy its primary objective.

For example, the Site-level Monitoring Program contains costs and manages staff work loads by minimizing the number of sites monitored consistent with producing a statistically sound estimate of statewide implementation rates for four categories of landowners. Providing similar, statistically sound estimates of implementation rates for individual industrial forestland owners or public agencies (for use in certification audits, for example) would require a much larger sample size overall, and individual sampling designs that suit the characteristics of each landowner's holdings. This sampling intensity would be prohibitively expensive in contractor fees and would require a significant increase in staff. Moreover, certification program administrators would be unlikely to accept audits by a state agency like the MFRC, even if done by third-party auditors, in place of audits done by third-party auditors affiliated with national or international certification programs.

Alternatives should be considered before modifying the current Site-level Monitoring Program. Site-level monitoring protocols are available for use by any interested party. Widespread adoption of these protocols as the standard for the timber sale inspection programs of public and private forest managers would make implementation information more widely available and promote use of the guidelines at the same time.

Prior to each field season, the DNR trains contractors in the use of site-level monitoring protocols. To date, only the DNR has employed these contractors for monitoring implementation of the guidelines. With little additional administrative overhead, the DNR could certify the skills of the contractors it trains as part of a larger program that links land managers interested in third-party monitoring of their forest management practices to consulting foresters capable of providing that service.

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Table 1. Overview of the history of the MFRC Guideline Implementation Monitoring Program

1989	Publication of water quality best management practices (BMPs)
1994	Publication of visual quality BMPs
	Publication of revised water quality and wetland BMPs
1991-92, 1995, 1997	Water quality BMP field audits by interdisciplinary teams
1994	Generic Environmental Impact Statement on Timber Harvesting and Forest Management
1995	Sustainable Forest Resources Act
1996-1998	Guidelines addressing riparian zone management, forest soil productivity, cultural and historic resources, and wildlife habitat development developed and integrated with best management practices on water quality, wetlands, and visual quality
1998	MFRC approves integrated guidelines
	Guideline Implementation Monitoring Committee (GIMC) established
	MFRC adopts guideline implementation goals for a) organizational support of guidelines; b) awareness and understanding of guidelines; c) commitment to apply guidelines.
1999	Publication of <i>Sustaining Minnesota Forest Resources: Voluntary Site-Level Forest Management Guidelines for Landowners, Loggers and Resource Managers</i> .
	Guideline monitoring protocols established
2000	Peer review of forest management guidelines for protecting forest riparian areas and seasonal ponds
	Field evaluations of guideline application
2001	Publication of <i>Monitoring the Implementation of the Timber Harvesting and Forest Management Guidelines on Public and Private Forest Land in Minnesota: Report 2000</i>
	Field evaluations of guideline application
2002	Publication of <i>Monitoring the Implementation of the Timber Harvesting and Forest Management Guidelines on Public and Private Forest Land in Minnesota: Report 2001</i>
	Field evaluations of guideline application
2004	Publication of <i>Baseline Monitoring for Implementation of the Timber Harvesting and Forest Management Guidelines on Public and Private Forest Land in Minnesota: Combined Report for 2000, 2001, and 2002</i>
	Field evaluations of guideline application
2005	Revision of <i>Sustaining Minnesota Forest Resources: Voluntary Site-Level Forest Management Guidelines for Landowners, Loggers and Resource Managers</i> .
	Field evaluations of guideline application
2006	Field evaluations of guideline application
2007	Riparian Science Technical Committee report
	Publication of <i>Biomass Harvesting on Forest Management Sites and Woody Biomass Harvesting for Managing Brushlands and Open Lands</i>
2008	Review of the Site-level Monitoring Program

Table 2. MFRC guidelines and monitoring.

