Forest Management Guideline Suggested Revisions: A Report to the Minnesota Forest Resources Council Site Level Committee

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Riparian Management Zone Monitoring in the Paul Bunyan State Forest. Field Calibration Training, June 2020.

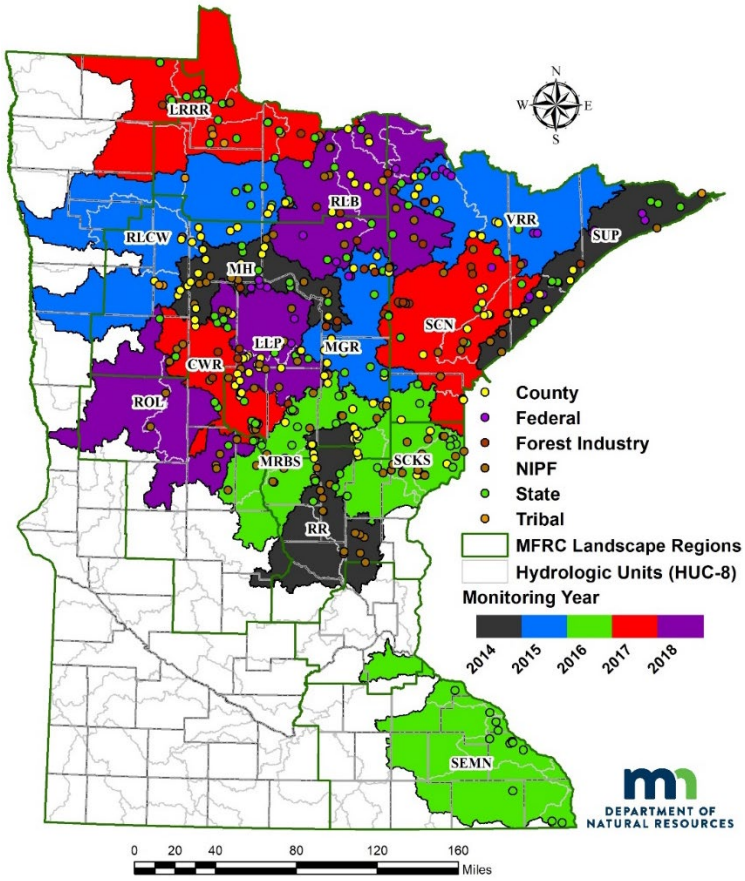
Photo: David C. Wilson

Introduction

This report is in response to a request by the Minnesota Forest Resources Council (MFRC) Site-Level Committee (SLC) to provide recommendations regarding potential forest management guideline (FMG) revisions based on observations and data from guideline implementation monitoring. As such, these recommendations are based on observations and data resulting from monitoring the implementation of FMGs on approximately 700 sites from 2009 – 2018 with focus on the most recent 5 years (Figure 1).

The Guideline Monitoring Program (GMP) is charged with monitoring the implementation of site-level FMGs. Through the process of monitoring implementation, the GMP does collect minor amounts of data related to effectiveness of guidelines such as whether erosion control practices effectively prevent erosion, or retaining scattered leave trees are effective against wind throw. However, we are primarily focused on how the existing guidelines are implemented. Therefore the majority of our data and recommendations in this report focus on modifying or adding language that could improve implementation or achievement of the intent of the current guidelines rather than the creation of new guidelines or expansion of topical areas. This report is organized around the topical areas addressed in the recent forest management guideline stakeholders survey conducted by the MFRC-SLC (MFRC 2021).

Throughout this report references are made to past guideline monitoring reports especially the most recent reports (Wilson et al., 2021, Wilson and Slesak 2020, Rossman et al, 2016 & 2018). For details on methods, protocols, and nomenclature, refer to these past reports.



- **MH:** Mississippi River Headwaters (2014)
- **SUP:** Superior North and South Watersheds (2014)
- **RR:** Rum River Watershed (2014)
- **VRR:** Vermillion River, Rainy River Watershed (2015)
- **MGR:** Mississippi River Grand Rapids Watershed (2015)
- **RLCW:** Red Lake, Red Lake River, Clearwater, and Wild Rice River Watershed (2015)
- **MRBS:** Mississippi River Brainerd–Sartell (2016)
- **SE MN:** Southeast Minnesota (2016)
- **SCKS:** Saint Croix River, Kettle and Snake River Watershed (2016)
- **CWR:** Crow wing River Watershed (2017)
- **SCN:** St. Louis, Cloquet and Nemadji River Watersheds (2017)
- **LRRR:** Lake of the Woods, Rapid River, Roseau River and Rainy River Watersheds (2017)
- **LLP:** Leech Lake and Pine River Watersheds (2018)
- **RLB:** Rainy River Headwaters, Little Fork, and Big Fork (2018)
- **ROL:** Red-eye River, Otter Tail River, and Long Prairie River (2018)

Figure 1. Forested watershed sample units monitored by MNDNR 2014-2018.

FMG Effectiveness and Potential Guideline Revisions

FMG effectiveness may be used as one measure related to the potential need for guideline revision. Improved wording, or altered technical specifications may be suggested for guidelines perceived as less effective. A recent survey conducted by the MFRC-SLC provides helpful information related to this topic (n = 339 responses from agency, industry, logger, and conservation organization stakeholders). In this survey, respondents rated the "perceived effectiveness" of FMGs and/or the effectiveness of the guidelines in getting users to apply recommended best management practices (BMPs) as intended to specific sites. True effectiveness, in most cases, can only be assessed via research on whether the guidelines, as written and implemented, actually achieve the sustainability goal that they were designed to achieve. For example; do the recommended number of leave trees actually mitigate songbird habitat and achieve the sustainable level of habitat for forest song bird species. We assume that survey responses are "perceived effectiveness" unless specific research is cited. Perceived effectiveness is a valuable piece of information to be considered, but may differ from the conclusions of an objective assessment of effectiveness.

Filter Strips & Water Quality

The function of a filter strip adjacent to a waterbody is to trap and filter out suspended sediment, and potential pollutants attached to sediment, before it reaches surface water and wetlands. The guidelines recommend establishment of filter strips adjacent to all water features. 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 2012). The guidelines recommend limiting soil disturbance to less than 5% dispersed soil exposure throughout the filter strip. Concentrated soil exposure is to be avoided. Guidelines further recommend locating landings, roads, and other infrastructure outside of filter strips to maintain the integrity and functionality of the filter strip.

During field monitoring, detailed filter strip information including location is recorded for only those filter strips where contractors observed disturbance(s) that potentially resulted in compromised filter strip function. All other filter strips are counted and labelled as meeting guideline recommendations and summarized at the site scale. Of 2,312 total filter strips (Figure 2) observed across sites, detailed filter strip data were recorded for 387 filter strips that triggered expanded data collection. Most (82.6%) filter strips for which detailed observations were recorded were located adjacent to non-open water wetlands (NOWW) (possibly indicating the need for stricter adherence to the guidelines around these sensitive and bio-diverse ecosystems), 12.3% were adjacent to streams, and only 5.1% were adjacent to open water wetlands (OWW).

For all filter strips recorded, 2.6% had exposed mineral soil within the filter strip at the time of monitoring visits, with most of these due to presence of roads or landings within the filter strip. Only 0.26% of filter strips (six strips) had erosion occurring within the filter strip, resulting in sediment being deposited into the adjacent wetland (Total Volume = 60 cubic feet) on five occasions. Overall, 97.4% of filter strips met the minimum disturbed soil recommendations of no concentrated soil exposure or less than 5% dispersed soil exposure. However, infrastructure placement reduced overall compliance on filter strip implementation to 83.3%; mostly due to placement of landings, skid trails, or roads within the filter strip (often with an alternative upland site available).

The RR and CRW watershed sample units (WSUs) had over 90% compliance with filter strip guidelines. In contrast, LRRR, SEMN, and VRR had lower compliance (52-67%), and may demonstrate either difficulties with filter strip implementation in steep landscapes (SEMN), landscapes composed substantially of NOWW (e.g., LRRR and VRR), or differences in weather related soil conditions, timing of harvest among units, or filter strip management practices among WSUs.

