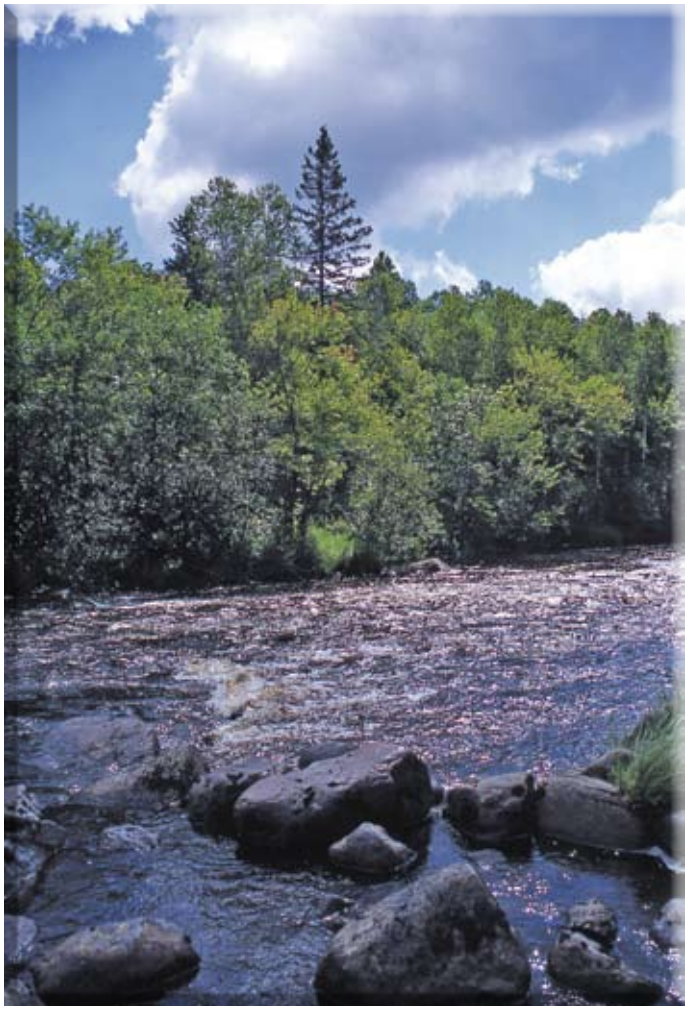

A report by the Minnesota Department of Natural Resources

Respectfully submitted to the Minnesota Forest Resources Council

Timber Harvesting and Forest Management Guidelines on Public and Private Forest Land in Minnesota

Monitoring for Implementation

2004, 2005, 2006 Results Compared to Baseline Monitoring Report

By Richard Dahlman

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Summary

This report is an update to the Legislature and Governor as required by the Sustainable Forest Resources Act (SFRA). The SFRA requires the Minnesota Department of Natural Resources to develop and administer a program, overseen and directed by the Minnesota Forest Resources Council (Council), to monitor implementation of the Council's timber harvest/forest management (TH/FM) guidelines on public and private forestlands. The first three years (2000–02) of monitoring assessed harvest practices before the guidelines were adopted and influenced those practices. Only sites harvested or under contract before the publication of the TH/FM guidelines were monitored. The next three years (2004–06) of monitoring assessed harvest practices after the guidelines had been adopted and may have influenced those practices. This report summarizes the monitoring data for 2004–06 and compares them to the results for 2000–02 (Dahlman and Phillips 2004). Although methods changed over the years to improve monitoring, every effort was made to make the data comparable across years.

In 2004–06, landowners, managers, and loggers generally followed the guidelines well. Improvement in implementation rates likely will result from additional training, better planning, and improved communications between landowners/resource managers and loggers. In addition, monitoring protocols, site selection, and visual sensitivity rating information can all be improved.

In 2004–06 279 sites were evaluated, and in 2000–02 315 sites were evaluated. Sites were located throughout the forested portions of the state. Despite efforts to sample sites from the primary ownership categories in proportion to the volume of timber harvest from lands in those categories, nonindustrial private forest (NIPF) lands were underrepresented in our sample. Sampling design will be further modified for future monitoring to address this issue.

Average harvest site size was about 25 acres in both monitoring periods. Individual sites ranged from 3 acres to more than 200 acres. Most harvest occurred during winter (53% in 2000–02 and 43% in 2004–06) or summer (12% in 2000-02 and 16% in 2004-06), while harvest on the remaining sites extended over more than one season. In both monitoring periods, most sites included waterbodies for which the guidelines recommend a filter strip or a filter strip and a riparian management zone (RMZ). Non-open water wetlands (NOWW) were the most common type of waterbody. The visual sensitivity guidelines applied to 79 sites in 2000–02 and 102 sites in 2004–06. Few sites contained cultural or historic resources or endangered, threatened, or special concern (ETS) species.

The Council's 2001 goal for all public agency, forest industry (FI), and professionally assisted NIPF timber sales is that of the landowner and logger discuss guideline application during preharvest planning at least 75% of the time. Although public agency and FI landowners exceeded that goal, NIPF landowners were well below that target. The guidelines need greater emphasis in private forest management education and assistance.

Visual quality guidelines were met in most cases despite the fact that awareness of the visual quality guidelines was limited. The availability of visual sensitivity maps and other aids to landowners for interpreting the guidelines should be improved.

Landowners used appropriate practices for all cultural resources and ETS identified on the monitored sites, but often did not check records for these resources. Additional training may increase diligence in checking records for cultural or historic resources and ETS species.

Landowners and loggers followed filter strip guidelines very well. As a result no erosion was observed in 98% of the filter strips, and no sediment reached adjoining waterbodies 99% of the time. Filter strip disturbance was limited as recommended in the guidelines 96% of the time in 2004–06 compared to 73% in 2001–02. In addition, roads, skid trails, and landings were located outside of filter strips more than 85% of the time.

The criteria for determining RMZ guideline implementation were strict and based on recommended total width and basal area (BA) of residual trees in harvested portions of the recommended RMZ area. RMZs around waterbodies in the harvest area were less likely to meet the guideline recommendations than were RMZs around waterbodies that were adjacent to the harvest area. Compliance with the recommended RMZ guidelines for width and BA decreased slightly between the two monitoring periods from 52% to 46% compliance. However, many of the instances of noncompliance involved open-water wetlands less than 1 acre or streams less than 3 feet wide that may have been obscured by snow cover at the time of harvest. Rates of adherence to RMZ recommendations, particularly for waterbodies within the harvest area, should be improved. In addition, our methods for determining RMZ guideline implementation may not have adequately assessed whether the intent of the guidelines was met.

Most crossings for both periods were on NOWW and did not involve the placement of fill. Rutting occurred on a third of the crossings of NOWW, seeps and springs, and seasonal ponds, but generally was limited and did not visibly disrupt the hydrology of the wetland.

Two-thirds of the road and skid trails approaches for crossings or entering wetlands were judged by the monitoring contractors to be stable enough to not require water diversion/erosion control, based on no visible evidence of erosion. Only 30% of the approaches that needed erosion control practices had them. Of the approaches that needed erosion control practices, 34% showed evidence of eroding, and more than 20% had sediment reaching the wetland or waterbody. Clearly, greater emphasis on erosion control practices for wetland and water crossing approaches in training programs for loggers, natural resource professionals, and NIPF landowners is warranted.

More than 52% of all sites met the guideline for limiting logging infrastructure (roads and landings) to less than 3% of the harvest site. However, the average area devoted to logging infrastructure increased 27% between monitoring periods, from 3.0% of the site in 2000–2002 to 3.8% in 2004–06. Guideline training needs to more effectively convey the importance of limiting the area devoted to infrastructure.

Landings were generally in fair to good condition and located away from filter strips, RMZs, and wetlands on 75% of the sites in 2004-06, up from 61% in 2000–02. About two-thirds of the landings were more than 50% vegetated, and 90% were not rutted. Only 10% were visibly eroded and less than 2% released sediment to waterbodies. Additional emphasis during training on landings and fueling and maintenance areas is warranted.

Forest logging roads and skid trails generally were in good shape (with the exception of problem waterbody crossings, approaches to crossings, and road segments). The use of access controls improved compared to the previous monitoring period. Access control was in place on 75% of temporarily closed roads and 100% of permanently closed roads, as well as on nearly 31% of the roads still in active use.

Skidding was focused on skid trails on 39% (42% previously) of the sites, and was either not evident or was randomly distributed lightly over most of the site on the other 61% (58% previously) of the sites. Recent and anticipated changes in harvest practices, such as full-tree harvest with redistribution of slash, biomass harvesting, and cut-to-length harvest systems, may require revision of some current skid trail guidelines.

More than 86% (86% previously) of the road segments and 82% (60% previously) of the skid trail segments met slope recommendations. Just 8% of road segments and 10% of skid trail segments did not require water diversion and erosion control, much lower then the 67% for approaches. Approximately 33% (14% previously) of the road segments had one or more water diversion and erosion control practices in place, as did 35% (46% previously) of the skid trail segments. Nearly 69% (<59% previously) of the road segments showed evidence of eroding, but on only 4% (12% previously) did sediment reach a waterbody.

More than 30% (2% previously) of the skid trails segments showed evidence of erosion, while on only 0.5% (0.8% previously) did sediment reach a waterbody. The increase in erosion on skid trails did not result in a corresponding increase in sediment reaching a wetland or waterbody, in part because segments are located away from waterbodies, primarily outside of filter strips and RMZs. The increase in evidence of erosion and the limited application of effective erosion control and water diversion practices is a cause of concern that has been addressed and will continue to be addressed in training programs for loggers and natural resource managers.

In general, rutting was a minor problem. Nearly 45% of the 279 sites had no rutting, and only 11% of the 6,147 locations evaluated for rutting on the 279 sites were rutted. In addition, on about two-thirds of the locations where rutting was observed, rutting covered less than 5% of the surface area and was confined to infrastructure (roads, skid trails, and landings) on 89% of the sites. Landowners, resource managers, and loggers need to be reminded that there is a significant possibility for rutting in all seasons.

Operators redistributed slash more frequently in 2004–06 than previously (43% compared to 20%), perhaps reflecting an increase in delimbing at the landing. Questions about the effects on regeneration of increases in soil compaction and poor distribution of the slash should be addressed by targeted research.

Adherence to guidelines for coarse woody debris (CWD) was good. General harvest areas met the guidelines for CWD 75% of the time in 2004–06 (79% in 2001–02). Consideration should be given to requiring placement of additional logs to meet the CWD guideline on some sites, or to revising the CWD guidelines based on additional research.

Leave-tree guidelines were fully met by either scattered leave trees or clumps on 47% (61% previously) of the sites. An additional 14% of the sites had both scattered leave trees and leave-tree clumps. Some of these likely met the intent of the guideline if the two were considered in combination. Monitoring procedures will be modified to assess this in the future.

Seventy-three percent of the sites (72% previously) retained at least one snag per acre, and 54% (37% previously) had more than two. Greater attention on the part of landowners and resource managers to CWD, leave trees, and snags, particularly within RMZs and on biomass harvest sites, is needed.

Introduction

This report is an update to the Legislature and Governor as required by the Sustainable Forest Resources Act (SFRA). The SFRA was enacted in1995 and modified in 1999 (Minnesota Statutes, Sections 89A.01 to 89A.10) to resolve important forestry policy issues through collaboration among diverse forestry interests. It created the Minnesota Forest Resources Council (Council), made up of representatives from 15 stakeholder groups, a chairperson appointed by the Governor, and an American Indian representative appointed by the Indian Affairs Council. The SFRA required that the Council initially focus on developing voluntary guidelines for use on public and private forestland in Minnesota to minimize the negative impacts of timber harvest and other forest management activities.

The Council began developing timber harvest and forest management (TH/FM) guidelines as mandated by the SFRA in April 1996. It developed site-level guidelines for four topical areas identified in Final Generic Environmental Impact Statement (GEIS) Study on Timber Harvesting and Forest Management in Minnesota (Jaakko Pöyry 1994): riparian zone management, forest soil productivity, historic and cultural resources, and wildlife habitat. These guidelines were integrated with the existing best management practice (BMP) publications, Protecting Water Quality and Wetlands in Forest Management (Minnesota Department of Natural Resources 1995) and Visual Quality Best Management Practices for Forest Management in Minnesota (Minnesota Department of Natural Resources 1994). The Council approved the integrated guidelines in December 1998, and published the guidebook Sustaining Minnesota Forest Resources: Voluntary Site-Level Forest Management Guidelines for Landowners, Loggers and Resource Managers (Minnesota Forest Resources Council 1999) in April 1999. These guidelines were revised and republished in 2005.

The SFRA requires the Minnesota Department of Natural Resources (DNR) to develop and administer a program, overseen and directed by the Council, to monitor implementation of the TH/FM guidelines on public and private forestlands:

> *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.*

The first three years of monitoring assessed sites harvested or contracted for before the publication of the TH/FM guidelines. Reports were published for the 2000 monitoring (Phillips 2001) and the 2001 monitoring (Phillips and Dahlman 2002), and for cumulative results for 2000–02 (Dahlman and Phillips 2004). This report summarizes the monitoring data for 2004–06 and compares the results to the 2000–02 cumulative results.

Methods

Site selection and data collection methods were modified over the years to improve monitoring while maintaining as much continuity as possible so data could be compared across years. The changes included:

1) revising questions on the data collection form and modifying field procedures focusing on measurable guideline practices

2) shifting from aerial photography of randomly selected townships (2000 and 2001) to the use of satellite imagery (2002, 2004, 2005, and 2006) as a method for initial site selection

3) changing which features are identified and measured on-site and which are identified and measured by aerial photo interpretation.

Data Forms

Two sets of forms were used to collect information about each site monitored. The first set focused on collecting information that could not be obtained through on-site evaluation. In 2000 two forms were used for this purpose. The detailed nature of these forms often made it difficult to get private landowners and public agency and FI resource managers, particularly nonindustrial private forest (NIPF) landowners, to complete them. The forms were consolidated into a single landowner questionnaire for 2001. Questions were deleted about certain resources or conditions on the property (e.g., type and number of waterbodies, soil type, soil drainage characteristics). However, additional information was also requested of the landowners/resource managers, including identifying:

1) their primary objective for management

2) whether they used TH/FM guidelines in planning or modifying timber harvesting or roads activities

3) whether, where, and how the landowner/resource manager and the logger/contractor discussed the TH/FM guidelines.

