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

Photos courtesy of MNDNR &MFRC

2011 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

This Page

Intentionally Left

Blank

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

Monitoring for Implementation 2011

By Richard Rossman

MN DNR Division of Forestry

August 2012

A report by the Minnesota Department of Natural Resources
Respectfully submitted to the Minnesota Forest Resources Council

Timber Harvesting and Forest Management Guidelines on Public and Private Forest Land in Minnesota: 2011 Monitoring Implementation Results is published by the Minnesota Department of Natural Resources, Division of Forestry, 500 Lafayette Road, St. Paul, MN 55155-4044. Phone 651-259-5300.

For more information on DNR Forestry programs and services, contact the DNR Information Center at 651- 296-6157 or toll-free 888-646-6367, or see www.mndnr.gov/forestry.

ACKNOWLEDGMENTS

Gratitude is expressed to the following individuals for their assistance in developing and revising the implementation monitoring protocols and/or assistance in the preparation of this report.

Minnesota Forest Resources Council- Site Level Committee for their guidance and support: Dave Parent, *Chair*; Bob Lintelmann; Shawn Perich; Mary Richards; Dale Erickson; Gene Merriam.

Director of the Division of Forestry for unwavering support of the program

Implementation monitoring field review team for their critical review of field procedures and suggestions for improving the monitoring protocols: Richard Dahlman, Rob Slesak.

Special contributions by:

Bruce Abbott - DNR - database management and data analysis

Resource Assessment - DNR - satellite imagery, aerial photo acquisition

Rob Slesak – Minnesota Forest Resources Council / DNR - critical review and guidance on report development

Executive Summary

The Minnesota Forest Resources Council (MFRC) document, *Sustaining Minnesota Forest Resources: Voluntary Site-Level Forest Management Guidelines for Landowners, Loggers and Resource Managers,* establishes best management practices (guidelines) for timber harvesting and forest management (TH/FM) on forested lands in Minnesota. Implementation monitoring of these TH/FM guidelines has been conducted on 989 timber harvest sites across public and private forest lands since 2000. This report provides results for monitoring that occurred in 2011 and attempts to assess trends in implementation levels over time.

In 2011, 84 sites were randomly selected from timber harvests that occurred during 2009-2010 and evaluated for guideline implementation. The distribution of sites among the primary ownership categories was in approximate proportion to the volume of timber harvested from each. The forest land ownership categories were state, federal, county, forest industry, and non-industrial private (including tribal lands, utilities, and nonprofit organizations).

Overall implementation of guidelines for this reporting period generally improved over previous reports including improvement in three important guidelines: leave tree retention, riparian management zones, and retention of coarse woody debris in riparian zones. The following is a brief listing of guidelines that have had high levels of implementation and/or have shown improvement over the monitoring periods, and those that have had low or declining levels.

High Implementation

On all ownerships:

- Combined implementation of several visual quality guidelines was greater than 75% on "most" and "moderate" sites including: apparent harvest size (89%), visibility of snags in the foreground (78%), reduced visibility of scattered slash (100% "moderately" and 33% "most"), slash piles and windrows (100%), visibility of landing slash and debris (78%). Landings were located outside of right of ways on 100% of "most" sensitive sites.
- All cultural resources were protected.
- Implementation of filter strip guidelines for width and limiting soil disturbance has remained high (85% of all filter strips), though slightly lower than 2009. Ninety-four percent of filter strips showed no evidence of erosion and 98% had no evidence of sediment reaching a wetland or waterbody.
- The condition of landings has generally been good with no rutting (90%), no erosion (81%), and no sediment reaching a waterbody (99%) occurring at most landings. Over 75% of all landings were located outside of wetlands and/or filter strips where possible.
- Use of access controls such as gates, rocks, and other practices occurred on 91% of temporarily and permanently closed roads.
- Coarse woody debris (CWD) retention in general harvest areas was high (94% of sites retained >2 downed logs per acre).
- Snag retention has continuously improved over time (87% of sites retained snags).

State, county, and federal agencies and forest industry reported high implementation of the following:

a) use of project maps and preharvest planning meetings with logging contractors (~100%)
b) checking public records for the presence of endangered, threatened, and special concern species improved to 97%
c) checking of public records for the presence of cultural resources improved to 95%, with 100% of all existing known cultural resources being protected.

The number of non-industrial private forest (NIPF) landowners who reported having a general management plan (63%) or a timber harvest plan (74%) has increased in each monitoring period.

Substantial improvement

Implementation of three important guidelines increased substantially in 2011 compared to previous years where implementation was consistently low. These guidelines have been highlighted in recent training and outreach. Notable improvements in implementation rates include:

- Over 70% of riparian management zones (RMZs) met recommended guidelines for width and basal area (BA), compared to past reports of 50% compliance.
- More than 85% of RMZs that had harvest activity met the CWD guideline of four sound down logs per acre compared to the past two reports of approximately 30%.
- Over 80% of sites satisfactorily met the leave tree retention guidelines in 2011 reflecting a greater than 20% improvement over previous reports.

Low Implementation

On all ownerships:

- Visual quality guidelines were implemented for; visibility of scattered slash on sites classified as “most” sensitive 33%, visibility of landing and landing slash and/or debris on vistas rated “most” 67%, landing locations within the ROW of “moderately” sensitive sites 67% and 60% for “less” sensitive sites, landing visibility on moderate sites 50%.
- Mean statewide infrastructure was 3.8% of harvest area compared to 4% reported in 2009. However, only 41% of sites met the infrastructure guideline (<3% infrastructure), which continues a steady decline in sites meeting this guideline primarily due to a consistent increase in landing area. Only state lands showed an increase in the percent of sites meeting the infrastructure guideline.
- Only 39% of biomass harvest sites retained the recommended 20% or more of fine woody debris and 70% retained incidental breakage of tops and limbs.
- Forty percent of landings located within wetlands and/or filter strips (~25% of all landings) had upland locations available on the harvest site.
- Only 19% of approaches that were identified as needing water diversion/erosion control practices (~10% of all approaches) had these practices in place.
- Monitoring contractors judged that 18% of all wetland and stream crossings could have

been avoided without unreasonable costs or reduced safety.

- The percentage of sites with rutting has remained relatively constant over time (45%-55% of sites), but the percent of locations on those sites where rutting covered more than 10% of the specific location has decreased.
- Sixty-six percent of segments that needed water diversion/erosion control practices (~50% of all segments) had such practices in place, which has improved from 55% in 2009. Nearly 80% of segments with potential to impact water quality (~15% of all segments) showed evidence of erosion (new data), with sediment reaching an associated waterbody approximately 20% of the time (3% of all segments).

Only 42% of NIPF landowners reported the development of project maps. Checking public records for the presence of endangered or threatened species and cultural resources also continues to be low for NIPF landowners, but has improved substantially over previous reports.

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:

- 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.
- Continue and increase 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 including: 1) wetland avoidance including landing location and crossings, 2) wetland identification, 3) implementation of water diversion and erosion control practices on segments, approaches, and existing roads, including how to recognize when practices are needed, 4) understanding and implementing FWD retention recommendations within biomass guidelines, 5) continued clarification of RMZ guidelines including a review of characteristics of high bank forest, and 6) review of recent guideline revisions approved by MFRC.
- Customize training and outreach for NIPF landowners and logging operators who work on private lands. Emphasize implementation of planning guidelines, checking for known occurrences of endangered, threatened or special concern species (ETS), cultural resources, and use of visual sensitivity maps.
- Access to information on 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. Specifically; post links on the MFRC website to the visual sensitivity maps posted on the DNR website, and eliminate or reduce cost associated with requests for the ETS information.

This Page

Intentionally Left

Blank

Table of Contents

This Page

Intentionally Left

Blank

List of Tables and Figures

Introduction

This report is an update to the Minnesota Forest Resources Council (Council) as required by the Sustainable Forest Resources Act (SFRA). The SFRA was enacted in 1995 and modified in 1999 (*Minnesota statutes, sections 89A.01 to 89A.10*) to resolve important forestry policy issues through collaboration among diverse forestry interests. In response to SFRA and the *Final Generic Environmental Impact Statement (GEIS) Study on Timber Harvesting and Forest Management in Minnesota* (Jaakko Pöyry 1994) , the Minnesota Forest Resources Council developed a set of timber harvest and forest management (TH/FM) guidelines in April 1996. Biomass harvesting guidelines for forest lands, brushlands, and open lands were added in 2007.

The SFRA (Minnesota Statutes, section 89A.07, subd. 2) states:

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

This report summarizes the monitoring data for 2011 and compares the results to previous estimates of TH/FM implementation (see past reports for greater detail).

Methods

Site selection and data collection methods have been modified over the years to improve monitoring, maintaining as much continuity as possible so data could be compared across years. A summary of significant changes for 2011 can be found on pages 13 and 14.

Site Selection

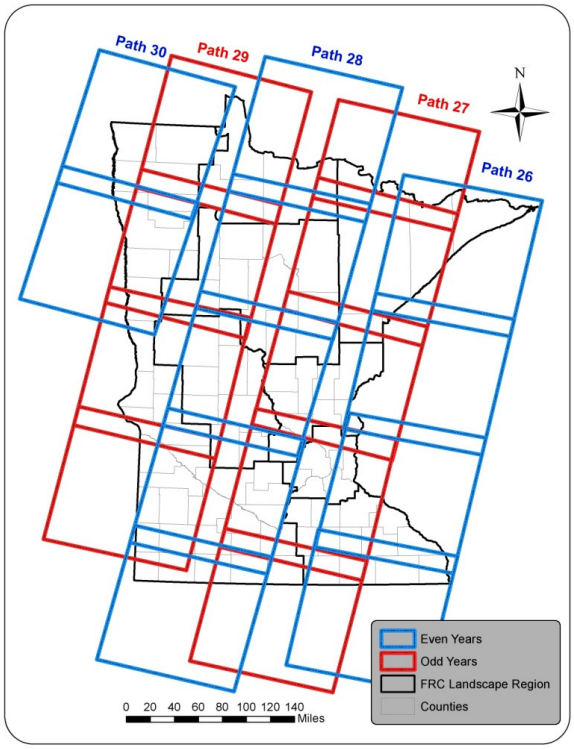
In Minnesota forest lands are managed and administered by public agencies, forest industry, tribes, municipalities, non-forest industry corporations, nonprofit organizations, and private landowners. Monitoring sites were selected from all forest ownerships. For purposes of this report, the ownerships 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 U.S. 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
Nonindustrial Private Forests (NIPF): All privately owned lands, plus nonforest industry corporate lands, municipal lands, and tribal lands

DNR staff compared satellite Landsat Thematic Mapper imagery to detect change resulting from apparent timber harvest throughout the forested areas of the state. In order to control costs, DNR staff processed every other satellite path, every other year. In odd numbered years (2007, 2009, etc.), staff processed scenes in path 27 and path 29. In even numbered years (2008, 2010, etc.), staff processed scenes in paths 26, 28, and 30. This procedure provided coverage of the majority of the state every two years (Figure 1).

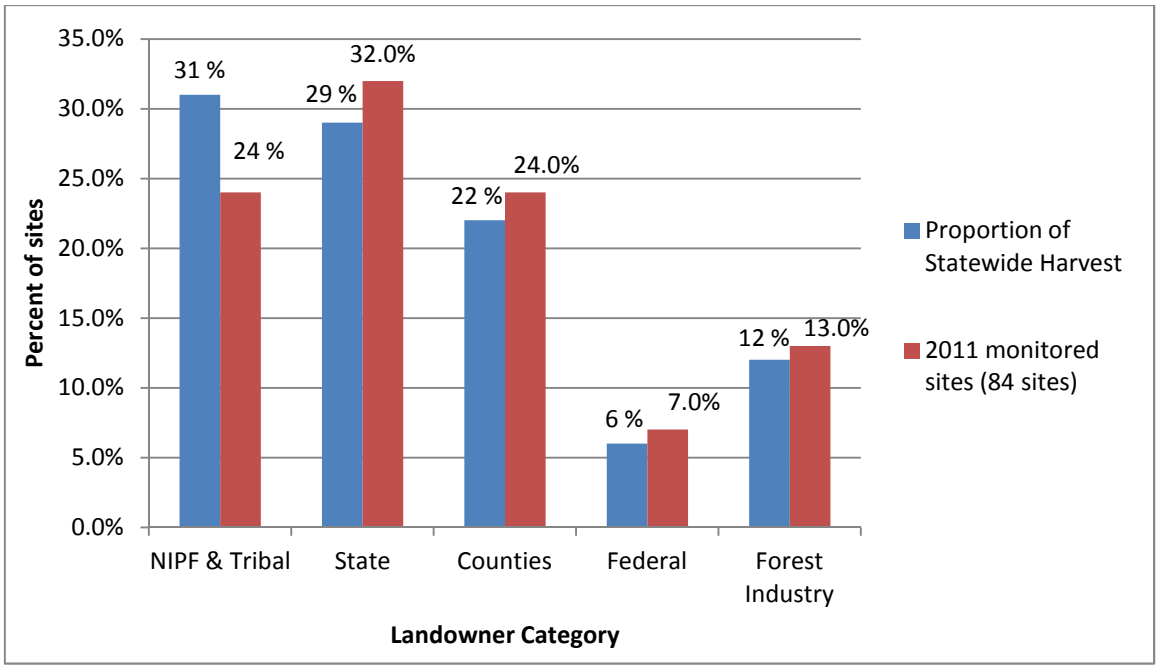
Imagery detected thousands of potential forest change polygons using a process known as image differencing. Some detected polygons were false change; others were nonharvest change (such as beaver flooding or forest pest defoliation). Image analysts sorted and visually inspected polygons, narrowing the list to sites with apparent forest change. From this initial pool of sites, 222 sites were randomly selected, and 80 additional sites were selected specifically from apparent NIPF ownership. Air photos were taken of these 302 sites in October 2010. 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 attempted to make contact with NIPF landowners to document that timber harvest activity had occurred and that additional site preparation work had not occurred on the site. The contractor requested permission to monitor the site, verified dates of harvest activity, 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. Only completed sites harvested during summer of 2009 through winter of 2011 were considered for monitoring.