- Of 2,312 filter strips monitored:
  - 387 (16.7%) had an identified concern,
  - 6 (0.26%) resulted in sediment delivery to surface water (99.7% effective).

- Potential Concerns:
  - Landing located within filter strip (242)
  - Road constructed within filter strip (62)
  - Skid trail developed within filter strip (60)
  - Erosion occurring within filter strip (6)
  - Sediment deposited into wetland or waterbody (5)

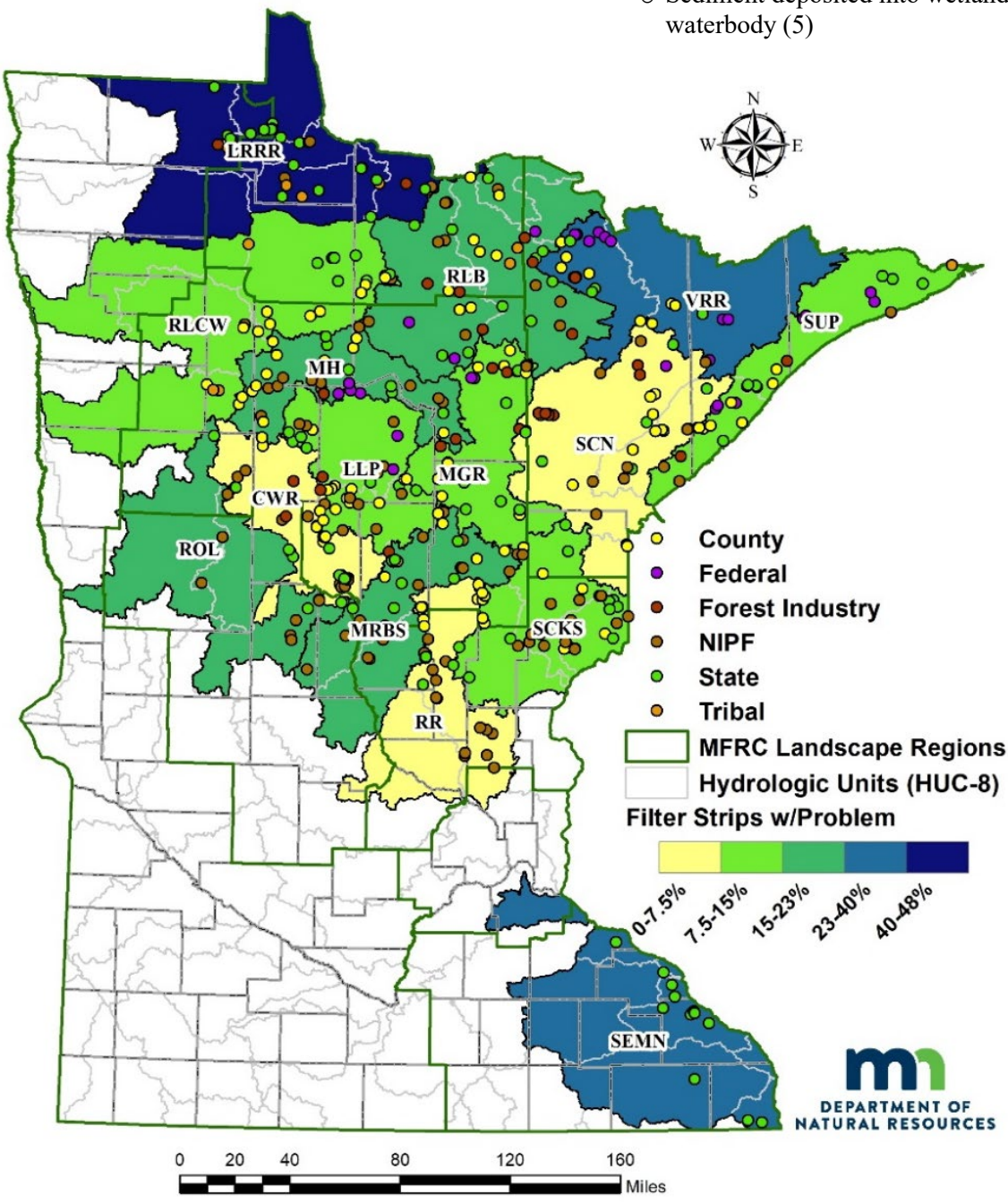


Figure 2. Filter strip use and performance 2014-2018.

FMG Stakeholder Survey Results

- 79% reported sufficient or better effectiveness of the FMGs related to filter strips.
- 61% of respondents reported these FMGs do not need to be modified, 23% reported that they should be modified.
- 7% of respondents indicated that FMGs related to this topic are not being implemented well or are being implemented too narrowly in the forest.
- Survey respondent recommendations for potential revision: clarify difference between guidelines related to filter strips and those for RMZs, review and reassess harvest guidelines within filter strips, widen filter strip requirements

GMP Recommendations

- The GMP feels that the filter strip guidelines are critical guidelines and the basic premise and language is solid. Our recommendations below are focused on language that highlights areas where there are opportunities to improve the implementation.

- Regarding the confusion identified in the survey over the difference between filter strip and RMZs: The filter strip is a water quality feature that relies on the forest floor and ground vegetation to "filter" out sediment and contaminants from runoff before it enters a waterbody. A Riparian management zone also serves to filter runoff but its primary function is to provide the critical habitat that occurs adjacent to waterbodies as well as shading, transpiration and contribution of organic matter to streams and wetlands. Typically, the RMZ is wider than the filter strip except for steep slopes adjacent to small wetlands (<1 acre) or small streams (<3 feet) where the RMZ might be 50 ft. and the filter strip would be greater than 50 due to slope.

  This may simply be an outreach issue. However, the following may help improve understanding:
  - Include better diagrams that show the overlap of filter strips and RMZs in open water bodies as well as just filter strips in non-open water bodies.
  - Develop a more inclusive table/chart with all water features listed along with requirement of Filter strip or RMZ indicated.
  - Modify language to say "if managing an RMZ, then a filter strip is already included within the RMZ provided minimal soil disturbance occurs. However, for waterbodies that do not require an RMZ then a dedicated filter strip is needed." The only issue here is for small wetlands or streams with adjacent steep slopes where recommendations call for a 50 ft RMZ but a wider filter strip. See filter strip width guide page 26 in General Guidelines.
- The FMGs currently recommend that land mangers consider locating leave tree clumps adjacent to waterbodies to enhance the protection of the waterbody (page 36 of Timber Harvest guidelines). To increase protection of waterbodies (especially seasonal ponds), clarify leave tree clump (LTC) guidelines to emphasize the use of LTCs around seasonal ponds AND place this language in the General Guidelines section (page 26) discussing filter strips in addition to the section addressing leave trees.

- Filter strips on existing infrastructure: We often encounter an existing road that is within a filter strip. Our basic feeling is that rather than create a new road outside the filter strip (and doubling the footprint of infrastructure), we should bring the existing road up to standards or guideline expectations including water diversion and erosion control. There are two camps on this; one camp agrees with the above, the other camps use the road, but considers it someone else's road that they are not responsible to fix. This issue could be addressed in guideline revisions.

- As indicated in the 5-year summary monitoring report (MNDNR 2021), and in Tables 1 and 2

below, location of landings within filter strips was the most common reason for non-compliance of filter strip guidelines. Additionally in 2016, for nearly half of the landings that were located within filter strips, "landing sprawl" or expansion of landings during operations appeared to be a major contributing factor. Compliance may be improved by more specific language regarding landing locations outside of filter strips, RMZs or wetlands and language recommending that landings and filter strips be clearly identified preferably during a season when wetlands are easily identified such as snow free season or specifically spring for seasonal ponds.

Table 1. Landing Location and Monitoring Year: Upland Site (US) or Wetland/Filter strip/RMZ (WFR).