In 2002 more questions were deleted. The resulting form was used with only minor modifications in subsequent years.

The second set of forms was the on-site form and maps. These are where observations of the site were recorded. Most features recorded were within the harvest area. Others features were adjacent or off-site but potentially impacted by the harvest activity.

Adjacent

Monitors recorded waterbodies outside the harvest area boundary but within the recommended filter-strip width (or within 1½ times the recommended riparian management zone [RMZ] width for waterbodies that require an RMZ) to capture potential impacts of harvest, such as deposition of sediment.

Off-site

Monitors recorded data for guideline practices on the last ¼ mile of roads and skid trails leading to a harvest area if their recent use was primarily for the activity being monitored. Along the ¼ mile of roads or skid trails, data were also recorded for guideline practices for off-site landings and for all waterbodies outside the harvest area boundary, but not adjacent to the site, if the roads, skid trails, or landings crossed the waterbodies or passed through their associated filter strips. Data were not collected for a road, skid trail, or off-site features along the road or skid trail if it was a public road such as a township road or a major forest system road that had significant traffic not associated with the activity being monitored, or it was a

preexisting logging road or skid trail that had significant traffic not associated with the activity being monitored or was not used for harvest activities on that site.

Data Collection

Independent contractors selected by competitive bid collected on-site data. DNR staff reviewed their paperwork and a multidisciplinary team reevaluated 10% of their fieldwork to ensure accurate and consistent data collection. In 2000 and 2001 DNR staff contacted landowners/resource managers to obtain permission to monitor the site, have them complete the needed forms, and obtain copies of timber sale permits, maps, and other supporting documentation. In 2002 the duties of the contractor were expanded to include making this contact with NIPF landowners. DNR staff continued to contact the resource managers of FI and public agency sites.

Contractors were given copies of all questionnaires and documentation for each site in preparation for the site visits. They recorded observations on paper copies of the on-site forms and returned the completed forms to the DNR for data entry and analysis.

Quality Control

Fifteen of the 279 sites were used for calibration training to prepare the contractors to monitor the sites accurately and consistently. A quality control team visited 11.2% of the remaining 268 sites to evaluate compliance with contract specifications for site monitoring. This process confirmed that data were being properly collected and provided useful insight for determining whether monitoring forms and field procedures needed additional modification.

Data Entry

DNR staff captured monitoring data using a relational database, Microsoft Access™ 97 for Windows 95, in 2000 and 2001. In 2002 a new Access™ database was developed to make data entry and queries easier and was used in 2002 and subsequent years.

Site Selection

In Minnesota forestlands are managed and administered by state, county, and federal public land management agencies, forest industry (FI), and private landowners (NIPF). Sites were selected from all forest ownerships.

The target sample for 2000, 2001, and 2002 was 120 sites per year. In both 2000 and 2001 the eastern half of 41 townships in the forested area of the state were randomly selected as primary sampling units (PSUs). Aerial photos were taken of each PSU to identify a pool of harvest sites for monitoring. In 2000 a half township was only included in the pool of PSUs if it contained at least 160 acres of forestland. This failed to provide an adequate number of sample sites for monitoring. Only 106 sites were monitored in 2000. Funding was inadequate to fly aerial photography for a larger number of PSUs. Therefore, the area for forestland required for each PSU was increased from 160 acres to six sections (3,840 acres) of timberland in order to increase the number of harvest sites identified per PSU. This modification was retained for the 2001 monitoring program. Monitors gathered data from 120 sites in 2001, but there were not enough NIPF sites, so a disproportionate number of state and county sites were sampled.

While preparing for monitoring in 2002, monitoring staff expressed concern that requiring six sections of timberland in the eastern half of a township was creating a sample bias by restricting monitoring to the most heavily forested areas of the state. There was also interest in combining guideline implementation monitoring with monitoring land-use change and harvest in riparian areas. For these reasons two approaches to identifying a pool of sample sites were tested in 2002. DNR staff took aerial photographs of 80 randomly selected strips measuring 1 mile by 6 miles, in order to spread the sample more widely across the state, and analyzed the photos to identify timber harvest sites of unknown age. The results were compared to computer analyses of satellite imagery for August 1999 and August 2001 to identify recent forest disturbance on approximately 70% of the state. More than 5,200 forest disturbances were identified by satellite imagery, from which monitoring sites could be randomly selected and aerially photographed.

Satellite imagery did not restrict site selection to heavily forested areas of the state, identified timber harvest sites more efficiently than did the aerial photography of selected townships, and had the added benefit of easy confirmation that a disturbance had occurred within the previous two years. For these reasons satellite imagery was used to identify the pool of sample sites for 2002 and subsequent years.

For 2002 DNR staff took aerial photos of 200 randomly selected sites from the forest disturbances detected, and contacted landowners/ resource managers for permission to visit their sites. Because NIPF landowners were very difficult to contact and many declined to participate, only 108 sites were monitored. Nineteen of these sites had been modified using the new TH/FM guidelines; these were excluded from the 2000–02 cumulative report and added to the pool of sites reported for 2004–06. In total the 2000–02 report summarizes observations from 315 sites.

The number of sites randomly selected from the forest disturbances detected by satellite imagery increased to 250 in 2004 and to 280 in 2005. However, the number of sites selected for monitoring each year was reduced to 90 sites. Both measures were taken to control costs and insure that an adequate number of NIPF harvest sites could qualify for on-site monitoring. It was difficult to get enough NIPF sites into the selection pool because of the following:

1) inability to contact many NIPF landowners for permission

2) private harvests often represent land use changes, not forest management

3) many NIPF landowners were reluctant to participate.

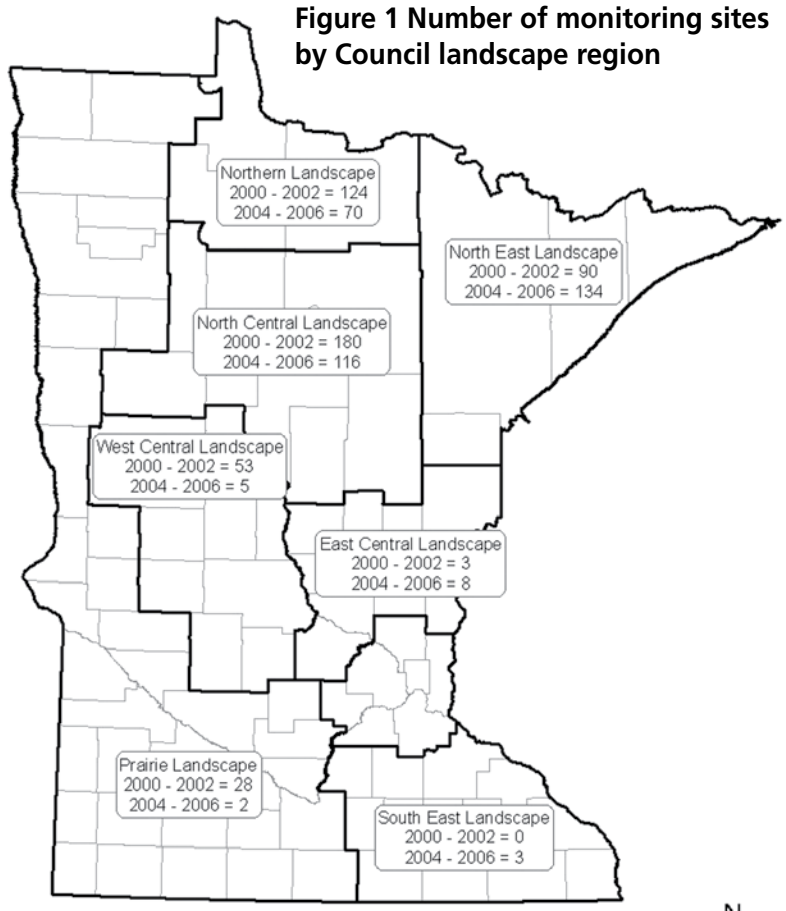
Obtaining an adequate number of NIPF sites continues to be a problem.

The 2004–06 results summarize observations for 279 sites, 260 sites (short of the goal of 270) monitored over those three years plus the 19 sites carried forward from 2002.

Site Locations

Use of TH/FM guidelines was monitored on all forestland ownerships: state, county, federal, FI, and NIPF. In addition to individual private landowners, the NIPF category includes a small number of tribal, municipal, and nonforest industrial ownerships. Monitors evaluated 279 sites in 2004–06 and 315 sites in 2000–02, distributed over the entire state as shown in Figure 1.

Figure 1 Number of monitoring sites by Council landscape region



The goal was to select 90 sites for each year of monitoring (2004–06) stratified in proportion to the annual volume of timber harvested from the category. Despite the efforts discussed above to insure an adequate number of NIPF sites, we were never able to obtain enough NIPF sites to meet this goal. The result has been that NIPF sites were monitored less intensively than other ownerships relative to the volume of timber harvested.

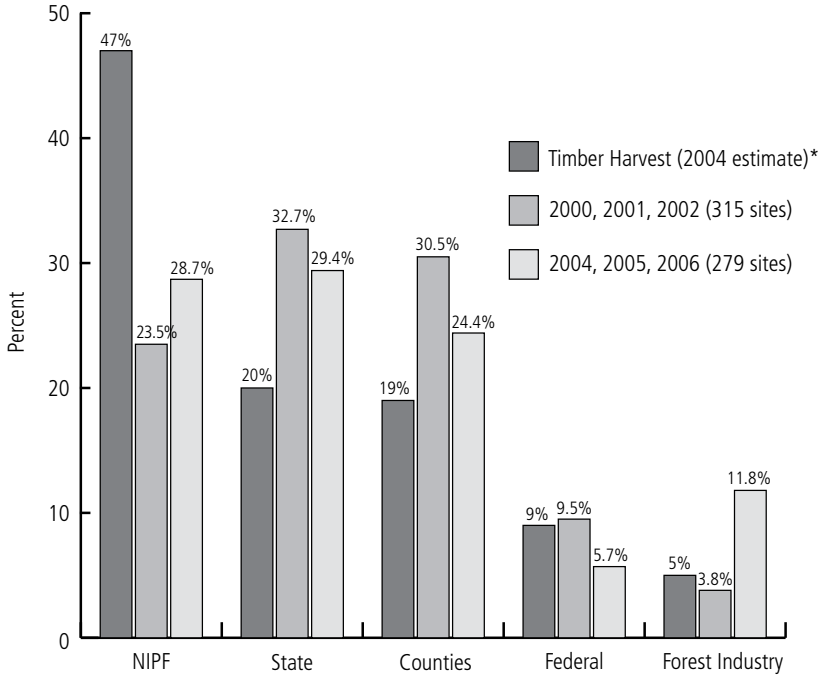
Some selected sites were dropped due to unexpected problems and were replaced by other sites from the same landownership category. We could not replace any NIPF sites lost due to such problems, which is why fewer than 90 sites were actually monitored in 2004 and 2005. The resulting departure from the desired sample distribution was similar for both monitoring periods. Figure 2 shows the percent of sites monitored by landowner category.

Aerial Photography Interpretation

The contractor and DNR shared responsibility for collecting on-site data. In 2000, DNR staff located and measured all landings within the harvest unit that could be identified on aerial photographs. In 2001, DNR identified all landing locations visible on the aerial photos, but the contractor was responsible for determining the size of the landings. As in 2000, the contractor also identified and delineated any landings not identified by DNR. In 2002 and all subsequent years, the contractor was responsible for identifying and measuring all landings.

In all cases the contractor delineated clumps of reserve trees within the harvest area on an aerial photomap for each site and determined the density of scattered leave trees. DNR staff later identified and delineated leave-tree clumps adjacent to each site on the aerial photomap based on on-site documentation and RMZ measures. In 2000 and 2001 DNR then determined acreage for all leave-tree clumps, harvest area, and total site area from the aerial photomaps. Since 2002 the contractor measured the size of all leave-tree clumps within the harvest area, and DNR determined the acreage of the leave-tree clumps adjacent to the harvest area, the acreage of the harvest area and total site (harvest area plus adjacent leave-tree clumps) from the aerial photomaps.

Figure 2 Comparison of Sampling Intensity to Timberland Ownership & Timber Harvest by Ownership



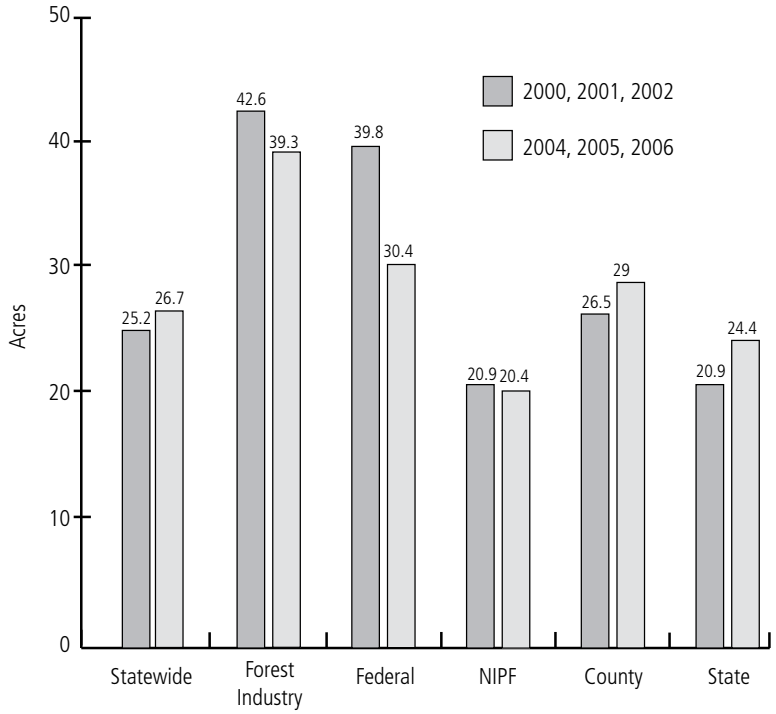
* Minnesota's Forest Resources. MN DNR 2005.

Results

Harvest Size

The average total site acreage (harvest area + adjacent leave-tree acreage + adjacent RMZ) was very similar for the two monitoring periods (Figure 3). Total site acreage ranged from 3 acres to more than 200 acres for both monitoring periods.