Figure 1: Forest Harvest Detection Satellite Processing



After all landowners were confirmed and permissions for access granted or denied, 192 sites were available for monitoring. A total of 90 sites were randomly selected across all landowner categories weighted in proportion to the volume of wood harvested from that ownership category from most recent statewide estimates. All available NIPF sites were selected for monitoring. Alternate sites were selected in case some sites had to be dropped for unanticipated reasons. The number of sites proved to be inadequate on NIPF and tribal lands, so the number of sites monitored was 84, not 90. The number of sites monitored by landownership category include: 20 NIPF, one Tribal, 27 state, 20 county, six federal and 11 forest industry. Figure 2 shows a comparison of sampling intensity to timber harvest estimates by ownership category.

Figure 2: Comparison of Sample Site Distribution to Timber Harvest by Ownership Category



**Harvest by ownership category internal estimates from North Central Forest Experiment Station.*

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 a high of 42 in 2006 to 27 in 2011. In spite of this reduced target for NIPF sites and the site selection protocol used, the monitoring program was unable to monitor the targeted number of NIPF sites. Of the 102 NIPF sites initially identified, landowners granted permission on 22 sites, two of which did not meet site criteria due to site preparation activity and conversion to other land use. Of the remaining sites:

- Contractors were unable to contact landowners or received no response for 41 sites
- Sites did not fit selection criteria (e.g., site prepped, conversion to other land use) for 16 sites
- NIPF landowners were unwilling to participate for 23 sites

Obtaining an adequate number of NIPF sites will likely continue to be a concern in future monitoring efforts.

Site Locations

A total of 84 sites were monitored in 2011. Site distribution across the seven MFRC landscapes is shown in Figure 3. Since the start of the current guideline monitoring process in 2000, the program has conducted monitoring on 923 sites throughout Minnesota. Table 1 shows the distribution of monitoring sites over the seven MFRC landscapes. Appropriately, the highest frequency of monitoring sites has occurred in the north-central (38%), northeast (26%), and northern (24%) landscapes.

Figure 3: Monitoring Site Locations by MFRC Landscape Region and Landsat, Thematic Mapper (TM) Scene Areas.

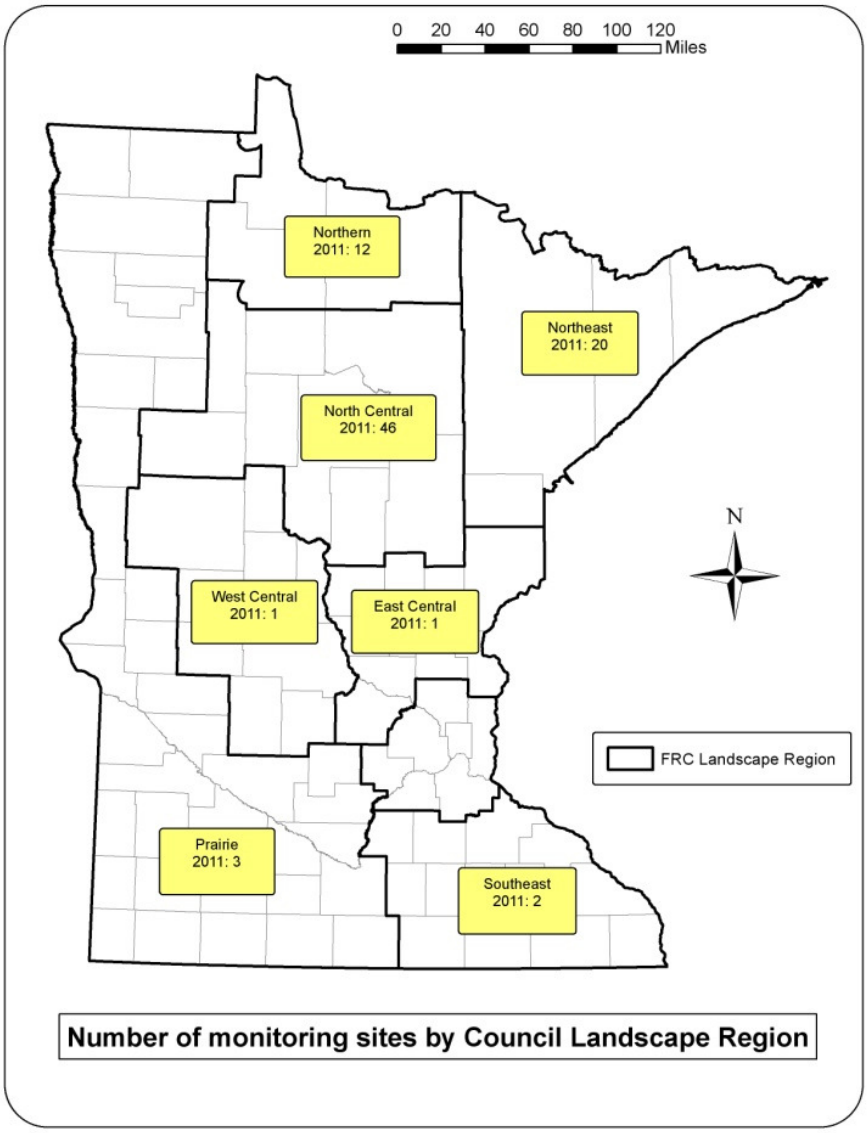


Table 1: Distribution of Monitoring Sites Over MFRC Landscape Regions 2000- 2011 (# of sites)					
	2000-03	**04-06**	**2009**	**2011**	**Total sites**
East Central	3	8	2	1	14
North Central	180	116	45	45	387
Northeast	90	134	14	20	258
Northern	124	70	25	12	231
Prairie	28	2	2	3	35
Southeast	0	3	0	2	5
West Central	53	5	0	1	59
Total	478	338	88	84	989

** Distribution of sites in the 2000-2003 report was a result of using a different site sampling strategy than is currently used; therefore, that report reflects a different pattern of sampling.*

Data Forms

The guideline implementation monitoring program utilizes a computer application for analysis of data and mapping of monitoring sites. This application, titled the Guideline Monitoring Application (GMA), utilizes both ESRI ArcMap9 and Microsoft Access to capture and analyze data. Two sets of data forms were used to collect information about each site monitored. Both data forms were completed on paper and then entered into the GMA database. The first (pre-site questionnaire) collected information from landowners and managers to provide background information and implementation information related to forest management guidelines (FMGs) for planning.

The second data form is the on-site form companioned with site maps. This is where observations of guideline practices on a variety of features (i.e., roads, landings, crossings) 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.

Modifications were made to the 2011 pre-site and on-site data forms, and monitoring protocols in an effort to streamline data collection and focus on the most relevant data. Major changes include:

1) Pre-site form
    a. added option for landowners to identify sites with a unique ID
    b. requested logger and purchaser information to improve feedback and aid in gathering site data
    c. requested information on the species harvested to relate to leave tree data
    d. documented whether biomass was harvested and what strategies were used for retention of fine woody debris
    e. identified leave tree strategies used by landowner or manager

2) On-site form
    a. only collected complete data on segments that could impact water quality; all other segments were documented with an abbreviated set of data

b. filter strip data collection was streamlined so that all filter strips were observed, but full data were collected only on those with apparent departures from guidelines; all others were counted and documented
c. full data were only collected on Approaches that did not meet guideline recommendations; all other approaches were documented and counted
d. added data collection quantifying erosion volume estimates
e. increased riparian management zone (RMZ) cross sectional data collection to three to better characterize condition of RMZs
f. added documentation of species and abundance of scattered leave trees to compare to preharvest composition
g. added a professional judgment of whether crossings could have been avoided while still accomplishing the site objectives and without unreasonable costs or reduced safety
h. added observations and estimates of fine woody debris (FWD) retention for biomass harvest sites
i. modified leave tree, coarse woody debris (CWD), and snag sample points and included FWD observations for each plot on sites where biomass harvest occurred

Adjacent

Data were collected on waterbodies outside the harvest area boundary but within the recommended filter-strip width (or within 1½ times the recommended 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 were collected on the last ¼ mile of roads leading to a harvest area if the 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, 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 field data. Contractors were required to provide one or more teams of at least two people each, who collectively met 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 four days of calibration training provided by DNR staff prior to the start of field-site visits. Calibration training was held May 2-5, 2011. The monitoring contractors collected on-site data from early May through mid-June.

Monitoring contractors delineated site boundaries 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, wetlands, and all features with data collected. 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.

In 2008 an electronic database was developed for collecting, storing, and processing the guideline implementation monitoring data. The Guideline Monitoring Application (GMA) interfaces with Arc Map and Microsoft Access ^{tm} 97, for real time data entry and mapping utilizing a field hardened laptop.

Quality Control

Three of the 84 sites were used for calibration training to prepare the contractors to monitor the sites accurately and consistently. A quality control team visited six 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.

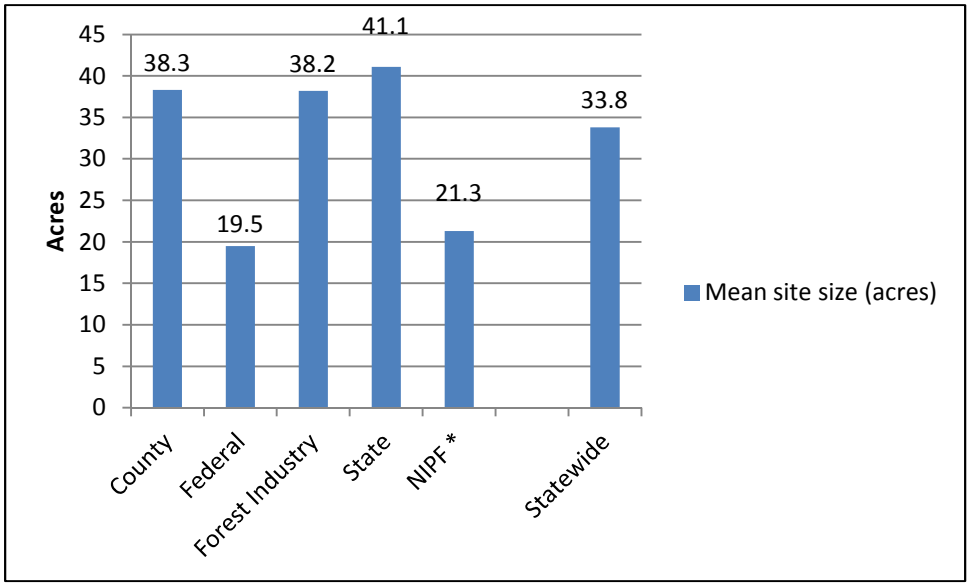
Results

Data referenced from previous monitoring reports may be found in Dahlman and Phillips (2004), Dahlman (2008), and Dahlman and Rossman (2010). See References page 53.

Monitoring Site Size

The mean statewide monitoring site size was 33.8 acres in 2011 (Figure 4). Total site acreage ranged from three acres to 153 acres. Over 60% of monitoring sites were smaller than 30 acres (Figure 5). Although not a guideline in itself, site size may influence implementation of other guidelines such as managing site infrastructure and acreage of leave tree clumps.

Figure 4: Mean Monitoring Site Size

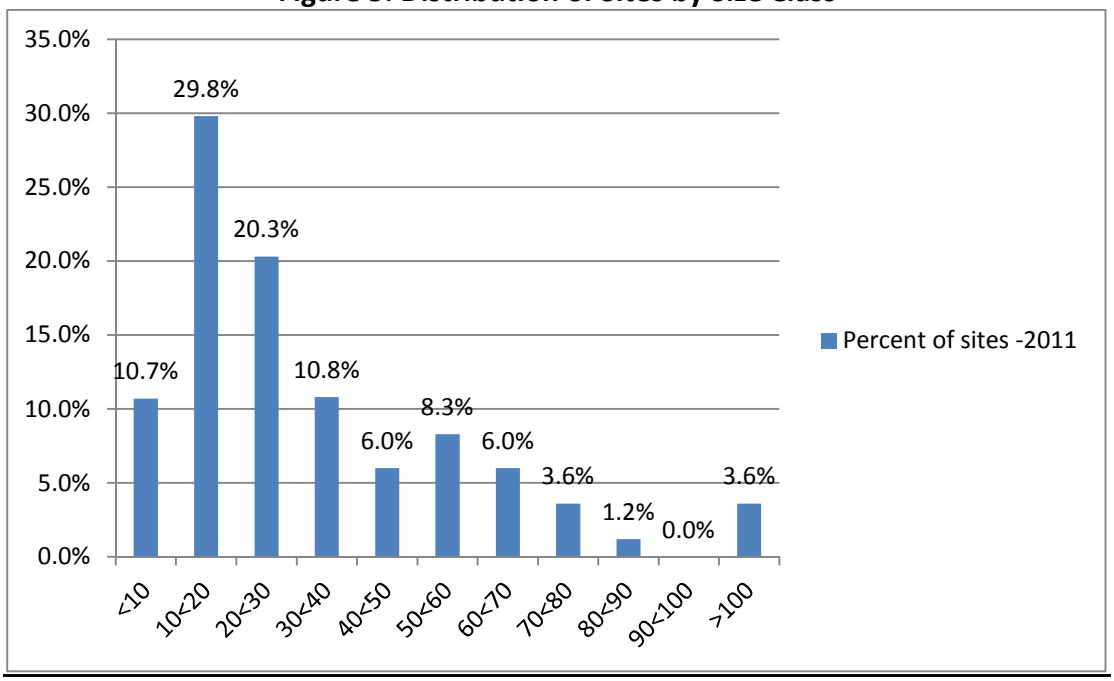


**NIPF category includes one tribal site*

Landowner Questionnaire

Landowners/resource managers partially or fully completed questionnaires for all 84 sites monitored in 2011. Although all 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.