Watershed Sample Unit	Monitoring Year	Total Sites (n)	Total Landings (n)	Landings in WFR (n)	# in WFR Where US available	% WFR where US available	% Sites w/landing in WFR where US available
CWR	2017	31	72	12	NA	NA	NA
LLP	2018	32	125	13	NA	NA	NA
LRRR	2017	31	199	75	NA	NA	NA
MGR	2015	29	95	30	15	15.79	37.9
MH	2014	35	137	22	15	10.95	22.9
MRBS	2016	34	25	25	13	52	35.3
RLB	2018	36	157	47	NA	NA	NA
RLCW	2015	24	73	20	13	17.81	45.8
ROL	2018	15	30	6	NA	NA	NA
RR	2014	28	48	14	10	20.83	32.1
SCKS	2016	34	49	45	35	71.43	67.6
SCN	2017	37	99	18	NA	NA	NA
SEMN	2016	12	3	3	0	0	0
SUP	2014	30	85	9	6	7.06	16.7
VRR	2015	26	135	67	41	30.37	61.5
Total	***2014-2018***	***434***	***1,332***	***406***	***335****	***25.14***	***35.53***

* Total number estimated from percent of observation in 2014-2016 with landings placed in wetland (NOWW) or filter strip (FIS) where upland sites were available.

Table 2. Distribution of Landing Placement (2014-2018).

Placement	# Landings	Percent
Open field	2	0.15%
Grass opening	1	0.08%
Old gravel pit	1	0.08%
Pasture	4	0.30%
Upland	919	68.99%
Wetland	153	11.49%
In filter strip	243	18.24%
Within RMZ	9	0.68%
Total	***1,332***	***100%***

Specific language recommendation & locations:

Page 23 of General Guidelines (GGs)[1]

Water Quality and Wetlands

✔ Plan forest management activities to avoid ~~operations~~ developing infrastructure in wetlands, including landings, skid trails and roads. Where avoidance is not practical, minimize impacts by limiting the extent of infrastructure in wetlands. ~~wetland activities~~.

- NOTE: I have had managers suggest that this means don't harvest or create any infrastructure in wetlands. I believe that what we intended was to avoid wetlands where possible, not to eliminate harvest in sites such as lowland conifers. We successfully harvest thousands of acres of lowland conifer on sites that are well frozen.

Page 22 timber harvest section:

✓ Avoid locating landings and yarding areas on ~~open water~~ wetlands or in filter strips or RMZs where possible (or where upland areas are available).

✓ Prevent landings from expanding into sensitive areas during operations including wetlands, filter strips, and RMZs.

✓ Clearly ID all wetlands and wetland boundaries during a season when they are clearly visible (not snow covered…) so that managers and operators can avoid impacts by:

- Locating landings outside of filter strips or wetlands
- Avoiding crossing wetlands where not needed or clipping the edge of wetlands (see report)
- More clearly define filter strips to aid avoidance
- Identifying likely locations for LTCs

Page 11 General Guidelines

Conducting a Site Inventory:

Conducting a site survey involves gathering information, surveying the site firsthand, and then considering a number of factors related to resource needs, landowner objectives and site capabilities. The following planning and design considerations are not all inclusive, but they do identify some of the key factors in making informed forest management decisions.

Add language in this section that specifically addresses locating/identifying wetlands on sites through data such as NWI as well as through on-site inspection during snow free season when wetlands are most visible.

[1] Colored highlighting and colored text are used to reference specific color-coded sections of the voluntary site-level timber harvesting guidelines manual (MFRC 2012), and specific language recommended to clarify or enhance communication of the guidelines, respectively. Existing language to be replaced or enhanced is represented by a ~~strikethrough~~.

Page 13 GGs

✓ Identify resources, features and site conditions that may require special attention, such as:

• Perennial and intermittent streams, lakes, open water **wetlands, non-open water wetlands and seasonal ponds**

We recommend specific language here suggesting that this evaluation be done during season when wetlands are most apparent (i.e. snow free)

Riparian Management Zones (RMZs)

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. RMZs provide direct shade to streams and lakes as well as shade to soils and ponded water that result in cooling or maintaining temperatures in runoff and internal drainage that is particularly important for cold water habitats. RMZ guidelines were substantially revised during the 2012 revisions. The Riparian Science Technical Committee final report was used extensively as a reference in those revision discussions. See pages TH35 & GG 38-39 for modified guidelines. As a result of the revisions:

- Area within RMZs are allowed to be counted towards the recommended 5% leave tree area
- RMZ guidelines were substantially simplified, including simplification of RMZ width categories as well as the recommended residual basal area retention to 60 square feet for all RMZs
- Modification of RMZ width recommendations depending on stream, lake or wetland characteristics

The 2012 Site Level Committee also had considerable discussions regarding the expansion of RMZs to seasonal ponds. A review of these discussions may benefit the current guideline revision process.

During RMZ monitoring, data are collected from three representative cross sections (transects) to characterize the composition of the full recommended RMZ width based on type and size of waterbody. Basal area (BA) within the RMZ is determined using a variable radius plot with 10 factor prism. Linear distances and BA are recorded for all portions of the transect corresponding to:

- Non-forest (sedge, brush, and scattered trees)
- Undisturbed forest (no apparent harvest)
- Partially harvested forest (harvest retained partial canopy)
- Clear-cut (for remaining recommended RMZ width)

Some RMZs have significant areas of non-forest vegetation (i.e., grass, sedge, brush, or shrubs) adjacent to water, while others are composed entirely of forest. Compliance is based on the combined width of non-forest, undisturbed forest, and partially harvested forest (where reserve trees meet the BA recommendations) from the water's edge landward. Basal area compliance is evaluated for all but the clear cut area and is based on the minimum recommended basal area of 60 ft^2. RMZs meeting 95% or more of recommended width and basal area are within the margin of error and considered compliant.

A total of 243 RMZs were identified on or adjacent to 166 sites monitored from 2014-2018 (Figure 3). Overall, 175 of 243 (72%) RMZs fully met the guideline recommendations for width and basal area of forest retention. Another 18.4% of sites with RMZs implemented an average of 75% of the recommended RMZ width and/or BA. From a watershed perspective, compliance for RMZ implementation is highest for the ROL watershed sample unit. ROL provided a small sample (5 sites with RMZs), but had 100% compliance on all RMZs adjacent to OWWs and streams. The LLP, SUP, SCN, and MH units also had high rates of guideline implementation for riparian management (> 80%). The RR, VRR, LRR, MGR, RLB, and SEMN units had lower rates of riparian BMP implementation (<70%). Overall, compliance on trout streams was

87%, while compliance on lakes was 79%, and 72% on non-trout waters.

RMZ compliance improved between statewide cycles ending in 2011 and 2018, respectively (p-value = 0.0000021). From 2009-2011, the average RMZ was in compliance with guideline recommendations (percent difference between observed and recommended RMZ width was 0%). From 2014-2018, the average RMZ exceeded guideline recommendations for width by almost 59%. The corresponding increase in average RMZ compliance can be seen in an increase from 56% total compliance (2009-2011, n = 45 RMZs) to 73% total compliance (2014-2018, n = 243 RMZs). It is important to note that many RMZs not meeting guideline recommendations for width still provided substantial benefit with average widths totaling 70-80% of the recommendation.