Figure 3 Average Site Acres by Ownership



Landowner Questionnaire

Landowners/resource managers partially or fully completed questionnaires for 307 of 315 sites monitored in 2000–02 and for 272 of 279 sites monitored in 2004–06. The sites without completed questionnaires were for NIPF landowners who chose not to fill out the questionnaire but allowed their timber harvests to be monitored. The questionnaires provided valuable information on factors that could affect implementation of the TH/FM guidelines, including management objectives, preharvest planning, and landowner commitment to applying the guidelines.

Management objectives

Management objectives are important factors influencing project planning and how a landowner might use the flexibility built into the guidelines. They may also influence how well the guidelines are implemented.

The questionnaire asked landowners/resource managers to identify up to three management objectives for their timber harvest (Table 1). The relative importance of objectives was the same for the two periods, with public agency (state, county, federal) and FI landowners listing timber harvesting and silviculture most frequently, and NIPF landowners listing income most frequently.

Beginning in 2001 the questionnaire also asked landowners/resource managers to identify their primary management objective (Table 2). Public agency and FI landowners listed timber production or silviculture as the primary management objective 84.5% of the time in the 2004–06 period (87.2% in the 2001–02 period). Wildlife habitat was a primary objective for 26% of the NIPF landowners in the 2004–06 period (27% in the 2000–02 period). Silviculture became much less important and income and insect and disease control became more important. A dramatic increase in stumpage prices and several major blowdowns likely contributed to this shift. Additional analysis is needed to determine if there is a connection between management objectives and guideline implementation.

Table 1 Landowner listing of three major objectives for management

Management Objectives	Landowner Category			
	2000–02		2004–06	
	NIPF	Public Agency & Forest Industry	NIPF	Public Agency & Forest Industry
Timber production	44.6%	92.8%	47.2%	94.8%
Silviculture	49.2%	70.5%	18.1%	74.1%
Wildlife habitat	44.6%	34.2%	51.4%	37.8%
Income	50.8%	24.5%	55.6%	32.1%
Recreation	33.8%	6.8%	33.3%	7.8%
Insect and disease	6.2%	10.5%	30.6%	17.6%
Other	10.8%	7.2%	23.6%	5.7%
Total number of sites	74	241	80	199

Table 2 Primary landowner objective for management

Management Objectives	Landowner Category			
	2000–02		2004–06	
	NIPF	Public Agency & Forest Industry	NIPF	Public Agency & Forest Industry
Timber production	16.2%	61.1%	16.4%	59.1%
Silviculture	27.0%	26.1%	6.9%	25.4%
Wildlife habitat	27.0%	1.9%	26.0%	4.7%
Income	10.8%	1.4%	17.8%	4.1%
Recreation	13.6%	0	11.0%	0
Insect and disease	0	1.9%	12.3%	5.2%
Other	5.4%	7.6%	9.6%	1.5%
Total sites where Landowner objectives were identified	37	157	73	193
Total number of sites	46	161	80	199

Preharvest planning

The TH/FM guidelines recommend the development of written plans for all forest management activities, including timber harvest. The TH/FM guidelines also encourage landowners/resource managers to use appropriate planning aids, such as aerial photography and topographic maps, when preparing a plan, and to prepare detailed site maps to help communicate the details of the plan to those who will carry it out.

Planning is particularly important for NIPF landowners because they often live distant from the harvest area and have little or no experience with forest management and timber sale contracts. In both periods fewer than half of NIPF landowners reported living on or adjacent to the property where their timber harvest occurred, and 11.8% to 16.7% reported living more than 100 miles away (Table 3).

Table 3 How close to the harvest site do NIPF landowners live?

Location	2000–02	2004–06
On or adjacent to property	48.5%	42.3%
<50 miles	22.1%	28.2%
50 to 100 miles	2.9%	5.1%
>100 miles	11.8%	16.7%
Not provided	14.7%	7.7%
Total	68	78

Written plans are standard for timber harvests on all public agency and FI lands. Just over half of NIPF landowners sites monitored in both periods reported having some type of planning assistance (Table 4). The number of NIPF landowners who reported having a general management plan and/or a project-specific timber harvest plan was greater in 2004–06 than in 2000–02. We assume that increased use of plans indicates increased awareness and implementation of the TH/FM guidelines. Additional analysis is needed to determine if there is a connection between professional assistance and management planning and guideline implementation for NIPF landowners. The percentage of NIPF landowners reporting they had a written a management plan or a timber harvest plan was slightly higher than the 20% reported in surveys of Minnesota NIPF landowners in general (Kilgore et al. 2007a, 2007b).

Table 4 NIPF project planning

Level of Planning	2000–02	2004–06
Total number of NIPF landowners	68	78
No response	25.0%	7.7%
No assistance	22.1%	41.0%
Had assistance	52.9%	51.3%
General plan – written	26.5%	37.2%
Timber harvest plan	26.5%	47.4%
Project supervision	NA	39.7%

Most landowners/resource managers used one or more sources of information in preparing their timber harvest plans (Table 5). The most commonly used resource was aerial photography. Initial analysis did not show a connection between use of planning aids and guideline implementation.

Table 5 Site information resources used to provide landowner assistance for evaluating and developing plans

	2000–02	2004–06
Aerial photographs	87.3%	82.1%
Topographic maps	28.9%	19.0%
Soil surveys	22.9%	22.2%
Visual sensitivity maps	23.8%	21.1%
Other*	28.3%	22.2%
None	0	7.5%
Don't know	0	5.0%
No response	2.5%	4.3%
Sites for which use of information resources was reported	91.1%	83.2%
Total number of sites	315	279

* Includes use of forest inventory data, county biophysical inventory data, and state protected waters listings.

One of the most effective tools for communicating the details of a harvest plan is a site map identifying the location of critical site features (Table 6). Site maps were developed for 81.7% of the sites for which the landowner/resource manager completed the questionnaire for 2004–06, compared to 86.3% in 2000–02. NIPF landowners were least likely to have a map.

Table 6 Percent of sites for which site maps were developed by landowner category

		Landowner Category					
		State	County	Federal	FI	NIPF	Total
Sites with maps	2000–02	95.1%	88.5%	96.7%	91.7%	39.2%	86.3%
	2004–06	100%	100%	100%	100%	34.7%	81.7%

Landowner commitment to applying the guidelines

One of the guideline implementation goals the Council adopted was to obtain landowner commitment to apply the TH/FM guidelines. The Timber Harvest and Forest Management Guideline Implementation Goals for 2000: A Progress Report (Minnesota Forest Resources Council 2001) describes the need for this commitment:

> *Background. Awareness and understanding of the guidelines must be accompanied by a willingness to actually apply the guidelines. Evaluating how often and the extent to which a discussion of guideline application takes place during the pre-harvest planning between the forest landowner, the resource manager, and the logger can measure evidence of a commitment to apply the guidelines.*

To obtain a measure of the landowner commitment to apply the guidelines, two questions were added to the landowner questionnaire.

1) Were the TH/FM guidelines used to plan the above activities or modify the plan?

2) Were the TH/FM guidelines discussed during the on-site meeting?

The Council's implementation goal (Minnesota Forest Resources Council 2001) relative to these two questions is a minimum of 75% for all public agency, FI, and professionally assisted NIPF timber sales. The assumption is that using the guidelines to modify management plans and discussing the guidelines with operators before harvest begins will improve implementation of the guidelines. General observation seems to confirm this. However, due to time constraints and the complexity of sorting out the impact of other factors, assessment of the data to determine what correlation there may be will have to be addressed at a later date.

Public agency and FI landowners exceeded the Council's goal for question 1 in 2004–06 (Table 7). NIPF landowners were well below the Council target, highlighting the continuing need to increase awareness of the TH/FM guidelines and sustainable forest management principles. Question 2 provides information about whether the landowner/resource manager and the logger/contractor discussed the guidelines.

Table 7 Use of TH/FM guidelines to modify the plan 2004-06

		NIPF	Public Agency & Forest Industry
Number of sites		80	199
Guidelines used to modify logging roads plan	Number of sites with response	34	147
	Percent of responding that used guideline	29.4%	93.2%
Guidelines used to modify timber harvest plan	Number of sites with response	40	182
	Percent of responding that used guideline	37.5%	95.1%

The percentage of landowners/resource managers who met with the timber purchaser/logger improved between the two reporting periods (Table 8). Discussion of guidelines related to logging roads was below the Council target of 75% for all ownership categories. Public agency and FI landowners met the Council target for discussing the TH/FM guidelines, while NIPF landowners did not.

Table 8 Meetings with logger/contractor

	2000–02		2004–06	
	NIPF	Public Agency & Forest Industry	NIPF	Public Agency & Forest Industry
Total number of sites	74	241	80	199
Meetings held	43.2%	80.5%	70.0%	95.0%
Roads guidelines discussed*	NA	NA	19.6%	67.2%
Timber harvesting guidelines discussed*	NA	NA	35.7%	87.8%

* TH/FM guidelines were not available for sites included in 2000-02 monitoring.

Forest Management and Harvest Methods

Forest management is the deliberate manipulation of the forest stand to achieve desired outcomes over an extended period of time. Timber harvest is the primary tool landowners/resource managers use to manage forests. The harvest method landowners/resource managers choose for a site depends on their management objectives and the tree species being managed. Table 9 summarizes the harvest methods reported.

Reserve trees

The TH/FM guidelines recognize the importance of vertical structure for wildlife habitat on clear-cut areas. They recommend leaving some mature (6-inch diameter at breast height [DBH] or larger) trees as individual trees, in clumps, or both. Landowners/resource managers recognized the value of this before the guidelines were published. Puettmann et al. (1998) reported that the percentage of harvests in Minnesota that were clear-cut harvests with reserves nearly doubled between 1991 and 1996, from 41% to 77%. The increase was attributed to growing interest in providing for wildlife habitat, riparian protection, aesthetics, and nutrient retention.

Table 9 Landowner/resource manager–reported timber harvest method

	2000–02	2004–06
Clear-cut with reserves	57.8%	69.2%
Clear-cut no reserves	27.9%	15.8%
Thinning	7.9%	4.6%
Salvage & TSI	2.5%	3.6%
Group selection	0.3%	1.8%
Seed tree	0.9%	0.7%
Unknown	2.5%	4.3%
Total	315	279

The percentage of sites harvested by a form of clear-cut was the same for both monitoring periods, but the percentage of clear-cuts with reserves increased from 57.8% to 69.2%, perhaps reflecting increased awareness of the leave-tree guidelines (Table 9).

Season of harvest

Most timber harvest activity occurred in winter (Table 10). The difference between monitoring periods likely reflects: 1) the random nature of site selection, 2) weather, and 3) market changes.

Table 10 Season of harvest

	2000–02	2004–06
Spring (March 16-May 31)	5.1%	1.1%
Summer (June 1-September 15)	12.1%	15.8%
Fall (September 16-December 15)	8.2%	10.7%
Winter (December 16-March15)	53.0%	43.4%
Summer-Fall	4.8%	8.9%
Fall-Winter	4.8%	8.6%
Other multiple seasons	6.6%	5.4%
Year around	2.2%	0%
Unknown	3.2%	6.1%
Total	315	279

Table 11 Visual sensitivity classification

		2000–02	2004–06
Number of sites with visually sensitive features		79	102
Percent of features by visual sensitivity rating	Most	19.0%	20.5%
	Moderate	40.5%	41.0%
	Less	40.5%	38.5%

Visual Quality

Visual quality BMPs were developed and published in 1995 by a multi-stakeholder group led by representatives of the resort and forest industries. Then the DNR worked with local representatives in 16 northern Minnesota counties to develop visual sensitivity classification maps to help landowners/resource managers and operators apply appropriate visual guidelines to their harvests (http://www.dnr.state.mn.us/forestry/visual_sensitivity/index.html). Features such a roads, rivers, lakes, or recreational trails were rated as most, moderately, or less visually sensitive. Only sites in the 16 counties with visual sensitivity classification maps for visual sensitivity were monitored. A total of 305 of the 315 sites monitored for 2000–02 and 255 of the 279 sites monitored for 2004–06 were located in these 16 counties. The percentage of features in each sensitivity class was similar for both monitoring periods (Table 11).

Apparent harvest size, the harvest acreage perceived by someone traveling at the normal speed for the travel route in question, applies to features rated most and moderately visually sensitive. For each such feature the contractor recorded the apparent harvest size in one of three categories: ≤5 acres, 6–10 acres, and >10 acres (Table 12).

Table 12 Apparent harvest size

	2001–02		2004–06	
	Most	Moderate	Most	Moderate
≤5 acres	75.0%	66.7%	82.6%	73.5%
6≤10 acres	25.0%	23.8%	17.4%	18.4%
>10 acres	0	9.5%	0	8.1%
Total	8	21	23	49

The guidelines recommend an apparent harvest size of less than 5 acres for sites classified as most sensitive and 5–10 acres for moderately sensitive sites. In 2004–06, 82.6% of the sites with vistas rated "most" sensitive met the guideline for apparent size, while 91.9% of the sites with vista sensitivity rated "moderate" met the guideline. This is comparable to the results for 2001–02.

The TH/FM guidelines recommend various techniques be used to limit the apparent harvest size (Table 13). Techniques most commonly used in both periods to limit apparent size were 1) use of natural terrain and 2) use of buffers or clumps of uncut trees.

Visibility of snags, slash, and landings also affects visual quality. Most harvests met the guidelines for such visibility in 2001–02 and 2004–06.

Table 13 Techniques used to limit apparent harvest size (Most & Moderate sensitivity)

	2001–02	2004–06
Use natural terrain	65.5%	26.4%
Use buffers or clumps of uncut trees	65.5%	87.5%
Apply multiple stage cuts	34.5%	2.8%
Create narrow openings into harvest area	27.6%	4.2%
Shape like natural opening	20.7%	0
Adjust contiguous linear feet of harvest frontage	10.3%	0
Total number of vistas*	29	72

* Percents do not total 100% because multiple techniques may have been used for some vistas.

Landowners/resource managers' awareness of the visual sensitivity of their property is important to effective application of guidelines to protect aesthetic resources. Landowners/resource managers were not always accurately aware of the visual sensitivity ratings for features associated with their harvest sites (Table 14).

