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

2009 Monitoring Implementation Results

A report by the Minnesota Department of Natural Resources

Respectfully submitted to the Minnesota Forest Resources Council

Minnesota
DEPARTMENT OF NATURAL RESOURCES

Timber harvesting and Forest Management Guidelines on Public and Private Forest land in Minnesota

Monitoring for Implementation 2009

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Executive Summary

The Minnesota Forest Resource Council document, *Sustaining Minnesota Forest Resources: Voluntary Site-Level Forest Management Guidelines for Landowners, Loggers and Resource Managers,* establishes the best management practices for timber harvesting and forest management (TH/FM) on all forested lands in Minnesota. Implementation monitoring of these TH/FM guidelines has been conducted on public and private forestlands since 2000. This report provides results for monitoring which occurred in 2009 and attempts to assess trends in implementation levels over time.

In 2009, 88 sites were randomly selected from timber harvests that occurred during 2007-2008 and evaluated for guideline implementation. The distribution of sites among the primary ownership categories was in proportion to the volume of timber harvested from each. The forest land ownership categories are state, federal, county, forest industry, and non-industrial private (NIPF, including tribal lands, utilities, and non-profit organizations).

Overall implementation of the guidelines was similar to previous reports. The following is a brief listing of those guidelines which have had high levels of implementation and/or have shown improvement over all 3 monitoring periods, and those which have had low or declining levels.

TH/FM Guidelines Implementation - High

On all ownerships;

- Snag retention: has remained steady (80%) or slightly improved
- CWD: retaining two or more "sound" down logs per acre general harvest area was good (94%) and has improved
- Filter strip guidelines for width and limiting soil disturbance: has remained good (90%+)
- Access controls such as gates, rocks, and other practices: good (72%) and has improved
- Visual quality guidelines: was good for apparent harvest size (92%+), visibility of slash piles and windrows (100%), visibility of scattered slash on vistas classified as moderately sensitivity (100%), and visibility of landings on vistas classified as most sensitive sites (100%).
- Landings: the condition of landings has been good, no rutting (92%), no erosion (79%), and no sediment reaching a waterbody (100%).
- Steep grades: avoidance of steep grades on approaches and segments was good, 90%+ had a grade less than 10%

State, county, and federal agencies and forest industry reported implementation of the following has been good; a) use of TH/FM guidelines during project planning (98%), b) use of project maps (100%) and pre-harvest planning meetings with logging contractors to discuss TH/FM guidelines (85%), and c) checking public records for the presence of endangered, threatened, and special concern species (90%+).

State and federal agencies and forest industry reported checking of public records for the presence of cultural resources (85%) has also been good.

Use of the TH/FM guidelines during project planning by NIPF landowners has improved (73% in 2009 compared to 37% in 2004-06).

TH/FM Guidelines Implementation - Low

On all ownerships;

- Leave-tree guidelines: low (61%) with little change from the baseline monitoring period.
- RMZ guidelines for width and basal area: low (52%), and has remained nearly the same for all 3 reporting periods.
- RMZ guideline to retain or create 4 or more sound down logs per acre within the harvested portion of a RMZ: continues to be low (32%)
- Visual quality guidelines: low for visibility of snags in the foreground of sites (50%), visibility of scattered slash on sites classified as most sensitive (50%), landing locations within the ROW on vistas classified as moderately sensitive (17%), landing locations within the ROW on vistas classified as less sensitive (42%), and visibility of slash and clearing debris on landing on vistas classified as moderately sensitive (50%)
- Infrastructure guideline: Mean statewide infrastructure was 4%, and only 47% of the sites met the <3% infrastructure guideline. Implementation of this guideline has decreased over the 3 reporting periods, mostly due to a consistent increase in landing area. The exception has been on federal lands (83% met the <3% infrastructure guideline).
- Landing location: More than 35% of all landings were located at least partially in a wetland and 33% were located at least partially within a filter strip.
- Water diversion/erosion control on approaches and segments: Only 30% of approaches and 55% of segments that needed water diversion/erosion control practices had such practices in place. Nearly 42% of approaches and more than 51% of segments showed evidence of erosion. Sediment was reaching an associated waterbody for 26% of approaches and 3% of segments (mostly those associated with roads).
- Rutting: The percentage of sites with rutting has decreased slightly compared to previous reports (48% for 2009), but the percent of locations on those sites where rutting covered more than 25% of the specific location has increased sharply.

Reported use of the TH/FM guidelines by NIPF landowners was low for use of project maps (44%), pre-harvest planning meetings with logging contractors to discuss TH/FM guidelines (55%), checking public records for the presence of endangered and threatened species (7%), and checking public records for the presence of cultural resources (18%).

Checking of public records for the presence of cultural resources remains low among reporting county forestry agencies (53%).

Recommended Action

Based on the monitoring results and experience gained through the monitoring process, a number of recommendations for improving implementation of the TH/FM guidelines were made including:

- Increased commitment by public agencies and forest industry to strengthen their use of the TH/FM guidelines, particularly for those guidelines with low levels of implementation.
- Continue to offer and improve the basic introductory and periodic refresher training on the TH/FM guidelines, and develop additional in-depth training programs targeting specific guidelines of concern, due to low levels of implementation or higher risk of impacts.
- The MFRC should revisit setting short-term and long-term implementation goals for the TH/FM guidelines. This will help provide a sense of the magnitude of issues related to specific guidelines and help set priorities for efforts to improve implementation.
- Revision of selected TH/FM guidelines to provide more specific standards to help individuals better plan and set appropriate permit and contract standards, and to allow better assessment of progress toward acceptable levels of implementation.
- Access to information on cultural resources and ETS species and to the visual sensitivity maps needs to be improved. It is sometimes difficult for individuals to access these records because they are unfamiliar with them and do not know where to find them.

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 15 representatives from 13 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 in April 1996. Four topical areas identified in the *Final Generic Environmental Impact Statement (GEIS) Study on Timber Harvesting and Forest Management in Minnesota* (Jaakko Pöyry 1994) were used for guideline development: 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. Biomass harvesting guidelines for forestlands, brushlands and open lands were added in 2007. Monitoring of the implementation of the biomass harvesting guidelines was not done in 2009.

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.*

Starting in 2000, 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). Monitoring was again conducted in

2004 – 2006 and summarized in 2007 (Dahlman 2008). The current report summarizes the monitoring data for 2009 and compares the results to previous monitoring efforts.

Methods

Site selection and data collection methods were modified over the years (2000 – 2009) to improve monitoring; maintaining as much continuity as possible so data could be compared across years. Significant changes for 2009 included:

1) Development and implementation of the Guideline Monitoring Application (GMA). This is a computerized data collection program that utilizes Arc Map to capture field data and stores the data in an Access database for analysis.
2) Revising the structure of the on-site and pre-site data collection form to fit the newly created computer based data collection program.

Site Selection

In Minnesota forestlands are managed and administered by public agencies, forest industry, tribal, municipal, non-forest industry corporate, non-profit organizations, and private landowners. Monitoring sites were selected from all forest ownerships. For purposes of the report the ownerships were grouped in the following categories:

State: All lands owned by the state
County: All lands owned by a county
Federal: All lands owned by the US Forest Service, Park Service, Fish and Wildlife Service, or Corps of Engineers
Forest Industry (FI): Lands owned by Blandin Paper, Potlatch, Forest Capital Partners, and Rajala Companies
Non-industrial Private Forests (NIPF): All privately owned lands, plus non-forest industry corporate lands, municipal lands, and tribal lands

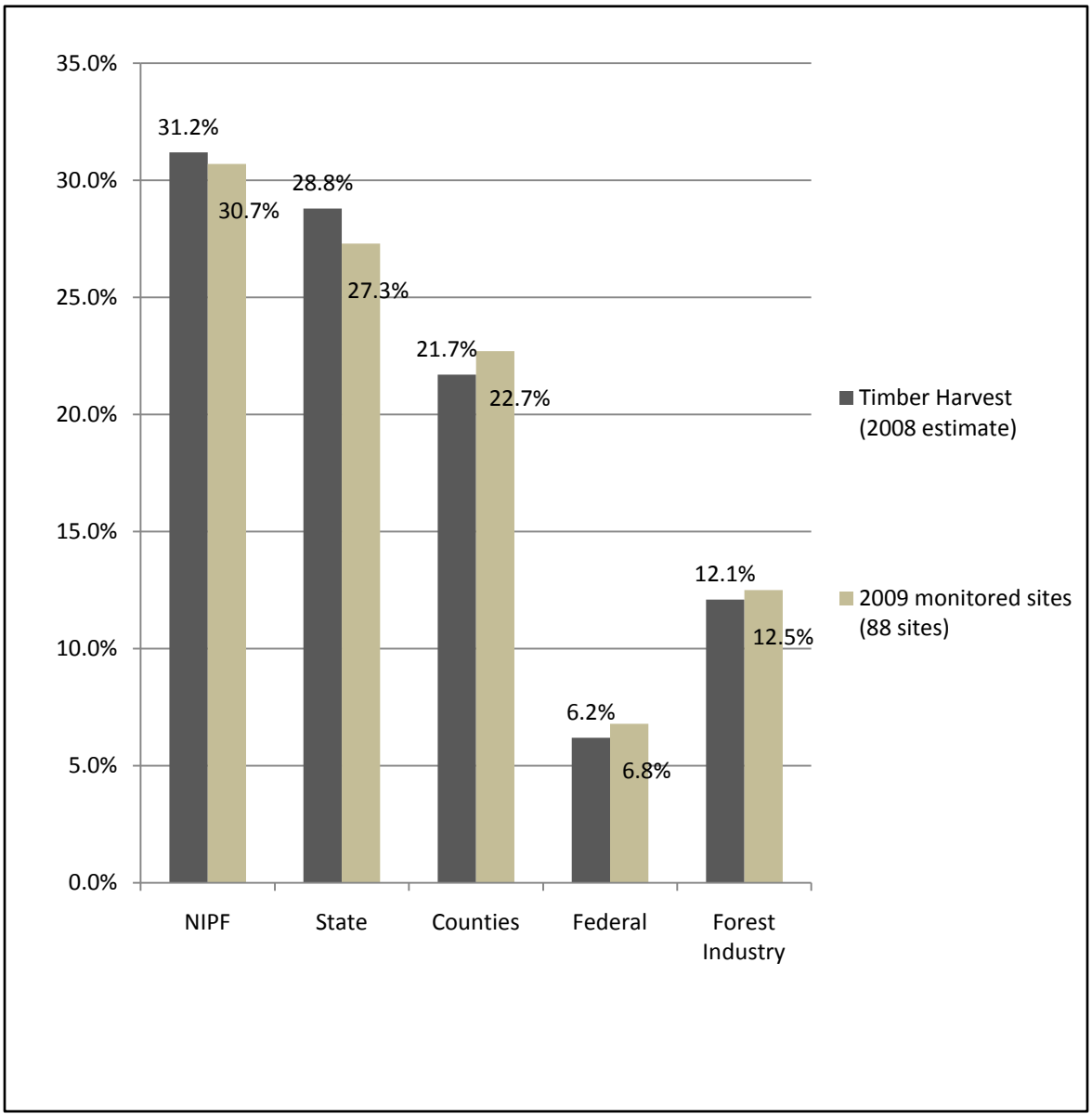
DNR staff utilized comparison of satellite imagery from late summer 2006 and 2008 to detect change resulting from apparent timber harvest throughout the forested areas of the state. Every other row of imagery was purchased, providing coverage of 70% of the state. This has been done since 2002 to control costs. The rows purchased are alternated each monitoring year so that the entire state is covered over time.

Imagery detected more than 10,000 forest disturbances that were potential timber harvests**.** From this initial pool of sites, 220 sites were randomly selected, and 80 additional sites were selected from apparent NIPF sites. Air photos were taken of these sites in October 2008. DNR staff evaluated sites to eliminate those that were clearly not timber harvest, and then identified ownership and landowner contacts for the remaining sites. The monitoring contractor made contact with NIPF landowners to document that the disturbance was timber harvesting activity and not land use change and that additional site preparation work had not occurred on the site. The contractor then obtained permission to monitor the site, requested completion of the pre-

site questionnaire and submission of copies of timber sale permits, maps, and other supporting documentation. DNR staff collected the same data on forest industry, tribal and public agency sites. This work was completed in April 2009.