Guideline	Monitored?
GENERAL GUIDELINES	
Identifying Goals and Objectives	Yes
Conducting a Site Inventory	Yes
Incorporating Sustainability into Forest Management Plans	Yes
Maintaining Filter Strips	Yes
Managing Riparian Areas	Yes
Protecting Cultural Resources	Yes
Managing Equipment, Fuel and Lubricants	Yes
Protecting the Normal Flow of Streams and Wetlands	Yes
Protecting Non-Open Water Wetlands and Seasonal Ponds	Yes
Managing Dry Washes in Southeastern Minnesota	Yes
Retaining Leave Trees (live trees)	Yes
Providing Coarse Woody Debris	Yes
Post-Operational Activities and Follow-up Visits	Yes
ACTIVITY SPECIFIC GUIDELINES	
Forest Road Construction and Maintenance	Partial
Timber Harvesting	Yes
Mechanical Site Preparation	No
Pesticide Use	No
Reforestation	No
Timber Stand Improvement	No
Fire Management	No
Forest Recreation Management	No

Table 3. Generalized Site-level Monitoring Program schedule. This is an optimal schedule of time-sensitive and other tasks that assumes sufficient staff time to accomplish the tasks and no unanticipated delays. This schedule indicates the amount of time that is required for particular tasks and the sequence in which the tasks are completed. It does not, however, accurately reflect how the process has been conducted in the past. Note that the process spans portions of three calendar years, beginning in July of year 1 and ending in April of year 3.

Year	Month	Step	Outcome
1	July - August	Identify and purchase satellite images.	
1	July – December	Preparation of RFP, evaluation of proposals and selection of contractor.	Contract for field data collections.
1	August – September	Standard satellite image processing (i.e., spatial rectification, cloud identification, mosaic images). Forest canopy disturbance detection. Selection of initial pool of sites.	Estimate of annual statewide timber harvest acres. Initial pool of monitoring sites.
1-2	October - January	Obtain and process aerial photographs of initial pool sites. Interpret aerial photographs to eliminate non-harvest sites from pool and delineate harvest area on aerial photographs. Identify site owners from county land records.	Refined pool of monitoring sites with owner contact information.
2	January	Verification of ownership of potential monitoring sites and elimination of sites not meeting criteria.	
2	January – April	Contractor contacts non-industrial private landowners; DNR staff contact industrial and government owners.	Permission to visit site for monitoring.
2	April	List of monitoring sites finalized.	
2	May	DNR provides calibration training for contractor.	
2	May – July	Contractor conducts field monitoring.	Accumulation of monitoring data.
2	June – August	Contractor reports results of monitoring to landowner.	
2	June – October	DNR performs quality checks on forms submitted by contractor and verifies contractor work with field visits.	Correction of errors in field data.
2-3	October – January	Transcription of field data forms.	Conversion of paper field data forms to electronic files.
2-3	December - April	Report preparation, publication, and distribution.	

Figure 1.