Figure 5: Distribution of Sites by Size Class



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.

Written plans are standard for timber harvests on all public agency and FI lands. In 2011, 63% of NIPF sites reported having some type of planning assistance compared to just over half of NIPF landowners, excluding tribal sites, in all previous monitoring periods (Table 2).

The number of NIPF landowners who reported having a written general management plan has increased from 27% in 2000-02 to 53% in 2011. Similarly, the number of landowners who reported having a timber harvest plan has increased in each monitoring period from 27% in 2000-00 to 74% in 2011. Landowners reported that 10 timber harvest plans were written plans and four were oral plans. Half of the harvest plans were developed by natural resource professionals and half by logging professionals. The increase in percent of NIPF landowners with general and timber harvest plans demonstrates continuous improvement in implementation of guidelines recommending the development of plans prior to initiating management activities.

Table 2: NIPF Project Planning

Level of Planning	2000–02	2004–06	2009	2011
Total # NIPF Sites	68	78	25	19*
No response	25.0%	7.7%	16.0%	5.3%
No assistance	22.1%	41.0%	24.0%	31.6%
Had assistance	52.9%	51.3%	60.0%	63.2%
General plan – written	26.5%	37.2%	52.0%	52.6%
Timber harvest plan	26.5%	47.4%	60.0%	73.7%
Site maps developed	39.2%	34.7%	44.4%	42.1%
Project supervision	NA	39.7%	60.0%	47.4%

**Does not include Tribal lands*

TH/FM guidelines emphasize the importance of site evaluation during preharvest planning as a means to facilitate on-site implementation of guidelines. Nearly all landowners and resource managers used one or more sources of information in preparing their timber harvest plans (Table 3). The most commonly used resource was aerial photography. Data indicate an increase in the use of resources in nearly all categories in 2011 compared to previous reports. A noted addition from previous reports is the increase in reported use of GIS tools and data that was previously included in the “other” category.

Table 3: Site Information Resources Used for Evaluating and Developing Plans				
	2000–02	2004–06	2009	2011
Aerial photographs	87.3%	82.1%	83.0%	86.9%
Topographic maps	28.9%	19.0%	22.7%	25.0%
Soil surveys	22.9%	22.2%	26.1%	31.0%
Visual sensitivity maps	23.8%	21.1%	28.4%	28.6%
GIS	-	-	-	9.5%
Other*	28.3%	22.2%	31.8%	31.0%
None of above	0	7.5%	4.5%	3.6%
Don't know or No response	2.5%	9.3%	7.9%	4.8%
Sites for which information resource use was reported	91.1%	83.2%	92.0%	91.7%
Total number of sites	315	279	88	84

**Includes use of forest inventory data, county biophysical inventory data, ecological classification data, County biological survey data, and subsection forest resource management plan (SFRMP).*
Note: Percents do not total 100% because some sites utilized two or more information resources

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. Site maps were developed for 87% of the sites for which the landowners and resource managers completed the questionnaire for 2011, similar to past reports (Table 2). Site maps were developed for 100% of county, federal, forest industry and state sites. NIPF landowners reported that site maps were developed for only 42% of the sites, which is fairly consistent with past reports (Table 2).

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 one primary tool landowners and resource managers use to manage forests. The harvest method landowners and resource managers choose for a site depends on their management objectives and the tree species being managed. Table 4 summarizes the harvest methods reported. The percent of sites that were clear-cut remains similar to past reports at 83% (Table 4).

Table 4: Timber Harvest Method				
	2000–02	2004–06	2009	2011
Clear-cut	85.7%	85.0%	81.8%	83.3%
Thinning	7.9%	4.6%	8.0%	6.0%
Salvage & TSI*	2.5%	3.6%	2.3%	4.8%
Group selection	0.3%	1.8%	1.1%	3.6%
Seed tree	0.9%	0.7%	0.0%	0.05
Shelterwood	NA	NA	5.7%	1.2%
Logger Choice	NA	NA	1.1%	1.2%
Unknown	2.5%	4.3%	0.0%	0.0%
Total	315	279	88	84

**TSI – Timber Stand Improvement*

Season of Harvest

TH/FM guidelines often recommend considering season of harvest as an option to help accomplish specific guidelines. Most timber harvest activity occurred in winter (Table 5). The difference in seasonal variation of harvests between monitoring reports likely reflects: 1) the random nature of site selection, 2) weather, and 3) changes in wood markets. The most notable variation is the substantially higher percent of summer harvests in 2011 compared to past reports. In the soil resources/rutting section (page 34), season of harvest is compared to occurrence of rutting on harvest sites.

Table 5: Season of Harvest

	2000–02	2004–06	2009	2011
Spring (3/16–5/31)	5.1%	1.1%	2.3%	0.0%
Summer (6/1–9/15)	12.1%	15.8%	14.8%	23.8%
Fall (9/16–12/15)	8.2%	10.7%	9.1%	10.7%
Winter (12/16–3/15)	53.0%	43.4%	47.8%	34.5%
Summer / Fall	4.8%	8.9%	1.1%	7.1%
Fall / Winter	4.8%	8.6%	11.4%	11.9%
Spring / Summer	-	-	-	4.8%
Other multiple seasons	6.6%	5.4%	8.0 %	6.0%
Year-round	2.2%	0%	1.1%	0.0%
Unknown	3.2%	6.1%	4.5%	1.2%
Total # sites	315	279	88	84

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, visual sensitivity classification maps were developed for 16 northern counties. These maps can be found at http://www.dnr.state.mn.us/forestry/visual_sensitivity/index.html. These maps identify features such as roads, rivers, lakes, or recreational trails that are rated as "most," "moderately," or "less," visually sensitive.

Monitoring contractors rated sites for visual quality when components of a harvest site could be viewed from a location frequented by the public including roads, trails, lakes, navigable streams, or campgrounds. Forty-four of the 84 sites had one or more visually sensitive features (vistas), with 46 total vistas recorded. Eighty percent was "less" sensitive, 13% "moderately" sensitive, and 7% "most" visually sensitive. Only three of these 44 sites were outside the 16 counties with visual sensitivity ratings.

The features that triggered the collection of visual quality data for 2011 include: 27 local, township, county, and state forest roads; six state highways; eight snowmobile or ATV trails; one nonmotorized trail; three lakes or navigable waterways; and one campground. 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 or using the public area.

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. The guidelines recommend an apparent harvest size of less than five acres for sites with vistas classified as "most" sensitive and five –10 acres for "moderately" sensitive vistas. In 2011, 67% of vistas rated "most" sensitive met the guideline for apparent size; for vistas rated "moderately" sensitive 100% met this guideline (Table 6). While the guideline for apparent harvest size does not apply to vistas rated "less," 84% still met the guideline for "moderate" or "most" (Table 6). Similar results were found in 2009 (see past reports).

The TH/FM guidelines recommend various techniques be used to limit the apparent harvest size. The most commonly used technique to limit apparent size was the use of buffers or clumps of uncut trees (85%), followed by use of natural terrain at 26% and creating narrow openings at 22% (Table 7).

Table 6: Visual Quality Guideline Compliance for Most and Moderate Sites

	Most		Moderate		Overall compliance
	Guideline	**% compliance**	**Guideline**	**% compliance**	
Apparent harvest size	<5 acres	66.7%	5-10 acres	100%	88.9%
Visibility of snags	No snags in foreground	66.7%	No snags in foreground	83.3%	77.8%
Visibility of slash piles	Not visible	100%	Not conspicuous	100%	100%
Visibility of scattered slash	Not visible w/in 50' <2' high Beyond 50'	33.3% 66.7%	<2' high Beyond 50'	100%	77.8%
Visibility of windrows	Not visible	100%	Not conspicuous	100%	100%
Visibility of landing slash & debris	Should not be visible	66.7%	Should not be visible	83.3%	77.8%
Landing location	Outside ROW*	100%	Outside ROW	66.7%	77.8%
Total vistas	3		6		9

**ROW – Right of Way*

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 2011, 78% of vistas met this guideline (Table 6). Table 32 in the wildlife habitat section shows that 95% of sites met the snag retention guideline with an increasing number of sites retaining more than one snag/acre. This demonstrates the ability to achieve good compliance in both of two potentially conflicting guidelines.

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 "moderately" sensitive. This guideline was met in all cases.

Guidelines recommend slash not be visible within 50 feet of a travel route and not exceed two feet in height beyond 50 feet for vistas rated "most." Only one-third (33%) of sites rated "most" met the first part of this guideline and 67% met the second part (Table 6). For vistas rated "moderate" the guidelines recommend slash not exceed 2 feet in height. All "moderate" vistas met this guideline. Overall 78% of "most" and "moderate" sites met slash visibility guidelines (Table 6).

Table 7: Techniques Used to Limit Apparent Harvest Size				
	2001-02	2004-06	2009	2011
Utilize natural terrain	29.2%	21.3%	27.1%	26.1%
Use tree buffers or uncut clumps of trees	29.2%	70.8%	38.6%	84.8%
Apply multiple stage cuts	15.4%	2.2%	2.9%	0.0%
Create narrow openings into harvest area	12.3%	0.0%	12.9%	21.7%
Shape like natural opening	9.2%	0.0%	2.9%	0.0%
Adjust linear feet of harvest frontage	4.6%	0.0%	0.0%	0.0%
Other: Thinning	NA	0.0%	5.7%	10.9%
Actual Harvest Size	NA	NA	2.9%	8.7%
None of the Above	NA	2.2%	7.1%	8.7%
Total Number of Vistas	79	117	43	46

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

The location of landings is very important to the visual impact of 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 should be 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. All sites rated "most" had landings located outside of the ROW. Vistas rated "most" met landing and slash/landing debris visibility guidelines 67% of the time (Table 6). Sixty-seven percent of vistas rated "moderate" had landings located outside of the ROW, and met the guideline for slash and clearing debris on landings 83% of the time. For vistas rated "less," 60% of landings were located outside of the ROW (Table 6).

Guidelines recommend that landowners and resource managers check the visual sensitivity rating for sites prior to conducting forest management activity. Almost 80% of landowners and resource managers indicated on the pre-site questionnaire that they checked visual quality (VQ) sensitivity ratings, and identified what the VQ sensitivity was determined to be. Staff later compared this information to the county visual sensitivity maps and vistas identified by the monitoring contractors for 77 sites located within counties with visual sensitivity ratings. As a result of this comparison:

- 37 (48%) landowners/managers correctly identified the VQ sensitivity rating
- 40 (52%) did not know or underestimated the VQ sensitivity rating

The majority of sites where landowners did not know the VQ sensitivity rating occurred on NIPF lands. The majority of those that correctly identified the VQ sensitivity identified the county visual sensitivity maps or internal agency listings as their source.

Cultural Resources

Cultural and historic resources such as old homestead sites, logging camps, human burial sites, and American Indian camp or village sites may be susceptible to damage from forest management. The guidelines recommend landowners and resource managers to check inventory records for the presence of known cultural and historic resources before beginning forest management activities. The proportion of sites for which landowners or resource managers reported checking records for cultural and historic resources has generally increased over time to 80% overall in 2011. Checking records for known cultural and historic resources on NIPF lands improved in 2011 but remains substantially lower than other ownership categories (Table 8).

Table 8: Checked for Presence of Cultural and Historic Resources

		State	County	Federal	NIPF	FI	Total
Percent of sites checked	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%
	2011	100%	85.0%	100%	30.0%	100%	79.8%

As part of the monitoring assessment, the state archaeologist's office checked all monitored sites against the archeological site inventory. Only one known cultural and historic resource was associated with sites monitored in 2011. Landowners and resource managers identified cultural and historic resources based on personal knowledge on three additional sites monitored in 2011. Monitoring contractors identified two additional cultural and historic resources on sites not identified by landowners and resource managers or by the archeologist's office. All features identified by landowners, monitoring contractors, or the state archeologist's office were reported to be excluded from the harvest area and no disturbances were reported for any of the cultural resources monitored, suggesting 100% implementation of protection guidelines.

ETS Species

TH/FM guidelines recommend checking for the presence of endangered, threatened, or special concern (ETS) species sensitive communities, or sensitive sites prior to the initiation of management activities (MFRC 2005). Reported checking on the presence of ETS species is high on public agency and forest industry lands and has improved substantially since 2000-02. Checking for the presence of ETS species remains very low on NIPF lands (Table 9). DNR staff compared monitoring site locations with known locations of ETS species in the DNR Natural Heritage Database (NHDB). In 2011 eight sites were reported to have known occurrences on or directly adjacent to monitoring sites. Two additional sites were reported by landowners and resource managers as having ETS species on or directly adjacent. Staff then compared

information provided by landowners and resource managers on the pre-site form with the results of the NHDB. Of the eight sites reported by the NHDB, only three were reported by landowners and resource managers, suggesting a low compliance rate for sites that actually had known ETS species on or adjacent to them. The NHDB contains a wealth of information for landowners who utilize it. Outreach to NIPF landowners and loggers is recommended to improve the implementation of these guidelines. It is unknown if loggers operating on NIPF lands conducted ETS inquiries without landowner awareness.