After all landowners were confirmed, 192 sites were available for monitoring. A total of 90 were randomly selected across all landowner categories weighted in proportion to the volume of wood harvested from that ownership category in 2008, plus 13 additional sites in case some sites had to be dropped for unanticipated reasons. The number of backup sites proved to be inadequate so the number of site actually monitored was 88, not 90. Figure 1 shows a comparison of sampling intensity to timber harvest estimates by ownership category.

Figure 1. Comparison of Sample Site Distribution to Timber Harvest by Ownership



**2008 harvest by ownership category internal estimates from North Central Forest Experiment Station (NCFES).*

Table 1. Number of Sites Monitored by Ownership (2009)	
Landowner category	# of sites
County	20
Federal	6
Forest Industry	11
State	24
NIPF + Tribal	27
Total Number of Sites	88

In past years, it was difficult to get enough NIPF sites into the final selection pool because of the following:

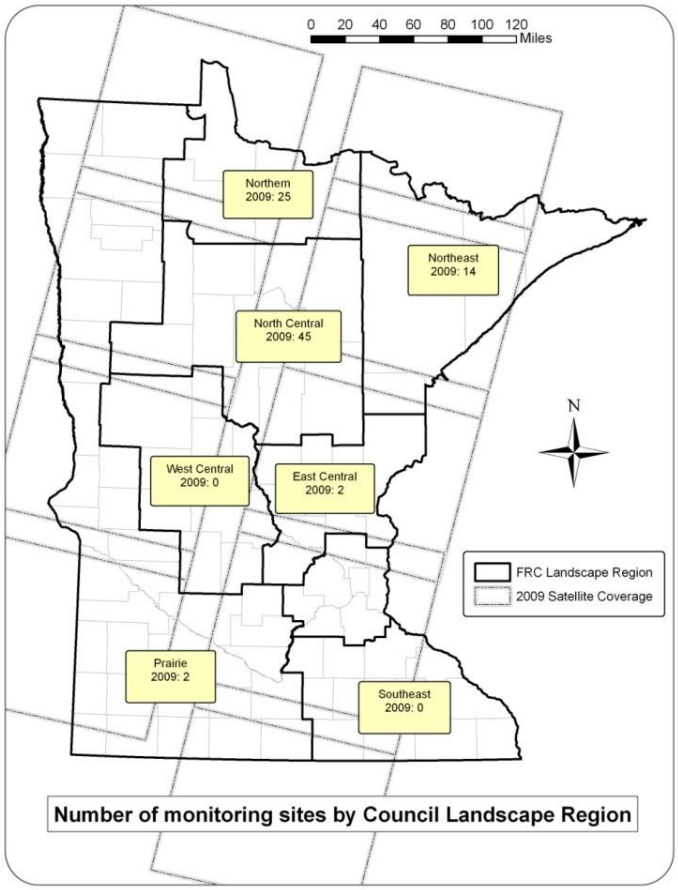
1) inability to contact many NIPF landowners for permission,
2) private harvests often represent land use changes, not forest management, and
3) many NIPF landowners were reluctant to participate.

Due in part to a downturn in timber prices, the timber harvest activity on NIPF lands has gone down, reducing the target number of monitoring sites on NIPF sites from 42 in 2006 to 28 in 2009. Because of this reduced target for NIPF sites and the site selection protocol used, the monitoring program was able to monitor the targeted number of NIPF sites. Obtaining an adequate number of NIPF sites will likely continue to be a concern in future monitoring efforts.

Site Locations

A total of 88 sites were monitored in 2009 compared with 315 sites for the 3 years of 2000–02, 279 sites for the 3 years of 2004–06. Sites for 2009 were distributed over the state as shown in Figure 2.

Figure 2. Monitoring site locations by MFRC landscape region and Landsat scene areas



Data Forms

Two sets of data forms were used to collect information about each site monitored. Both data forms were completed on paper and entered into the GMA database. The first (pre-site questionnaire) collected information from landowners and managers that cannot be observed on-site. Information collected on this data form provides background information and implementation information related to FMG guidelines for planning.

The second data form is the on-site form and maps. This is where observations of guideline practices on a variety of features (i.e. roads, landings, crossing) and their locations on the site were recorded. Most features recorded were within the harvest area. Others features were adjacent to or off-site but potentially impacted by the harvest activity.

Adjacent

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

Data for guideline practices was collected on the last ¼ mile of roads leading to a harvest area if their recent use was primarily for the activity being monitored. Along the ¼ mile of roads, 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 an off-site road if it was a public road such as a township road, a major forest system road, or logging road or landing 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 all field data. Contractors were required to provide one or more teams of at least two people each, who collectively meet the following four criteria:

1. Forest management - expert with a degree in forestry and with five or more years of experience in timber sale administration, which may include felling, job layout and supervision, and equipment operation (skidder, forwarder, processor, etc.).
2. Soil science - expert with a degree in soil science and at least three years of experience interpreting soils in the field for forestry applications.
3. Water quality - expert with a degree in aquatic biology, engineering, fisheries management, hydrology, or watershed management with at least five years of experience with nonpoint source pollution and wetland classification.
4. Adequate knowledge of aerial photo interpretation, use of GIS and GPS, field botany, Minnesota tree identification, and forest measurement techniques.

The contractors were also required to satisfactorily complete 4 days of calibration training provided by DNR staff prior to the start of field site visits. Calibration training was held May 4-7, 2009. The monitoring contractors collected on-site data from early May through late June.

Contractors were provided paper copies of air photos with the timber harvest area delineated, pre-site questionnaires, and all other documentation provided by landowners/resource managers for each site in preparation for the site visits. In addition, all site photos and electronic data forms were pre-loaded onto field hardened computers for data entry in the field (see Data Entry below).

While on-site, the contractors modified the site boundary to reflect the actual harvest site utilizing field observation as well as site documentation. In all cases the contractor delineated clumps of reserve trees greater than ¼ acre in size within the harvest area on the aerial photomap, and determined the density of scattered leave trees for each site. Contractors also delineated the location of RMZs, roads and landings. DNR staff later identified and delineated leave-tree clumps adjacent to each site on the aerial photomap based on on-site documentation. The acreage of RMZs, leave tree clumps, and final site acreage was determined utilizing Arc Map. Acreage of roads and landings was determined by on-site measurements taken by the contractors.

Quality Control

Four of the 88 sites were used for calibration training to prepare the contractors to monitor the sites accurately and consistently. A quality control team visited 8 of the remaining 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

In 2008 an electronic database was developed for collecting, storing, and processing the guideline implementation monitoring data. The 2009 monitoring process field tested this new system and identified many issues that have been resolved. The Guideline Monitoring Application (GMA) interfaces with Arc Map and Microsoft Access ^{tm} 97, for in-the-field data collection utilizing a field hardened laptop. Contract specification required the monitoring contractor to complete a minimum of 20 sites using the GMA and the field hardened laptops. Contractors completed electronic data entry on 48 sites and completed paper data forms for all 88 sites monitored. Both electronic data forms and paper copies of the on-site forms were submitted to DNR and checked for accuracy and completeness. DNR staff entered the data for the 40 sites not entered in the electronic database by the contractors.

Results

Data referenced from previous monitoring reports may be found in Dahlman and Phillips (2004) and Dahlman (2008).

Harvest Characteristics

The mean statewide harvest site acreage was very similar for all the three monitoring periods (Figure 3). The mean harvest size for sites monitored in 2009 was 23.7 acres. Total site acreage ranged from 3 acres to more than 200 acres for all three monitoring periods, with over 70% smaller than 30 acres (Table 2).

Figure 3. Mean harvest size (acres)

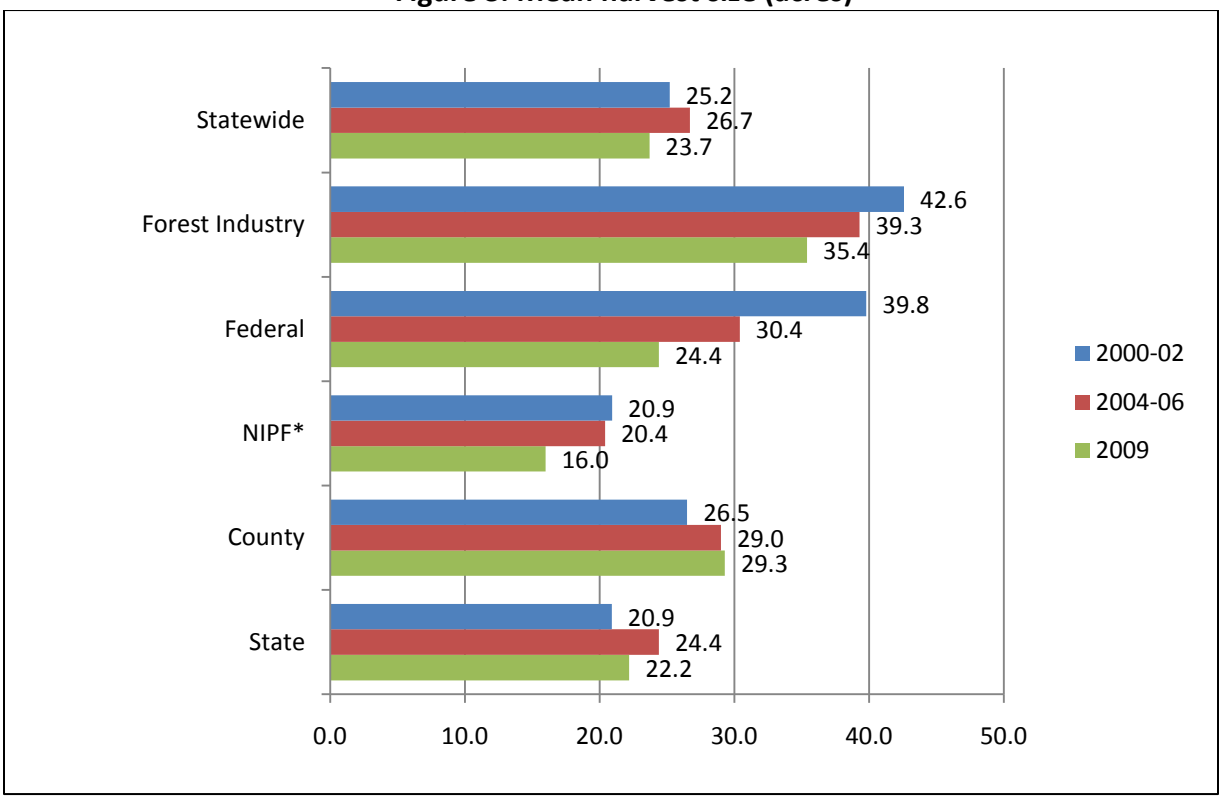


Table 2. Site size distribution			
	2000-02	**2004-06**	**2009**
≤10	27.9%	19.4%	21.6%
10<20	30.2%	32.6%	31.8%
20<30	18.1%	18.6%	20.5%
30<40	8.6%	11.1%	9.1%
40<50	3.5%	7.5%	9.1%
50<60	2.9%	4.3%	3.4%
60<70	4.1%	1.4%	2.3%
70<80	1.3%	1.8%	0.0%
80<90	1.0%	0.4%	1.1%
90<100	0.6%	0.7%	1.1%
>100	1.9%	2.2%	0.0%
Number of sites	315	279	88

Landowner Questionnaire

Landowners/resource managers partially or fully completed questionnaires for 86 of the 88 sites monitored in 2009 (compared to 307 of 315 sites monitored in 2000–02, and 272 of 279 sites monitored in 2004–06). One forest industry landowner and one NIPF landowner 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, pre-harvest planning, and landowner commitment to applying the guidelines. Although most landowners filled out the questionnaire, not all landowners completed all sections of the questionnaire. Therefore there is some variability in the total number of respondents for tables 2-9 and 11.

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 pre-site questionnaire asked landowners/resource managers to identify up to three management objectives for their timber harvest (Table 3). The relative importance of objectives was similar for the 3 periods, with public agency (state, county, federal) and forest industry landowners listing timber harvesting and silviculture most frequently. However, in 2009 NIPF landowners shifted emphasis to silviculture, wildlife habitat, and recreation compared to previous reports, where they identified income most frequently.