Table 14 Perceived vs. actual visual sensitivity rating for All Sites Monitored 2004-06

		None	Most	Moder-ate	Less	No County Rating Available	Don't Know	No Response	Total
Total Number of Features	Per-ceived	89	12	60	53	41	0	35	290
	Actual	177	24	48	45	NA	NA	NA	294

Cultural Resources

Cultural/historic resources such as old homestead sites, logging camps, human burial sites, and Native American camp or village sites are generally fragile and may be susceptible to damage from forest management. The guidelines ask landowners/resource managers to check inventory records for the presence of known cultural/historic resources before beginning forest management activities. The proportion of sites for which landowners/resource managers reported checking records for cultural/historic resources was higher in 2004–06 than in 2000–02 for state, federal, and FI lands, but lower for county and NIPF lands (Table 15).

The results reported in Table 15 are low because state and federal forestry agencies have program staff review records of cultural/historic resources for all forest management sites before setting up timber harvests. However, the field staff completing the monitoring questionnaires may have failed to reflect this. The same may also be true for some county agencies and FI ownerships.

As part of the monitoring, the state archaeologist's office checked the monitored sites against the archeological site inventory. Known cultural/historic resources were associated with only two of the sites monitored in 2004–06 (Table 16). However, the landowners/resource managers identified cultural/historic resources based on personal knowledge on 13 of the timber harvest sites. The contractors did not include three of the resources the landowners/resource managers reported because they were located well away from the harvest site. But the contractor did observe four additional cultural resources the landowner/resource manager missed. No disturbances were reported for any of the cultural resources monitored.

Table 15 Landowner/resource manager checked for presence of cultural/historic resources

		State	County	Federal	NIPF	Forest Industry	Total
Percent of sites	2000–02	53.4%	50.0%	76.7%	16.2%	16.7%	44.4%
	2004–06	73.2%	38.2%	93.8%	5.0%	93.9%	48.7%

Table 16 Number of cultural resources associated with harvest sites (2004–06)

State Archaeologist's Office	Landowner/Resource Manager Reported	Monitoring Contractor Reported
2	13	14

ETS Species

TH/FM guidelines also recommend checking for the presence of **e**ndangered, **t**hreatened, and **s**pecial concern (ETS) species. Landowners/resource managers reported checking on the presence of ETS species for 73.1% of the sites in 2004–06, up from less than 50% previously (Table 17).

Table 17 Presence of ETS species checked by landowner/ resource manager

		State	County	Federal	NIPF	Forest Industry	Total
Percent of Sites	2000-02	62.1%	51.0%	63.3%	8.1%	100.0%	47.6%
	2004-06	93.9%	77.9%	100.0%	33.7%	93.9%	73.1%

Six landowners/resource managers identified the timber wolf as being in the vicinity of their land, and three noted bald eagles. No special practices were needed for the wolves or eagles since no den sites or nests were near the harvest sites. Other species reported included goshawk, Blanding's turtle, wood turtle, heron (rookery), goblin fern, Garber's sedge, ram's-head lady's-slipper, and matricary grapefern. The rookery and plants were excluded from the harvest area in all cases. Harvest activity was restricted to winter for the turtles and goshawk. A review of the DNR inventory of ETS species by DNR monitoring staff found a reference to a lichen in the general vicinity of one site. No special management was recommended for this species.

Wetlands and Waterbodies

A major focus of the TH/FM guidelines is protecting wetlands and waterbodies, including non-open-water wetlands (NOWW), open-water wetlands (OWW), perennial and intermittent streams, lakes, seasonal ponds, and seeps and springs. Impacts to all wetlands and waterbodies from rutting and sediment have been minor, but water diversion/erosion control practices on approaches to crossings need improvement.

Type and distribution of waterbodies

The types and numbers of waterbodies or wetlands associated with the monitoring sites are shown in Table 18. As in the previous report, more than 63% were found within the harvest area of a site, where the risk of disturbance is greatest. Additional waterbodies (37%)

Table 18 Number of waterbodies by type

	2000–02	2004–06
Filter Strip Recommended		
NOWW	77.2%	73.3%
Seep & springs	0.4%	2.5%
Total seasonal ponds	5.9%	11.9%
Intermittent streams <3' (non-trout)	3.9%	4.8%
Filter Strip & RMZ Recommended (Including Trout Waters)		
Streams	5.2%	5.3%
OWW	6.7%	1.4%
Lakes	0.7%	0.8%
Total waterbodies	1,099	1,018
Sites with waterbodies	285	254
Sites with no waterbodies	35	25

were adjacent to the harvest area or off-site. At least one waterbody or wetland was found on or adjacent to 91% of the monitored sites. NOWW were more common than any other waterbody or wetland type, accounting for 73.3% of the total.

Proper identification of waterbody types, particularly seasonal ponds, has been a problem for monitoring. Training contractors on classification criteria for seasonal ponds has helped increase consistency in waterbody identification and number of seasonal ponds reported in each succeeding year of monitoring.

The filter strip and RMZ guidelines are the primary tools for protecting wetlands and waterbodies by defining specified widths adjoining a wetland or waterbody where management activities are to be less intrusive than in the general harvest area.

Filter strips and RMZs serve different but complementary functions. Filter strips are intended to maintain a relatively undisturbed forest floor around a wetland or waterbody while permitting the harvest of some or all trees within the filter strip. They disperse and slow surface flows of water, allowing it to infiltrate into the soil where sediment, debris, nutrients, and chemicals can be trapped before it enters a wetland or waterbody. Filter strips are recommended for all wetlands and waterbodies. RMZs minimize vegetative disturbance and encourage retention and establishment of longer-lived tree species. RMZs are recommended for all OWW, lakes, and perennial streams, and all intermittent streams wider than 3 feet.

Filter strip application

Filter strip guidelines have been in effect since publication of the initial water quality BMPs in 1990. The TH/FM guidelines recommend establishment of filter strips adjacent to all perennial and intermittent streams, lakes, OWW, NOWW, seasonal ponds, and seeps and springs. The recommended width of a filter strip is 50 feet with an additional 2 feet for each 1% increase in slope over 10%, to a maximum of 150 feet.

Two criteria used to evaluate implementation of the filter strip guidelines were 1) amount of disturbance and 2) distribution of disturbance. For filter strips to be effective, mineral soil exposure should be less than 5% and dispersed. Evaluating a filter strip requires measuring the slope of the land, selecting the filter strip width the guidelines recommend for that slope, and determining the amount and distribution of soil disturbance within that filter strip area.

The guidelines recommend that roads, skid trails, landings, and clearing debris should be located outside filter strips and RMZs whenever practical. In 2004–06, roads and skid trails were located outside filter strips and RMZs 86% of the time, and landings 89.5% of the time (Table 19). This does not include entries for crossing wetlands or waterbodies, which are discussed in a later section.

Table 19 Roads, skid trails, and landings in filter strips, 2004–06

	Total Filter Strips	Roads and Skid Trails Filter Strips Avoided	Landings Filter Strips Avoided
Total	1,408	86.0%	89.5%

Despite the intrusion of roads, skid trails, and landings into filter strips, the guideline limiting filter strip disturbance to <5% dispersed evenly was met more than 95.9% of the time (Table 20). This is an improvement over the 72.8% meeting the guideline reported for 2001–02, and is consistent with the 90% compliance reported earlier for BMP monitoring (Phillips et al. 1994).

The differences in filter strip disturbance between the two monitoring periods may be due to enhanced resource manager and operator awareness due to training they received when the TH/FM guidelines were introduced.

Table 20 Filter strip disturbance

	NOWW		All Other Waterbodies		Total for All Waterbodies	
	2000–02	2004–06	2000–02	2004–06	2000–02	2004–06
No disturbance	72.2%	91.6%	74.2%	89.4%	72.8%	91.1%
<5% Dispersed		4.8%		4.9%		4.8%
<5% Concentrated	17.3%	1.8%	16.5%	3.5%	17.0%	2.3%
≥5% Dispersed	3.3%	0.5%	4.4%	1.1%	3.7%	0.6%
≥5% Concentrated	7.2%	1.3%	4.9%	1.1%	6.5%	1.2%
Total number of filter strips	875	1,038	387	370	1,262	1408

The decline in observations of erosion in filter strips between the two monitoring periods reflects the improvement in limiting disturbance (Table 21).

Table 21 Filter strip condition—effectiveness

	2001-02	2004-06
No erosion visible	93.2%	97.9%
Erosion evident	6.8%	2.1%
Sediment reaching waterbody	2.1%	0.9%
Total number of filter strips	933	1,408

Riparian management zones

The TH/FM guidelines introduced RMZ guidelines in 1999. Data were collected on RMZ width and residual tree basal area (BA) for the following categories: 1) width of nonforested vegetation, 2) width and BA of uncut riparian forest, 3) width and residual BA of partially harvested riparian forest, and 4) width of clear-cut (<25 ft^2/acre BA) for the rest of the recommended RMZ width for the specific type and size of waterbody.

A total of 76 waterbodies were identified for which RMZs are recommended on or adjacent to sites monitored in 2004–06. Several streams traversed the harvest areas with an RMZ on each side, and some harvest sites intersected with the RMZ of a waterbody at more than one location, resulting in 87 RMZs.

Data were collected from a single representative cross section of each RMZ characterizing the composition of the full recommended RMZ width for each type and size of waterbody. Linear distances were recorded for:

1) nonforest (sedge, brush, and scattered trees with a BA less than 25 ft^2/acre)

2) undisturbed forest (no harvest with BA greater than 25 ft^2/acre)

3) partially harvested forest (harvest retained at least 25 ft^2/acre BA)

4) clear-cut (harvest retained less than 25 ft^2/acre BA).

Many RMZs had significant areas of nonforest vegetation (i.e., grass, sedge, brush, or shrubs) or were entirely composed of nonforest vegetation. Compliance was based on the combined width of the nonforest, undisturbed forest, and partially harvested forest. BA compliance was only considered for the partially harvested portion. This portion had to meet the minimum BA recommended for the size and type (trout or nontrout) of waterbody. The clear-cut portion was considered as out of compliance.

The intent of the RMZ guidelines appears to have been recognized for a substantial portion of the RMZs monitoring in both monitoring periods. However, full compliance with the recommended RMZ guidelines for width and BA was lower for 2004–06 than for 2000–02 period (Table 22).

Many of the on-site RMZs that did not meet the guidelines were open-water wetlands (OWW) less than 1 acre or streams less than 3 feet wide for which no RMZ had been identified. Landowners/resource managers and operators may not have been aware of the existence these small waterbodies because of snow cover.

Table 22 RMZs that met guidelines for width and basal area (including trout waters)

		Percent RMZs That Met Guidelines	Total RMZs	Percent On-site RMZs That Met Guidelines	Total On-site RMZs	Percent Adjacent RMZs That Met Guidelines	Total Adjacent RMZs
Lakes & OWW	2000–02	47.6%	84	31.3%	32	57.7%	52
	2004–06	54.5%	22	25.0%	4	61.1%	18
Perennial streams	2000–02	56.5%	69	30.8%	26	72.1%	43
	2004–06	43.1%	65	37.9%	29	47.2%	36
Total	2000–02	51.6%	153	31.0%	58	64.2%	95
	2004–06	46.0%	87	36.4%	33	51.9%	54

Waterbodies adjacent to the harvest area were more likely than waterbodies in the harvest area to have an RMZ that fully met the guidelines. RMZ compliance clearly needs improvement, particularly for waterbodies within harvest areas.

The decline in full compliance may be real, or due to normal variation in sampling. It may also reflect a need to improve the field evaluation definitions and assessment procedures. We currently measure RMZ composition on a single representative cross section. A number of the RMZs very nearly met the guidelines, but fell a few feet short of the average recommended width.

Crossings and approaches

Logging equipment crossings are the forest management features that have the greatest potential for disturbing wetlands and waterbodies. Equipment may alter the cross section, carry mud and debris, or leak fuel, oil, or other hazardous liquids into the wetland or waterbody. In addition, crossings can modify water flow, disrupt the movement of fish and other aquatic organisms, cause upstream ponding, increase channel scouring, or destabilize banks. If operators do not properly install, maintain, and rehabilitate crossings, impacts can be substantial and continue long after the crossing ceases to be used. Operators should avoid crossings whenever practical.

The approaches to any crossing are just as important for protecting water quality as the crossings themselves. Approaches can funnel surface water, sediment, organic debris, nutrients, and chemicals into the water. In addition, crossings can modify water flow, disrupt the movement of fish and other aquatic organisms, cause upstream ponding, increase channel scouring, or destabilize banks. Water diversion/erosion control practices need to be in place as soon as a crossing and approaches are created. They also need to be maintained as long as the crossing exists and until the location is stabilized once the crossing is removed.

The types of waterbodies and wetlands crossed and proportion of road and skid trail approaches to entering or crossing them was similar between the two monitoring periods (Table 23, Table 24). Most crossings for both periods were on NOWW.

Table 23 Road and skid trail crossings by waterbody and wetland type

Waterbody Type	2000–02	2004–06
NOWW	81.8%	84.4%
OWW	1.6%	0%
Seasonal pond	0.4%	3.4%
Seeps and springs	0.2%	4.7%
Perennial streams (including trout waters)	13.1%	3.2%
Intermittent stream	2.9%	4.3%
Total	548	654

Table 24 Types of approaches for roads and skid trails

		2000–02	2004–06
Approaches to crossings	Roads	38.8%	31.0%
	Skid trails	61.2%	69.0%
	Total	1,033	1,272
Approaches entering wetland to harvest timber	Roads	22.5%	20.8%
	Skid trails	77.5%	79.2%
	Total	80	96
Total of all approaches	Roads	37.6%	30.3%
	Skid trails	62.4%	69.7%
	Total	1,113	1,368

Monitoring found a smaller proportion of crossings on winter-only operations in 2004–06 than in 2000–02 (Table 25). This difference likely reflects normal variations in sampling.

Table 25 Percent of road and skid trail water and wetland crossings by season of operation

Season of Operation	Road and Skid Trail Crossings 2000–02	Road and Skid Trail Crossings 2004–06
Spring	0.4%	0.2%
Summer	5.7%	9.9%
Fall	6.6%	14.1%
Winter	66.7%	46.2%
Summer–fall	3.5%	7.3%
Fall–winter	4.7%	14.9%
Summer–fall–winter	8.0%	0%
Other multiple seasons	1.3%	4.0%
Year round	1.3%	0%
Unknown	1.8%	3.4%
Total	548	654

Most crossings did not involve the placement of fill (Table 26), limiting the potential for long-term damage.