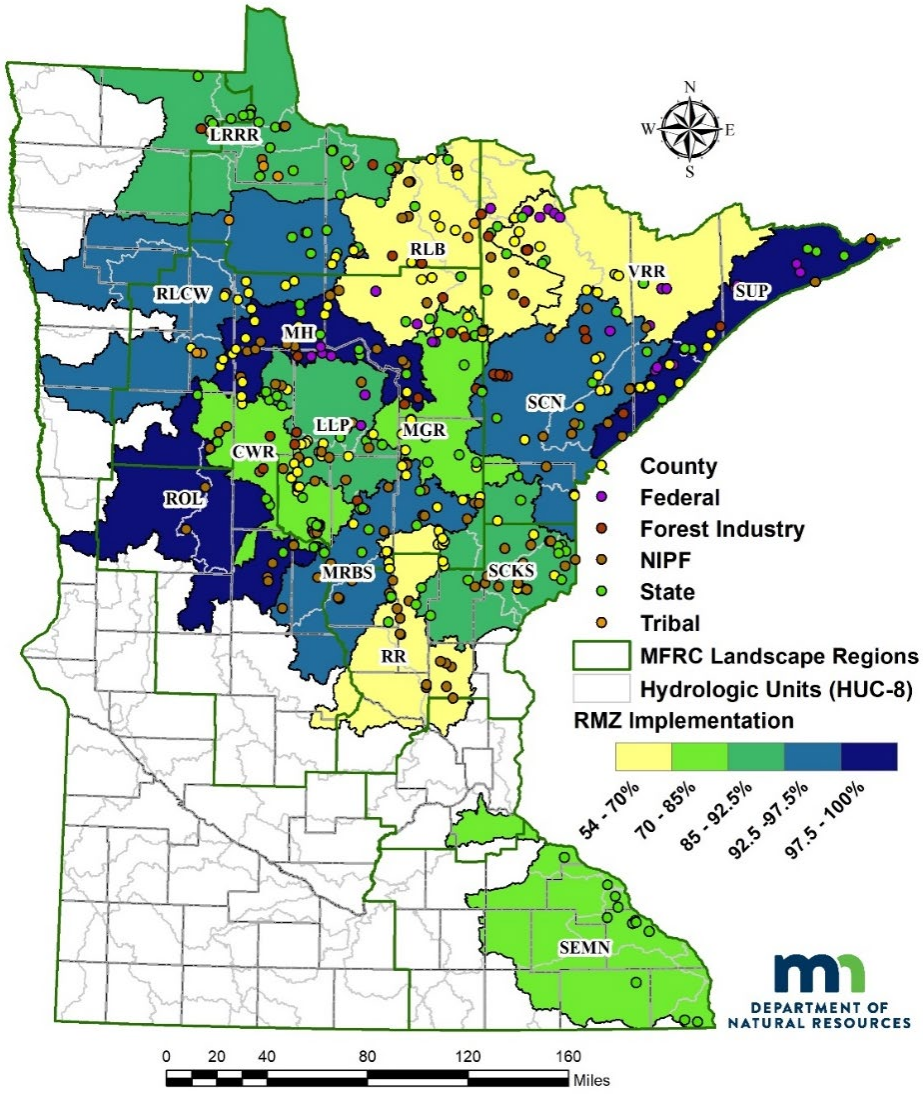


Figure 3. Riparian Management Zone implementation 2014-2018.

FMG Stakeholder Survey Results

- 76% reported sufficient or better effectiveness of the FMGs related to this topic
- 50% of respondents reported these FMGs do not need to be modified, 28% reported that they should be modified
- 10% of respondents indicated that FMGs related to this topic are not being implemented well or are being implemented too narrowly in the forest.
- Survey respondent recommendations for potential revision: clarify and simplify the types of surface water around which RMZ guidelines are applied (e.g., open-water vs. closed-water wetlands, temporary vs. permanent streams, etc.), review impacts of 2012 revision which allowed RMZ areas to be counted towards total reserve land (are site-level sustainability goals still being met?), widen and clarify harvest guidelines for within RMZs to ensure sustainability objectives are being met

GMP Recommendations

Leave tree guidelines show relatively high compliance and have shown improvement over the monitoring period from 2009 to 2018. Although some of this improvement is likely due to the inclusion of RMZs in leave tree areas, most sites met leave tree guidelines without inclusion of RMZs.

- GMP found 94% compliance with leave tree (LT) guidelines and the majority of those did not use the RMZ caveat to meet minimum LT requirements. Many met requirements all three ways (scattered, clumps, RMZs).
- 83% of leave tree clumps (LTCs) were used to protect non-open water wetlands. So, the concept of using LTCs to protect wetlands is being used! This could be further investigated related to seasonal ponds.
- Consider clarifying language recommending that if an RMZ is to be used as a LTC, then the 80 BA minimum should be used within the RMZ so that it meets requirements of a LTC (see page 37 TH guidelines). Note that the GMP rarely monitored RMZs that had harvesting within the RMZ.
- Clarification of what is the RMZ and what is the filter strip may help (see discussion in filter strips)
- Open water wetlands are defined in the glossary as Type 3,4 & 5 wetlands using the Circular 39 wetland classification. It may be appropriate to modify the Glossary to include the definition of open water wetland based on the Cowardin wetlands classification system to be consistent with National Wetlands Inventory.
- As identified in the 5-year monitoring report (MNDNR 2021), retaining CWD within RMZs can sometimes be confused with guidelines that recommend avoiding placement of slash within filter strips (See the section on slash, coarse woody debris, and snags, page 49). Clear communication in guideline training could contribute to improved implementation. Clarification in the guidelines may also contribute to better understanding and implementation.

  Page 40 General Guidelines:

  ✓ Create or retain at least four leave logs per acre within the RMZ.
  Use sound forest management where insect and disease concerns exist. See *General Guidelines: Providing Coarse Woody Debris.*

  This guideline should only apply when management is being conducted within the RMZ. If a particular RMZ is a no harvest zone, we do not believe that the intent is to create CWD by dropping residuals. Confusion has occurred in interpreting the intent of this guideline. Perhaps it should read as: *ensure that 4 leave logs per acre (CWD) are retained when harvest activities are conducted within RMZs.*

Visual Quality

The visual quality guidelines were initiated by the forest industry and the tourism industry and developed in 1995 to be later incorporated into the FMGs. Associated with the development of visual quality BMPs, visual sensitivity classification maps were developed for the 16 northern counties with land departments and can be found at Visual Sensitivity Classifications Link. These maps and narratives identify features such as roads, rivers, lakes, or recreational trails that are rated as "most," "moderately," or "less," visually sensitive. Visual quality guidelines are directly tied to these ratings. The online visual sensitivity maps have not been updated in many years, and are incomplete with respect to recreational trails, waterways, and even some surface roads.

Figure 4. A visual quality buffer implemented between a recent harvest site and the adjoining public road.

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. Visual quality guidelines were evaluated on 269 monitoring sites located within 29 counties. For these 269 sites, 74.6% managed visual sensitivity in compliance with guidelines related to leave trees, snags, landing and infrastructure management, and other aesthetic values (Figure 4). For the 16 northern counties with visual quality guidelines, average compliance was 81.4% (228 vistas) (Table 3).

Past reports indicate that better access to visual sensitivity maps and narratives could improve compliance. In particular, it appears that features identified in the visual sensitivity narratives were often overlooked because these features do not appear on the online map.

Table 3. Visual quality sensitivity and guideline compliance for 16 northern counties with VQ standards.

County	Sites (n)	Vistas (n)	Less Sensitive	Moderate Sensitivity	More Sensitive	Percent Sensitive	Percent Compliant
Aitkin	32	19	16	2	1	15.8	78.9
Becker	6	2	2	0	0	0	80
Beltrami	20	15	11	2	2	26.7	82.9
Carlton	5	1	1	0	0	0	66.7
Cass	53	41	23	10	8	43.9	80.7
Clearwater	8	2	2	0	0	0	88
Cook	10	7	3	2	2	57.1	74.7
Crow Wing	19	21	9	10	2	57.1	82.9
Hubbard	15	10	3	0	6	60	73.6
Itasca	36	23	13	5	5	43.5	85.4
Koochiching	37	16	9	3	4	43.8	79.1
Lake	23	9	8	1	0	11.1	76.9
Lake Of	10	5	5	0	0	0	83.6
Mille Lacs	7	5	4	1	0	20	95.3
Pine	24	12	10	2	0	16.7	89.8
St Louis	65	40	25	11	4	37.5	83.6
Total	***370***	***228***	***144***	***49***	***34***		***81.4***

FMG Stakeholder Survey Results

- 81% reported sufficient or better effectiveness of the FMGs related to this topic
- 53% of respondents reported these FMGs do not need to be modified, 19% reported that they should be modified
- 6% of respondents indicated that FMGs related to this topic are not being implemented well or are being implemented too narrowly in the forest.
- Survey respondent recommendations for potential revision: update the sensitivity classifications based on current use and development, create more user-friendly tools for accessing visual sensitivity ratings, clarify and simplify guidelines for the various sensitivity ratings, opportunities for education regarding proper forest management.