Beginning in 2001 the questionnaire also asked landowners/resource managers to identify their primary management objective (Table 4). As with the listing of the 3 top management objectives, public agency and forest industry landowners continue to identify timber production or silviculture as their primary management objective (80.3% of the time in 2009, 84.5% of the time in the 2004–06 period, and 87.2% in the 2001–02 period). Wildlife habitat was a primary objective for 33.3% of the NIPF landowners in 2009 (up from 26% in 2004-06 and 27% in the 2000–02 period). Timber production as a primary objective for NIPF sites has decreased since 2000-02. Recreation increased slightly, but investment as a primary objective increased dramatically. The reason for this shift may reflect the boom in stumpage prices and real estate values prior to 2009. Additional analysis is needed to determine if there is a connection between management objectives and guideline implementation.

Table 3. Landowner listing of three major objectives for management						
Management Objectives	**Landowner Category**					
	2000–02		**2004–06**		**2009**	
	NIPF	**Public Agency & FI**	**NIPF**	**Public Agency & FI**	**NIPF**	**Public Agency & Forest Industry**
Timber production	44.6%	92.8%	47.2%	94.8%	51.6%	90.2%
Silviculture	49.2%	70.5%	18.1%	74.1%	11.1%	62.3%
Wildlife habitat	44.6%	34.2%	51.4%	37.8%	59.3%	29.5%
Income	50.8%	24.5%	55.6%	32.1%	37.0%	41.0%
Recreation	33.8%	6.8%	33.3%	7.8%	55.6%	4.9%
Insect and disease	6.2%	10.5%	30.6%	17.6%	14.8%	18.0%
Fire risk	NA	NA	0.0%	0.0%	0.0%	1.6%
Other	10.8%	7.2%	23.6%	5.7%	3.7%	3.3%
No Response	19.6%	2.5%	8.8%	3.0%	3.7%	1.6%
Total number of sites	74	241	80	199	27	61

Table 4. Primary landowner objective for management						
Management Objectives	**Landowner Category**					
	2000–02		**2004–06**		**2009**	
	NIPF	**Public Agency & FI**	**NIPF**	**Public Agency & FI**	**NIPF**	**Public Agency & Forest Industry**
Timber production	16.2%	61.1%	16.4%	59.1%	7.4%	39.3%
Silviculture	27.0%	26.1%	6.9%	25.4%	11.1%	41.0%
Wildlife habitat	27.0%	1.9%	26.0%	4.7%	33.3%	3.3%
Income	10.8%	1.4%	17.8%	4.1%	11.1%	3.3%
Recreation	13.6%	0	11.0%	0	14.8%	0
Insect and disease	0	1.9%	12.3%	5.2%	0	1.6%
Investment	0	0	0	0	14.8%	8.2%
Other	5.4%	7.6%	9.6%	1.5%	3.7%	1.6%
Reduce Fire Risk	0	0	0	0	0	0
No Response	19.6%	2.5%	8.8%	3.0%	3.7%	1.6%
Total number of sites	46	161	80	199	27	61

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 and the communication of plans are particularly important for NIPF landowners because they often live distant from the harvest area (Table 5) and have little or no experience with forest management and timber sale contracts. In all 3 monitoring periods fewer than half of NIPF landowners reported living on or adjacent to the property where their timber harvest occurred, with many reporting that they live more than 100 miles away.

Table 5. How close to the harvest site do NIPF landowners live?			
Location	**2000–02**	**2004–06**	**2009**
On or adjacent to property	48.5%	42.3%	16.0%
<50 miles	22.1%	28.2%	32.0%
50 to 100 miles	2.9%	5.1%	20.0%
>100 miles	11.8%	16.7%	24.0%
No Response	14.7%	7.7%	8.0%
Total	68	78	25

Written plans are standard for timber harvests on all public agency and FI lands. Just over half of NIPF landowners, excluding tribal sites, in all 3 monitoring periods reported having some type of planning assistance (Table 6).

The number of NIPF landowners who reported having a general management plan and/or a project-specific timber harvest plan has increased in each monitoring period. It is hoped that this increased use of plans indicates increased awareness and implementation of the TH/FM guidelines. However, additional study and analysis is needed to determine if there is a connection between professional assistance, management planning and guideline implementation for NIPF landowners.

Table 6. NIPF project planning			
Level of Planning	**2000–02**	**2004–06**	**2009**
Total number of NIPF landowners	68	78	25*
No response	25.0%	7.7%	16.0%
No assistance	22.1%	41.0%	24.0%
Had assistance	52.9%	51.3%	60.0%
General plan – written	26.5%	37.2%	52.0%
Timber harvest plan	26.5%	47.4%	60.0%
Project supervision	NA	39.7%	60.0%

*Does not include Tribal lands

Most landowners/resource managers used one or more sources of information in preparing their timber harvest plans (Table 7). The most commonly used resource was aerial photography. Additional study and analysis is needed to determine if there is a connection between the use of planning aids and guideline implementation.

Table 7. Site information resources used for evaluating and developing plans			
	2000–02	**2004–06**	**2009**
Aerial photographs	87.3%	82.1%	83.0%
Topographic maps	28.9%	19.0%	22.7%
Soil surveys	22.9%	22.2%	26.1%
Visual sensitivity maps	23.8%	21.1%	28.4%
Other*	28.3%	22.2%	31.8%
None	0	7.5%	4.5%
Don't know	0	5.0%	4.5%
No response	2.5%	4.3%	3.4%
Sites for which information resource use was reported	91.1%	83.2%	92.0%
Total number of sites	315	279	88

*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 8). Site maps were developed for 81.8% of the sites for which the landowner/resource manager completed the questionnaire for 2009, compared to 81.7% for 2004-06 and 86.3% for 2000–02. NIPF landowners were least likely to have a map.

Table 8. 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%
	2009	100%	100%	100%	90.6%	44.4%	81.8%

Forest Management and Harvest Methods

Active forest management is the deliberate manipulation of forest stands 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. Values in Table 9 for 2000-02 and 2004-06 were reported on the pre-site questionnaire. Values for 2009 were reported by the monitoring contractors on the on-site form.

Table 9. Timber Harvest Method			
	2000–02	2004–06	2009
Clear-cut	85.7%	85.0%	81.8%
Thinning	7.9%	4.6%	8.0%
Salvage & TSI	2.5%	3.6%	2.3%
Group selection	0.3%	1.8%	1.1%
Seed tree	0.9%	0.7%	0.0%
Shelterwood	NA	NA	5.7%
Logger Choice	NA	NA	1.1%
Unknown	2.5%	4.3%	0.0%
Total	315	279	88

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) changes in wood markets.

Table 10. Season of harvest			
	2000–02	2004–06	2009
Spring (3/16–5/31)	5.1%	1.1%	2.3%
Summer (6/1–9/15)	12.1%	15.8%	14.8%
Fall (9/16–12/15)	8.2%	10.7%	9.1%
Winter (12/16–3/15)	53.0%	43.4%	47.8%
Summer–Fall	4.8%	8.9%	1.1%
Fall–Winter	4.8%	8.6%	11.4%
Other multiple seasons	6.6%	5.4%	8.0 %
Year around	2.2%	0%	1.1%
Unknown	3.2%	6.1%	4.5%
Total # sites	315	279	88

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. Following this effort, the DNR worked with local representatives in 16 northern 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 in past years. In 2009 all sites visible from a public road, state designated recreation trail, lake, or stream were monitored for visual quality.

There were a total of 37 of the 88 sites with one or more visually sensitive features. Only 2 of those sites were outside the 16 counties with visual sensitivity ratings. The percentage of features in each sensitivity class was similar for all three monitoring periods (Table 11).

Table 11. Visual sensitivity classification

		2000–02	2004–06	2009
Number of sites with visually sensitive features		79	102	37
Number of visually sensitive features		79	117	43
Percent of features by visual sensitivity rating	Most	19.0%	20.5%	14.0%
	Moderate	40.5%	41.0%	41.9%
	Less	40.5%	38.5%	44.2%

Each visually sensitive feature was rated from a location (vista) representative of the view an individual would see when passing the site along that travel route. Unlike past years, each vista was evaluated using the guidelines for all 3 visual rating levels, most, moderate, and less. This was done to assess differences between sensitivity levels. Past monitoring observations indicated that there may be little difference between sensitivity ratings for some visual guidelines. If confirmed this could indicate a need for better defining the standards for each level of sensitivity or for combining 2 or all 3 sensitivity standards for some guidelines.

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: less than 5 acres, 5–10 acres, and more than 10 acres (Table 12).

The guidelines recommend an apparent harvest size of less than 5 acres for sites with vistas classified as most sensitive and 5–10 acres for moderately sensitive vistas. In 2009 100% of the sites with vistas rated most sensitive met the guideline for apparent size, compared to 82.6% for 2004–and 75% for 2000-02. For vistas rated moderately sensitive 94.4% met the guideline in 2009, compared to 91.9% for 2004-06 and 90.5% for 2000-02.

In 2009 apparent harvest size was assessed for all vistas, regardless of visual sensitivity rating. The majority of vistas (81.4%) actually met the guideline for apparent harvest size for sites rated most sensitive regardless of visual sensitivity rating. While the guideline for apparent harvest size does not apply to vistas rated “less”, 73.7% of the vistas rated “less” met the apparent harvest size guideline for vistas rated “most” and 84.8% met the guideline for “moderate” (Table 12).

Table 12 Apparent Harvest Size, 2009				
	Sensitivity Rating			
	Less	Moderate	Most	Total Features
Not Visible	21.1%	44.4%	50.0%	15
< 5 Acres	52.6%	38.9%	50.0%	20
5 < 10 Acres	10.5%	11.1%	0.0%	4
> 10 Acres	15.8%	5.6%	0.0%	4
Total	19	18	6	43

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

Table 13 Techniques used to limit apparent harvest size			
	2001-02	2004-06	2009
Utilize natural terrain	29.2%	21.3%	27.1%
Use tree buffers or uncut clumps of trees	29.2%	70.8%	38.6%
Apply multiple stage cuts	15.4%	2.2%	2.9%
Create narrow openings into harvest area	12.3%	0.0%	12.9%
Shape like natural opening	9.2%	0.0%	2.9%
Adjust contiguous linear feet of harvest frontage	4.6%	0.0%	0.0%
Other: Thinning	NA	0.0%	5.7%
Actual Harvest Size	NA	NA	2.9%
None of the Above	NA	2.2%	7.1%
Total Number of Vistas	79	117	43

*Percents do not total 100% because some vistas utilized two or more techniques limiting apparent harvest size

Visibility of snags, slash piles, windrows, scattered slash, and landings also affects visual quality. For vistas rated “most” or “moderate” the guidelines recommend not leaving snags in the foreground, but retaining them against the background and below the sky line. In 2009 less than half of the vistas met this guideline (Table 14).

Table 14 Snags in Foreground for Less, Moderate, and Most visually sensitive sites, 20092009)				
Sensitivity rating	Less	Moderate	Most	Total
Sites with snags in foreground	36.8%	11.1%	50.0%	27.9%
Total sites	19	18	6	43

The guidelines recommend that slash piles and windrows in the harvest area should not be visible from vistas rated as most and not be conspicuous from vistas rated as moderate. This guideline was met in all cases.

For vistas rated most the guidelines recommend slash not be visible within 50 feet of a travel route and not exceed 2 feet in height beyond 50 feet. For vistas rated moderate the guidelines recommend slash not exceed 2 feet in height. All moderate vistas met these guidelines as did 50% of the vistas rated most sensitive.

The location of landings is very important to the visual impact of a site because equipment and logs are stored there. This obvious sign of activity can draw a traveler's attention to a site. The guidelines recommend that for all visually sensitive vistas landings should be located outside the right-of-way (ROW) of a travel route, and for vistas rated "most" or "moderate "slash and clearing debris on landings be should placed where it is not visible. For vistas rated "most" landings should not be visible, and for vistas rated "moderate" landings should not be visible, or kept screened from view for as long as possible during logging. Vistas rated "most" met these guidelines in all cases (Table 15). Vistas rated "moderate" did not meet the guidelines for locating landings outside of the ROW in 5 of 6 instances, and met the guideline for slash and clearing debris on landings only 50% of the time. Vistas rated less also had poor compliance with locating landings outside of the ROW.

Table 15 Landings Visible, 2009

Sensitivity Rating	Landing Visible	Landing in ROW	Slash or Clearing Debris piles on landing visible
Less	63.2%	36.8%	26.3%
Moderate	33.3%	27.8%	16.7%
Most	0 of 6	0	0
Overall	41.9%	27.9%	18.6%

Landowners/resource managers were frequently not aware of the visual sensitivity of their property which likely limited effective application of guidelines to protect aesthetic resources (Table 16).