Overview of the monitoring program

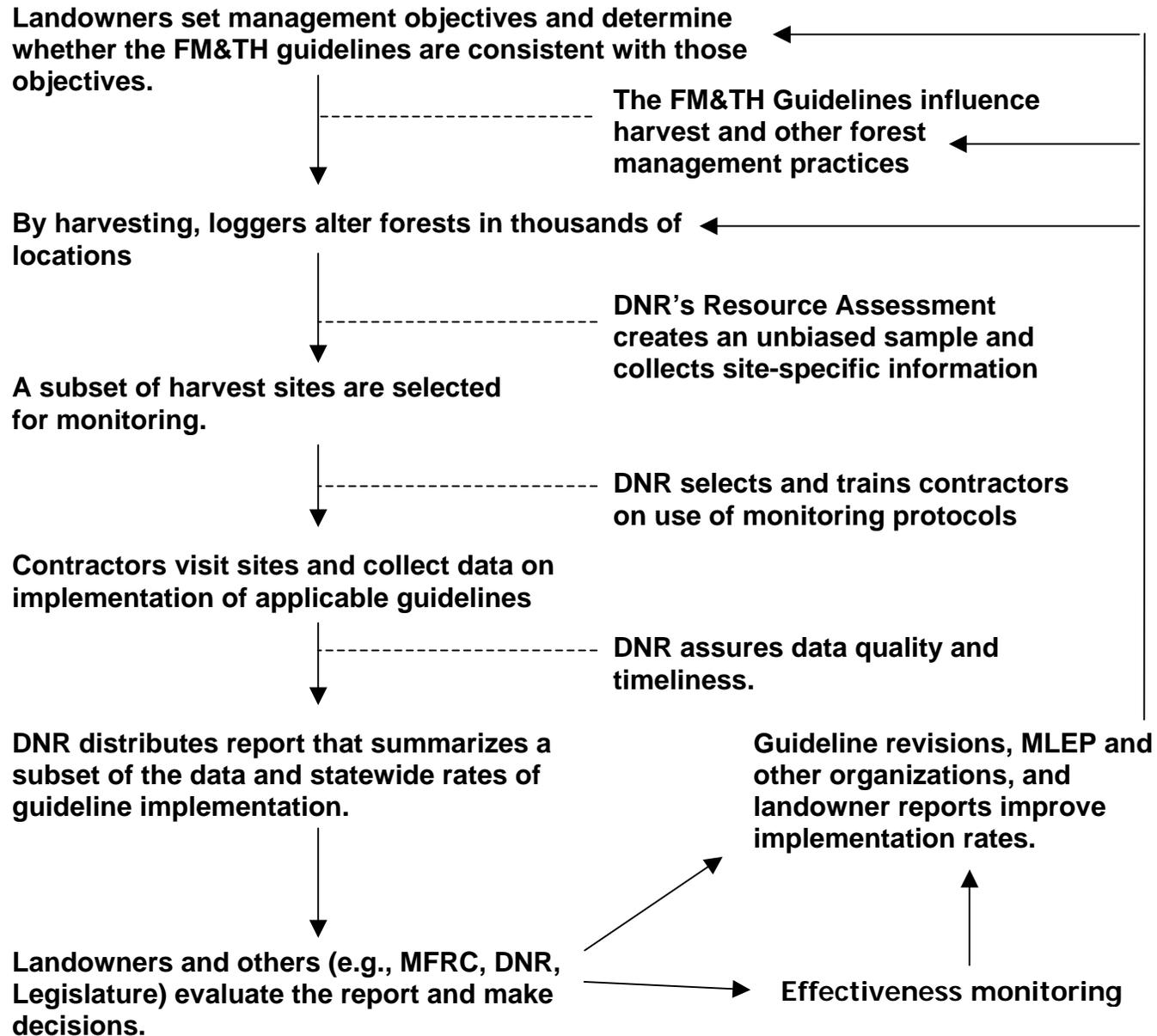


Figure 2. Confidence that the estimated implementation rate derived from a monitoring sample is representative of the true implementation rate varies as a function of sample size (N) and the implementation rate. Plotted here are upper and lower bounds of 95% confidence intervals based on sample sizes of 10, 50, and 90 and implementation rates from 0 to 100%. Sample size is the number of sites on which a guideline applies and an assessment of implementation is made. For an estimated implementation rate of 50%, we can be 95% confident that the true implementation rate calculated from a sample of 10 will be between 18% and 82%. (Strictly speaking, the true implementation rate will be between 36% and 64% about 95% of the time.) For a sample of 50, we can be 95% confident that the true implementation rate is between 36% and 64%, and for a sample of 90, we can be 95% confident that the true implementation rate is between 39% and 61%.