Table 9: Presence of ETS Species Checked by Landowner and Resource Manager

		State	County	Federal	NIPF	FI	Total
Percent of sites checked	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%
	2011	100%	90%	100%	25%	100%	83.3%

The TH/FM guidelines also recommend that appropriate management actions be taken to protect or enhance ETS species known or discovered on a harvest site. A wide range of protection strategies exist depending on the species involved, habitat of that species and sensitivity to disturbance. Information regarding rare species, including conservation and management recommendations, is available on the DNR Rare Species Guide at www.dnr.state.mn.us/rsg/index.html. For seven of the 10 sites with reported ETS species (both landowner and NHDB reported), the location or habitat of the species is outside the harvest area or in wetlands or waterbodies with fully implemented filter strips and/or RMZs. For the remaining three sites, no protection strategies were observed on-site or identified in harvest documents.

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 permit 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 10. As in the previous reports, most waterbodies were found within the harvest area of a site, where the risk of disturbance is greatest. Over 90% of all monitoring sites had 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 69% of the total.

Table 10: Percent of Total Waterbodies by Type

	2000-2002	2004-2006	2009	2011
Where Filter Strip Recommended *				
NOWW	77.2%	73.3%	64%	69.3%
Seep & springs	0.4%	2.5%	9.8%	3.1%
Seasonal ponds	5.9%	11.9%	17.5%	17.2%
Intermittent streams <3' (non-trout)	3.9%	4.8%	1.9%	4.3%
Dry wash	-	-	-	0.4%
Man-made ponds	NA	NA	1.2%	0.2%
Where Filter Strip & RMZ Recommended (Including trout waters) **				
Perennial streams – non trout	5.2%	5.3%	3.0%	2.0%
Perennial streams - trout	-	-	-	1.2%
OWW	6.7%	1.4%	0.9%	1.6%
Lakes	0.7%	0.8%	0.5%	0.0%
Beaver ponds	NA	NA	1.2%	1.2%
Total waterbodies (#)	1,099	1018	428	511
Sites with waterbodies (#)	285	254	83	76
Sites with no waterbodies (#)	35	25	5	8

** 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

A filter strip is "an area of land adjacent to a waterbody that acts to trap and filter out suspended sediment, and chemicals attached to sediment, before it reaches the surface water." 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. 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 (MFRC 1999).

During 2011 monitoring, data collection for filter strips was modified to streamline on-site data collection and focus data collection on areas for future improvement. All filter strips were observed and counted in the field with full data sheets completed for only those filter strips where they observed disturbance(s) that potentially resulted in a compromised filter strip. All other filter strips were documented and recorded as being in good condition.

Of 602 total filter strips, 529 (88%) were adjacent to NOWW, 64 adjacent to streams, and nine adjacent to OWW. Filter strip data sheets were recorded for 189 filter strips, all but three of which occurred on NOWW. Not all filter strips that triggered a full data set were determined to be "non-compliant" with the TH/FM guidelines.

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. 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 2011, 21% of filter strips had roads and/or skid trails and 9% had landings located within recommended widths. 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. Six percent of all filter strips had roads located within the recommended filter strip width (not associated with a crossing), with most of these occurring on roads that existed prior to timber harvest activity.

Of the 21 pre-existing roads located within filter strips:

- two were township roads and not rated
- 10 triggered need for water diversion/erosion control (WD/EC) practices
    - one of the 10 had appropriate WD/EC installed where needed
    - nine of the 10 needed WD/EC but were not installed
- nine did not need additional WD/EC

Ten of these pre-existing roads had erosion occurring, two of which had sediment reaching a wetland. Although relocation of existing roads may not be practical or recommended, greater effort should be focused on implementing appropriate WD/EC on these roads. Future training efforts should include implementation of WD/EC on pre-existing roads.

Skid trails were located within the recommended filter strip width on 16% of all filter strips. Guidelines recommend locating skid trails away from filter strips whenever practical. While guidelines recommend to "avoid locating skid trials in filter strips," guidelines allow that "forest

management activities may be conducted in filter strips as long as the integrity of the filter strip is maintained." Many (63%) skid trails located within filter strips had little or no exposed soil (< 5% distributed), but eight skid trails located within filter strips had erosion occurring and four of these resulted in sediment into wetlands. Continued emphasis should be placed on avoiding location of skid trails within filter strips where practical and minimizing exposed mineral soil on these skid trails where unavoidable.

Landings were located in 11% of the filter strips which is nearly equal to past reports. More information on landing location can be found in a later section of this report on page 29.

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 85% of the time in 2011. The majority of disturbances occurred on roads, skid trails, or landings within filter strips and not in the general filter strip itself (Table 11). Ninety-four percent of filter strips showed no evidence of erosion and 98% of all filter strips had no evidence of sediment reaching a wetland or waterbody (Table 12). Of the 10 Filter strips with sediment reaching waterbody, six were from roads and landings, and four from skid trials.

When looking at the condition of general filter strips exclusive of roads, skid trails, or landings; 98% had less than 5% mineral soil disturbance. Clearly, locating these features outside of filter strips where possible and implementing appropriate WD/EC on existing roads within filter strips is critical to improving the implementation of filter strip guidelines.

Table 11: Filter Strip Disturbance

	Total # Filter Strips	Filter strips with roads, skid trails, or landings *	Filter strips without roads, skid trails or landings	Erosion evident in filter strip (% of total)	Sediment reaching a waterbody (% of total)
No soil exposure	**502**	14.8%	68.6%	0	0
<5% Dispersed	**1**	0.2%	0.0%	0	0
<5% Concentrated	**5**	0.5%	0.3%	0	0
≥5% Dispersed	**14**	1.5%	0.8%	0	0
≥5% Concentrated	**80**	12.8%	0.5%	6.0%	1.7%
Total	**602**	29.7% of 602	70.3% of 602	6.0% of 602	1.7% of 602

** excluding approaches*

Table 12: Filter Strip Condition - Effectiveness

	2001-02	**2004-06**	**2009**	**2011**
No erosion visible	93.2%	97.9%	98.9%	94.0%
Erosion evident	6.8%	2.1%	1.1%	6.0%
Sediment reaching waterbody	2.1%	0.9%	0.4%	1.7%
Total number of filter strips	933	1408	561	602

In 2011, monitoring contractors estimated volume of any erosion occurring in filter strips and judged whether erosion would continue beyond the next storm event. Table 27 in the soil resources section summarizes these findings. The majority of occurrences of erosion within filter strips was documented adjacent to NOWWs and all occurrences of sediment reaching a wetland or waterbody occurred in NOWWs. In no cases did sediment reach streams or OWWs. Volume estimates of sediment reaching a waterbody ranged from a trace (less than 1 cubic foot) to 30 cubic feet, with 40% estimated to be 1 cubic foot or less. In most cases, monitoring contractors judged that erosion would continue beyond the next storm event (Table 13).

Table 13: Occurrence of Erosion and Volume Estimates for Filter Strips with Data sheets

Water type	Total # of filter strips	Filter strips with erosion occurring	Filter strips where sediment is reaching wetland/waterbody	Volume of sediment reaching wetland or waterbody	Number of occurrences where erosion will continue
Stream	1	1	1	0	1
OWW	2	1	0	0	1 unsure
NOWW	186	34	9	Trace -30 cubic ft	7
Total	189	36	10	-	8

Riparian Management Zones

Riparian area is defined as the area of land and water forming a transition from aquatic to terrestrial ecosystems along streams, lakes, and open water wetlands. Riparian management zone (RMZ) is defined as that portion of the riparian area where site conditions and landowner objectives are used to determine management activities addressing riparian resource needs. It is the area where riparian guidelines apply. Width and basal area recommendations for RMZs are based on type of waterbody, size of waterbody, and management objective (even-age or uneven-age management). The recommendations are divided into two primary groups: designated trout waters (designated trout streams and their designated tributaries as well as designated trout lakes) and non-trout streams and lakes and open water wetlands.

Non-trout waters:

- For non-trout streams less than 10 feet wide and for lakes and OWW less than 10 acres, the recommended RMZ for even aged management is 50 feet.
- For non-trout streams greater than 10 feet wide and for lakes and OWW greater than 10 acres, the recommended RMZ for even aged management is 100 feet.
- For non-trout streams, lakes, and OWW under uneven age management, the recommended RMZ increases in width to:
    - 100 feet for streams 3-10 feet wide
    - 200 feet for streams greater than 10 feet wide and lakes and OWWs greater than 10 acres.

For designated trout waters:

- For designated trout streams and designated tributaries (both intermittent and perennial), and for designated trout lakes, the recommended RMZ width is 150 feet for even age management and 200 feet for uneven age management.

In addition, guidelines recommend placement of leave tree clumps adjacent to RMZs where practical.

For each RMZ, data were collected from three representative cross sections to characterize the composition of the full recommended RMZ width for each type and size of waterbody (a change from one cross section in past reports). 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)
4) clear-cut (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 evaluated for the partially harvested portion based on 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 24 RMZs were identified on or adjacent to 19 (23%) sites monitored in 2011 (Table 14). Some RMZs had significant areas of nonforest vegetation (i.e., grass, sedge, brush, or shrubs) and two were composed entirely of nonforest vegetation. Six RMZs had partial harvest within the recommended RMZ width; five of these RMZs met recommended guidelines and one did not. Ten sites with RMZs utilized leave tree clumps (LTCs) as a leave tree retention strategy; seven of these sites managed LTCs adjacent to the RMZ.

Table 14: 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
	2011	87.5%	8	50%	2	100%	6
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
	2011	62.5%	16	100%	2	57.1%	14
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
	2011	70.8%	24	75%	4	70.0%	20

Overall, 71% of RMZs fully met recommended guidelines for width and BA. This is a substantial improvement over past years, which reported approximately 50% over all three reports (52% for 2000-02, 46% for 2004-06, and 52% in 2009). All RMZs adjacent to lakes, OWWs, and on-site streams met the recommended RMZ guidelines (Table 14).

Of the seven RMZs that did not fully meet the RMZ guidelines, all appeared to have made some attempt to implement RMZ width recommendations. Five of the seven had 50% or more of the recommended RMZ width and basal area (Table 15). These results represent a positive improvement in attempted implementation of RMZ guidelines over past year's results.

Four of the seven RMZs that did not fully meet guidelines had unharvested forest of varying widths managed to the top of the slope adjacent to the waterbody. This suggests that managers may have felt that managing unharvested forest to the top of the adjacent slope was adequate to meet RMZ guidelines. However, these sites did not represent a "high bank" forest as defined in the guidelines; therefore this practice did not meet the guideline recommend-ations. Clarification in future education and outreach efforts may be needed on this topic. Only one RMZ of 24 fit the criteria of a high bank forest as defined in the guidelines and this site fully met recommendations.

Table 15: RMZs Not Meeting Guidelines for Width and Basal Area

RMZ Setting	Recommended RMZ	Composition of Actual RMZ				% of Recommended RMZ Width
		Width Non-forested (ft)	Width Forested no-harvest (ft / BA)	Width and BA Forested Partial Harvest (ft / BA)	Width Clear-cut (<25BA) (ft / BA)	
On-site streams	-	-	-	-	-	-
Adjacent trout stream	150	54	60/47	0	46/0	76%
	150	24	61/197	0	65/0	57%
On-site streams	-	-	-	-	-	-
On-site OWW	50	27	15/30	0	8/0	84%
Adjacent streams	50'	0	23/133	0	27/7	46%
	100'	0	27/110	0	89/0	27%
	50'	0	30/100	0	20/7	60%
	50'	0	20/80	16/60	14/0	72%
Adjacent OWW	-	-	-	-	-	-

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. Guidelines recommend that operators should minimize number of crossings and avoid crossings whenever practical.

The types and relative proportion of waterbodies and wetlands crossed changed slightly in 2011 compared to previous reports. Notably, no seasonal pond crossings were recorded in 2011. Most seasonal ponds are very small (less than 0.2 acres) and typically can be avoided if properly identified. Improved ability and diligence of loggers and forest managers to identify these important wetland types through emphasis during recent training may have contributed to the avoidance of crossings on these wetlands in 2011. Nearly 75% of all crossings resulted from skid trails, and over 90% of all crossings occurred on NOWW (Table 16).

One of the key guidelines to avoiding impacts to wetlands and waterbodies is to avoid crossings whenever practical. In 2011 monitoring contractors were asked to determine whether a crossing could have been avoided and site objectives still accomplished without unreasonable costs or reduced safety. This is one of the few "judgment calls" made by the monitoring contractors during data collection. Contractors reported that 18% of all crossings could have been avoided, with nearly all occurring on skid trails (Table 16). Only one stream crossing was determined by the contractors as being avoidable (skid trail crossing intermittent stream). Continued and improved avoidance of unnecessary crossings will reduce wetland impacts and improve guideline implementation.

Table 16: Number of Crossings by Infrastructure Component and Avoidance Potential

	Crossings (#)	NOWW*	Beaver Pond	OWW	Stream	Could Have Been Avoided
Roads	62	57	1	0	4	0
Landings	12	12	0	0	0	2
Skid trails	204	185	0	1	18	49
Total	278	254	1	1	22	51

**NOWW includes seasonal ponds and seeps and springs*

Situations where crossings were determined to be avoidable included: multiple crossings of a wetland were one crossing would suffice, cutting across the tip of a wetland rather than driving around the edge, or crossing small isolated wetlands that could easily have been avoided. Photo figures 1 and 2 show examples of crossings that the monitoring contractors determined to be avoidable. The **blue** boundary indicates wetland boundaries, **FID:CRS_ _ _** indicates a crossing, and **red** line indicates site boundary.