Table 16 Visual Sensitivity Rating - Landowner Perceived vs. Actual

		No Response	Don't Know or No County Rating	None	Less	Mod.	Most	Total Vistas	Total Sites	Total Sites With VQ Rating
2004-06	Perceived	35	41	89	53	60	12	125	279	114
	Actual	NA	NA	177	45	48	24	117	279	102
2009	Perceived	26	23	14	20	4	1	25	88	25
	Actual	NA	NA	51	19	18	6	43	88	37

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 has generally increased over time for state, federal, and FI lands, but remained near 50% for county and less than 20% for NIPF lands (Table 17).

Table 17. Landowner/resource manager checked for presence of cultural/historic resources

		State	County	Federal	NIPF	FI	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%
	2009	87.5%	52.6%	100%	17.9%	90.9%	59.1%

The results reported in Table 17 are lower than is actually the case because most public agencies and forest industry have specialized staff who review the records of cultural/historic resources for all forest management sites, however, the field staff completing the monitoring pre-site questionnaires failed to report this.

As part of the monitoring, the state archaeologist's office checked all monitored sites against the archeological site inventory. No known cultural/historic resources were associated with sites monitored in 2009 (Table 18). Landowners/resource managers identified cultural/historic resources based on personal knowledge on 2 of the 88 sites monitored in 2009. The monitoring contractor did not include one of the sites referenced by the landowner in 2009 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 18. Number of cultural resources associated with harvest sites

	State Archaeologist's Office	Landowner/Resource Manager Reported	Monitoring Contractor Reported	Number of Sites Monitored
2004-06	2	13	14	279
2009	0	2	5	88

ETS Species

TH/FM guidelines also recommend checking for the presence of endangered, threatened, and special concern (ETS) species prior to the initiation of management activities. Reported checking on the presence of ETS species is high on public agency and forest industry lands and has improved since 2000-02. Checking for the presence of ETS species remains very low on NIPF lands (Table 19).

Table 19. Presence of ETS species checked by landowner/resource manager

		State	County	Federal	NIPF	FI	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%
	2009	100%	80%	100%	7.4%	90.9%	67.0%

Table 20. ETS species identified for nine sites in 2009.

Ownership	Natural Heritage Database report	Reported by Landowner	Based on	Action taken
Federal	Rich Tamarack - (Alder) Swamp Type - No legal protective status - no harvest or trafficking permitted in adjoining wetland. Goshawk - no modification deemed necessary	Goshawk in timber stand adjoining the harvest site	Internal inventory	None, harvest was in stand adjacent to tamarack and alder type.
NIPF	Rare mussel (Black Sandshell) in Big Fork River - Special Concern -	"Don't know"	No response	None
NIPF	Red-Shouldered Hawk - presence inferred from flying response to recording - Special Concern -	Eagle nest across the road from the harvest site in a wetland - did not check with anyone - no action related to Red-shouldered hawk	Personal knowledge	None needed
State	Western Jacobs Ladder - MN Endangered - no Federal status	Timber wolf but no mention of Jacobs Ladder	Internal DNR inventory	None taken
State	A Caddisfly - Special Concern	Caddisfly - stated that wide filter strip was maintained	Internal DNR inventory	Wide filter strips
State	Mingan Moonwort - Special concern	Mingan moonwart- Pre-site identified that plant is in adjoining Balsam Fir stand and no modification needed	Internal DNR inventory	None needed
State	None reported	Colonial bird – Great blue heron nests	Internal specialist & personal knowledge	10 acres reserved/excluded
NIPF	None reported	Showy lady slipper – no status	personal knowledge	Excluded from harvest area
NIPF	None reported	Showy lady slipper- no status	personal knowledge	Excluded from harvest area

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. The filter strip and RMZ guidelines are the primary tools for protecting wetlands and waterbodies by defining specified areas 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. The duff layer and ground cover of the forest floor in a filter strip disperse and slow surface water flows, trapping sediment, debris, nutrients, and chemicals and permitting much of the water to infiltrate into the soil before entering a wetland or waterbody. Filter strips are recommended for all wetlands and waterbodies.

RMZs minimize vegetative disturbance and "retain relatively continuous forest cover for the protection and maintenance of aquatic and wildlife habitat, aesthetics, recreation and forest productivity" (MFRC 2005). RMZs are recommended for all OWW, lakes, and perennial streams, all intermittent streams wider than 3 feet, and all intermittent streams less than 3 feet wide that are designated trout stream tributaries.

Type and Distribution of Waterbodies

The types and numbers of waterbodies or wetlands associated with the monitoring sites are shown in Table 21. As in the previous reports, most waterbodies were found within the harvest area of a site, where the risk of disturbance is greatest. Only 5 (6%) sites did not have at least one waterbody or wetland on, adjacent, or along the logging road accessing the site. NOWW were more common than any other waterbody or wetland type, accounting for 64% of the total.

Contractor experience and training on classification criteria has helped improve proper identification of waterbody types, particularly seasonal ponds and seeps and springs. As a result the percentage of wetlands identified NOWW wetlands has decreased and the percentage identified as seeps and spring or seasonal ponds has increased in each succeeding monitoring report.

Table 21 Percent of total and number of waterbodies by type			
	2000-2002	2004-2006	2009
Filter Strip Recommended *			
NOWW	77.2%	73.3%	64%
Seep & Springs	0.4%	2.5%	9.8%
Seasonal Ponds	5.9%	11.9%	17.5%
Intermittent Streams <3' (Non-trout)	3.9%	4.8%	1.9%
Filter Strip & RMZ Recommended (Including trout waters) **			
Streams	5.2%	5.3%	3.0%
OWW	6.7%	1.4%	0.9%
Lakes	0.7%	0.8%	0.5%
Beaver ponds	NA	NA	1.2%
Man-made ponds	NA	NA	1.2%
Total Waterbodies (#)	1,099	1018	428
Sites with Waterbodies (#)	285	254	83
Sites with No Waterbodies (#)	35	25	5

* Includes wetlands or waterbodies where just a filter strip is recommended

** Includes wetlands or waterbodies where both a filter strip and RMZ are recommended

Filter Strips

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 wetlands and waterbodies. 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.

During on-site monitoring the contractors recorded the percent slope and recommended filter strip width, the percent and distribution (dispersed or concentrated) of soil disturbance, and evidence of visible erosion and sediment reaching a wetland or waterbody.

To be effective, soil disturbance should be minimized within a filter strip. The guidelines recommend limiting soil disturbance to less than 5% dispersed (not concentrated) soil exposure throughout the filter strip. Disturbance concentrated in one area of a filter strip could direct surface water flow through the filter strip and promote erosion. High traffic areas such as roads, skid trails, and landings pose the greatest risk of soil disturbance. For that reason the guidelines recommend locating high disturbance areas such as roads, skid trails and landings outside of filter strips whenever practical.

In 2009 roads and skid trails were located outside of filter strips 78.3% of the time compared to 86.0 % of the time in 2004-06 (Table 22). Landings were located outside of 90% of filter strips in 2009 compared to 89.5% in 2004-06. This does not include roads and skid trails that pass through filter strips for approaches to enter or cross wetlands or waterbodies, which are discussed in a later section.

In some cases where roads, skid trails and/or landings were located within filter strips, there may have been a valid reason that met the intent of the guideline. Unfortunately the background documentation provided by the landowners/resource managers does not provide adequate information to assess whether it was reasonable to locate a road, skid trail or landing inside rather than outside of the filter strip. In some instances harvest operations may have utilized existing infrastructure that was already located within filter strips. In other cases there may have been no practical alternative location for roads, skid trails and or landings outside of filter strips.

Table 22. Roads, skid trails, and landings avoidance of filter strips

	Total Filter Strips	Roads and Skid Trails Filter Strips Avoided	Landings Filter Strips Avoided
2004-06	1,408	86.0%	89.5%
2009	561	78.3%	90.2%

Despite the intrusion of roads, skid trails, and landings into filter strips (other than crossings), the guideline limiting filter strip disturbance to <5% dispersed was met more than 90% of the time in 2009 (Table 23). This is consistent with the 95.9% reported in 2004-06 and maintains the improvement over the 72.8% reported for 2001–02.

Table 23. Filter Strip Disturbance, 2009

	Roads, Skid Trails, & Landings in Filter Strips (Excluding Approaches)	General Filter Strip (Excluding Roads, Skid Trails & Landings)	Erosion Evident in Filter Strip	Sediment from Filter Strip Erosion Reaching a Waterbody
No Disturbance	90.2%	96.1%	NA	NA
<5% Dispersed	0.5%	0.5%	0.0%	0.0%
<5% Concentrated	0.2%	1.1%	0.5%	0.4%
≥5% Dispersed	1.2%	1.4%	0.6%	0.0%
≥5% Concentrated	7.8%	0.9%	0.0%	0.0%
Total Number of Filter Strips	561	561	6 of 561	2 of 561

This high level of filter strip implementation has accomplished the primary goal of the filter strip guidelines of preventing the movement of sediment, debris, nutrients, and chemicals into wetlands and waterbodies. Evidence of erosion in filter strips and sediment reaching waterbodies has shown continuous improvement over the 3 reporting periods, with 2009 data indicating that 98.9% of filter strips showed no evidence of erosion and only 0.4% showed evidence of sediment reaching a water body (Table 24).

Table 24. Filter Strip Condition - Effectiveness			
	2001-02	2004-06	2009
No erosion visible	93.2%	97.9%	98.9%
Erosion evident	6.8%	2.1%	1.1%
Sediment reaching waterbody	2.1%	0.9%	0.4%
Total number of filter strips	933	1408	561

Riparian Management Zones

The TH/FM guidelines introduced RMZ guidelines in 1999. For each RMZ, data was collected from a single representative cross section to characterize the composition of the full recommended RMZ width for each type and size of waterbody. Basal area (BA) within the RMZ was determined using a variable plot with 10 factor prism. Linear distances and BA 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), and
4) clearcut (harvest retained less than 25 ft^2/acre BA) for the rest of the recommended RMZ width for the specific type and size of waterbody.

Compliance was based on the combined width of the nonforest, undisturbed forest, and partially harvested forest. Basal area compliance was only considered for the partially harvested portion. This portion had to meet the minimum BA recommended for the size, type (trout or non-trout) of waterbody, and management option (even age or uneven age) applied to the RMZ. Recommended BA for RMZs is 60 ft^2/acre or more for trout lakes and streams and 25 to 80 ft^2 / acre for other open-water bodies.

A total of 21 RMZs were identified on 18 waterbodies on or adjacent to 17 (19.3%) sites monitored in 2009. A stream bisected the harvest area on 2 sites resulting in a RMZ on each side of the stream, and one OWW intersected with a site in two locations resulting in 2 RMZs recorded for that waterbody. Some RMZs had significant areas of nonforest vegetation (i.e., grass, sedge, brush, or shrubs) and one was composed entirely of nonforest vegetation.

Overall compliance to RMZ guidelines has remained at approximately 50% over all 3 reports (51.6% for 2000-02, 46% for 2004-06, and 52.4% in 2009). Also consistent with past reports, there was higher compliance for RMZs of waterbodies adjacent to the harvest site compared to those waterbodies within the harvest site (60% vs. 33.4%) (Table 25).

Of the 10 RMZs that did not fully meet the RMZ guidelines, two stream RMZs and one OWW RMZ nearly met the guidelines, but fell short in width of RMZ or in BA of the partial harvested portion of the RMZ. The other seven RMZs fell well short of the recommended RMZ in width (Table 26). Full implementation of the RMZ guidelines has not improved since 2000-02. This highlights a need for continuing and improved education efforts. The MFRC also recognizes the

need to revise the RMZ guidelines based on extensive research that has become available since the RMZ guidelines were developed. Revising the guidelines based on improved science will likely help improve support for, and compliance with, the RMZ guidelines.