GMP Recommendations

The GMP generally agrees with the majority of respondents that the VQ guidelines are being well applied, however, we also agree that updating the sensitivity classifications based on current use and development, and creating more user-friendly tools for accessing visual sensitivity ratings is needed. As indicated in past reports, there appeared to be inconsistencies with how the visual quality sensitivity (VQS) ratings (which trigger specific practices) were being determined. It appeared that land managers & loggers often only look at the VQS ratings for nearby roads that are identified on the map. This may be in part because the roads map is the main focus on the website and the narratives are somewhat obscure on the website. Because the VQS rating establishes the level of VQ guidelines to be used on a site, it seems that it would be difficult to consistently implement these guidelines if the VQS ratings are not consistently being used or understood. Improving the accessibility of the VSRs tied with outreach and education could improve implementation.

Cultural Resources

FMG Stakeholder Survey Results

- 86% reported sufficient or better effectiveness of the FMGs related to this topic
- 67% of respondents reported these FMGs do not need to be modified, 14% reported that they should be modified
- 3% of respondents indicated that FMGs related to this topic are not being implemented well or are being implemented too narrowly in the forest.
- Survey respondent recommendations for potential revision: enhance education and improve access to information concerning locating and identifying cultural resources, simplify and clarify existing guidelines.

The GMP agrees with the 86% of respondents that the CR guidelines are being effectively implemented. Although few monitoring sites had known or discovered cultural resources, compliance to protection measures is high and there appears to be good understanding of the guidelines. Our experience is that the State Historical and Preservation Office staff as well as DNR staff respond quickly to requests for information, but locations are general to the forty-acre parcel.

Spill Kits

FMG Stakeholder Survey Results

- 79% reported sufficient or better effectiveness of the FMGs related to this topic
- 62% of respondents reported these FMGs do not need to be modified,
- 13% reported that they should be modified
- 6% of respondents indicated that FMGs related to this topic are not being implemented well or are being implemented too narrowly in the forest.
- Survey respondent recommendations for potential revision: prescribe a minimum spill kit for enhanced compliance and to help meet certification standards, clarify requirements to improve implementation.

GMP Recommendations

Spill kits would fall under the general category of "**Managing Equipment, Fuel and Lubricants" in the General Guidelines P 44&45.** The guidelines under this category were slightly modified during the 2012 revisions related to reporting and handling of petroleum spills. The actual term "spill kit" is not used in the current or prior guidelines and there is not a requirement to have specific spill kits on sites. This is something that has been required by some forest certification standards and has overlapped into the site-level guidelines. Having a spill kit on site during operations and the use of spill kits to contain spread of contaminants is certainly a logical extension to the existing guidelines, and spill kits are specifically mentioned in the field pocket guide.

Because spill kits are not specified in the current site-level guidelines, and because monitoring occurs after activities are completed, there is no monitoring data specific to presence of spill kits or materials to control leaks on site during operations. Monitoring contractors document evidence of leaks and spills or the resulting cleanup when on site.

The current guidelines could be revised to include the recommendation that spill kits be present and available on all operations where spills could occur and may improve the prevention of spread of spills or leaks on sites.

- Slides in the current on-line Introduction to Forest Management Guidelines address this issue with language that may be worth considering.
    - ***Slide 11***:
        - ***Up to ten cubic yards of contaminated*** *soil may be thin-spread, if conditions are met. (MPCA approval is required if spill is over 5 gallons). If the landowner has given permission, contaminated soil may be spread at least 200 feet or more from surface water, wells, and sewers, between April and October. The contaminated soil must be spread less than two inches thick and incorporated into native soil.*
        - ***If the contaminated soil is more than*** *ten cubic yards, call the State Duty Officer at the same number mentioned earlier: 800-422-0798 for immediate advice and approval of your cleanup plan.*

      It may be instructional to illustrate what a 5 gallon spill looks like. It is not always easy to estimate the volume of a spill once it is on the ground.

- Another instructive presentation has been developed by the Guideline Monitoring Program with input from the DNR Forestry Silviculture and Certification Teams. David Wilson can provide this PowerPoint.

Seasonal Ponds

FMG Stakeholder Survey Results

- 72% reported sufficient or better effectiveness of the FMGs related to this topic
- 52% of respondents reported these FMGs do not need to be modified, 26% reported that they should be modified
- 11% of respondents indicated that FMGs related to this topic are not being implemented well or are being implemented too narrowly in the forest.
- Survey respondent recommendations for potential revision: clarify the description of seasonal ponds, improve education on identification of seasonal wetlands during different seasons (e.g., difficult to identify during the winter when snow covered), emphasize the ecological importance of these features.

GMP Recommendations

For the purposes of implementation monitoring, seasonal ponds fall into the general category of non-open water wetlands (NOWW). Implementation information related to leave tree clumps, filter strips, infrastructure development, and occurrence of crossings cited above for NOWWs include seasonal ponds. Therefore we offer similar recommendations of enhanced language related to these practices. A deep dive into the monitoring data may reveal the level of implementation for filter strip guidelines and wetlands protection measures specific to seasonal ponds. See Table 4 for a coarse breakdown of how LTCs are used to protect on-site features.

- See notes above in the filter strip and water quality section related to filter strips and RMZs compliance and occurrence of locating leave trees around wetlands and seasonal ponds to enhance protection.
- Because of the nature of seasonal ponds they are particularly challenging to identify in the field especially during snow cover or dry seasons. Strengthening guidelines related pre-harvest planning

and site evaluation to clearly identifying seasonal ponds (and other wetlands) during snow free seasons would likely improve implementation and protection of these features. This applies to identifying opportunities to locate leave trees around them as well as identifying wetlands and filter strips for avoidance of infrastructure placement within these sensitive features. Use of native plant community classifications and recent ongoing inventory of seasonal ponds (i.e., Chippewa National Forest) could aid in focusing efforts to identify and protect seasonal ponds.

Table 4. Use of leave tree clumps to protect on-site features.

Protected Feature	Count	Percent
Lake/pond	1	0.7%
Non-open water wetland	115	82.7%
Open water wetland	5	3.6%
Steep slope	6	4.3%
Stream/river	7	5.0%
Visual quality corridor	5	3.6%
Total	***139***	***100.0%***

Leave Tree Distribution

The FMGs recommend retaining mature, live trees on clear-cut timber harvests to provide vertical structure and habitat for wildlife while harvested stands regenerate. The guidelines provide two options for meeting the leave tree (or green tree retention) recommendations:

- Scattered: Retain 6-12 scattered individual trees greater than 6" diameter at breast height (DBH) per acre in the harvest area (scattered leave trees).
- Leave tree clumps: Retain at least 5% of a clear-cut harvest area in patches at least ¼ acre.

Table 5. Management Strategies Applied at the Site Level (Multiple Selections Allowed).

Observed site harvest method?	Count
Clearcut (All strategies combined)	373
Group selection	3
Seed tree	2
Shelterwood	8
Single tree selection	11
Thinning (All strategies combined)	19
TSI	1
Salvage/Sanitation cut	19
Conversion to pasture	1
Total Treatments Observed	***434****

*Three sites were observed with multiple treatments applied.

In both cases (scattered and LTC) leave trees should be at least six inches DBH. Due to enhanced wind firmness (MNDNR 2021) and more favorable wildlife habitat characteristics (Grinde et al., 2020), leave tree clumps are the preferred method and ideally would be located on site; however, areas adjacent to a harvest may be considered in evaluating leave tree acreage. Many Counties maintain a GIS layer indicating long-term retention zones composed of leave tree clumps not to be harvested when adjoining stands are cut. Maintenance of these records can greatly enhance the intended purpose of LTC by ensuring long-term benefits associated with the structural, biological, and ecological roles of these legacy patches. In the 2012

revisions to the site-level guidelines, the MFRC modified the guidelines to include the area managed within RMZs as leave tree clumps. Scattered leave trees are evaluated on a sample plot basis, using a number of ½ acre circular plots dependent on the size of the harvest site. Total scattered leave trees per acre is then calculated as $TPA = \frac{\sum trees}{0.5*n}$, where *trees* includes all trees counted on all plots and *n* is the number of plots sampled on the site.