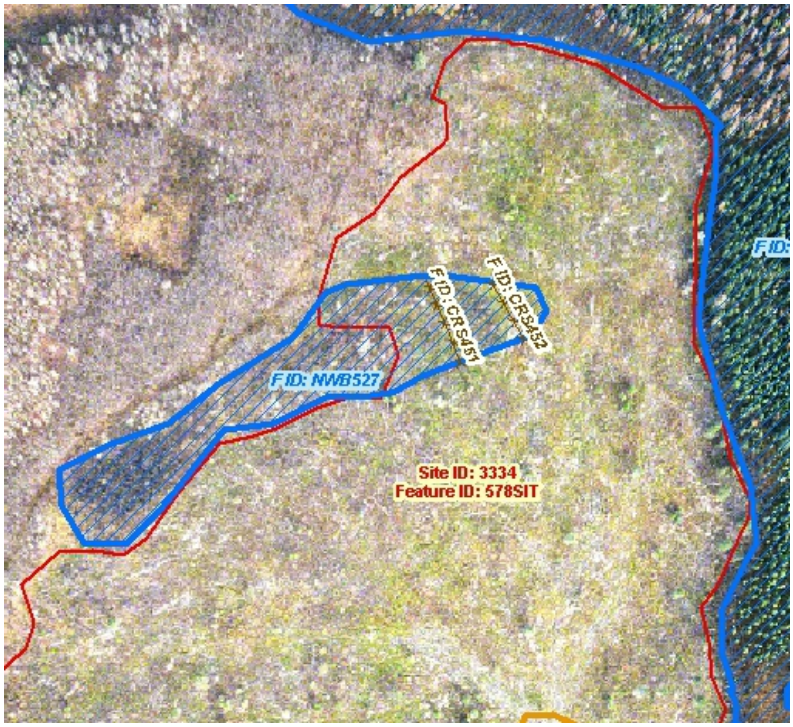


Photo Figure 1: Example of multiple crossings of a wetland

Photo Figure 2: Example of small wetlands being crossed rather than avoided

Frozen crossings continue to be the most frequently used type of crossing due to the high frequency of winter harvests (tables 17 and 18). Most crossings did not involve the placement of fill limiting the potential for long-term damage. Twenty-two stream crossings were recorded

during 2011 monitoring. Four of these crossed perennial streams and 18 crossed intermittent streams. Nearly half of the stream crossings (46%) did not use any crossing structures or it was unknown if any structures were used. Of the remaining 12, six used frozen or ice bridge, four used culverts, one used corduroy, and one used a low water ford (Table 18).

Table 17: Percent of Road and Skid Trail Water and Wetland Crossings by Season of Operation

	Road and Skid Trail Crossings 2000-02	Road and Skid Trail Crossings 004-06	Road and Skid Trail Crossings 2009	Road and Skid Trail Crossings 2011
Spring	0.4%	0.2%	0.7%	0
Summer	5.7%	9.9%	11.0%	15.1%
Fall	6.6%	14.1%	12.8%	7.6%
Winter	66.7%	46.2%	43.6%	45.7%
Summer–fall	3.5%	7.3%	1.5%	2.5%
Fall–winter	4.7%	14.9%	14.3%	17.3%
Summer–fall–winter	8.0%	0%	2.2%	10.1%
Spring - summer	1.3%	4.0%	11.8%	1.8%
Year-round	1.3%	0%	1.1%	0
Unknown	1.8%	3.4%	1.1%	0
Total # of crossings	548	654	273	278

Rutting occurred on 33% of all crossings of NOWW, and seeps and springs. Of the crossings that were rutted, approximately 13% were identified as having rutting exceeding 25% (Table 18). Both of these results are similar to, but slightly higher than the 2009 report. 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.

Table 18: Crossing Structures Used

Structure Type	2000-02	2004-06	2009	2011
Frozen	37.3%	45.3%	51.2%	46.8%
Ice bridge	6.7%	2.0%	1.7%	1.3%
Corduroy or slash mat	9.6%	12.0%	5.7%	9.1%
Culvert	3.2%	3.5%	3.3%	2.2%
Fill	2.3%	5.3%	6.5%	3.8%
Low-water ford	1.8%	2.3%	2.0%	0.3%
Wood mat	0.7%	0.0%	0.0%	0.3%
Dry or Not frozen	0.5%	28.1%	27.7%	30.5%
Bridge	0.2%	0.8%	0.0%	0.0%
Unknown or no crossing structure	37.7%	0.7%	2.0%	12.6%
Total number of crossing structures*	563	737	303	318

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

Rutting on NOWW crossings (including seeps and springs) did not visibly disrupt the hydrology of the wetland in most cases. However, 13 of 254 (5%) recorded crossings had continuous rutting >300 feet, or rutting more than 50% of the width of the crossing or bisecting a wetland (Table 19). This is similar but lower than the 8% reported in 2009. Rutting occurred primarily on skid trails. These situations indicate potential for blocking surface and subsurface water flow in wetlands.

The percent of road crossings rutted is down (12%) compared to 25% reported in 2009. Rutting on skid trails and landings was higher compared to 2009. One-third of all crossings related to landings resulted in >25% rutting (Table 19). This lends strong support to avoiding placement of landings in wetlands were possible.

Table 19: Condition of NOWW, Seep and Spring, and Seasonal Pond Crossings

		Roads	Skid Trails	Landings	Total
Total number of NOWW, seep and spring, and seasonal pond crossings		58	185	12	254
Percent of rutting by category of extent	<2%	-	-	-	0
	2≤5%	3.4%	3.2%	0	3.1%
	5≤10%	5.2%	8.1%	8.3%	7.5%
	10≤25%	1.7%	11.9%	0	9.0%
	>25%	1.7%	15.7%	33.3%	13.3%
Total percent of all crossings with rutting		12.1%	38.9%*	41.7%	32.9%
Number of all crossings rutted >300' or bisecting wetland		0	11	2	13
Number of crossings rutted >300' or bisecting wetlands where rutting was not caused by logging		0	0	0	0

**4 of 84 rutted skid trail crossings were caused by ATVs rather than harvesting equipment.*

Approaches

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. Guidelines recommend that water diversion/erosion control practices should be in place as soon as crossings 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.

In 2011 monitoring protocols were modified for approaches to help streamline data collection, entry, and evaluation. Monitoring contractors collected full field data sheets on only those approaches that required implementation of water diversion/erosion control (WD/EC)

practices, and/or did not appear to meet guideline recommendations. All other approaches had an abbreviated data set collected. Of the 657 total approaches identified, monitoring contractors completed full data sheets on 67. Data suggest that 92% of all approaches were either in stable condition and did not need additional WD/EC, or had WD/EC properly installed and functioning.

Table 20: Condition of All Approaches

	Roads	Skid Trails	Landings	Total
Total number of approaches (#)	139	493	27	657
Approaches - diversion practices not needed (#)	125	443	25	593
# Approaches - diversion practices needed (#)	12	50	2	64
# Approaches - diversion practices installed where needed	6	6	0	12
Rutted (# of total)	0	9	1	10
Erosion evident (# of total)	10	28	1	39
Sediment reaching waterbody (# of total)	5	9	0	14

WD/EC practices and rapid revegetation are important for preventing sediment from moving down an approach and into the associated wetland or waterbody. Conditions observed where installation of additional WD/EC practices were not needed include: approaches with low slope (<2%), approaches with little or no exposed mineral soil, approaches with natural roughness and/or breaks for water diversion. Data for 2011 indicate that 90% of the approaches were judged by the monitoring contractors to be stable enough to not require additional WD/EC practices (Table 20). This is higher than the 77% reported in 2009 and 67% reported in 2004-06 and may reflect better guideline implementation through improved selection of crossing locations, or favorable conditions for vegetative establishment. Change in data collection protocol may also have influenced the results of this data.

Of the 64 approaches that needed water diversion/erosion control practices, only 12 (19%) had practices installed (Table 20). This is substantially lower than reported in 2009 (30%). Over 60% of the approaches that needed WD/EC practices showed evidence of eroding. This result is considerably higher than 40% in 2009 and 34% in 2004-06. Of those approaches where WD/EC was needed, sediment was identified as reaching the associated waterbody in 22% of cases. Erosion and sediment reaching a waterbody was a significantly greater problem on roads than skid trails or landings.

Utilization of slash water bars or scattered slash on skid trail approaches would increase guideline implementation and reduce potential impacts to wetlands and waterbodies. These results reinforce the need to emphasize the importance of WD/EC practices for approaches to crossings and how to identify when WD/EC practices are needed during training programs for loggers, land managers, and 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 ensure operators use effective practices on crossings and approaches.

Soil Resources

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

Logging and Hauling Equipment Traffic

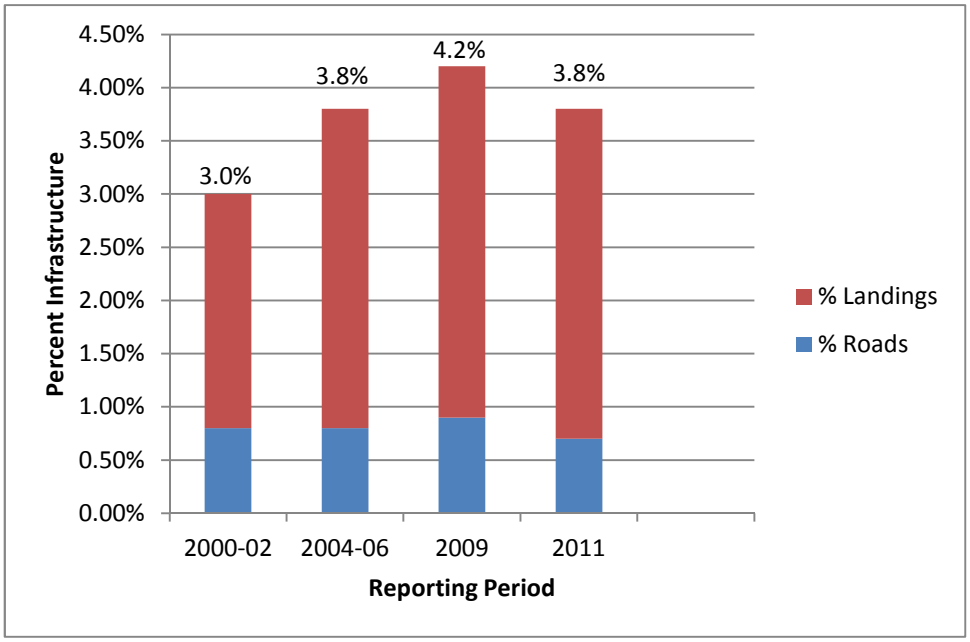
Equipment traffic can compact and rut soil, damage or remove vegetation whose root systems hold the soil in place, reduce movement of air and water into and through the soil, and redirect surface water flow. These impacts restrict plant root growth, reduce the availability of nutrients and moisture for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

The most effective way to minimize impacts of traffic on soil productivity during timber harvest operations is to limit the amount of high traffic area in roads and landings. The current TH/FM guidelines recommend that basic infrastructure (roads and landings) occupy no more than 3% of the harvest area. This guideline is accomplished through careful site design and operational layout.

Monitoring contractors determined total on-site infrastructure by measuring area occupied by landings and roads within or directly adjacent to the site. The reported statewide mean infrastructure for 2011 dropped to 3.8% after steadily climbing from 3% in 2000-02 to 4% in 2009 (Figure 6). The increase in percent infrastructure since 2000-02 has primarily occurred in landing area, with road infrastructure generally stable. Mean on-site landing size in 2011 was 1.0 acres, and mean on-site total infrastructure acreage was 1.2 acres.

Statewide, 41% of the sites monitored in 2011 had 3% or less of the site in infrastructure, therefore meeting the infrastructure guideline (Table 21). This is down from 47% in 2009 and 52% in 2004-06. All ownership categories except state have a lower percentage of sites with $\leq$3% infrastructure in 2011 compared to the previous reports. This continuing trend in low percentage of sites that meet the infrastructure guidelines suggests a continued strong effort is needed to increase awareness of the importance of minimizing infrastructure on harvest sites.

Figure 6: Mean Percent Infrastructure by Reporting Period



Site size impacts ability to operate a harvest operation on ≤ 3% infrastructure. When evaluating on-site infrastructure with site size, highest compliance with infrastructure guidelines (and lowest mean percent infrastructure) was achieved on sites in the 30-40 acre size class (Table 21). This appears to be a harvest size which facilitates the development of efficient infrastructure without adding additional landings. Sites in the 0-10 acre category had the lowest rate of meeting infrastructure guidelines (highest mean % infrastructure), with rates increasing to the 30-40 acre size class. This is correlated with the lowest mean percent of sites in landings which also occurred on the 30 -40 acre size class, with poorest compliance in the 0-10 and 40 - 50 acre size classes (Table 21).

Table 21: Percent On-Site Roads and Landings by Site Size

Site Size Categories	Number of Sites	Mean % Roads Infrastructure	Mean % Landing Infrastructure	Mean % Total Infrastructure	% sites with ≤3% Infrastructure
0-10	9	0.3%	4.4%	4.7%	22.2%
10≤20	25	0.9%	3.3%	4.3%	36.0%
20≤30	17	0.7%	3.3%	4.0%	41.2%
30≤40	8	0.6%	1.6%	2.2%	75.0%
40≤50	4	0.2%	4.3%	4.5%	25.0%
50≤80	14	0.6%	2.5%	3.1%	57.1%
80+	3	0.9%	3.5%	4.4%	33.3%
All sites	84	0.7%	3.1%	3.8%	40.5%

Landing Characteristics

In addition to limiting their total area, guidelines recommend locating landings outside of wetlands, filter strips, and RMZs to maintain water quality and soil productivity, and away from cultural resource areas. Guidelines also recommend containment of fuel or lubricant spills, thin spreading contaminated soil, and/or reporting spills when necessary.