Table 25. RMZs that met guidelines for width and basal area (including trout waters)

		Total RMZs That Met Guidelines	Total RMZs	On-site RMZs That Met Guidelines	Total On-site RMZs	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
	2009	57.1%	7	50.0%	2	60.0%	5
Streams	2000–02	56.5%	69	30.8%	26	72.1%	43
	2004–06	43.1%	65	37.9%	29	47.2%	36
	2009	50.0%	14	25.0%	4	60.0	10
Total	2000–02	51.6%	153	31.0%	58	64.2%	95
	2004–06	46.0%	87	36.4%	33	51.9%	54
	2009	52.4%	21	33.4%	6	60.0%	15

Table 26. RMZs Not Meeting Guidelines for Width and Basal Area – 2009

RMZ setting	Recommended RMZ	Composition of actual RMZ				% of recommended RMZ	
		Width Non-forested (ft)	Width Forested no-harvest (ft)	Width and BA Forested Partial Harvest (ft / BA)	Width Clearcut (<25BA) (ft)	Width	Basal Area of Partial Harvested portion
On-site streams	50’	-	40’	-	10‘ (0 BA)	80%	0%
Adjacent trout stream	150’	15 ‘	47 ‘	88’ (40BA)	-	100%	67%
On-site streams	50’	10 ‘	-	-	40‘ (0 BA)	20%	0%
	50’	10 ‘	-	-	40‘ (10 BA)	20%	0%
On-site OWW	50’	-	-	35’ (30BA)	15’ (0 BA)	70%	100%
Adjacent streams	100’	2 ‘	63 ‘	-	35’ (10 BA)	65%	0%
	100	36’	-	-	64’ (10 BA)	64%	0%
	50’	-	30 ‘	-	20’ (0 BA)	20%	0%
Adjacent OWW	100’	-	72 ‘	-	28’ (0 BA)	72%	0.0%
	50’	-	-	24’ (60BA)	26’ (0 BA)	48%	100%

Crossings and Approaches

Crossings are sections of roads or skid trails, and in some instances landings, where equipment crosses a wetland or waterbody. Logging equipment crossings are the forest management features that have the greatest potential for disturbing wetlands and waterbodies. Equipment may alter the cross section of the wetland or waterbody, and carry sediment, logging debris, 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 as needed, impacts can be substantial and continue long after the crossing ceases to be used. Operators should avoid crossings whenever practical.

Approaches are the portion of a trail or road immediately leading into a wetland or onto the crossing of a wetland or waterbody. 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. 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 approach and crossing is removed or becomes inactive.

The types of waterbodies and wetlands crossed and proportion of crossings of each changed slightly in 2009 compared to previous reports. A decrease was noted in the proportion of NOWW crossings, along with an increase in the proportion of the seasonal pond and the seeps and springs categories. (Table 27). Most crossings in all three periods were on NOWW. The percent of crossings identified as occurring on seasonal ponds as well as seeps and springs increased roughly in proportion to the decrease in crossings of NOWWs. This primarily reflects improved identification of these types of wetlands by the monitoring contractors. The majority of seasonal ponds are very small (less than 0.2 acres) and could be avoided if properly identified. Improved ability of loggers and forest managers to identify these important wetland types would increase their avoidance and minimize impacts.

The transportation features that approaches are affiliated with was expanded in 2009 to include landings in addition to roads, and skid trails. The majority of approaches are affiliated with skid trials followed by roads, and then landings.

Table 27. Road and skid trail crossings by waterbody and wetland type

Waterbody Type	2000-02	2004-06	2009
NOWW	81.8%	84.4%	75.4%
OWW	1.6%	0.0%	0.4%
Seasonal Pond	0.4%	3.4%	5.1%
Seeps and Springs	0.2%	4.7%	11.0%
Beaver Ponds	NA	NA	1.5%
Perennial Streams	13.1%	3.2%	1.1%
Intermittent Stream	2.9%	4.3%	5.5%
Total # of crossings	548	654	273

* In previous monitoring reports, beaver ponds were included in the NOWW category.

Data indicated that most (70%) crossings occurred on winter-only or fall/winter operations in 2009, similar to 2004–06. (Table 28). An upward trend in the percentage of summer crossings and a downward trend in percentage of winter crossings was also noted.

Frozen crossings continue to be the most frequently used type of crossing. Most crossings did not involve the placement of fill (Table 29), limiting the potential for long-term damage. However, results indicate a slightly increasing trend in the use of fill over the 3 reports, and a decrease in the number of crossings using corduroy or slash mat.

Table 28. 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	Road, Skid Trail and Landing* Crossings 2009
Spring	0.4%	0.2%	0.7%
Summer	5.7%	9.9%	11.0%
Fall	6.6%	14.1%	12.8%
Winter	66.7%	46.2%	43.6%
Summer–fall	3.5%	7.3%	1.5%
Fall–winter	4.7%	14.9%	14.3%
Summer–fall–winter	8.0%	0%	2.2%
Other multiple seasons	1.3%	4.0%	11.8%
Year round	1.3%	0%	1.1%
Unknown	1.8%	3.4%	1.1%
Total # of crossings	548	654	273

*Crossings associated with landings were not recorded separately in the 2004-06 report.

Rutting occurred on 29.1% of the 255 crossings of NOWW, seeps and springs, and seasonal ponds. Of the crossings that were rutted, approximately 42% were identified as having rutting exceeding 25% (Table 30). This continues to be an opportunity for improved implementation. Avoiding crossings of wetlands where possible, and careful placement of landings relative to wetland locations, would help to reduce the occurrence of rutting simply by reducing vehicle traffic in wetlands.

Rutting on NOWW crossings (including seasonal ponds and seeps & springs) did not visibly disrupt the hydrology of the wetland in most cases. However, 21 of 255 (8.2%) recorded crossings had continuous rutting >300’ or rutting more than 50% of the width of the crossing or bisecting a wetland (Table 30). These situations indicate increased potential for blocking surface and subsurface water flow in wetlands.

Table 29 Crossing structures used on roads and skid trails			
Structure Type	2000-02	2004-06	2009
Frozen	37.3%	45.3%	51.2%
Ice bridge	6.7%	2.0%	1.7%
Corduroy or slash mat	9.6%	12.0%	5.7%
Culvert	3.2%	3.5%	3.3%
Fill	2.3%	5.3%	6.5%
Low-water ford	1.8%	2.3%	2.0%
Wood mat	0.7%	0.0%	0.0%
Dry or Not frozen	0.5%	28.1%	27.7%
Bridge	0.2%	0.8%	0.0%
Unknown or no crossing structure	37.7%	0.7%	2.0%
Total number of crossing structures*	563	737	303

*Totals exceed the number of crossings because operators used multiple structures on some crossings

Table 30. Condition of NOWW, seep and spring , and seasonal pond crossings, 2009					
		Roads	Skid Trails	Landings	Total
Total number of NOWW, seep and spring, and seasonal pond crossings		67	179	9	255
Percent of rutting by category of extent	<2%	0.0%	0.0%	11.1%	0.4%
	2≤5%	3.0%	2.2%	0.0%	2.4%
	5≤10%	1.5%	3.4%	11.1%	3.1%
	10≤25%	11.9%	11.2%	0.0%	11.0%
	>25%	9.0%	13.4%	11.1%	12.2%
Total percent of all crossings with rutting		25.4%	30.2%	33.3%	29.1%
Number of all crossings rutted >300' or bisecting wetland		4	16	1	21
Number of crossings rutted >300' or bisecting wetlands where rutting was not caused by logging		2	0	0	2

Selecting crossing locations where the approaches are nearly flat or have a minimal grade minimizes potential for erosion. Most approaches (75-80%) in all three monitoring periods had a grade ≤5%. Over half of the approaches in 2009 had a grade of <2% (Table 31). Guidelines recommend constructing roads with a grade of less than 10%; however, 4.4% of road approaches and 8.1% of skid trail approaches were greater than 10%. Steeper approaches are more susceptible to erosion and sediment movement.

Table 31. Grade of all approaches to crossings			
Approach Grade	**2000–02**	**2004–06**	**2009**
≤ 2%	49.1%	30.0%	55.7%
3 ≤ 5%	25.8%	50.6%	23.5%
6 ≤ 10%	14.6%	13.2%	13.9%
11 ≤ 15%	3.8%	4.9%	4.5%
16 ≤ 25%	1.2%	1.2%	2.2%
≥ 26%	0.6%	0%	0.3%
Unknown	4.9%	0.1%	0.0%
Total	1,113	1,368	584

Erosion control and water diversion practices and rapid revegetation are important for preventing sediment from moving down an approach and into the associated wetland or waterbody. Data for 2009 indicates that 76.5% of the approaches were judged by the monitoring contractors to be stable enough to not require water diversion/erosion control (Table 32). This is an increase over 2004-06 results of 67.1% and may reflect better guideline line implementation through improved selection of crossing locations.

Approximately 30% of approaches that needed water diversion/erosion control practices had water diversion/erosion control practices in place (Table 32). Nearly 40% of the approaches that needed water diversion/erosion control practices showed evidence of eroding (34% in 2004-06). Of those approaches where water diversion/erosion control was needed, sediment was identified as reaching the associated waterbody in 26.3% of the cases in 2009 (Table 32). Erosion and sediment reaching a waterbody was a significantly greater problem on roads than skid trails or landings.

Table 32. Condition of approaches, 2009				
	Roads	Skid Trails	Landings	Total
Total number of approaches (#)	157	395	32	584
Approaches - diversion practices not needed	69.4%	78.2%	90.6%	76.5%
Approaches - diversion practices needed	30.6%	21.8	9.4%	23.5%
>50% vegetated	88.5%	95.2%	96.9%	93.5%
Rutted	0.0%	1.8%	3.1%	1.4%
Approaches - diversion practices needed (#)	48	86	3	137
Approaches with diversion practices installed where needed	20.8%	33.7%	66.7%	29.9%
Erosion evident (diversion practices needed)	83.3%	19.8%	0.0%	41.6%
Sediment reaching waterbody (diversion practices needed)	62.5%	7.0%	0.0%	26.3%

These results reinforce the need to strongly emphasize the importance of water diversion/erosion control practices for wetland and water crossing approaches (especially for roads) 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, clear communications with loggers and equipment operators, and improved project supervision to insure operators use effective practices on crossings and approaches. Further investigation is needed to correlate how well water diversion/erosions control practices are installed with the occurrence of erosion and sedimentation.

Soil Resources

The TH/FM guidelines attempt to limit negative impacts and encourage practices that maintain or enhance soil productivity. Two significant timber harvest activities that can affect soil productivity are logging and hauling equipment traffic and the removal of biomass from a site. Protocols will be developed for monitoring biomass guideline implementation in future years.

Logging and Hauling Equipment Traffic

Equipment traffic can compact and rut soil, damage or 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.

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.

The statewide average infrastructure has increased from 3% (2.2% landings and 0.8% roads) in 2000–02 and 3.8% (3% landings and 0.8% roads) in 2004–06, to 4.2% (3.3% landings and 0.9% roads) of the site in 2009 (Figure 4 and Table 33). The increase has been in landing area not roads. Statewide, 46.6% of the sites monitored in 2009 met this guideline, down from 52.3% in the previous report (Table 34). All ownership categories except federal, have a lower percentage of sites that met the <3% infrastructure guideline in 2009 compared to the previous report. This continuing high percentage of sites that do not meet the infrastructure guidelines suggests a strong effort is needed to increase awareness of the importance of minimizing infrastructure on harvest sites.