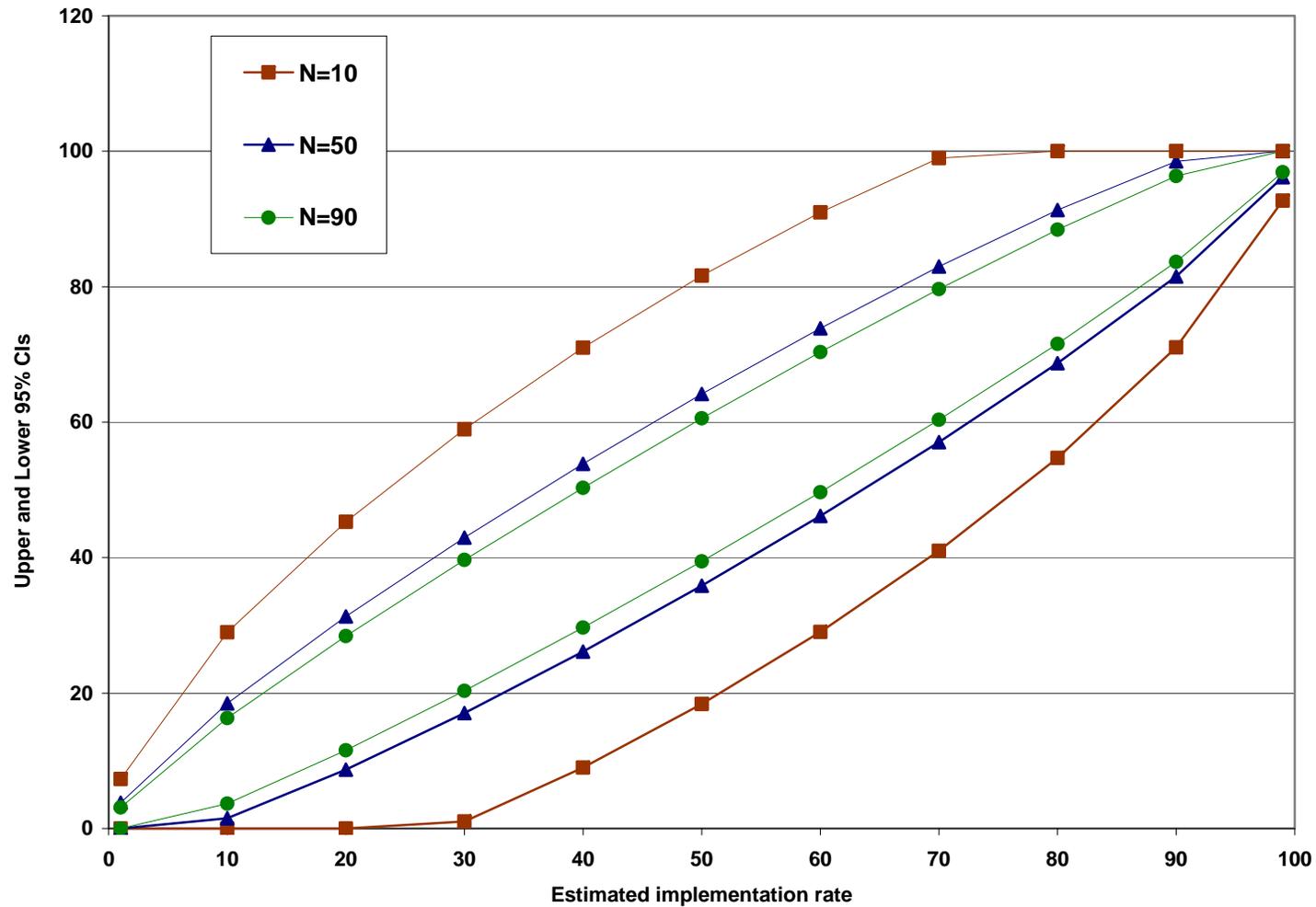


Figure 3. MFRC Site-level Monitoring Program expenditures for fiscal years 1998-2007 and estimated costs for fiscal years 2008-2010, exclusive of salaries. Expenditures for 2001 and 2002 were likely higher than displayed below. Dollar amounts are not adjusted for inflation.