In 2011, 180 landings were recorded by monitoring contactors. No landings were located within RMZs or on top of cultural resources. Over half of landings were located at least partially in a wetland or filter strip, including 36% located partially or totally within a wetland, and an additional 22% located at least partially within a filter strip but not within a wetland (Table 22). In 2009 and 2011, monitoring contractors determined whether suitable upland area was available for location of landings that would still accomplish the site objectives without unreasonable costs or reduced safety. Of those landings located within wetlands and/or filter strips, 41% had upland locations available on the site, resulting in an overall implementation rate of 76% for locating landings outside of wetlands and filter strips when possible.

Table 22: Landing Location

			Percent by Location
Upland only			42.2%
Within RMZ			0.0%
Atop cultural resource			0.0%
In upland and filter strip			21.7%
In wetland only			18.9%
In upland, filter strip & wetland			17.2%
Total			100%
	On-Site	**Off-Site**	**Total**
New landing	95.2%	46.1%	91.6%
Pre-existing landing	84.8%	53.9%	8.4%
Total (#)	167	13	180

Landings were generally in fair to good condition. Just over half of all landings were more than 50% vegetated at the time of monitoring, which is lower than results recorded for 2004-06 and 2009. Ten percent of landings were rutted, with total rutting occupying less than 10% of the landing area in all cases. In 2011, 19% of the landings had visible erosion (similar to past reports), with sediment from landings reaching a wetland or waterbody on less than 1% of all landings. Trash from logging activity was observed on only 4% of all the landings, substantially lower than the 2009 report, but similar to 2004-06 report. Of landings with trash present, 7% had trash from other sources, including hunters, firewood cutters, and general public, and tree planters (Table 23).

Only nine landings (5% of total) had evidence of fueling and equipment maintenance activity identified by monitoring contractors. Guidelines recommend that spills up to 5 gallons be thin spread over the upland part of the site, and spills over 5 gallons must be reported to MPCA duty

officer for recommended action. If all small spills are thin spread, then no evidence should be observable during monitoring field visits. The evidence noted on all nine sites included visible oil/petroleum product stains on the landing (oil spots), often accompanied by "oily" smell. One landing had oil filters and empty jugs of petroleum product present.

Table 23: Landing Condition

	2002	2004-2006	2009	2011
Number of landings	151	596	159	180
Percent >50% vegetated	82.8%	62.60%	69.2%	51.1%
Percent of landings rutted	2.6%	9.90%	7.5%	10.0%
Total Number of landings rutted	4	50	12	18
Number rutted ≤2%	2	31	3	5
Number rutted 2≤5%	2	9	2	7
Number rutted 5≤10%	0	7	3	6
Number rutted 10≤25%	0	1	4	0
Number rutted ≥25%	0	2	0	0
Number of landings rutted attributed to logging	0	47	12	18
Erosion evident (%)	10.0%	10.2%	21.0%	18.9%
Sediment reaching waterbody (%)	0.7%	1.3%	0.0%	0.6%
Logging trash (%)	17.2%	4.2%	12.0%	4.4%
Other trash (%)	8.8%	6.4%	12.0%	6.7%

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 safely accomplish the landowner's management objectives (see infrastructure discussion). Guidelines also recommend utilization of existing roads where practical, and use of access controls on forest roads as a means of reducing costs, limiting the area disturbed by roads, and protecting erosion control practices.

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 103 roads were monitored on 62 sites in 2011. Twenty-two of the 84 sites monitored did not have forest roads recorded (Table 24). Some of these sites did not have a forest road monitored because they were located next to township or county road or a state highway. Some roads were not monitored because traffic from other users made it impossible to

determine the impact of the harvest activity. Over half (55%) of the sites with roads utilized only pre-existing roads, with the remaining sites utilizing at least some new road. Only 1/3rd of all sites had new road construction resulting from the timber harvest activity.

Use of access controls on all roads such as gates, rocks, and other practices was similar to the 2009 report and has improved since the baseline report for 2000-02. Access controls were installed on 68% of all roads in 2011 (Table 24).

Use of access controls on active roads was also similar to the 2009 report but improved from 2000-06 monitoring. Most of the active roads monitored in 2011 were permanent roads used over many years for various activities. FMGs do not require closure of these roads, but encourage controlling access at times when roads are susceptible to damage. Thirty-eight percent of these active roads had access control structures in 2011 (Table 24). Based on the responses to the pre-site questionnaire, roads are kept open for various reasons including forest management access, recreation, private land access, and tribal access.

Access controls on temporarily and permanently closed roads have improved since 2000-02. Temporarily closed roads had access controlled 86% of the time, lower than 100% reported in 2009 but higher than 76% in 2004-06 and 66% in 2000-02. Permanently closed roads had access controlled 100% of the time (Table 24).

Table 24: Road Status

	Active*	Temporarily Closed	Permanently Closed	Status Unknown	All roads
Access controlled	17	30	22	1	70
Access not controlled	27	5	0	1	33
Access status unknown	0	0	0	0	0
All roads	44	35	22	2	103

**FMGs do not require access controls on active roads*

Road, Skid Trail, and Landing Segments

The TH/FM guidelines recommend implementing water diversion/erosion control (WD/EC) 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, but are particularly important near wetlands and waterbodies. These practices should be installed as soon as soil is disturbed during construction, 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.

For the purposes of guideline implementation monitoring, segments are defined as parts of roads, skid trails, and landings with a grade of ≥2%, 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 (this data recorded in other sections). In order to streamline data collection/entry and to focus on areas of concern, monitoring contractors during 2011

monitoring were instructed to only collect full data sheets on segments that had potential to impact water quality. All other segments were documented with an abbreviated data set. This change focuses attention on water quality, but still documents the number and general condition of all segments encountered. A total of 378 segments on roads, skid trails, and landings were identified in the 2011 monitoring. Fifty-nine or 16% of these segments were determined to have potential to impact water quality (WQ segments). Nearly 2/3rds of segments determined by contractors to have potential to impact water quality occurred on skid trails (Table 25).

Table 25: Condition of All Segments

	Roads	Skid trails	Landings	Total
Total number of segments	67	308	3	378
Segments w/ potential to impact water quality (WQ segments)	26.9%	12.3%	100%	15.6%
Segments - WD/EC not needed	7.5%	60.7%	0%	50.8%
Segments – WD/EC needed	92.5%	39.3%	100%	49.2%
Segments with WD/EC installed where needed	38.7% of 62	81.0% of 121	33.3% of 3	66.1% of 186
Sediment reaching waterbody	6.0%	1.6%	66.7%	2.9%
# Segments – diversion practices needed	62	121	3	186

Over 80% of all segments identified occurred on skid trails, 18% on roads, and 1% on landings. Nearly 50% of all segments were judged to require water diversion/erosion control due to slope length, slope steepness, and surface condition (Table 25). This is substantially lower than the 74% reported in 2009 and the 91% reported in 2004-06, but similar to 59% reported for 2000-02. Two-thirds of the segments judged to need WD/EC had one or more of these practices installed, indicating substantial improvement from just over half in 2009. Only three percent of all segments had erosion that resulted in deposition of sediment into wetlands or water bodies, which is identical to 2009 report.

Compliance to guideline recommendations for installing WD/EC where needed was highest on skid trails (81%), a substantial improvement over the 48% reported in 2009. Implementation of this guideline on roads and landings continues low at 39% and 33% respectively (Table 25).

By definition, 100% of WQ segments required some form of WD/EC practices. Over half of these segments had WD/EC installed (Table 26). Roads had the highest frequency of WD/EC implementation on WQ segments at 61%, with skid trails at 55% and landings at 33% (not reported in previous reports). Nineteen percent of WQ segments had erosion resulting in sediment deposited into wetlands or waterbodies which represents 3% of all segments. Because of the proximity of these segments to water, extra effort should be made to install WD/EC measures (Table 26).

Table 26: Segments with Potential to Impact Water Quality				
	Roads	**Skid trails**	**Landings**	**Total**
# of segments that could impact water quality (from Table 25)	18	38	3	59
≥50% vegetated	22.2%	36.8%	0.0%	30.5%
Rutted	11.1%	5.3%	100%	6.8%
Segments (diversion practices needed)	100%	100%	100%	100%
Segments with diversion practices installed where needed	61.1%	55.3%	33.3%	55.9%
Erosion evident (recorded segments only)	100%	68.4%	100%	79.7%
Sediment reaching waterbody	22.2%	13.2%	66.7%	18.6% of 59

On the 33 WQ segments were WD/EC practices were installed, practices included: six earth berm or log/slash water bars, 18 slash placed to divert water, two road profiles designed to divert water, and seven seeded. Of these practices, 28 (85%) of them were installed properly.

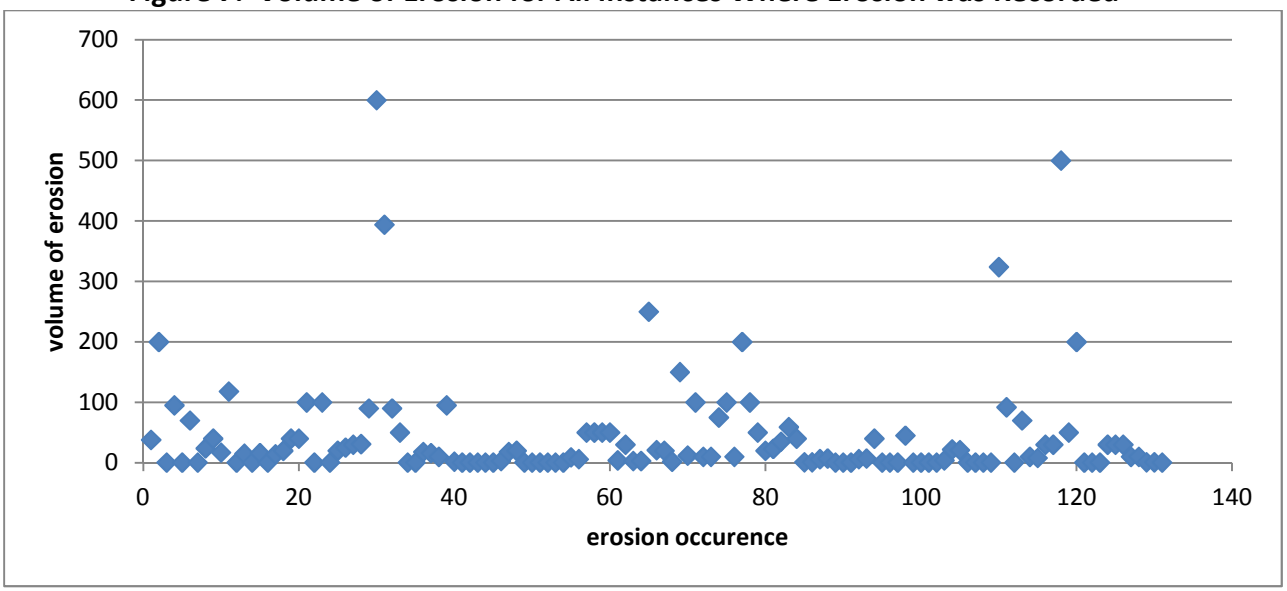
Erosion

In 2011, monitoring contractors were asked to indicate locations (e.g., approaches, landings, segments, filter strips, etc.) where soil erosion was occurring, and to estimate the volume of erosion that had occurred. Erosion was categorized into sheet, rill, or gully erosion. Estimates of displaced sediment volume were made by measuring length, width, and depth of eroded features. Table 27 summarizes the occurrence of erosion and the volumes for each feature category where erosion was recorded. Nine percent of all features checked for possible erosion had erosion occurring, and two percent had sediment reaching a wetland or waterbody. Most (88%) occurrences of erosion were recorded as sheet erosion. The highest relative occurrence (as a percent of the total category features) of erosion occurred on landings, which were also the feature with the highest single volume recorded at 600 ft^3 (Table 27). Nearly half (49%) of the erosion volume estimates were 10 ft^3 or less, with 31% as "trace" (<1 ft^3). Volume estimates ranged widely from "trace" to 600 ft^3, with a mean of 43 ft^3 (SD = 88 ft^3) (Table 27 and Figure 7).

Table 27: Frequency and Type of Erosion Occurring on Various Site Features										
Feature Category	*Total Features*	*Erosion Evident*	*Type of erosion Occurring (#)*			*Volume Range (ft^3)*	*Median (ft^3)*	***Mean*** ***(ft^3)***	***Standard Deviation (ft^3)***	***Sediment Reaching Wetlands***
			Sheet	*Rill*	*Gully*					
Cultural resources	2	0	-	-	-	-	-	-	-	-
Steep slopes	29	1	1	-	-	Trace	Trace	Trace	-	0
Landings	180	34	33	-	1	Trace - 600	27.5	67.8	120.2	1
Segments	378	47	34	13	0	Trace - 500	20.0	50.5	91.3	11
Filter strips*	602	36	36	-	-	Trace – 30	1.0	9.3	3.2	10
Approaches	657	39	34	3	2	Trace - 250	0.5	21.	47.9	14
Total	1848	157	138	16	3	Trace – 600	12	42.8	88.0	36

** Volume of erosion in filter strips was only recorded for sediment reaching a wetland or waterbody*

Figure 7: Volume of Erosion for All Instances Where Erosion was Recorded



** Volume of erosion in filter strips was only recorded for sediment reaching a wetland or waterbody*

Rutting

The TH/FM guidelines recommend minimizing rutting on roads, skid trails, and landings, and avoiding rutting in the general 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 8. For this, and previous reports, rutting has been summarized in six relative ranges of surface coverage: none, ≤2%, 2≤5%, 5≤10%, 10≤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 on 1836 locations on the 84 sites monitored.

Monitoring contractors found rutting on 56.0% of 84 sites monitored in 2011, similar to previous reports (Table 28). Just over 90% of all specific locations checked for rutting had no rutting evident. Rutting greater than 10% surface area decreased from the 2009 assessment, but was still higher than earlier reports. The majority of locations where rutting was greater than 10% were on crossings, which have higher potential to impact water quality and wetland function compared to other locations (Table 28).