Table 33. Percent infrastructure by ownership									
	2000-02			2004-06			2009		
	Roads	Landings	Total	Roads	Landings	Total	Roads	Landings	Total
State	0.8%	2.5%	3.3%	0.8%	3.5%	4.3%	0.7%	4.2%	4.9%
County	0.7%	2.2%	2.9%	0.6%	2.9%	3.5%	0.8%	2.8%	3.6%
USFS	0.8%	1.4%	2.2%	0.5%	2.0%	2.5%	1.2%	1.0%	2.2%
Forest Industry	1.0%	3.2%	4.2%	1.0%	2.6%	3.6%	1.3%	4.0%	5.3%
NIPF	0.6%	2.2%	2.8%	0.7%	3.1%	3.8%	1.2%	2.9%	4.1%
Statewide	0.8%	2.2%	3.0%	0.8%	3.0%	3.8%	0.9%	3.3%	4.2%

Figure 4 Average Percent Infrastructures within Harvest Area by Ownership

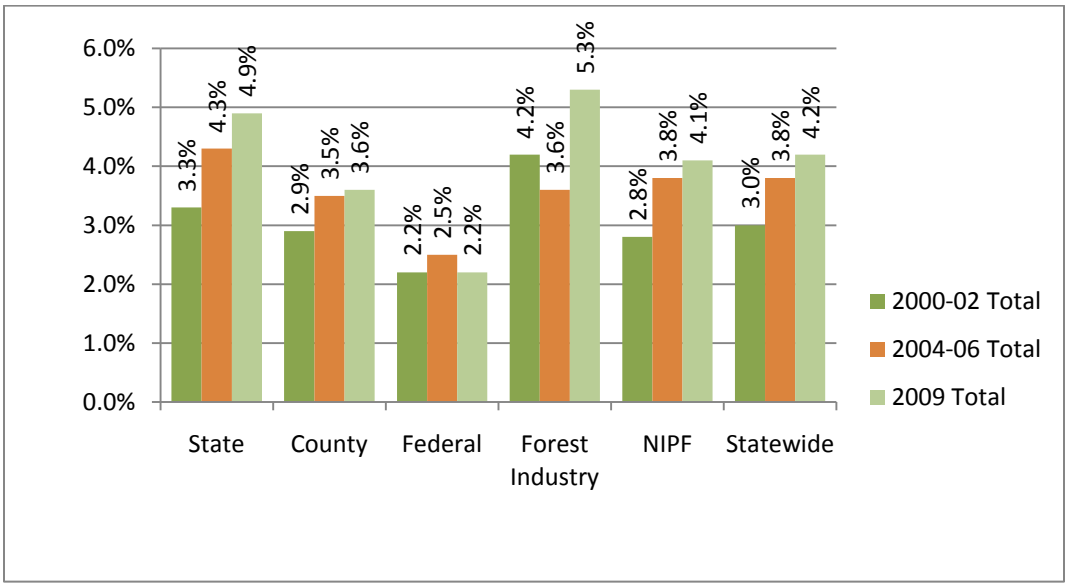


Table 34. Percent of site with infrastructure <3%		
	2004-06	2009
State	45.1%	37.5%
County	51.5%	50.0%
Federal	75.0%	83.3%
Forest industry	66.7%	45.5%
NIPF	50.0%	44.4%
Statewide	52.3%	46.6%
Total Number of Sites	279	88

Landing Characteristics

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 occur. 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.

No landings were located within RMZs or on top of Cultural Resources. More than 35% of all landings were located at least partially in a wetland and 32.7% were located at least partially within a filter strip (Table 35). Of those landings located within wetlands and/or filter strips, 51.3% of them had upland locations available on the site. Collection of additional monitoring data may provide insight into whether these uplands were practical alternatives for landing locations, requiring a subjective analysis by the on-site monitoring contractor.

Nearly 17% of landings utilized pre-existing landings, approximately ½ on site and ½ off site, compared to 11% in 2004-06 (Table 35).

Table 35. Landing location, 2009

			Percent by Location
Upland Only			50.3%
Within RMZ			0.0%
Atop cultural resource			0.0%
In Filter Strip Only			15.1%
In Wetland Only			17.0%
In Upland, Filter Strip & Wetland with Upland			17.6%
Total			100%
	On-Site	**Off-Site**	**Total**
New landing	86.3%	55.0%	83.1%
Preexisting landing	13.7%	45.0%	16.9%
Total (#)	139	20	159

Landings were generally in fair to good condition. Nearly 70% were more than 50% vegetated which is comparable to results recorded for 2004-06. Only 7.5% if the landings were rutted, with most rutting less than 10% of the landing area. Twenty one percent of the landings had visible erosion (an increase from 2004-06), but no sediment was recorded as reaching adjacent waterbodies. Trash left on landings increased from the 2004-06 report, but was similar to the 2000-02 report (Table 36). Trash from logging activity was observed on 12% of the landings, and 12% had trash from other sources.

Table36 Landing condition			
	2002	2004-06	2009
Number of landings	151	596	159
>50% vegetated (%)	82.8%	62.60%	69.2%
Percent of landings rutted	2.6%	9.90%	7.5%
Number of landings rutted	4	50	12
Number rutted ≤2%	2	31	3
Number rutted 2≤5%	2	9	2
Number rutted 5≤10%	0	7	3
Number rutted 10≤25%	0	1	4
Number rutted ≥25%	0	2	0
Number of landings rutted attributed to logging	0	47	12
Erosion evident (%)	10.0%	10.2%	21.0%
Sediment reaching waterbody (%)	0.7%	1.3%	0.0%
Logging trash (%)	17.2%	4.2%	12.0%
Other trash (%)	8.8%	6.4%	12.0%

Forest Road Characteristics

Forest roads get prolonged and intense use much like landings. 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, improving operability, and limiting the area disturbed to minimize erosion.

Access control is important for limiting the negative impacts of forest roads. Forest roads are frequently intended for temporary or seasonal use and 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 93 roads were monitored on 57 sites in 2009. Thirty one of the 88 sites monitored did not have forest roads recorded (Table 37). Some of these sites did not have a forest road because they were located next to township or county roads or state highway. Some roads were not monitored for other sites because traffic from other users made it impossible to determine the impact of the harvest activity.

Use of access controls such as gates, rocks, and other practices has improved since the baseline report for 2000-02. Access controls were installed on 72% of all roads in 2009, compared to 59% in 2004-06 and 37% in 2000-02.

Substantial improvement in access control was observed on active roads. Most of the active roads are permanent roads used over many years for many activities. Forty-one percent of the active roads had control structures in 2009, compared to 31% in 2004-06 and less than 5% in 2000-02.

Access control on temporarily and permanently closed roads has improved as well. Temporarily closed roads access was controlled 100% of the time, compared to 75.5% in 2004-06 and 66.4% in 2000-02. The remaining 7 roads (7.5%) were identified as permanently closed, with access controlled 100% of the time, compared to 100% in 2004-06 and 86.7% in 2000-02.

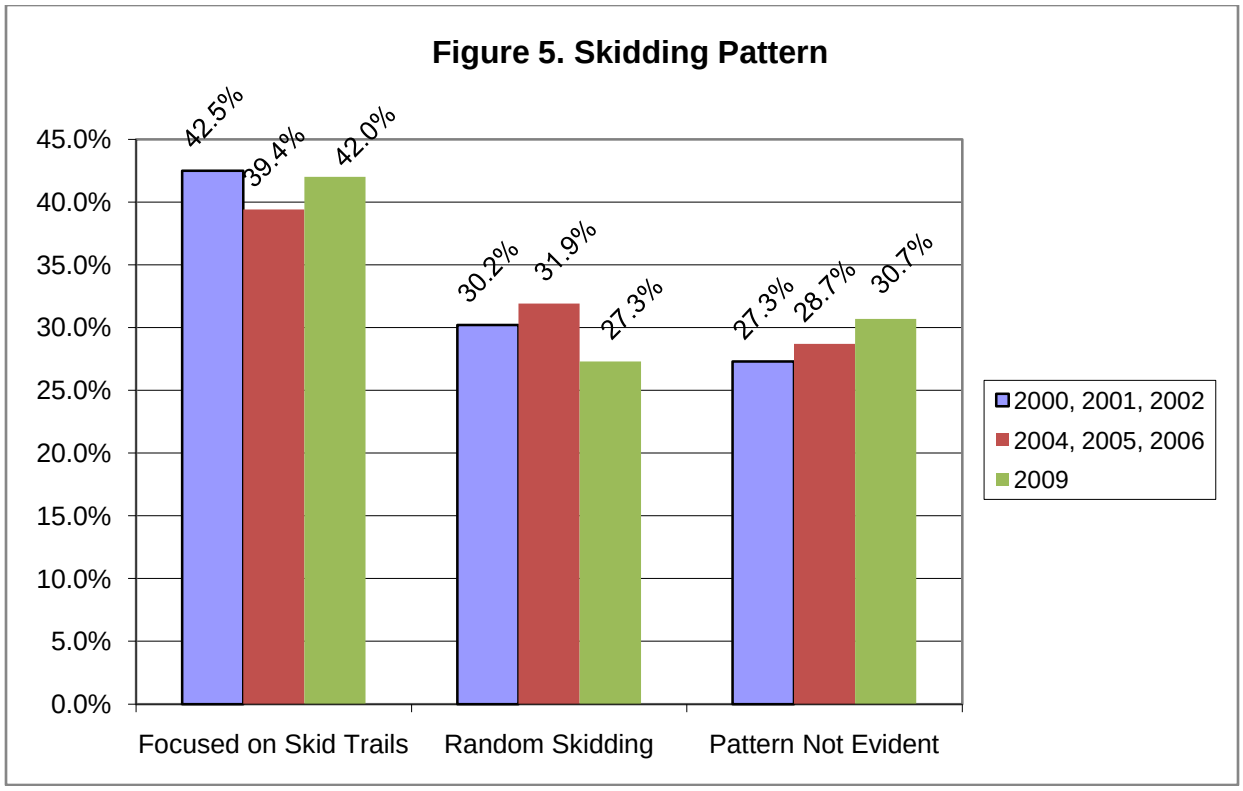
Table 37. Road status, 2009

	Active	Temporarily Closed	Permanently Closed	Status Unknown	All roads
Controlled	41.0%	100.0%	100.0%	0	72.0%
Not Controlled	59.0%	0.0%	0.0%	0	24.7%
Status Unknown	0.0%	0.0%	0.0%	100%	3.2%
All Roads	39	44	7	3	93
Sites with Roads					57
Sites with No Roads					31

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, the monitoring contractors were instructed to identify the dominant skidding pattern for the harvest site. Skidding and forwarding equipment can cause soil compaction and rutting, which can reduce site productivity. For this reason the guidelines recommend planning and laying out skid trails to minimize the number of skid trails and site disturbance while also achieving necessary operating efficiency.

The skidding patterns observed in 2009 were similar to those reported previously. Skidding was focused on skid trails on 42.0% (39.4% in 2004-06 and 42.5% in 2000-02) of the sites, and was either not evident or was randomly distributed over most of the site on the other 58.0% (60.6% in 2004-06 and 57.5% in 2000-02) of the sites (Figure 5).



Road, Skid Trail, and Landing Segments

The TH/FM guidelines recommend avoiding road grades in excess of 10%, and skid trail grades in excess of 35%, whenever practical. They also recommend using water diversion / erosion control practices on roads and skid trails to protect wetlands and waterbodies, minimize maintenance costs, and reduce impacts to soils. These practices apply to roads and skid trails in all locations, not just near wetlands and waterbodies. These practices should be installed as soon as soil is disturbed during construction and maintained as long as the road or skid trail is active, and until it is temporarily or permanently closed and the site is re-vegetated and stabilized.

Contractors assessed implementation of these guidelines by identifying segments, which are parts of roads ,skid trails, and landings with a grade $\geq$2% with slope lengths sufficient to trigger installation of water diversion or erosion control, and that are not part of an approach to enter or cross a wetland or waterbody. A total of 185 segments on roads, skid trails, and landings were identified in the 2009 monitoring.

More than 95% (86% in 2004-06 and 2000-02) of the road segments had a grade of 10% or less and 77% (82% in 2004-06 and 60% in 2000-02) of the skid trail segments had a grade of 15% or less (Table 38).

Table 38. Segment grade, 2009				
Segment Grade	**Number of Segments**			
	Roads	Skid Trails	Landings	Total
2≤5%	54.8%	12.3%	40.0%	42
6≤10%	40.5%	37.0%	40.0%	70
11≤15%	4.8%	27.5%	20.0%	41
16≤25%	0.0%	12.3%	0.0%	17
>25%	0.0%	10.9%	0.0%	15
Total	42	138	5	185

Approximately 74% of all segments were judged to require water diversion/erosion control due to slope length, steepness, and surface condition (Table 39). This is much lower than the 90.8% reported in 2004-06 but higher than the 58.9% reported for 2000-02. Over half (55%) of the segments judged to need water diversion/erosion control had one or more of these practices installed.

Over half of all segments were more than 50% vegetated and only 2.7% (9.4% previously) were rutted. Road segments were vegetated much less frequently (28.6%) than skid trail (61.5%) or landing (40.0%) segments. Only 4.8% (7.0% previously) of road segments and 2.4% (10% previously) of skid trail segments were rutted in 2009. No segments associated with landings were rutted (Table 39). Rutting on segments has decreased compared to the 2004-06 and 2000-02 reports.

More than 84% of the road segments that needed water diversion and erosion control practices showed evidence of eroding, compared to 74.5% in 2004-06 and 59.4% in 2000-02. Evidence of sediment reaching a wetland or waterbody from a road segment judged as needing water diversion and erosion control was documented in 9.1% of the cases (Table 39).