Table 26 Crossing structures used on roads and skid trails

Structure Type	2000–02	2004–06
Frozen	37.3%	45.3%
Ice bridge	6.7%	2.0%
Corduroy or slash mat	6.0%	12.0%
Log or slash bundle	3.6%	0%
Culvert	3.2%	3.5%
Fill	2.3%	5.3%
Low-water ford	1.8%	2.3%
Wood mat	0.7%	0%
Dry	0.5%	0.8%
Not frozen	not recorded	27.3%
Bridge	0.2%	0.8%
Unknown or no crossing structure	37.7%	0.7%
Total*	563	737

* Totals exceed the 100% because operators used multiple structures on some crossings.

Rutting was a problem on 34.5% of the 605 crossings of NOWW, seeps and springs, and seasonal ponds. Most rutting of crossings was limited, and did not visibly disrupt the hydrologic function of the wetland (Table 27). Addressing how to restrict the damage to wetlands caused by ATV traffic using logging roads needs careful consideration by landowners/resource managers and logging contractors in their overall timber harvest planning.

Table 27 Condition of NOWW, seep and spring, and seasonal pond crossings (2004, 2005, 2006)

		Roads	Skid Trails	Total
Total number of NOWW, seep and spring, and seasonal pond crossings		184	421	605
Percent of rutting by category of extent	<2%	3.8%	3.8%	3.8%
	2<5%	2.2%	4.7%	3.9%
	5<10%	2.2%	7.9%	6.2%
	10<25%	2.7%	4.7%	4.1%
	≥25%	10.3%	19.3%	16.5%
Total percent of rutting		21.2%	40.4%	34.5%
Number of all crossings rutted		39	170	209
Number of all crossings that are rutted >300' or bisecting wetland		8	29	37
Number of crossings rutted >300' or bisecting wetland where rutting was not caused by logging		5	1	6

Selecting crossing locations where the approaches are nearly flat or have a minimal grade minimizes potential for erosion. Most approaches in both monitoring periods had a grade <5% (Table 28).

Table 28 Grade of approaches to road and skid trail crossings

Approach Grade	2000–02	2004–06
< 2%	49.1%	30.0%
3 < 5%	25.8%	50.6%
6 < 10%	14.6%	13.2%
11 < 15%	3.8%	4.9%
16 < 25%	1.2%	1.2%
> 26%	0.6%	0%
Unknown	4.9%	0.1%
Total	1,113	1,368

Data for 2004–06 identify where water diversion/erosion control practices were needed and what impact resulted from not applying them. Two-thirds of the approaches were judged by the monitoring contractors to be stable enough to not require water diversion/erosion control, based on no visible evidence of erosion (Table 29). Contributing factors include the high percentage of approaches with a grade <5% (Table 28) and the fact that approximately 84.3% were found to be more than 50% vegetated (visual estimate of vegetative cover) (Table 30).

Few approaches judged to be susceptible to erosion (diversion practices needed) had water diversion/erosion control practices in place (Table 29). Of the approaches that needed water diversion/erosion control practices, 34% showed evidence of eroding, and more than 20% had sediment reaching the wetland or waterbody. Erosion and sediment reaching a waterbody was a greater problem on roads than skid trails (Table 30).

These results reinforce the need to strongly emphasize the importance of water diversion/erosion control practices for wetland and water crossing approaches in training programs for loggers, natural resource professionals, and NIPF landowners. It also highlights the importance of including explicit language regarding these practices in contracts and improved project supervision to insure operators use effective practices on crossings and approaches.

Table 29 Water diversion practices for approaches to crossings and wetland entry

	2000–02	2004–06
Total number of approaches	1,113	1,368
Approaches diversion practices not needed	NA	918 (67.1%)
Approaches diversion practices needed	NA	450 (32.9%)
Approaches with diversion practices	6.9% of all approaches	30.9% of 450 (10.2% of all approaches)
Approaches without diversion practices	93.1% of all approaches	69.1% of 450 (89.8% of all approaches)

Table 30 Condition of approaches 2004–06

	Roads	Skid Trails	Total
Total number of approaches	415	953	1368
Approaches diversion practices not needed	65.8%	67.7%	67.1%
>50% vegetated	77.8%	87.1%	84.3%
Rutted	2.4%	6.7%	5.4%
Approaches diversion practices needed	142	308	450
Erosion evident (diversion practices needed)	64.1%	20.1%	34.0%
Sediment reaching waterbody (diversion practices needed)	41.5%	11.0%	20.7%

Soil Resources

The TH/FM guidelines attempt to limit negative impacts and encourage practices that maintain or enhance productivity. The two most significant timber harvest activities that can affect soil productivity are logging and hauling equipment traffic and the removal of biomass from a site.

Logging and hauling equipment traffic

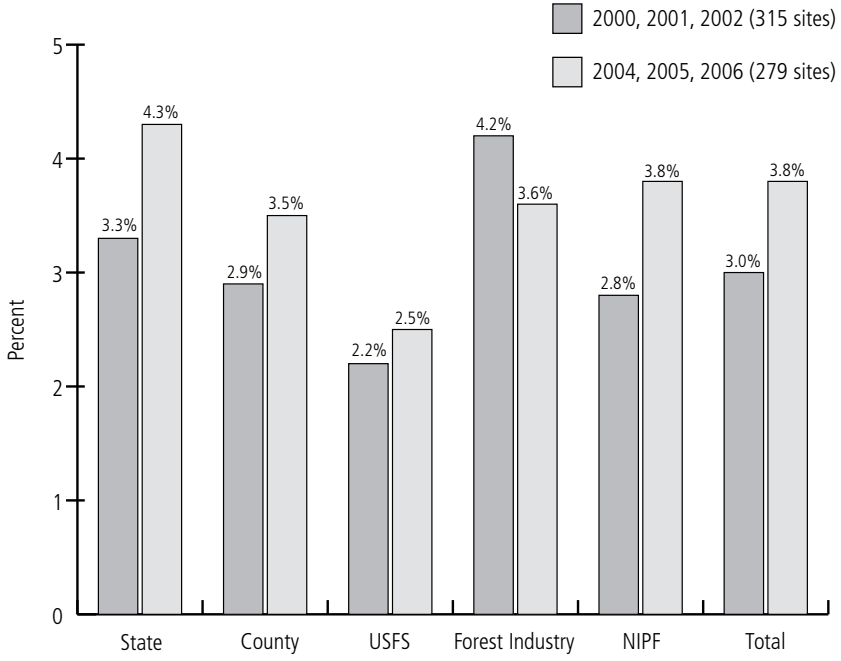
Equipment traffic can compact and rut soil, remove vegetation whose root systems hold the soil in place, reduce movement of air and water into and through the soil, and redirect surface water flow. These impacts restrict plant root growth, reduce the availability of nutrients and moisture for plant growth, increase the potential for erosion, and can change surface and subsurface hydrology.

Table 31 Percent of site with infrastructure <3% 2004-06

	% of Sites with Infrastructure <3%	Total Sites
State	45.1%	82
County	51.5%	68
Federal	75.0%	16
Forest industry	66.7%	33
NIPF	50.0%	80
Statewide	52.3%	279

The first step in minimizing impacts of traffic is to limit the affected area. The TH/FM guidelines recommend that basic infrastructure (roads and landings) occupy no more than 3% of the harvest area. Statewide 52.3% of the sites met the guideline (Table 31). The statewide average infrastructure increased 26.7%, from 3% of the site (2.2% landings and 0.8% roads) in 2000–02 to 3.8% (3% landings and 0.8% roads) in 2004–06. The largest increases were on NIPF and state lands (Figure 4).

Figure 4 Percent Infrastructure for Harvest Area by Ownership



Landings

The most prolonged and intense equipment activity on a harvest site is normally on the landings. This is where the harvested trees or logs are skidded for processing and loading, and where most equipment maintenance and fueling occurs. As a result, minimizing the area landings occupy, and locating landings away from wetlands and waterbodies and outside of filter strips and RMZs, is especially important.

Landings and associated fueling and maintenance areas were located outside filter strips, and RMZs, and wetlands on 75% of the sites in 2004-06, compared to 61% in 2000–02. This includes landings on several forested wetland harvest sites where no practical upland locations were available for landings.

Table 32 Landing location 2004–06

	On-Site	Off-Site	Total
Upland	53.1%	79.2%	55.3%
Wetland	28.5%	12.5%	27.1%
Within filter strip	18.3%	8.3%	17.5%
Within RMZ	0.1%	0	0.1%
Atop cultural resource	0	0	0
Total*	776	72	848
*Some landings impact more than one of the above			
	On-Site	Off-Site	Total
New landing	83.4%	5.5%	88.9%
Preexisting landing	6.1 %	5.0%	11.1%
Total	533	63	596
Landing location unknown			7

Landings were generally in fair to good condition. Nearly 63% were more than 50% vegetated, and 9.9% of the landings were rutted, but the rutting was < 5% for most. Ten percent of the landings had visible erosion. Fortunately, sediment reached a wetland or waterbody from only 1.3% of the landings. Only 10.6% of the landings had trash, with 60% of the trash from non-logging sources. The 2002 monitoring reported 26% of the landings had trash, with two-thirds from logging (Table 33).

Table 33 Landing condition

2002			2004–06
151	Number of landings		596
82.8%	>50% vegetated		62.6%
2.6%	Percent of landings rutted		9.9%
	Number of landings rutted	50	
NA	Number rutted ≤2%	31	
NA	Number rutted 2≤5%	9	
NA	Number rutted 5≤10%	7	
NA	Number rutted 10≤25%	1	
NA	Number rutted >25%	2	
NA	Number of landings rutting attributed to logging	47	
10.0%	Erosion evident		10.2%
0.7%	Sediment reaching waterbody		1.3%
17.2%	Logging trash		4.2%
8.8%	Other trash		6.4%

Forest roads

The TH/FM guidelines recommend limiting forest roads to the minimum necessary to accomplish the landowner's management objectives. The guidelines also recommend careful location, design, construction, maintenance, and closure of forest roads as a means of reducing costs and improving operability, and limiting the area disturbed to minimize erosion.

Forest roads occupied an average of 0.8% of the harvest area for 2004–06 (ranging from 1.0% for FI land to 0.6% for county lands). These data only account for the acreage in roads within the harvest site. They do not include the area of roads used to access the site, or roads adjacent to or crossing the site, but not used for the harvest operation monitored.

Access control is important for limiting the negative impacts of forest roads. Forest roads are frequently intended for temporary or seasonal use and have little traffic. As a result, they are constructed to a lesser standard than county and state highways. These roads can be easily damaged if they are used when soft and wet. Adequate access control limits such damage and reduces problems with erosion, rutting, and maintenance. The TH/FM guidelines recommend temporarily closing roads when conditions warrant, and permanently or temporarily closing roads when not in use.

A total of 229 roads were monitored on 210 sites. Sixty-nine of the 279 sites monitored did not have forest roads recorded. Some of these sites were located next to township or county roads or state highways. Roads were not monitored for other sites because traffic from other users made it impossible to determine the impact of the harvest activity. In addition, there were seven roads where the use of the road for timber harvest activity could not be determined. These were NIPF lands where the landowner declined to complete the landowner questionnaire, and the contractor was unable to determine the road status during the on-site inspection.

Access control on the sites monitored in 2004–06 increased over 2000–02. Gates or other means controlled access to 59% of the roads, compared to only 37% previously. Only 40% of the forest roads remained active after harvest was complete, compared to 50% in 2000–02 (Table 34, Table 35). In addition, 31% of the active roads had control structures, compared to less than 5% previously. Most of the active roads were all-season roads used for many activities. Forty-eight percent of the roads were temporarily closed, and access was controlled on 75% of these. The remaining 23 roads (10%) were identified as permanently closed, with access controlled 100% of the time.

Table 34 Road status (2000–02)

Access Control Status	Active	Temporarily closed	Permanently closed	Cannot Determine	Total
Controlled	4.8%	66.4%	86.7%	NA	37.1%
Not controlled	95.2%	33.6%	13.3%	NA	61.9%
Cannot determine	0	0	0	3	1.0%
Sites with roads	49.9%	38.8%	10.3%	1.0%	291
Sites with no roads					24

Table 35 Road status 2004–06

	Unknown	Active	Temporarily Closed	Permanently Closed	Total
Controlled	20.0%	30.8%	75.5%	100%	59.0%
Not controlled	40.0%	67.0%	21.8%	0	38.0%
Unknown	40.0%	2.2%	2.7%	0	3.0%
Total roads*	5	91	110	23	229
Sites with roads					190
Sites no roads recorded					89

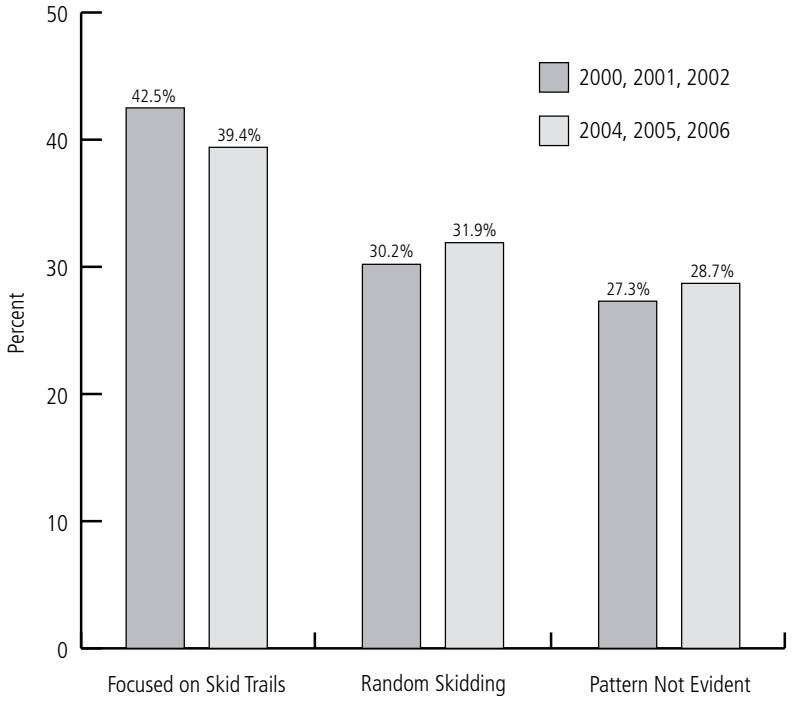
* Some sites had multiple roads.