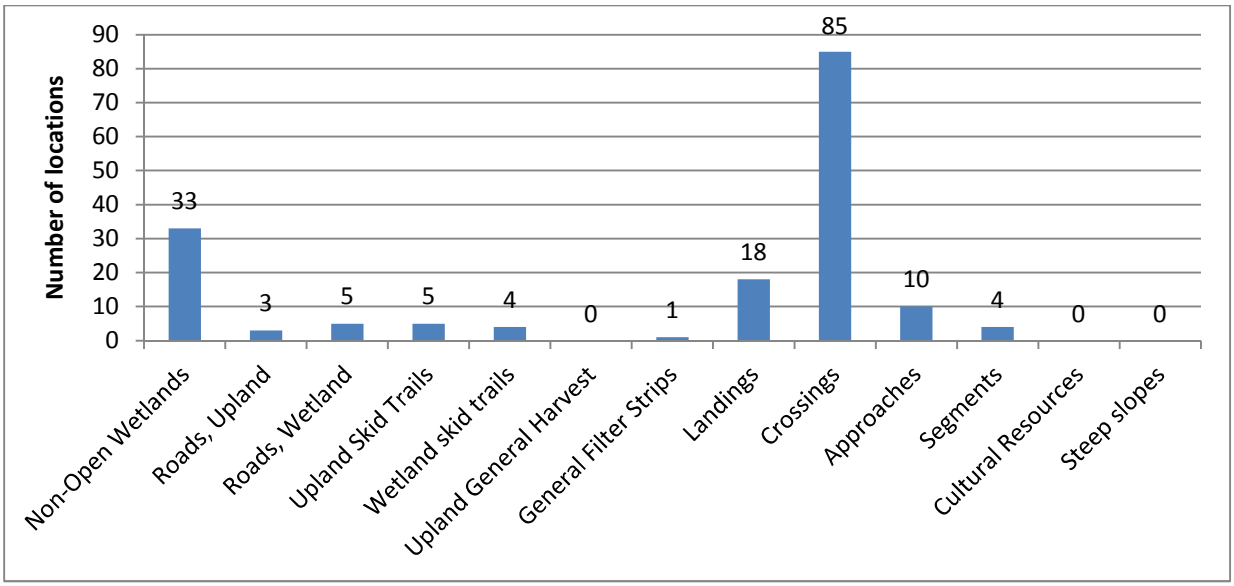
No rutting was found on Cultural resource sites, steep slopes, or the upland portion of general harvest areas.

Table 28: Sites and Locations With Evidence of Rutting					
		2002	2004–06	2009	2011
Number of locations evaluated for rutting		2,257	6,147	2629	1836
Number of locations rutting was observed		136	697	168	176
Percent of monitoring sites with rutting		57.3%	55.2%	47.7%	56%
Percent of rutting by category of extent for those locations where rutting was identified	<2%	52.9%	35.2%	14.0%	21.0%
	2≤5%	25.0%	28.8%	14.0%	14.2%
	5≤10%	5.9%	12.3%	18.0%	17.0%
	10≤25%	9.6%	8.5%	42.0%	23.3%
	>25%	6.6%	18.7%	43.0%	23.3%
Total percent of locations rutted		**6.0%**	**11.3%**	**6.4%**	**9.6%**
Percent of all rutting on infrastructure		98.5%	88.7%	73.2%	65.3%
Percent of all rutting not from logging		NA	5.7%	10.1%	4.5%

The number of specific locations where rutting was identified is shown in Figure 8. Consistent with past reports, half of all observed rutting occurred on crossings. Data indicate that 1/3 of all crossings had observed rutting. Avoidance of crossings where practical, and ensuring that winter crossings are well frozen, should be a focus of future efforts to reduce the occurrence of rutting.

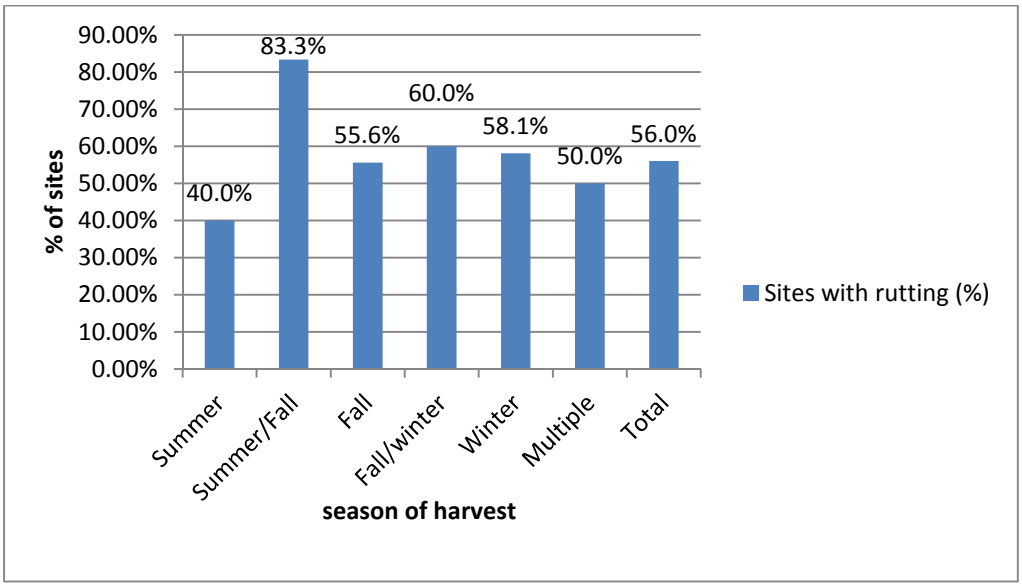
The monitoring results for 2011 and previous years have found that the distribution of rutted sites by season of harvest is roughly proportional to the proportion of timber harvest by each season. However, when evaluating rutting data for sites harvested during a specific season, the six sites harvested during “summer/fall” resulted in the highest frequency of sites with rutting (83%), while sites harvested in “summer only” had the lowest frequency (40%) of sites with rutting (Figure 9). This contrast in “summer only” vs. “summer/fall” harvests may indicate response of sites to fall recharge or weather patterns that resulted in wet soil conditions during the fall of 2009 and 2010. All seasons, with the exception of summer, had more sites rutted than not rutted.

Figure 8: Number of Locations Where Rutting was Observed



We would expect winter harvest sites to have the lowest occurrence of rutting, however, data show that almost 60% of winter harvest sites had some rutting. Clearly, winter harvesting alone does not ensure adequately frozen soils and low occurrence of rutting. The high occurrence of rutting on crossings, combined with frequency of rutting on winter harvest sites, demonstrates the need to adequately freeze down winter crossings.

Figure 9: Frequency of Rutting by Season of Harvest



Slash Disposal and Distribution

Retaining slash on harvest sites contributes to: sustaining soil productivity as well as providing shelter for plants and animals, reducing wind velocity and fluctuations in ground surface temperature, and habitat for small mammals and ground-active beetles (MFRC 2008). The positive benefits of retaining or redistributing slash on harvest sites 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.

Guidelines recommend favoring practices that allow for dispersed slash on the site, rather than piling slash, where dispersed slash does not conflict with management objectives or reforestation. Guidelines also recommend managing the visibility of slash on visually sensitive sites. Specific guidelines exist for retention of slash or fine woody debris on biomass harvest sites.

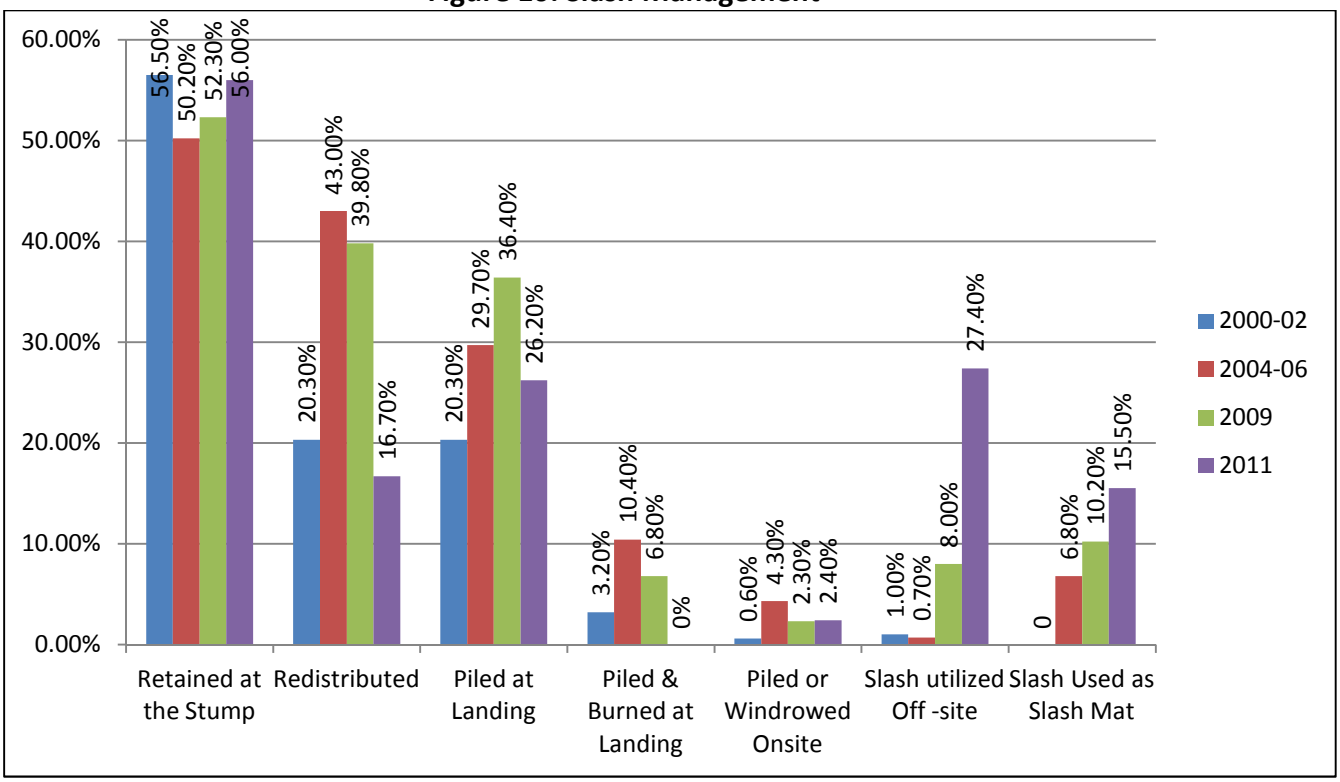
Retaining slash on site at the stump is the preferred method of slash treatment. It has consistently been the most common method used on 50% or more sites in all four reporting periods. Slash piled at landings was the second most commonly used slash disposal method in 2011 vs. redistribution of slash back onto the site, which has been the second most common practice in past reports. This change is likely due to increased utilization of slash for biomass as well as plans or attempts at marketing biomass that never developed, leaving slash piled at the landing.

Slash that was utilized off site jumped sharply from nearly 0% in 2000-02 and 2004-06 to 8% in 2009 to 27% in 2011 (Figure 10). Twenty-three of 84 sites had slash utilized for biomass in 2011 (see biomass section below for more details)**.** Data indicate a continued and consistent increase in sites utilizing slash as slash mats, likely due to increase in the number of monitoring sites harvested during non-frozen seasons, and is consistent with guideline recommendations.

Biomass & Fine Woody Debris Retention

Biomass harvesting guidelines were added to the Site-Level Forest Management Guidelines in 2008. Two of the primary recommendations in the biomass harvesting guidelines recommend that harvest operations on biomass harvest sites should retain and scatter tops and limbs from 20% of trees harvested, and should avoid removing fine woody debris (FWD) resulting from incidental breakage of tops and limbs in the general harvest area. Fine woody debris (FWD) represents woody material that is smaller than 6” in diameter as opposed to coarse woody debris (CWD) that is greater than or equal to 6” diameter. FWD is often synonymous with both “slash,” and “tops and limbs.”

Figure 10: Slash Management



* On several sites more than one slash disposal method was used therefore % is greater than 100.

Monitoring contractors were instructed to document if there was evidence that ≥ 20% of FWD were retained and scattered on the harvest site. Evidence that contractors used to determine this included: clumps (clutches) of slash or tops evident across the site that represents approx 20% or more, scattered slash or tops evident across the site that represents approx 20% or more, slash or tops across the site from one species that represents about 20% of original stand, or other evidence that ≥ 20% of slash had been retained. This determination was strictly an ocular estimate and was used because utilization of standard FWD plot protocols was cost prohibitive. In addition, contractors were asked to indicate if there was evidence that FWD from incidental breakage had been retained. Contractors and DNR staff also reviewed planning and sale documents provided by landowners and managers for regulations or written indication of FWD retention strategies. In instances were slash was retained on the site but piled or concentrated only at the landing, monitors recorded that slash was not retained and scattered on the general harvest site.

Of the 84 sites monitored, 23 (27%) had biomass removed from the site. Contractors judged that only 39% of these sites had ≥20% of the FWD retained and scattered on the site. Of the 23 sites where biomass was harvested, 70% had evidence that incidental breakage was retained. Because the biomass harvesting guidelines were published in 2008, and the 2011 monitoring cycle included sites harvested during summer of 2009 through winter of 2011, it is unclear if some of these sites where put under contract prior to the publishing of the biomass guidelines.

Therefore, these sites would not be expected to have guidelines fully implemented. Regardless, this is an opportunity for improved implementation.