Thirty nine percent of the skid trails segments that needed water diversion and erosion control practices showed evidence of erosion, compared to 33.3% in 2004-06 and 2.3% in 2000-02. One percent of these skid trail segments had sediment reaching a wetland or waterbody, similar to earlier reports.

Seventy-five percent of segments associated with landings that needed water diversion and erosion control practices had evidence of erosion, but in no cases did sediment reach a waterbody. Segments associated with landings were recorded as road or skid trail segments in previous reports.

These numbers show fairly consistent results over the years. Segments with evidence of erosion did not result in sediment reaching a wetland or waterbody to the degree recorded for approaches because segments are located away from waterbodies, primarily outside filter

strips and RMZs. However, impacts to water quality may still occur as demonstrated by the 9% of road segments where sediment reached a waterbody.

Table 39. Condition of segments, 2009				
	Roads	**Skid trails**	**Landings**	**Total**
Total number of segments	42	138	5	185
Diversion/erosion control not needed	21.4%	27.5%	20.0%	25.9%
Segments – diversion practices needed	78.6%	72.5%	80.0%	74.1%
>50% vegetated (all segments)	28.6%	61.5%	40.0%	53.5%
Rutted (all segments)	4.8%	2.45	0.0%	2.7%
Segments (diversion practices needed)	33	100	4	137
Segments with diversion practices installed where needed	15.2%	48.0%	50.0%	55.1%
Erosion evident (diversion practices needed)	84.8%	39%	75.0%	51.1%
Sediment reaching waterbody (diversion practices needed)	9.1%	1.0%	0.0%	2.9%

Rutting

The TH/FM guidelines recommend minimizing rutting on roads, skid trails and landings, and avoiding rutting in the harvest area. Rutting occurs when tires or tracks of equipment displace and compact soil and tear the root mat when the soil is not strong enough to support the load applied by the vehicles. Rutting modifies surface hydrology, damages roots, and reduces soil pore space. This can inhibit root growth, reduce aeration, and slow or disrupt movement of water into and through the soil.

The presence or absence of rutting 6 inches deep or deeper was recorded for a variety of features summarized in Figure 6. For this and previous reports, rutting has been summarized in six relative ranges: none, $\leq$2%, 2$\leq$5%, 5$\leq$10%, 10$\leq$25%, >25%. Rutting was assessed separately for each of the following features: wetlands, filter strips, RMZs, upland harvest areas, wetland harvest areas, waterbody crossings, approaches, segments, and the general road and skid trail system observed on each site. For each occurrence the contractor visually estimated and recorded the percent of rutting observed. The contractor also recorded whether the rutting was related to logging or other activities. Rutting was assessed for total of 2629 locations on the 88 sites monitored.

Monitoring contractors found rutting on 47.7% (42) of the 88 sites monitored in 2009, compared to 55.2% in 2004-06 and 57.3% in 2002 (Table 41). This represents a positive trend in the number of sites with no rutting. The percent of all locations rutted decreased to 6.4% in 2009 from 11.3% in 2004-06, but was nearly equal to the 6% reported in 2002. Unfortunately rutting greater than 25% increased sharply in 2009 to 43% of all locations

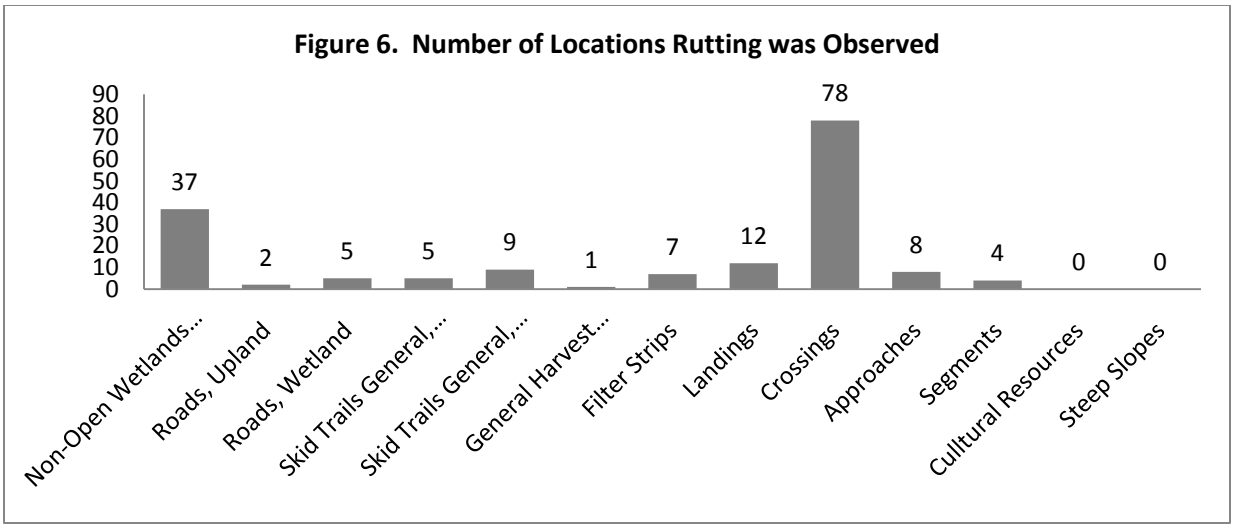
where rutting was observed, compared to 18.7% in 2004-06 and 6.6% in 2002 (Table 40). The majority of the locations where rutting was greater than 25% were on crossings. Crossings are one of the locations where the potential impact to water quality and wetland function is very high. The extent of rutting on wetland crossings is of concern.

Rutting was confined to roads, skid trails, and landings 73.2% of the time in 2009, compared to 88.7% in 2004-06 and 98.5% in 2002 (Table 40). The reason for this decline is not clear.

Table 41. Sites and locations with evidence of rutting

		2002	2004–06	2009
Number of locations evaluated for Rutting		2,257	6,147	2629
Number of locations Rutting was observed		136	697	168
Number of Sites with Rutting		57.3%	55.2%	47.7%
Percent of rutting by category of extent for those locations where rutting was identified	<2%	52.9%	35.2%	14.0%
	2≤5%	25.0%	28.8%	14.0%
	5≤10%	5.9%	12.3%	18.0%
	10≤25%	9.6%	8.5%	42.0%
	>25%	6.6%	18.7%	43.0%
Total percent of locations rutted		6.0%	11.3%	6.4%
Percent of all rutting on infrastructure		98.5%	88.7%	73.2%
Percent of all rutting not from logging		NA	5.7%	10.1%
Percent of location not rutted		94.0%	88.7%	93.6%
Percent of sites not rutted		42.7%	44.8%	52.3%

The number of specific locations where rutting was identified is shown in Figures 6. Nearly ½ of all observed rutting occurred on crossings. Data indicates that nearly 1/3 of all crossings had observed rutting. Avoidance of crossings where practical should be a focus of future efforts to reduce the occurrence of rutting.



The monitoring results for 2009 and previous years have found that the distribution of rutted sites is roughly proportional to the seasonal timber harvest (Figures 7). However, when looking at all the sites monitored in a specific season, the percent of sites with rutting varied from a low of 40.5% of sites harvested in winter, to 100% of sites harvested in spring (Table 41). Clearly, winter harvesting alone does not ensure frozen soils and low rutting.

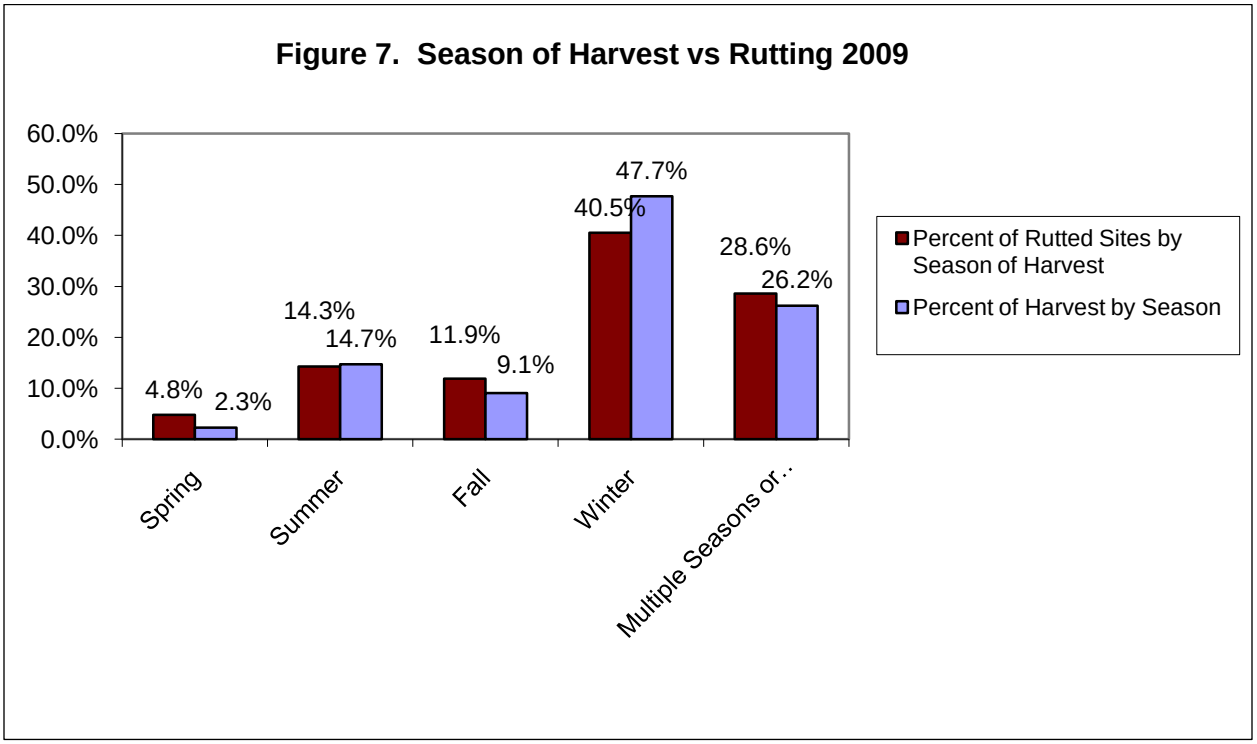


Table 41. Rutting by season, 2009					
Season of harvest	**Number of sites with rutting**	**Percent of sites with rutting**	**Number of sites with No rutting**	**Percent of sites with No rutting**	**Total sites**
Spring	2	100%	0	0.0%	2
Summer	6	46.2%	7	53.8%	13
Fall	5	62.5%	3	37.5%	8
Winter	17	40.5%	25	59.5%	42
Fall/winter	5	50.0%	5	50.0%	10
Multiple	7	53.8%	6	46.2%	13
Total	42	47.7%	46	52.3%	88