Overall, 357 sites were evaluated for implementation of the leave tree guidelines from 2014-2018. Of the remaining 77 sites, 44 were managed with selection harvests, thinning, seed tree, or shelterwood strategies (Table 21). These silvicultural prescriptions retain abundant vertical structure and were therefore not evaluated for leave tree guideline compliance. An additional 19 sites involved salvage or sanitation harvests, so leave tree guidelines were not applied. Sixteen sites indicated no leave trees were retained due to a silvicultural or safety reason, and applied an exception to the leave tree guidelines (Table 6). Overall, 335 of the 357 sites to which leave tree guidelines applied (93.8%) had adequate leave trees remaining on site. Of the 22 sites with fewer leave trees than recommended, 11 sites had between 75% and 95% of the recommended trees retained. In total, 353 evaluated sites had some level of leave tree retention. The weighted average (weighting by site acres) of net compliance per WSU is shown in Table 7.

Table 6. Reasons Cited for Exception to Leave Tree Guidelines.

Reason for Leave Tree Exception	Sites
No Exception Applied (Clearcut sites only)	357
Forest insects and diseases (e.g., dwarf mistletoe on black spruce, bark beetles).	4
Operator safety (e.g., loggers, aerial spray applicators).	1
Fire Damage Salvage	3
Lakes, homes, cabins. Black spruce stands extended buffer areas	1
Small sale area	1
Wind damage/blow down	1
Public safety (e.g., hazard trees near rights-of-way, recreation sites, airports).	1
Specific forest management applications (e.g., genetic considerations for seed).	4
Total Sites Considered for Evaluation (Clearcut Sites)	***373***
Total Sites Not Considered for Evaluation (Non-Clearcut Sites)	***61***

Table 7. Watershed Scale Compliance with Leave Tree Guideline Recommendations.

WSU	Total Sites (n)	Total Acres	Sites w/Leave Tree Retention (n)	Scattered Leave Trees per Acre (n)	Percent of Site in Leave Tree Clumps	Percent of Site in RMZ	Percent Net Compliance
CWR	31	800	22	5.01	5.45	12.24	96.1
LLP	32	1,449	28	6.08	8.01	6.93	96.1
LRRR	31	1,059	26	5.29	5.51	6.71	82.9
MGR	29	922	27	2.79	2.05	7.85	86.6
MH	35	981	30	28.11	2.05	6.17	97.8
MRBS	34	882	26	8.15	5.12	9.36	95
RLB	36	1,323	30	5.79	2.7	7.1	96.1
RLCW	24	746	23	9.41	3.97	2.96	100
ROL	15	272	10	7.47	10.2	2.86	100
RR	28	342	17	19.72	3.3	2.16	97.8
SCKS	34	2,021	25	6.63	4.53	3.65	87.7
SCN	37	2,578	34	2.59	3.65	14.4	96.2
SEMN	12	263	9	10.58	2.09	4.37	100
SUP	30	872	22	7.58	5.04	12.35	97.1
VRR	26	1,196	24	3.6	6.73	9.65	92.6
Total	***434***	***15,708***	***353***	***8.6***	***4.7***	***7.2***	***93.8***

Overall, 73% of sites met the retention guidelines utilizing leave tree clumps and/or RMZs alone or in combination. The use of scattered leave trees alone accounted for compliance on 70% of sites. Many sites met the guideline for leave tree retention in multiple ways. The increase in reported utilization of leave tree clumps is likely due to the revisions made to the guidelines in 2012 that widened RMZs and included forested portions of RMZs as qualifying for the 5% goal of LTC retention. Of the 163 sites that utilized the LTC strategy, 142 fully met the guideline via RMZs and 106 fully met the guideline via stand-alone LTCs. Thirty-one sites fully met the guideline via both methods, and 4 required a combination of the two (scattered leave trees not considered). The inclusion of the generally wider RMZs as qualifying leave trees has substantially increased the number of sites meeting the guideline via leave tree clumps. In total, 127 sites retained less than 5% of the site in LTCs but met leave tree guidelines by also retaining scattered leave trees.

At the watershed scale, rates of full leave tree guideline implementation on sites ranged from a high of 100% in RLCW, ROL, and SEMN to a low of 83% in LRRR (Table 7 and Figure 5).

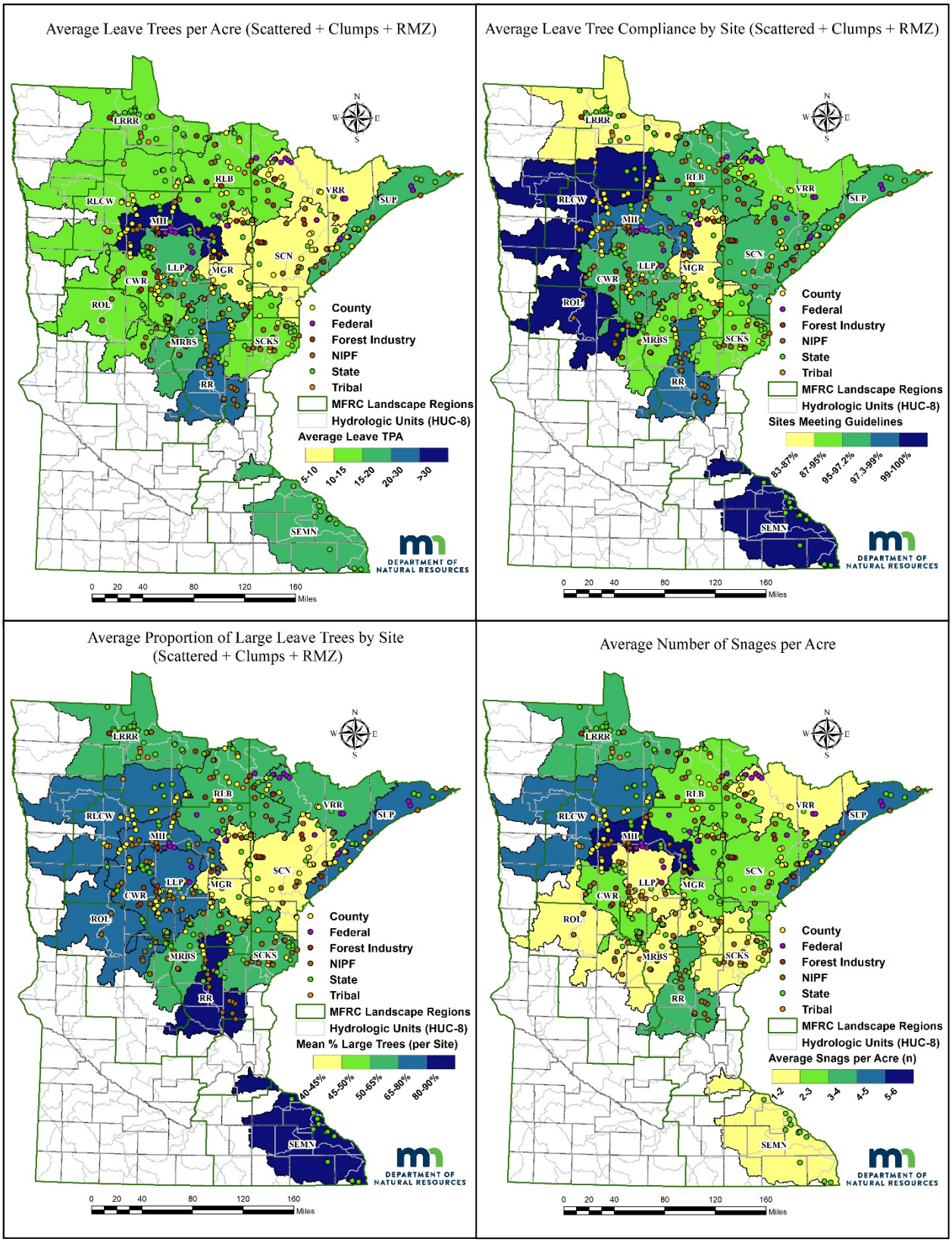


Figure 5. Watershed Sample Unit Distribution of Leave Tree and Snag Retention and Compliance.