Only three sites where biomass was harvested had specific regulations identified in provided documents that addressed the retention of 20% or more of the slash. Monitoring contractors and DNR staff were unable to find documentation in 10 of the sites where sale documentation was provided, and in the remaining 10 sites no sale documentation was provided by landowners or managers.

Photos 3 & 4 below show differing levels of biomass utilization after a timber harvest. Top photo depicts a timber harvest area in which all of the slash and CWD has been retained on the site. Bottom photo shows an example of a very high level of biomass utilization, with most of the slash, CWD, snags and brush removed from the site.

Photo Figure 3: Slash and CWD retained (*Photo courtesy of Minnesota DNR Forestry)*

Photo Figure 4: High level of biomass utilization (*Photo courtesy of Minnesota DNR Forestry)*

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 in 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 94% of the time in 2011, an improvement over past reports (Table 29). In addition, there continues to be a high percentage of sites (83%) with greater than five down logs per acre. Three of the five sites that did not meet the recommended CWD guidelines were pine thinnings which typically do not generate CWD. Although guidelines recommend creation of CWD in stands without two or more per acre, this is often counter to recommended bark beetle management strategies for pine thinnings. Given the consideration of this important insect and disease management strategy, data suggests that 98% of sites met the intent of CWD retention guidelines.

More than 85% of the RMZs that had harvest activity met the CWD guideline of four sound down logs per acre. This is a substantial improvement from all previous reports (Table 29). CWD retention results show continued improvement in the implementation of these guidelines.

Table 29: CWD in 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%
2011	84	6.0%	10.7%	83.3%
	RMZ			
	Number of RMZs	**RMZs with Harvest Activity**	**Of column B <4/Ac**	**Of column B >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%
2011	24	14	14.2%	85.7%

*** Note CWD was not recorded for 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 leave trees should be at least six inches in diameter and a mix of species representative of the preharvest stand. The preferred alternative is to retain leave tree clumps (LTCs) 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.

Table 30: Percent of Sites That Meet or Exceed Leave Tree Guidelines

	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 or Both	Sites with Scattered and Clumped Leave Trees That in Combination Met Guidelines
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%	0
2011	71	54.9%	32.4%	71.8%	8
2011 Total	71			71.8%	83.1%

Leave trees were evaluated on 71 sites. Twelve sites were not evaluated for leave trees because they were not clearcut and 1 site was a lowland black spruce site where dwarf mistletoe (Arceuthobium pusillum) management prescribed removal of all trees during harvest. The leave tree guidelines were fully met by either ≥6 scattered leave trees or ≥5% clumps on 72% of the 71 sites that were evaluated for leave trees in 2011 compared to 61% in 2009, 47% in 2004-06 and 61% in 2000-02 (Table 30). An additional 8 sites had both <6 scattered leave trees/acre and < 5% in ¼ acre+ leave tree clumps, but in combination met the intent of the guidelines. With this consideration, it was determined that 83% of the sites met the intent of the leave tree guidelines for 2011. These results show continuous improvement over the last three reporting periods and substantial improvement in 2011 (Table 30).

A total of 12 sites (17%) did not meet the leave tree retention guidelines. Of these sites all had some leave trees retained. Six of these sites had 50% or more of the recommended leave trees retained by one or both methods. One site indicated in the pre-site questionnaire that 5% leave tree clumps (reserve areas) were designated on other cutting blocks some distance from the site. Table 31 details leave tree retention for all sites by category.

Table 31: Scattered Leave Trees and Clumps on Harvest Sites				
	Leave Tree Distribution	Percent of sites		
		2004-06	2009	2011
NA-Harvest activity not a clearcut (#)	NA	4.7%	15.9%	12
No leave trees		1.8%	2.3%*	1.4%**
Clumps only	<5% clumps (-)	0.7%	0.0%	-
	>5% clumps (+)	0.3%	0.0%	2.8%
Scattered leave trees only	<1/Ac (-)	10.8%	5.7%	2.8%
	1<6/Ac (-)	25.4%	21.6%	6.9%
	6≤12/Ac (+)	15.4%	18.2%	13.9%
	>12/Ac (+)	12.2%	8.0%	13.9%
Scattered leave trees and clumps	<5% clumps and <1/Ac (-)	2.2%	0.0%	1.4%
	>5% clumps and <1/Ac (+)	2.5%	1.1%	1.4%
	<5% clumps and 1<6/Ac (-)	7.1%	3.4%	5.5%
	<5% clumps and 1 <6/Ac (+)	-	-	11.1%
	>5% clumps and 1<6/Ac (+)	3.6%	8.0%	12.5%
	<5% clumps and 6≤12/Ac (+)	4.3%	2.3%	5.5%
	>5% clumps and 6≤12/Ac (+)	3.6%	3.4%	11.1%
	<5% clumps and >12/Ac (+)	2.9%	4.5%	5.5%
	>5% clumps and >12/Ac (+)	2.5%	5.7%	4.2%
Total number of sites		279	88	84

** 2 lowland black spruce sites with windthrow and disease concerns*

*** 1 lowland black spruce site were dwarf mistletoe management prescribed felling of all trees*

(+) represents conditions that meet guidelines, (-) represent conditions that do not meet guidelines

Snag Distribution

Snags provide habitat for wildlife requiring tree cavities, perches, and bark foraging sites. For monitoring purposes a snag is defined as a dead tree stem standing at least 8 feet tall and 6 inches DBH. The TH/FM guidelines recommend retaining all snags possible and do not recommend specific numbers or distribution of snags. Nearly all of the sites in the four reporting periods retained some snags. Eighty-seven percent of the sites in 2011 retained at

least one snag per acre, and 56% had more than two (Table 32). This data suggests continuing improvement in snag retention.

Table 32: 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%
2011	84	4.8%	8.3%	31.0%	56.0%

Conclusions and Recommendations

Overall implementation of the guidelines has remained high or improved substantially in several areas and has decreased in others compared 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 2011 show that implementation of many guidelines is high including retaining snags for wildlife, retaining CWD in general harvest area, limiting disturbance in filter strips, 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 snags, 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 cultural resources and endangered or threatened species, and holding preharvest meetings with loggers. In addition, implementation of three important guidelines have increased substantially for this reporting period including leave tree retention, riparian zone management, and retention of coarse woody debris in riparian zones. 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: percent infrastructure, location of landings in wetland and/or filter strips were uplands are available, use of water diversion/erosion control, visibility of scattered slash and visibility of landings on “most” visually sensitive sites, location of landings in ROW, occurrence of sites with rutting (primarily on wetland crossings), retention of FWD on biomass harvest sites, and avoidance of crossings were possible. Additionally, the use of guidelines in pre-planning activities and preharvest meetings was low for NIPF landowners. Given the critical role that the above guidelines play in mitigating impacts to water quality, wildlife, and soil productivity, landowners, managers and logging operators should strive 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

As recommended in the 2009 report, 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. I 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 should continue 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 such as identification of specific WD/EC practices and locations where needed, or location of landings away from wetlands and filter strips, 3) require clear written documentation of project planning and supervision, including actions to implement specific guidelines, especially when utilizing alternative methods of implementation.

Some agencies and organizations have made recent progress in this direction often related to opportunities for improvement identified by forest certification organizations. Although field personnel can improve implementation of certain guidelines, top-down administrative support and policies are necessary for broad improvement across the state.

Training and outreach

Since their inception, training in the TH/FM guidelines has been considered the foundation to successful voluntary implementation. The introductory guideline training has been frequently offered and well attended, however, additional in-depth training programs and alternative delivery methods should be developed targeting specific guidelines where improved implementation is desired. Recent steps have been taken in this direction including the development of on-line guideline training (MLEP, Univ. of MN and DNR) providing more flexible access to training and reducing travel costs. In addition both MLEP and SFEC are developing and delivering workshops with cooperation from DNR and University of MN focusing on regulations and guidelines for access road location and construction specifically related to wetland crossings. In some cases agencies and organizations may require in-house training to fully discuss specifics of guideline implementation strategies. MFRC and DNR should consider taking a periodic break from monitoring and focus on implementation training.

Specific topics to consider for focused training could include: 1) understanding importance of wetland avoidance including landing location and crossings, 2) continuation and expanded wetland identification tips, 3) use of water diversion and erosion control practices on segments, approaches, as well as need for implementation on existing roads, and how to recognize when practices are needed, 4) understanding and implementing FWD retention recommendations within biomass guidelines, 5) continued clarification of RMZ guidelines including a review of characteristics of high bank forest, and 6) review of recent guideline revisions approved by MFRC.

Additional effort should be devoted to identifying unique outreach needs for reaching NIPF landowners, loggers who work on NIPF lands and natural resource professionals who advise them. Additional topics for training related to increasing implementation on NIPF lands include: access and utilization of cultural resource, ETS, and visual quality sensitivity information; and advantages of preharvest planning and development of maps.

Improved Clarity and Access to Information

Access to information on ETS species, and visual sensitivity ratings needs to be improved. For some users, information is difficult to find and understand. For example posting links on the MFRC website to the visual sensitivity maps posted on the DNR website may improve access and implementation of these guidelines. An additional deterrent for many landowners is the cost associated with requests for the ETS information. Improved access to useful and applicable information particularly on NIPF lands will likely improve implementation of planning and protection guidelines.

This Page

Intentionally Left

Blank

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.

Fine woody debris (FWD): Tops, limbs and woody debris of less than 6-inch diameter at the large end. Fine woody debris is often synonymous to slash.

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.

Gully erosion: An erosion channel cut into the soil along a line of water flow producing channels larger than rills. For the purposes of guideline monitoring, a gully has a minimum depth of 6 inches and a minimum length of 2 feet.

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.

Rill erosion: Rill erosion is the detachment and transport of soil by a concentrated flow of water forming an erosion channel cut into the soil along a line of water flow, often resembling a braided stream pattern. For purposes of guideline monitoring, a rill becomes a gully when the depth exceeds 6 inches. See gully.

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.

Sheet erosion: The more or less uniform removal of thin layers of soil from an area without the development of conspicuous water channels. Sheet erosion is often characterized by exceedingly numerous, tiny erosion channels or soil pedestals as the general soil layer are washed away.

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.

This Page

Intentionally Left

Blank

REFERENCES

Dahlman, R. 2008. *Timber Harvesting and Forest Management Guidelines on Public and Private Forest Land in Minnesota; Monitoring for Implementation; 2004, 2005, 2005 Results Compared to Baseline Monitoring Report.* Prepared by the Minnesota Department of Natural Resources.

Dahlman, R., and M. J. Phillips. 2004. *Baseline Monitoring for Implementation of the Timber Harvesting and Forest Management Guidelines on Public and Private Forest Land in Minnesota: Combined Report for 2000, 2001, and 2002.* Document MP-0904. St. Paul: Minnesota Department of Natural Resources.

Dahlman, R., and D. Rossman. 2010. *Timber Harvesting and Forest Management Guidelines on Public and Private Forest Land in Minnesota; Monitoring for Implementation 2009.* Prepared by the Minnesota Department of Natural Resources.

Harmon, M. E., J. F. Franklin, F. J. Swanson, P. Sollins, S. V. Gregory, J. D. Lattin, N. H. Anderson, S. P. Cline, N. G. Aumen, J. R. Sedell, G. W. Lienkaemper, K. Cromack Jr., and K. W. Cummins. 1986. Ecology of coarse woody debris in temperate ecosystems. *Advances in Ecological Research* 15: 133–302.

Jaakko Pöyry. 1994. *Final Generic Environmental Impact Statement (GEIS) Study on Timber Harvesting and Forest Management in Minnesota.* Prepared for the Minnesota Environmental Quality Board, St. Paul.

Minnesota Department of Natural Resources. 1994. *Visual Quality Best Management Practices for Forest Management in Minnesota.* St. Paul: Minnesota Department of Natural Resources, Division of Forestry. 78 p.

Minnesota Department of Natural Resources. 1995. *Protecting Water Quality and Wetlands in Forest Management.* St. Paul: Minnesota Department of Natural Resources. 140 p.

Minnesota Department of Natural Resources. 1995. *Minnesota's Forest Resources.* St. Paul: Minnesota Department of Natural Resources, Division of Forestry. 65 p.

Minnesota Forest Resources Council. 1999. *Sustaining Minnesota Forest Resources: Voluntary Site-level Forest Management Guidelines for Landowners, Loggers and Resource Managers.* St. Paul: Minnesota Forest Resources Council.

Minnesota Forest Resources Council. 2001. *The Timber Harvest and Forest Management Guideline Implementation Goals for 2000: A Progress Report.* MFRC #ME-0301. St. Paul: Minnesota Forest Resources Council. 12 p.

Minnesota Forest Resources Council. 2005. *Sustaining Minnesota Forest Resources: Voluntary Site-level Forest Management Guidelines for Landowners, Loggers and Resource Managers.* St. Paul: Minnesota Forest Resources Council.

Minnesota Forest Resources Council. 2007. *Biomass Harvesting Guidelines for Forest lands, Brushlands and Open Lands.* St. Paul: Minnesota Forest Resources Council.

Phillips, M. J. 2001. *Monitoring the Implementation of the Timber Harvesting and Forest Management Guidelines on Public and Private Forest Land in Minnesota: Report 2000.* Document MP-0201. St. Paul: Minnesota Department of Natural Resources.

Phillips, M. J., and R. Dahlman. 2002. *Monitoring the Implementation of the Timber Harvesting and Forest Management Guidelines on Public and Private Forest Land in Minnesota: Report 2001.* Document MP-0902. St. Paul: Minnesota Department of Natural Resources.

Phillips, M. J., R. Rossman, and R. Dahlman. 1994. *Best Management Practices for Water Quality - Evaluating BMP Compliance on Forest Lands in Minnesota: A Three Year Study.* St. Paul: Minnesota Department of Natural Resources, Division of Forestry.