Slash Disposal and Distribution

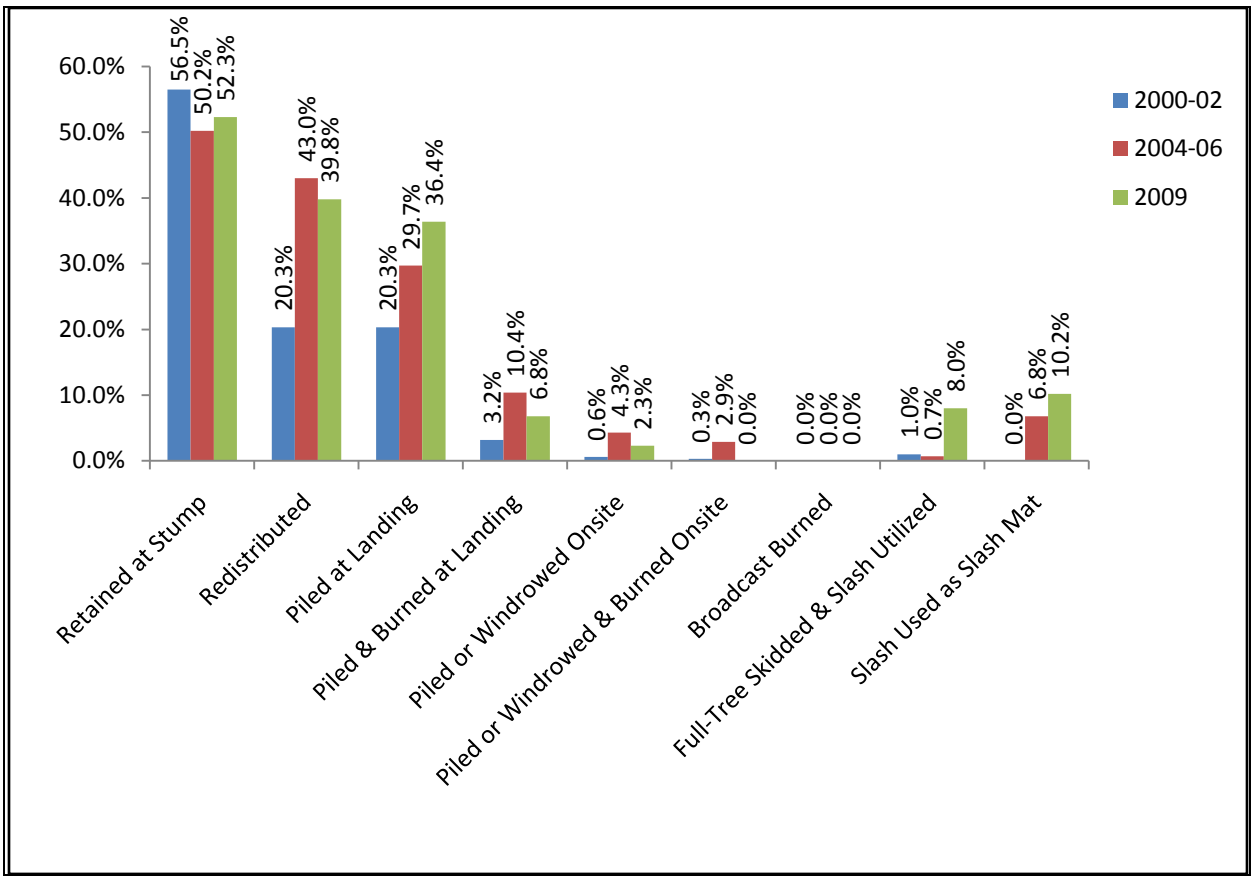
Retaining or redistributing slash on the site helps keep nutrients on the site. This is particularly important for nutrient-poor sites with soils that are: 1) predominantly deep, well drained, or excessively well-drained sand; 2) predominantly deep organic; or 3) predominantly shallow soils over bedrock. Slash also provides cover, food, and growing sites for plants and animals. The positive benefits of 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.

Retaining slash on the site at the stump is the preferred method of slash disposal for maintaining forest soil productivity on most sites. It has consistently been the most common method used (52.3% of sites in 2009), followed by slash redistribution back onto the site (39.8% of the sites is 2009) (Figure 8).

Piling slash on landings has steadily increased over time (20.3% for 2000-02, 29.7% for 2004-06, and 39.4% for 2009) while piling and burning slash at landings dropped from 10.4% in 2004-06 to 6.8% in 2009, but was up from the 3.2% reported in 2000-02.

Slash that was full tree skidded and utilized off site jumped from nearly 0% in previous reports to 8% in 2009 (Figure 8). Nine of 88 sites had slash utilized for biomass in 2009. Although the percent slash retained on these sites was not measured, 7 of the 9 sites indicated that slash was also retained at the stump, redistributed back on to the site, used as slash mat, or piled at the landing, suggesting that there was some level of slash retention on these sites.

Figure 8. Slash Management



Wildlife Habitat

Coarse Woody Debris

Coarse woody debris (CWD) provides important habitat for forest animals and plants. It is derived from the bole and large limbs of trees as they die and fall. After harvest, the new young trees do not contribute additional CWD to replace losses due to rot or removal during timber harvest. Retaining existing CWD and supplementing it by retaining large pieces of slash is important for providing this habitat component until the new stand is old enough to generate CWD from natural mortality. 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 in riparian areas. The guidelines also note that hollow butt sections or other defective lengths of at least 6 feet are preferred, and sound logs that are six- to 12-inch diameter can be used if they are the best available candidates.

General harvest areas met the guideline of two or more "sound" down logs per acre 93.5% of the time in 2009, compared to 75% in 2004–06, and 79% in 2000-02 (Table 42). In addition, there was a large increase (more than double) in the percentage of sites with greater than 5

down logs per acre in 2009 compared to previous reports. Less than 32% of the RMZs that had harvest activity met the CWD guideline of 4 sounds down logs per acre. This is up from the 29.6% reported in 2004-06 but down from the 68.7% reported in 2000-02 (Table 42).

Table 42. 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%
2009	74	5.4%	7.1%	86.4%
	RMZ			
	Number of RMZs	**RMZs with Harvest Activity**	**<4/Ac**	**>4/Ac**
2000–02	93	64	31.3%	68.7%
2004–06	85	54	70.4%	29.6%
2009	21	19	68.4%	31.6%

** Note CWD was not recorded for sites that were thinned or selectively harvested, or for the portion of RMZs that had no harvest activity.

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 six inches in diameter and a mix of species representative of the pre-harvest stand. The preferred alternative is to retain clumps because they provide additional desirable habitat features and reduce the potential loss of leave trees from sun scald and wind throw.

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, non-forested wetland, or previously harvested area, and the leave-tree clump is not large enough to be economically manageable by itself.

The leave-tree guidelines were fully met by either scattered leave trees or clumps on 60.8% of the 74 sites that were evaluated for leave trees (14 sites were not evaluated because they were not clearcut), compared to 47.3% in 2004-06 and 61.3% in 2000-02 (Table 43). Only 2 sites had no leave trees. These were lowland black spruce sites where windthrow and disease concerns prescribe removal of all trees during harvest. Three sites had both scattered leave trees and

leave-tree clumps, each below the guideline (Table 44). These 3 sites still did not meet the guideline when a weighted score for the scattered trees and clumps was calculated.

Table 43. 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 (at least ¼ acre size)	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%
2009	74	50.0%	21.6%	60.8%

**percent values relate to 74 sites where recommendations apply (clearcut sites)

Table 44. Scattered leave trees and clumps on harvest sites

	Leave Tree Distribution	Percent of sites	
		2004-06	2009
NA-Harvest activity was not a clearcut	NA	4.7%	15.9%
No leave trees		1.8%	2.3%*
Clumps only	<5% clumps	0.7%	0.0%
	>5% clumps	0.3%	0.0%
Scattered leave trees only	<1/Ac	10.8%	5.7%
	1<6/Ac	25.4%	21.6%
	6≤12/Ac	15.4%	18.2%
	>12/Ac	12.2%	8.0%
Scattered leave trees and clumps	<5% clumps and <1/Ac	2.2%	0.0%
	>5% clumps and <1/Ac	2.5%	1.1%
	<5% clumps and <6/Ac	7.1%	3.4%
	>5% clumps and <6/Ac	3.6%	8.0%
	<5% clumps and 6≤12/Ac	4.3%	2.3%
	>5% clumps and 6≤12/Ac	3.6%	3.4%
	<5% clumps and >12/Ac	2.9%	4.5%
	>5% clumps and >12/Ac	2.5%	5.7%
Total number of sites		279	88

* 2 lowland black spruce sites: windthrow and disease concerns.

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. Nearly all of the sites in the three reporting periods (94% in 2001–02, 97% in 2004–06, and 96% in 2009) retained some snags. Eighty-one percent of the sites in 2009 (72%, and 73% previously) retained at least one snag per acre, and 58.1% (36.6% and 54.1% previously) had more than two (Table 45). This data suggests continuing improvement in the commitment to retaining snags. However, as noted earlier, snags retained in the foreground of a harvest site can be a visual quality concern. This potential conflict should be discussed and resolved during training and considered in the guideline revisions process.

Table 45. 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%
2009	74	4.1%	16.2%	21.6%	58.1%

Conclusions and Recommendations

Overall implementation of the guidelines was similar to previous reports. One of the primary measures of success of the TH/FM guidelines is monitoring results that demonstrate continuous improvement in guideline implementation over time, and maintaining that high level once achieved. Results from 2009 show that implementation of many guidelines is high including: retaining snags for wildlife, retaining CWD in general harvest area, limiting disturbance in filter strip, use of road access controls, condition of landings, limiting rutting, protect cultural resources and ETS species, and visual quality guidelines for apparent harvest size and visibility landings and slash. Also, most public agency and forest industry landowners did well utilizing the TH/FM guidelines to modify harvest plans, checking inventories for known CR and ETS, and holding pre-harvest meetings with loggers that included discussion of the TH/FM guidelines. Landowners, managers, and loggers should be congratulated on their good work implementing these guidelines.

Other guidelines have demonstrated a low, or in a few cases, decreasing level of implementation on all ownerships including: leave-tree guidelines, RMZ guidelines for width and basal area, CWD retention within RMZs, percent infrastructure, location of landings in wetland and/or filter strips, use of water diversion/erosion control practices, and intensive rutting (>25%) in wetlands and on crossings. Additionally, the use of guidelines in pre-planning activities and pre-harvest meetings was very low for NIPF landowners. Given the critical role that the above guidelines play in mitigating impacts to water quality, wildlife, and soil productivity, there is an immediate need to improve implementation to avoid negative impacts on our forest resource. The following recommendations are intended to be used as a framework to improve the overall level of guideline implementation.

Setting Implementation goals

The MFRC should revisit setting short-term and long-term implementation goals for the TH/FM guidelines. Although some broad goals were developed and assessed early in the program, quantitative goals for specific guidelines have never been established despite early intentions to do so (Minnesota Forest Resources Council, 2001). The lack of goals creates ambiguity in defining progress and setbacks, and inhibits the setting of priorities for efforts to improve implementation. We recommend that the Council use past monitoring data and other pertinent information to develop challenging and attainable goals that recognize the flexible and voluntary nature of the existing TH/FM guidelines. Goals could include maintenance levels (for example, within X% of current level) for those judged to already be adequate as well as improvement goals for those that need improvement.

Operational / Policy Changes - Demonstrations of Commitment

Public agencies and forest industry need to strengthen their commitment to implementing the TH/FM guidelines. Improved implementation of those guidelines with low levels of implementation will be the best indicator of improved commitment, but intermediate actions would demonstrate efforts to improve. Some example actions could be 1) require periodic refresher training on all the guidelines for field staff, supervisory personnel, and contractors, 2)

require inclusion of better guideline standards in permits and contracts or, 3) require clear written documentation of project supervision, including actions to correct departures for permit standards. Although field personnel can improve implementation of certain guidelines, top-down administrative policies including periodic performance reviews will likely be necessary for broad improvement across the state.

Training

Since their inception, training in the TH/FM guidelines has been considered the foundation to successful voluntary implementation. The basic introductory and periodic refresher training on the TH/FM guidelines should be continued and improved, and made mandatory for all forestry field and supervisory staff (public agency, forest industry, and private consultants), all logging and related contractors, and all other natural resource professionals that have involvement in planning or supervising road, trail, or vegetative management projects in forested areas. Additional in-depth training programs and alternative delivery methods should be developed targeting specific guidelines of concern, due to low levels of implementation or higher risk of impacts. Specific topics to consider could include 1) understanding importance of wetland avoidance, 2) technical information related to water and wetland crossings, and 3) use of water diversion and erosion control practices.

Improved Clarity and Access to Information

Access to information on cultural resources, ETS species, and visual sensitivity ratings needs to be improved. For some users, information is difficult to find and understand. An additional deterrent for many landowners is the cost associated with requests for the ETS information. Improved access to useful and applicable information will likely improve implementation of any related guidelines.

Changes to TH/FM Guidelines:

The upcoming revision of the TH/FM guidelines provides an opportunity to clarify and in some case simplify the FMG's. Monitoring results could be used during this revision to aid in this process. For example, the TH/FM guidelines should provide specific standards for rutting and snag retention, and should address the combined use of scattered leave trees and clumps to satisfy leave tree guidelines (the monitoring program is using a weighted score). The forest biomass harvesting guidelines should also be modified to reflect a more measurable goal of fine woody debris (FWD) retention. Addition of a guideline specifically recommending clear, written documentation explaining the use of practices that differ from the recommended TH/FM guidelines and recommending clear written documentation of project supervision, including actions to correct departures from permit standards.

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 road, trail, or landing 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: Sound stumps and fallen trunks or limbs more than 6 inches in diameter at the large end and at least 6 feet long.

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 one 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 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 with soil displacement and tearing of the root mat 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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