Skid trails

The TH/FM guidelines recommend limiting skid trails to no more than 10% to 15% of the harvest area. While heavily trafficked skid trails are often easy to detect, identification of most skid trails is very difficult. As a result, it was not practical to determine the proportion of a site in skid trails. However, because skid equipment does cause to soil compaction and reduced site productivity, the monitoring contractors were instructed to identify the dominant skidding pattern for the harvest site.

The skidding patterns observed in 2004–06 were nearly the same as those reported previously. Skidding was focused on skid trails on 39% (42% previously) of the sites, and was either not evident or was randomly distributed lightly over most of the site on the other 61% (58% previously) of the sites (Figure 5).

Figure 5 Skidding Pattern



Road and skid trail segments

The BMPs in use before 1999 recommend using erosion control and water diversion practices in all locations associated with wetlands and waterbodies, such as approaches to crossings, where surface runoff and sediment might impact water quality. The TH/FM guidelines recommend using these practices on all roads and skid trails during construction, as long as the road exists, and after it is permanently closed until the site is revegetated and stabilized.

To facilitate monitoring implementation of erosion control and water diversion practices in locations not associated with wetlands or waterbodies monitoring contractors were instructed to evaluate portions of roads and skid trails with a grade >2%, identified in Tables 36 and 37 as segments. The TH/FM guidelines recommend landowners/resource managers and loggers use these practices during construction, as long as the road exists, and after it is permanently closed until the site is revegetated and stabilized. However, implementation monitoring can only collect data for practices in place after the harvest activity is complete.

A total of 553 road and skid trail segments were identified. The TH/FM guideline recommend avoiding road grades in excess of 10%, and skid trail grades in excess of 15%, whenever practical. More than 86% (86% previously) of the road segments and 82% (60% previously) of the skid trail segments met these recommendations (Table 36, Table 37).

Just 8% of road segments and 10% of skid trail segments were judged stable enough to not require water diversion and erosion control (Table 39), much lower then the 67% for approaches (Table 30). Monitoring in the 2000-02 period only recorded whether diversion and erosion control practices were installed. The option to record “not needed” was added in 2004.

Approximately 33% (14% previously) of the 115 road segments had one or more water diversion and erosion control practices in place, as did 35% (46% previously) of the 438 skid trail segments (Table 38, Table 39).

Table 36 Segment grade (2000–02)

Segment Grade	Number of Segments		
	Roads	Skid Trails	Total
2 to ≤ 5%	35.4%	7.0%	149
6 to ≤ 10%	50.2%	53.3%	493
11 to ≤ 15%	12.5%		
16 to ≤ 25	1.6%	26.1%	151
> 25%	0		
Unknown	0.3%	12.2%	69
Rock outcrops	0	1.4%	8
Total	311	559	870

Table 37 Segment grade (2004–06)

	Roads	Skid Trails	Total
2 to ≤5%	41.7%	31.9%	188
6 to ≤10%	45.2%	30.6%	186
11 to ≤15%	12.2%	20.3%	103
16 to ≤25%	0.9%	15.1%	67
>25%	0	2.1%	9
Rock	0	0	0
Unknown	0	0	0
Total	115	438	553

Approximately 29% (35% previously) of the road segments were more than 50% vegetated, and fewer than 7% (0% previously) were rutted. Sixty-two percent (47% previously) of skid trail segments were more than 50% vegetated, and 10% (5.5% previously) were rutted (Table 40, Table 41).

Nearly 69% (<59% previously) of the road segments showed evidence of eroding, but only 4% (11.6% previously) had sediment reaching a wetland or waterbody (Table 40, Table 41). More than 30% (2.3% previously) of the skid trails segments showed evidence of erosion, while only 0.5% (0.8% previously) had sediment reaching a wetland or waterbody. The increase in skid trail segments with erosion did not result in a corresponding increase in sediment reaching a wetland or waterbody because segments are located away from waterbodies, primarily outside filter strips and RMZs.

Table 38 Water diversion/erosion control structures on road and skid trail segments (2001–02)

Structure Type	Number of Segments Each Type of Structure was Used		
	Roads	Skid Trails	Total
Number of segments with structures	14.1%	46.4%	37.2%
Number of segments with no structures	85.9%	53.6%	62.8%
Total segments	156	390	546

Table 39 Segment diversion practices 2004–06

	Roads	Skid Trails	Total
Segments with diversion practices	33.1%	34.2%	34.4%
Segments with no diversion practices	59.1%	55.8%	56.4%
Segments—diversion practices not needed	7.8%	1.0%	9.2%
Total number of segments	115	438	553

Table 40 Condition of segments 2002

	Roads	Skid Trails	Total
Total number of segments	69	128	197
Diversions used	23.2%	50.7%	41.1%
>50% vegetated	34.7%	46.9%	42.6%
Rutted	0	5.5%	3.6%
Erosion evident	59.4%	2.3%	22.3%
Sediment reaching waterbody	11.6%	0.8%	4.6%

Table 41 Condition of segments 2004–06

	Roads	Skid Trails	Total
Total number of segments	115	438	553
Diversion/erosion control not needed	7.8%	9.6%	9.2%
>50% vegetated (all segments)	28.7%	61.6%	54.8%
Rutted (all segments)	7.0%	10.0%	9.4%
Erosion evident (all segments)	68.7%	30.1%	38.2%
Sediment reaching waterbody (all segments)	4.3%	0.5%	1.3%
Approaches diversion practices needed	106	396	502
Erosion evident (diversion practices needed)	74.5%	33.3%	42.0%
Sediment reaching waterbody (diversion practices needed)	4.7%	0.5%	1.4%

Rutting

Rutting occurs when tires or tracks of equipment create depressions because soil is not strong enough to support the load applied by the vehicles. Rutting modifies surface hydrology, damages roots, compacts the soil, and plugs soil pores. This can inhibit root growth, reduce aeration, and slow or disrupt movement of water into and through the soil.

In 2000, the presence or absence of rutting 6 inches deep or deeper was noted for wetlands, filter strips, RMZs, roads, and skid trails. The presence of rutting was also noted for the general harvest area if rutting exceeded 5% of the surface area. This latter criterion was changed to 2% for 2001. Since 2002 monitoring has identified six ranges of percent rutting (none, <2%, 2<5%, 5<10%, 10<25%, >25%) for wetlands, filter strips, RMZs, upland harvest areas, wetland harvest areas, waterbody crossings, approaches to crossings, road and skid trail segments, and the general road and skid trail system observed on each site. For each occurrence the contractor visually estimated and recorded the range of rutting observed (none, <2%, 2<5%, 5<10%, 10<25%, >25%). The contractor also recorded whether the rutting was related to logging.

The TH/FM guidelines recommend minimizing rutting on the roads, skid trails and landings, and avoiding rutting in the harvest area. We found rutting on 55.2% (57.3% previously) of the sites (Table 42). Rutting was confined to roads, skid trails, and landings on 88.7% (98.5% previously) of the sites. These sites meet the guideline for restricting equipment impacts to the site infrastructure, but may depart from other guidelines due to erosion and sedimentation. The numbers of sites where we found rutting for specific site features is given in Figures 6 and 7.

Figure 6 Locations Where Rutting was Observed 2000, 2001, 2002

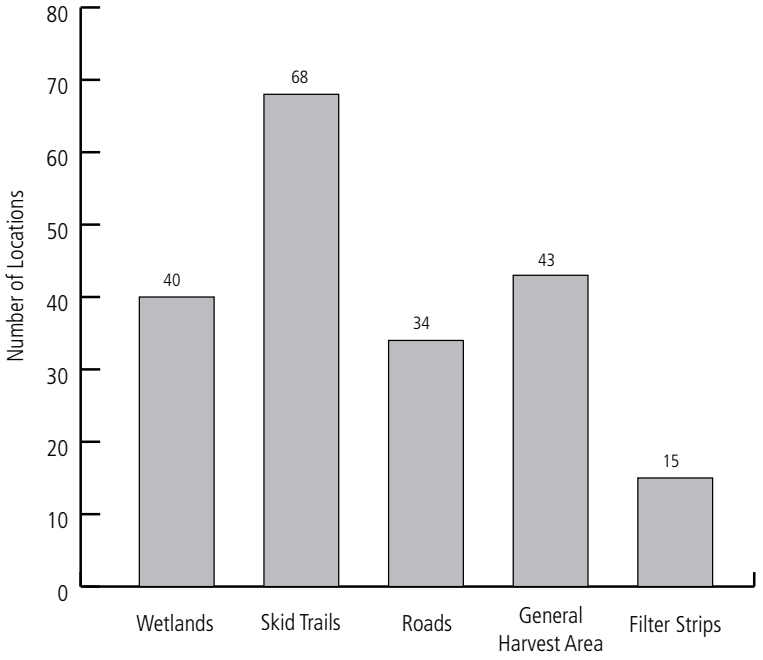
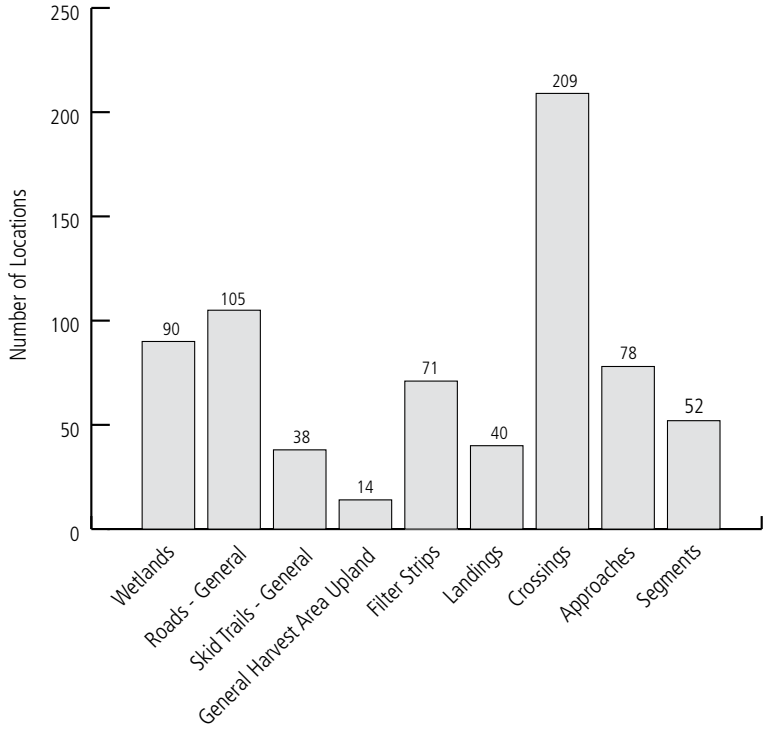


Figure 7 Locations Where Rutting was Observed 2004, 2005, 2006



Sixty-four percent of the locations (78% previously) where rutting was observed had less than 5% of their surface area in ruts (Table 42).

Rutting occurred in roughly the same proportion for all seasons of timber harvest (Figure 8, Figure 9) in 2004–06 and the previous monitoring period.

Table 42 Locations rutted

		2002	2004–06
Number of sites with rutting		51 of 89	154 of 279
Number of locations evaluated for rutting		2,257	6,147
Number of locations rutting was observed		136	697
Percent of rutting by category of extent for locations with ruts	≤2%	52.9%	35.2%
	2≤5%	25.0%	28.8%
	5≤10%	5.9%	12.3%
	10≤25%	9.6%	8.5%
	>25%	6.6%	18.7%
Total percent of locations rutted		6.0%	11.3%
Percent of all rutting on infrastructure		98.5%	88.7%
Percent of all rutting not from logging		NA	5.7%
Percent of locations not rutted		94.0%	88.7%
Percent of sites not rutted		42.7%	44.8%

Figure 8 Season of Harvest vs. Rutting (2000, 2001, 2002)

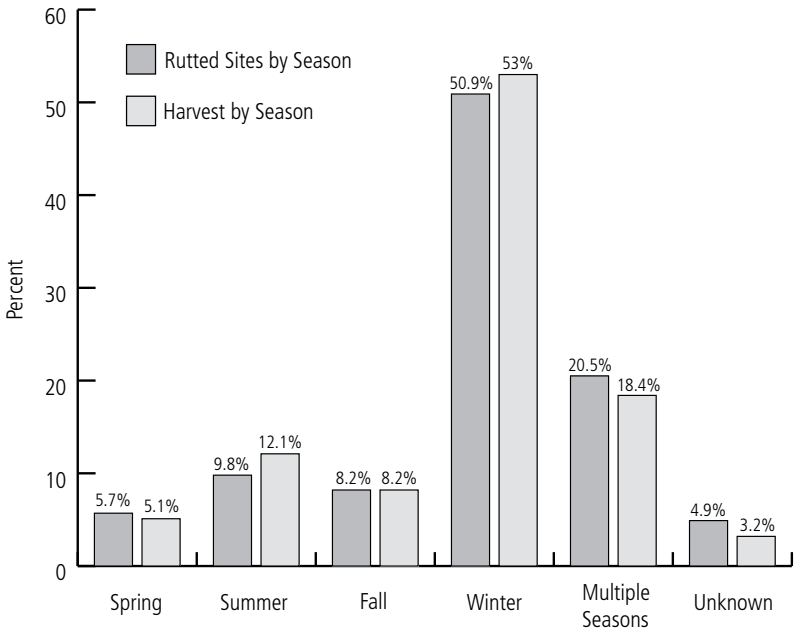
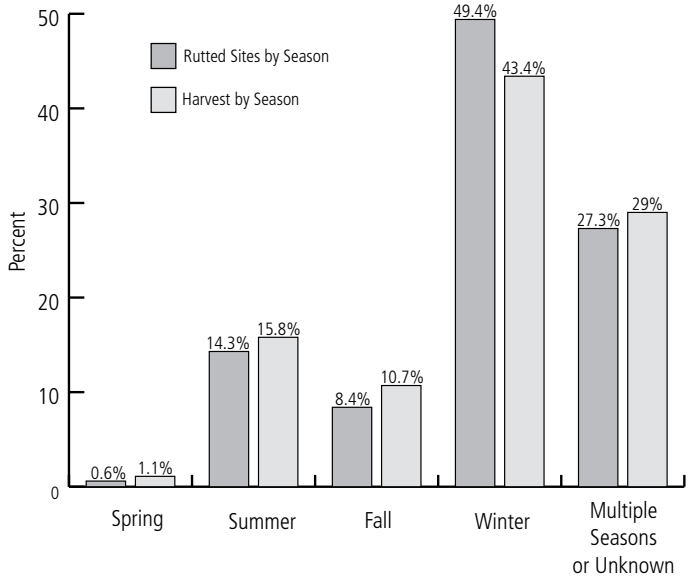