Leave Tree Clump Characteristics
Contractors identified and evaluated 543 leave tree clumps (LTCs) on 244 sites during this monitoring cycle.

Blowdown occurred in only 12% of LTCs (66 of 543 clumps) with an average of 6.9% of trees within LTCs being impacted. In comparison, blowdown affected 8.1% of scattered leave trees on 143 sites (33% of sites) where blowdown of scattered leave trees was reported. A non-parametric Wilcoxon/Mann – Whitney Rank Sum Test (Mann and Whitney, 1947; Wilcoxon, 1945) indicates that there is a significant difference in percentage of leave trees experiencing blowdown within clumps vs scattered leave trees on sites. Scattered leave trees are approximately 39.5% more likely to experience excess blowdown over the level found in leave tree clumps. However, this comparison may be clouded by differences in spatial scale when comparing between sites and clumps. In future monitoring, this comparison will be made on a sample plot basis.

Although LTCs are preferred for wind firmness, the preference for LTCs for wildlife is not so straight forward. While small mammals may be more common in LTCs, the preference for clumps vs. scattered leave trees differs for various bird species (Grinde et al., 2020). For example, the golden-winged warbler appears to prefer scattered LTCs, but species like the chestnut-sided warbler and American redstart are more common in clumps with more mature trees.

In this reporting period, contractors also noted when LTCs were used to protect or enhance sensitive feature on the harvest site. Approximately half of the LTCs were used to protect or enhance another feature. Almost 83% of LTCs used to protect another feature were associated with non-open water wetlands (Table 4).

Guidelines recommend that a mix of species is desirable for retention as leave trees and that preference should be given to particular species for their longevity, wind firmness, cavity potential and value to wildlife species, recognizing that it is necessary to work with what is available on a particular site. Table 8 shows the frequency of the most common mature tree species identified in LTCs. Eight of the top ten species listed as the most common species found in a LTC are ranked as having excellent or good value to wildlife. 33% of the LTCs had aspen in the top five most common species in the LTC, possibly reflecting recent outreach emphasizing the importance of retaining aspen for den habitat. Several species including paper birch, black ash, red maple, and white cedar are frequently found in LTCs but not as frequently as the main species in the LTC. Other common species included white pine, burr oak, white spruce, basswood, tamarack, sugar maple, northern red oak, elm, and jack pine.

Table 8. Leave Tree Clump Species Distribution and Wildlife Value.

Species	# of LTCs with Species as Most Common	# of LTCs with Species in Top 5	% of LTCs with Species Present	Wildlife Rating for Tree Species
Aspen	106	179	28.96	Excellent
White Cedar	92	101	16.34	Good
Elm	90	99	16.02	Excellent
Black Ash	79	119	19.26	Excellent
Jack pine	73	88	14.24	Fair
Red pine	35	76	12.30	Good
N. Red Oak	28	87	14.08	Excellent
Black spruce	16	32	5.18	Fair
Red maple	15	122	19.74	Good
Sugar maple	14	80	12.95	Excellent
Paper birch	13	138	22.33	Fair
White pine	13	22	3.56	Excellent
White Ash	8	12	1.94	Excellent
Balsam Fir	8	57	9.22	Fair
White spruce	7	29	4.69	Good
Basswood	5	35	5.66	Excellent
Tamarack	4	15	2.43	Good
Hickory	3	9	1.46	Good
Pin Oak	3	12	1.94	Excellent
Other	3	12	1.94	N/A
Balm of Gilead	1	11	1.78	Excellent
Burr Oak	1	23	3.72	Excellent
Tag alder	1	1	0.16	Excellent
Black cherry	0	10	1.62	Excellent
Hackberry	0	1	0.16	Good
White oak	0	8	1.29	Excellent

FMG Stakeholder Survey Results (Leave Trees)

- 74% reported sufficient or better effectiveness of the FMGs related to this topic
- 53% of respondents reported these FMGs do not need to be modified, 30% reported that they should be modified
- 10% of respondents indicated that FMGs related to this topic are not being implemented well or are being implemented too narrowly in the forest.
- Survey respondent recommendations for potential revisions include: clarify 5% retention language in guidelines as a minimum recommended practice, encourage reserve patches over individual leave trees to address windthrow, and provide additional guidance on maintaining reserves that are representative of the stand.

GMP Recommendation

The leave tree guidelines are being well implemented and have shown improvement over time.

- As indicated above, there has been suggestion that the current guidelines lead to excessive blowdown of reserved leave trees especially scattered LTs. Our data suggests that there is a significant difference between blowdown in LTCs vs scattered. ***Blowdown occurred in only 12% of LTCs (66 of 543 clumps) with an average of 6.9% of trees within LTCs being impacted. In comparison, blowdown affected 8.1% of scattered leave trees on 143 sites (33% of sites) where blowdown of scattered leave trees was reported.*** This data further supports use of LTCs rather than scattered LTs, but also suggests that blowdown is not an overarching concern even for scattered LTs. See TH guidelines pages 36-38 for specifics on how the current SLGs address the preference to LTCs vs scattered as well as windthrow.
- Past monitoring reports have shown that the use of LTC strategy as compared to scattered leave trees has increased over time. The 2016/17 report indicates that LTCs were used on more than 50% of sites as a strategy for meeting the leave tree guidelines. However, this improvement may be influenced by the inclusion of RMZs as leave tree clumps.
- As indicated in the stakeholder survey, some respondents seek additional guidance encouraging representation of historical species (pre-harvest stand) within the leave tree population. Some forest certification standards require that leave trees represent a historical mix of species that occurred prior to harvest. The FMGs do not explicitly recommend this. As shown above, monitoring data indicates a broad range of preferred species being retained as leave tees on monitoring sites, but does not compare to pre-harvest species mix. Clarification could be written to indicate what species mix the guidelines recommend.
- Additional investigation related to leave trees species composition vs original stand composition may be needed. The GMP has some of this data at the site level in the pre-harvest data and in the leave tree species data. This data has not been evaluated because it is not a current guideline and it would take substantial time to develop and evaluate.
    - A deep dive into the data might provide a weighted count relating the pre-harvest stand to the post-harvest leave trees at a watershed scale.
    - Going forward the GMP will increase LT plot data to include more species specific and diameter specific data.
- GMP staff have often received questions related to some intermediate silvicultural practices (such as seed tree or shelterwood harvests) and the recommendations for retaining leave tees. Typically these sites retain high numbers of residuals to accomplish the silvicultural purpose. The GMP currently documents these practices but considers these to be non-clearcut harvests and does not collect detailed leave tree data. The real test of leave trees is what is retained at the final harvests for these stands The SLC should consider clarifying recommendations related to leave trees on these intermediate harvests, including maintenance of records related to long-term legacy patches.
- The GMP can provide excellent data on how leave tree guidelines are implemented on monitoring sites, but we cannot identify (hypothesize) whether the current leave tree guidelines are effective or sufficient to provide the vertical structure and habitat necessary to sustain populations identified in the Generic Environmental Assessment. A review of such research should be conducted to reach appropriate conclusions.
- The current FMGs "allow" counting RMZs as leave tree clumps which is a commonsense revision made in the 2012 guideline update. However, there is some inconsistency in recommended basal area for these two features.
    - Page 37 of TH guidelines:
        - Harvesting within clumps is acceptable as long as *the function of the clump is retained, key leave trees are not disturbed, and the clump is not doubling as a legacy patch*
        - *To retain the functionality of the clump, do not reduce the basal area below 80 ft_2/acre in trees 6 inches DBH or larger.*

        - For stands with the basal area below 80 ft^2/acre, do not harvest within the leave tree clump.
        - Consider retaining representation of all species within the clump.
    - Page 38 of GGs: ***Recommended minimum residual basal area for all RMZ's is 60 ft^2.***
- If a manger or operator selectively harvests within a RMZ down to 60 basal area, removes all of one species, or removes the largest of the trees within the RMZ, it could be perceived that it no longer meets the criteria of a leave tree clump. GMP recommends harmonizing residual basal area criteria for logical consistency and to simplify communication and interpretation of the guidelines.