Figure 9 Season of Harvest vs. Rutting (2004, 2005, 2006)

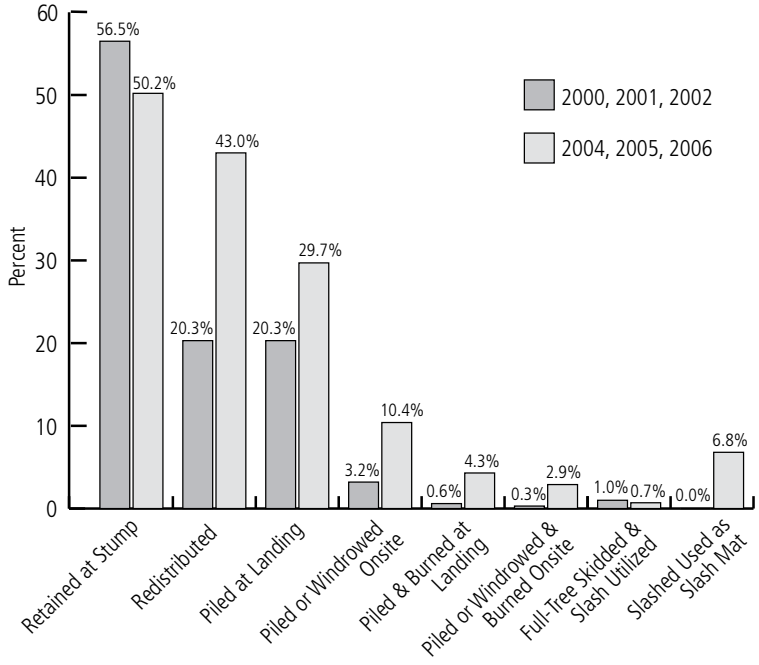


Slash disposal and distribution

Retaining or redistributing slash on the site helps keep nutrients on the site. This is particularly important for nutrient-poor sites with soils that are: 1) predominantly deep, well drained, or excessively well-drained sand; 2) predominantly deep organic; or 3) predominantly shallow soils over bedrock. Slash also provides cover, food, and growing sites for plants and animals. The positive benefits to retaining or redistributing slash on the site must be balanced with the need to safely and efficiently operate equipment on the site, to regenerate the stand, and to minimize the potential for additional compaction that might occur from redistributing the slash.

Slash retained on the site at the stump was the most common method use and was applied on 50% (59% previously) of the sites (Figure 10). This is the preferred method of slash disposal for maintaining forest soil productivity on most sites. Operators redistributed slash back onto the site more frequently in 2004–06 than previously (43% compared to 20%). This reflects a shift to more mechanized delimbing at the landing. There is some concern that this practice results in extra compaction and poor distribution of the slash, limiting regeneration.

Figure 10 Slash Management*



* Note that up to three options were recorded for each site, reflecting different silvicultural practices and harvest equipment utilized for some species on a site.

Wildlife Habitat

Coarse woody debris

Coarse woody debris (CWD) provides important habitat for forest animals and plants. The TH/FM guidelines recommend creating or retaining two to five bark-on down logs per acre for the general harvest area and at least four bark-on down logs per acre for riparian areas. The guidelines also note that hollow butt sections or other defective lengths of at least 6 feet are preferred, and that sound logs and 6- to 12-inch diameter logs can be used if they are the best available candidates. Logs on the ground prior to a timber harvest and slash generated by logging are both sources of CWD.

Phillips (2001) reported that only 21% and 22% of general harvest areas and riparian management zones, respectively, met the guideline recommendation for bark-on down logs in 2000. Phillips suggested that for many of these logs the bark had sloughed off by the time the inspections were conducted. The intent of the "bark-on down logs" recommendation was to ensure that logs would serve as functional habitat until the regenerating stand began to provide replacements. For this reason the working definition for CWD was modified by DNR monitoring staff from "bark-on down logs" to logs greater than 6 inches in diameter at the small end and at least 6 feet long, that fall into categories 1 and 2 of the decay classes (Table 43) described by Harmon et al. (1986).

General harvest areas met the guideline of two or more "sound" down logs per acre 75% of the time in 2004–06 (79% previously) (Table 44). Thirty-seven of the 85 RMZs identified in 2004–06 were entirely nonforested or had no harvest activity. Only 18.8% (47.3% previously) of the RMZs that did have harvest activity met the CWD guideline of 4 sound logs per acre. Data from 2000-01 found that undisturbed forested RMZs did not meet the CWD guideline any more often than the RMZs that did have harvest activity.

Table 43 Decay class visual indicators (Harmon et al., 1986)

	Hollow	Solid
1	bark intact part or all of heartwood gone bole possibly broken on impact	bark intact solid through to center unbroken bole
2	bark part or totally gone inner/outer sapwood colonized some fragmentation remaining heartwood colonized	bark part or totally gone outer sapwood only colonized bole still solid
3	color change in wood complete sapwood completely colonized log x-section becoming elliptical extensive fragmentation little remaining heartwood	color change in sapwood sapwood mostly colonized heartwood being colonized bole still intact form
4	pile of well colonized fragments possibly merges with class 5	bole starting to collapse decay well into heartwood
5	pile of well decayed fragments	completely collapsed well integrated into humus

Table 44 CWD - general harvest area and RMZs

General Harvest Area				
	Number of Sites	<2/Ac	2 to 5/Ac	>5/Ac
2000–02	204	20.6%	40.7%	38.7%
2004–06	279	24.7%	35.1%	40.1%
RMZs				
	Number of RMZs	RMZs with Harvest Activity	<4/Ac	>4/Ac
2000–02	93	68.8%	21.5%	47.3%
2004–06	85	62.1%	44.7%	18.8%

Leave-tree distribution

The TH/FM guidelines recommend retaining mature, live trees on clear-cut timber harvests to provide vertical structure for wildlife as the stand regenerates. The guidelines provide two options for meeting the leave-tree recommendations: 1) retain six or more scattered individual trees per acre on the harvest area, or 2) retain at least 5% of a clear-cut harvest area in leave-tree clumps of at least ¼-acre. In both cases the trees must be at least 6 inches in diameter and a mix of desirable species. The preferred alternative is to retain clumps.

Leave-tree clumps are most frequently located on-site; however, areas adjacent to a clear-cut may be considered in evaluating leave-tree acreage. Adjacent clumps of mature trees are counted as leave-tree clumps if they are located between the site and an adjacent RMZ, wetland, or previously harvested area, and the leave-tree clump could not be large enough to be commercially manageable by itself.

The leave-tree guidelines were fully met by either scattered leave trees or clumps on 47.3% (61.3% previously) harvest areas of the 266 sites where the guidelines apply (Table 45).

Table 45 Number of sites that met or exceeded the guideline recommendations for leave-tree clumps and/or scattered individual leave trees

	Number of Sites for Which Recommendations Apply	Sites With ≥6 Scattered Leave Trees/ Acre	Sites With ≥5% of Site in Leave-Tree Clumps	Sites With ≥6 Scattered Leave Trees/ Acre & or ≥5% of Site in Leave-Tree Clumps
2000–02	293	48.8%	31.4%	61.3%
2004–06	266	40.9%	12.5%	47.3%

Table 46 Scattered leave trees and clumps on harvest sites 2004–06

	Leave-Tree Distribution	Percent of Sites
NA—Harvest activity was a thinning		4.7%
No leave trees		1.8%
Clumps only	<5% clumps	0.7%
	>5% clumps	0.3%
Scatter leave trees only	<1/Ac	10.8%
	1< 5/Ac	25.4%
	6 < 12/Ac	15.4%
	>12/AC	12.2%
Scattered leave trees and clumps	<5% clumps & <1/Ac	2.2%
	>5% clumps & <1/Ac	2.5%
	<5% clumps & 1< 5/Ac	7.1%
	>5% clumps & 1< 5/Ac	3.6%
	<5% clumps & 6 < 12/Ac	4.3%
	>5% clumps & 6 < 12/Ac	3.6%
	<5% clumps & >12/Ac	2.9%
	>5% clumps & >12/Ac	2.5%
Total number of sites		279

An additional 14.3% of the sites had both scattered leave trees and leave-tree clumps, each below the guideline (Table 46). Some of these likely met the intent of the guideline if the two were considered in combination. Future monitoring should attempt to assess this situation for consideration during the next guideline revisions. Only five sites where the leave-tree guidelines should have been applied had no leave trees at all.

Snag distribution

Snags provide habitat for wildlife requiring tree cavities, perches, and bark foraging sites. For monitoring purposes a snag was defined as a dead tree stem standing at least 8 feet tall and 6 inches DBH. The TH/FM guidelines do not recommend specific numbers or distribution of snags. For evaluation purposes, snags were grouped into four categories: 0, <1, 1–2, and >2 per acre. Nearly all of the sites (94% in 2001–02 and 97% in 2004–06) retained some snags. Seventy-three percent of the sites (72% previously) retained at least one snag per acre, and 54.1% (36.6% previously) had more than two (Table 47).

Table 47 Snag retention on timber harvest sites

	Total Number of Sites	Snags/acre			
		0	< 1	1-2	> 2
2001–02	175	7.4%	20.6%	35.4%	36.6%
2004–06	279	3.2%	23.7%	19.0%	54.1%

Conclusions and Recommendations

Implementation of the TH/FM guidelines was generally good, however, several areas need improvement. Improvements should be addressed through additional training, better planning, and improved communications between landowners/resource managers and loggers. Some work is also needed on improving monitoring protocols, site selection, and visual sensitivity rating information.

NIPF Sampling

The goal of the TH/FM guideline implementation monitoring program has been to select sites stratified in proportion to the annual volume of timber harvested from state, county, federal, FI, and NIPF forestlands. Obtaining an adequate number of NIPF sites continues to be a problem. The result has been that NIPF sites were monitored less intensively than other ownerships relative to the volume of timber harvested. Sampling design will be reviewed carefully in advance of the next monitoring effort to address this issue.

Commitment to Guideline Implementation

The Council set a goal in 2001 for all public agency, FI, and professionally assisted NIPF timber sales that a discussion of guideline application between the landowner and logging contractor take place a minimum of 75% of the time during preharvest planning. Public agency and FI landowners exceeded the Council's goal, but NIPF landowners were well below the Council target. Emphasizing the importance of incorporating the TH/FM guidelines into management plans and timber harvest agreements through private forest management education and assistance programs is important to achieving the Council goals.

Visual Quality

The visual quality guidelines were met in the majority of cases. Landowner/resource manager awareness of the visual quality guidelines was limited. This may be due to lack of knowledge of where to find the visual sensitivity ratings maps. The Web address for the visual sensitivity maps should be highlighted in guideline training.

Landowner/resource manager awareness may also be limited because the visual sensitivity maps do not clearly identify the visual sensitivity rating for all rivers, streams, lakes, and recreational facilities. Revising the maps for roads and the text for rivers, streams, lakes, and recreational facilities would be helpful.

Cultural Resources and ETS Species

Appropriate practices were implemented for all the cultural resources and ETS identified on the sites monitored. The proportion of state, federal, and FI resource managers that reported checking records for cultural/historic resources and ETS species was good, but low for county and NIPF lands. Additional training is desirable to increase the awareness of the importance of checking records for cultural/historic and ETS resources for all landowners/resource managers, particularly NIPF landowners, county land departments, consulting foresters, and logging contractors.

Filter Strip Application

The filter strip guidelines were implemented very well. The guideline recommending limiting filter strip disturbance to <5% dispersed evenly over the filter strip was met more than 95.9% of the time for 2004–06, an improvement over the 72.8% reported for 2001–02. In addition, roads, skid trails, and landings were located outside of filter strips more than 85% of the time. The result was that no erosion was observed in 98% of the filter strips, and more than 99% of the time no sediment was reaching the adjoining waterbody.

Riparian Management Zones

Compliance with the recommended RMZ guidelines for width and BA decreased between the two monitoring periods, 51.9% for 2004–06 versus 64.2% for 2000–02.

Many of the on-site RMZs that did not meet the guidelines were OWW less than 1 acre or streams less than 3 feet wide for which no RMZ had been identified. Landowners/resource managers and operators may not have been aware of the existence these small waterbodies because of snow cover.

Waterbodies adjacent to the harvest area were more likely than waterbodies in the harvest area to have an RMZ that fully met the guidelines. RMZ compliance clearly needs improvement, particularly for waterbodies within harvest areas.

The decline in full compliance may be real or due to normal variation in sampling. It may also reflect a need to improve the field evaluation definitions and assessment procedures. We currently measure RMZ composition on a single representative cross section. A number of the RMZs very nearly met the guidelines, but fell a few feet short of the average recommended width. Further evaluation of RMZ issues is recommended to help determine the appropriate actions to improve RMZ guideline implementation.

Crossings

Most crossings for both monitoring periods were on NOWW. Most crossings did not involve the placement of fill. Rutting was a problem on 34.5% of the 605 crossings of NOWW, seeps and springs, and seasonal ponds. Most rutting of crossings was limited, and did not visibly disrupt the hydrologic function of the wetland.

Training programs should highlight the need to reduce rutting of wetland and water crossings to protect wetlands and water quality. Landowners/resource managers and logging contractors also need to address how to restrict the damage to wetlands caused by ATV traffic using logging roads needs. This issue should receive careful consideration in overall timber harvest planning and design.

Approaches

Two-thirds of the approaches were judged by the monitoring contractors to be stable enough to not require water diversion/erosion control, based on no visible evidence of erosion.

Only 30.9% of the approaches judged to be susceptible to erosion had water diversion/erosion control practices in place. Of these approaches, 34% showed evidence of eroding, and more than 20% had sediment reaching the wetland or waterbody.

These results reinforce the need to strongly emphasize the importance of water diversion/erosion control practices for wetland and water crossing approaches in training programs for loggers, natural resource professionals, and NIPF landowners. It also highlights the importance of including explicit language regarding these practices in contracts and improved project supervision to insure operators use effective practices on crossings and approaches before, during, and after timber harvest.

Roads and Landings

The TH/FM guidelines recommend that basic infrastructure (roads and landings) occupy no more than 3% of the harvest area. Statewide, 52.3% of the sites met the guideline. The statewide average infrastructure increased 26.7%, from 3% of the site (2.2% landings and 0.8% roads) in 2000–02 to 3.8% (3% landings and 0.8% roads) in 2004–06. The increase in the area used for landings may be due to many factors, including differences in weather, changes in combinations of harvest equipment, market fluctuations, and availability of trucking.

Future training for landowners/resource managers and timber purchasers/loggers needs to strongly emphasize the importance of limiting infrastructure more effectively.

Landings

Landings were generally in fair to good condition. Landings and associated fueling and maintenance areas were located outside filter strips, RMZs, and wetlands on 75% of the sites in 2004–06, compared to 61% in 2000–02. The 25% of landings that were not located outside of filter strips, RMZs, and wetlands includes landings on several forested wetland harvest sites where no practical upland locations were available for landings. Nearly 63% of the landings monitored were more than 50% vegetated, and 90.1% of the landings were not rutted. Ten percent of the landings had visible erosion. Fortunately, sediment reached a wetland or waterbody from only 1.3% of the landings. Only 10.6% of the landings had trash, with 60% of the trash from nonlogging sources. The 2002 monitoring reported 26% of the landings had trash, with two-thirds from logging.

Future training for landowners/resource managers and timber purchasers/loggers needs to strongly emphasize the importance of locating landings and fueling and maintenance areas in upland areas outside filter strips and RMZs to limit potential impacts to waterbodies.

Forest Roads and Skid Trails

Forest logging roads and skid trails were in good shape with the exception of problems discussed in other sections for waterbody crossings, approaches to crossings, and road segments.

The use of gates or other means of controlling access on roads improved compared to the previous monitoring report. Access control was in place on 75% of temporarily closed roads and 100% on permanently closed roads, as well as on nearly 31% of the roads still in active use.

Skidding was focused on skid trails on 39% (42% previously) of the sites, and was either not evident or was randomly distributed lightly over most of the site on the other 61% (58% previously) of the sites.

The TH/FM guidelines recommend limiting skid trails to no more than 10% to 15% of the harvest area, and limiting off-trail traffic to less than 30% of the site. Because changes in harvest practices (e.g., full-tree harvest with redistribution of slash and biomass harvesting) and equipment (e.g., cut-to-length harvest systems) may render the guideline outdated, these guidelines should be re-visited.

Road and Skid Trail Segments

The TH/FM guidelines recommend avoiding road grades in excess of 10%, and skid trail grades in excess of 15%, whenever practical. More than 86% (86% previously) of the road segments and 82% (60% previously) of the skid trail segments met these recommendations.

Just 8% of road segments and 10% of skid trail segments were judged stable enough to not require water diversion and erosion control, much lower then the 67% for approaches.

Approximately 33% (14% previously) of the road segments had one or more water diversion and erosion control practices in place, as did 35% (46% previously) of the skid trail segments.

Nearly 69% (<59% previously) of the road segments showed evidence of eroding, but only 4% (11.6% previously) had sediment reaching a wetland or waterbody.

More than 30% (2.3% previously) of the skid trails segments showed evidence of erosion, while only 0.5% (0.8% previously) had sediment reaching a wetland or waterbody. The increase in skid trail segments with erosion did not result in a corresponding increase in sediment reaching a wetland or waterbody because segments are located away from waterbodies, primarily outside of filter strips and RMZs.

The increase in evidence of erosion and the limited application of effective erosion control and water diversion practices is a cause of concern that has been addressed and will continue to be addressed in training programs for loggers and natural resource managers.

Rutting

Overall rutting was a minor problem. The guidelines recommend minimizing rutting, and restricting traffic to roads, skid trails, and landings as much as practical. Nearly 45% of the 279 sites had no rutting, and only 11.3% of the 6,147 locations evaluated for rutting were rutted. In addition, 64% of the locations where rutting was observed had less than 5% of the surface area in ruts, and rutting was confined to infrastructure roads, skid trails, and landings on 88.7% of the sites.

Training programs should emphasize that landowners/resource managers and loggers need to be prepared to address the potential for rutting regardless of season. Rutting occurred in roughly the same proportion for all seasons of timber harvest. Landowners/resource managers and loggers need to ensure that the soil is dry and firm or adequately frozen to support harvest operations, strengthen traffic surfaces when that is not possible, or stop operations until conditions improve.

Slash Disposal and Distribution

Operators redistributed slash back onto the site more frequently in 2004–06 than previously (43% compared to 20%). This reflects a shift to more mechanized delimbing at the landing. There is some concern that this practice results in extra compaction and poor distribution of the slash, limiting regeneration. Targeted research should be undertaken to assess the impacts of different slash utilization, disposal and distribution practices to aid making informed revisions to the guidelines, monitoring protocols, and training curricula.

CWD, Leave-Tree, and Snag Distribution

Implementation of the guidelines was good for CWD, but only fair for leave trees and snags. General harvest areas met the guideline of two or more "sound" down logs per acre 75% of the time in 2004–06 (79% in 2001–02). Only 18.8% (47.3% previously) of the RMZs that did have harvest activity met the CWD guideline. Limited data from 2000 found that undisturbed forested RMZs did not meet the CWD guideline any more often than the RMZs that did have harvest activity. Consideration may need to be given to requiring placement of additional logs to meet the CWD guideline on some sites, or to revising the CWD guidelines based on additional research. Research should be undertaken to assess CWD in conjunction with studies of slash utilization, disposal, and distribution.

The leave-tree guidelines were fully met by either scattered leave trees or clumps on 47.3% (61.3% previously) of the 266 sites where the guideline applied. An additional 14.3% of the sites had both scattered leave trees and leave-tree clumps, each below the guideline. Some of these likely met the intent of the guideline if the two were considered in combination. Monitoring will be modified to assess this in the future.

Seventy-three percent of the sites (72% previously) retained at least one snag per acre, and 54.1% (36.6% previously) had more than two.

Training programs need to encourage landowners/resource managers to give greater attention to CWD, leave trees, and snags, particularly within RMZs and on biomass harvest sites.

Glossary

Adjacent: Outside the harvest area boundary, but within the recommended filter strip width (for waterbodies that only require a filter strip), or within 1½ times the recommended RMZ width (for waterbodies that require an RMZ).

Apparent harvest size: The portion of a site visible from a visually sensitive travel route or vista.

Approach: The portion of a trail or road immediately leading into a wetland or onto the crossing of a wetland or waterbody, from the edge of the waterbody or wetland to the point where a turn or naturally occurring break would divert water off the road or trail. This may be to the outer (landward) edge of the filter strip or RMZ for the wetland or waterbody, but often extends farther upslope.

Basal area (BA): The cross-sectional area of a live tree 4½ feet above ground. Basal area may be measured in square feet per tree or square feet per acre.

Best Management Practice (BMP): For water quality and wetland protection a BMP is a practice determined by a state or a designated planning agency to be the most effective and practical means of controlling point or non-point source pollution. For visual quality a BMP is a practice determined to be effective and practical for limiting negative impacts of forest management activities perceived by the traveling public. In this publication the term refers to the BMPs in Protecting Water Quality and Wetlands in Forest Management (Minnesota Department of Natural Resources 1995) and in Visual Quality Best Management Practices for Forest Management in Minnesota (Minnesota Department of Natural Resources 1994).

Clear-cutting: A regeneration or timber harvest method that removes essentially all trees in a stand in one operation.

Coarse woody debris: Stumps and fallen trunks or limbs more than 6 inches in diameter at the large end.

Cultural resource: An archaeological site, cemetery, historic structure, historic area, or traditional-use area of cultural or scientific value.

Culvert: A metal, wooden, plastic, or concrete conduit through which water can flow.

Endangered species: A species threatened with extinction throughout all or a significant portion of its range.

ETS species: Endangered, threatened, and special concern species (see individual definitions).

Even-age management: A planned sequence of treatments designed to maintain and regenerate a stand of trees with on or two age classes. The range of trees ages is usually less that 20% of the rotation age.

Felling: The process of severing trees from stumps.

Filter strip: An area of land adjacent to a waterbody that traps and filters out suspended sediment and chemicals attached to sediment so they do not reach the surface water. Harvesting and other forest management activities are permitted in a filter strip as long as the integrity of the filter strip is maintained and mineral soil exposure is kept to a minimum.

Forest management: The deliberate manipulation of the forest stand to achieve a variety of desired outcomes or management objectives over an extended period of time.

Guidelines: A specific practice or combination of practices designed, when applied on-site, to protect specified functions and values.

Harvest area: The portion of a site from which timber is harvested.

Ice bridge: A temporary bridge constructed from snow and ice, used to cross an area during winter.

Implementation monitoring: The process of identifying and recording the combination of guidelines applied to protect specific resource functions and values on a site where a timber harvest or other forest management activity is conducted.

Infrastructure: The network of access roads, trails, and landings used to move equipment onto and around a forest management site.

Intermittent stream: A stream with a well-defined channel, banks, and beds that flows only certain times of the year, when it receives water primarily from runoff or snowmelt. During dry years, intermittent streams may cease to flow entirely or may be reduced to a series of separate pools.

Landing: A place where trees and logs are gathered in or near the forest for further processing or transport.

Leave trees: Live trees selected to remain on a forest management site to provide present and future benefits to wildlife, including shelter, resting sites, cavities, perches, nest sites, foraging sites, mast, and coarse woody debris.

Low-water ford: A place in a stream designated for vehicle crossing during low water flow.

Non-open-water wetland (NOWW): A wetland that generally does not have observable surface water. In the U.S. Fish and Wildlife Service wetland classification system, it includes type 1 (seasonal flooded basins), type 2 (inland fresh meadows), type 6 (shrub swamps), type 7 (wooded swamps), and type 8 (bogs) wetlands.

Off-site: Outside the harvest area boundary and more than the recommended filter-strip width (for waterbodies that only require a filter strip), or more than 1½ times the width of recommended RMZ (for waterbodies that require an RMZ).

On-site: Within the harvest area, the area where trees are harvested.

Open-water wetland (OWW): A wetland with shallow to deep open water generally having readily observable surface water. Water depth varies from a few inches to less than 10 feet. In the U.S. Fish and Wildlife Service wetland classification system, it includes type 3 (shallow marsh), type 4 (deep marsh), and type 5 (shallow open water) wetlands.

Perennial stream: A stream with well-defined channels, banks, and beds that exhibits essentially continuous flow. Perennial streams flow year round, but surface water may not be visible during extreme drought.

Permanent road: A forest road intended to be left in place for the long term.

Primary Sampling Unit (PSU): A stratified subsample of the state (e.g., two townships) in which timber harvests are identified and added to the pool of potential monitoring sites.

Primary skid trail: An arterial route used by skidders or forwarders to haul trees and logs to the landing. Primary skid trails are heavily traveled routes fed by a system of secondary skid trails of less frequent travel. Primary skid trails are typically traversed 10 or more times by heavy equipment.

Riparian area: The area of land and water forming a transition from aquatic to terrestrial ecosystems along streams, lakes, and OWWs.

Riparian management zone (RMZ): The portion of a riparian area where site conditions and landowner objectives are used to determine management activities that address riparian resource needs. It is the area where riparian guidelines apply. See the TH/FM guidebook for specifics on recommended RMZ widths and management.

Rutting: The creation of linear depressions by the tires or tracks of vehicles, usually under wet conditions.

Seasonal pond: A small depressional wetland in which water collects during wet periods of the year, typically in the spring and fall; it may be dry during other periods. Seasonal wetlands often exhibit characteristics of U.S. Fish and Wildlife Service wetland classification system types 1, 3, 6, and 7 wetlands. Seasonal pond characteristics may include: 1) ponded water or evidence of recent standing water (blackened organic matter); 2) an identifiable edge due to earlier ponded water or local topography; 3) typically less than ½ acre in size; 4) the presence of black ash; 5) minor presence of woody shrubs, such as alder, along the edges; 6) the presence of tussocks; 7) the absence in many cases of persistent aquatic plants; and 8) typically fishless.

Seasonal road: A permanent road designed for long-term periodic use, such as during dry and frozen periods. Seasonal roads are built to lesser engineering standards and have minimal material surfacing.

Secondary skid trail: A skidding route used to haul felled trees or logs from the back portions of a site to the primary skid trails. Secondary skid trails branch out from a primary skid trail and are less heavily traveled. Secondary skid trails are traversed three to 10 times by heavy equipment.

Seep: A small wetland (often less than an acre) that occurs where groundwater comes to the surface. Seeps are often located on or at the base of hillside. Soils at these sites remain saturated for some or all of the growing season, and often remain unfrozen throughout the winter.

Silviculture: The art and science of controlling the establishment, growth, composition, health and quality of forests and woodlands to meet the diverse needs and values of landowners and society on a sustainable basis.

Skidding: The act of moving trees from the site of felling to a loading area or landing.

Slash: Residual woody material created by logging or timber stand improvement.

Snag: A standing dead tree.

Special concern species: A species that, although not endangered or threatened, is extremely uncommon in Minnesota or has unique or highly specific habitat requirements. Special concern species may include 1) species on the periphery of their range in Minnesota, but not listed as threatened or endangered; and 2) species that were once threatened or endangered but now have increasing, protected, or stable populations.

Spring: A small wetland where groundwater visibly flows to the surface, typically year round, and often creates a small stream.

Threatened species: A species likely to become endangered in the foreseeable future throughout all or a significant portion of its range.

Timber harvest: The felling, skidding, on-site processing, and loading of trees onto trucks.

Timberland: Land suitable for producing timber crops, not withdrawn from timber production by statute or administrative regulation, and capable of producing at least 20 cubic feet of timber per acre per year.

Uneven-age management: A planned sequence of treatments designed to maintain and regenerate a stand with three or more age classes. All age classes could be represented.

Vista: The location on a visually sensitive travel route or feature from which a timber harvest site is viewed when rating a site for implementation of visual quality guidelines.

Visual quality: A subjective measure of the impact that viewing an object, landscape, or activity has on a person's perception of attractiveness.

Wetlands: Lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or where the land is covered by shallow water. Wetlands must have the following three characteristics: 1) a predominance of hydric soils (soils that result from wet conditions), 2) inundation or saturation by surface water or groundwater at a frequency and duration sufficient to support a prevalence of hydrophytic vegetation (plants adapted to wet conditions), and 3) under normal conditions, a prevalence of hydrophytic vegetation.

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