Invasive Species

Invasive species are addressed through a set of planning considerations (considerations not guidelines) on page 6 & 7 of the GGs. The Guideline Monitoring Program currently does not monitor for the implementation of invasive species prevention practices because there are no guideline bullets to monitor. Therefore there is little monitoring data to support any guideline revision or addition. Anecdotally, contract staff who conduct field monitoring have noted that invasive species are observed on sites typically around landings and access routes.

Many practices designed to prevent the spread of invasive species involve activities which are taken during active management operations such as washing vehicles and monitoring mud on tires and tracks etc. Monitoring the implementation of these type of practices is difficult to accomplish under our "after the fact" protocols. Documentation of the occurrence of invasive species on a monitoring site at the time of monitoring could certainly be done. However, the existence of these species may not relate to implementation alone, it could relate to the effectiveness of existing laws and policies themselves, or to pre-existing conditions and/or be a response to canopy removal and flush of existing seed bank. Given the importance of prevention of invasive species spread, the GMP should investigate methods of monitoring any specific guidelines developed through the guideline revisions process.

Endangered, Threatened, and Special Concern Species

The FMGs recommend checking for the presence of endangered, threatened, or special concern species (ETS), sensitive communities, or sensitive sites on or near management sites prior to the initiation of activities. Additionally, the guidelines recommend that appropriate actions are taken to protect known occurrences. Over 90% of agency and industry owned sites reported that they checked for known ETS prior to initiating activities. Land managers reported that 20 of 292 agency and industry sites checked had known ETS species on or adjacent to the harvest site. Management activity was modified on 11 of these 20 sites with 4 of the remaining instances not needing modification and the rest in situations where the species was off-site and not impacted by harvest activity. Checking for the presence of ETS species is largely unknown for NIPF lands because the abbreviated pre-site questionnaire for this group did not include a similar question. Nonetheless, 6% of NIPF owners reported having checked for ETS species (Table 9).

The DNR's Natural Heritage Information System (NHIS) is frequently used to determine if monitoring sites have known ETS species present and to cross check with responses from land managers. The NHIS is a collection of databases that provides information on Minnesota's rare plants, animals, native plant communities, and other rare features. The NHIS contains a wealth of information, and outreach to land owners, land managers, and loggers is recommended to improve use of the NHIS and implementation of related guidelines. Additionally, a more publically accessible version of NHIS providing simple presence / absence information for the broad class of ETS species would help greatly in making these checks easier to accomplish for stewards not directly connected to the DNR Natural Heritage Program. Simply knowing that an ETS is present in the vicinity of a harvest would go a long way towards justifying the additional effort

involved with contacting Natural Heritage staff for more specific information.

Table 9. Sites Checked for Threatened and Endangered Species (ETS) Listed by Ownership.

Ownership	Sites (n)	% Checked	% Protected
County	112	87.5	42.9
Federal	29	93.1	100
Industry	33	90.9	0
NIPF	119	**5.9**	0
State	130	93.1	83.3
Tribal	11	81.8	100
Total	434	67.3	55

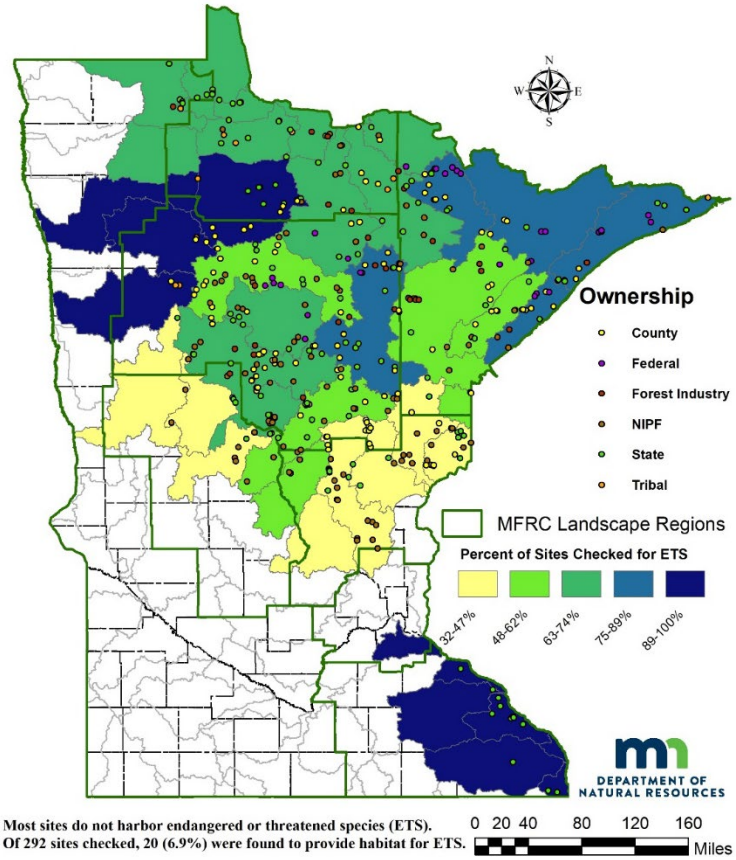


Figure 6. Percent of All Sites Checked for ETS Species in Monitored Watersheds.

FMG Stakeholder Survey Results

- 72% reported sufficient or better effectiveness of the FMGs related to this topic
- 56% of respondents reported these FMGs do not need to be modified, 21% reported that they should be modified
- 6% of respondents indicated that FMGs related to this topic are not being implemented well or are being implemented too narrowly in the forest.
- Survey respondent recommendations for potential revision: update to reflect current ETS classifications and issues of concern, enhance education on ETS species identification and how to avoid impacts on ETS species, highlight species that are vulnerable to forest management

GMP Recommendations

Knowledge of the presence or absence of ETS species is critical to the ability of land managers and operators to implement FMGs related to these species. Where awareness of ETS species exists, levels of implementation are high. However, as reported in past implementation reports, differences have been noted between reported existence of known ETS species and findings of the GMP when queried by the NHIS program. This difference appears to be related to two things; time of checking the data base related to start of harvest, and the connotation of "on or near" as stated in the guideline.

- The NHIS is frequently updated and it is important to not only check the database when planning an activity but also just prior to initiation of the activity. It is possible that new information has been documented in the time between planning and initiation.

- The FMGs on page 12 of the GGs recommend consulting with MN DNR for information on known occurrence of endangered, threatened, or special concern species (ETS species), sensitive communities, or sensitive sites on or near a management area prior to activity. In this case "near" is not defined and may have created the difference in responses indicated above. NHIS staff report on the known occurrence of species within ¼ mile plus and consider this distance to be important in protection ETS species during management activities. The impression of GMP staff is that most land managers responding to pre-site questionnaires consider "near" as directly adjacent and typically appear to only consider species directly on the site. It may be helpful to work with NHIS staff and clarify what the FMGs intend by use of the term "near". This will not only aide in monitoring, but more importantly ensure that due consideration is given to species identified in the NHIS.
- As referenced above in the excerpts from the 5-year report, a more publicly accessible version of NHIS providing simple presence / absence information for the broad class of ETS species would help greatly in making these checks easier to accomplish for stewards not directly connected to the DNR Natural Heritage Program. Simply knowing that an ETS is present in the vicinity of a harvest would go a long way towards justifying the additional effort (and cost) involved with contacting Natural Heritage staff for additional information. Cost to the land manager of obtaining a full report or query from NHIS has been identified as a concern and related to GMP staff.
- In the past Kurt Rusterholz (retired DNR) has reminded us that Appendix J from the FMGs needs to be updated. Appendix J contains all ETS species and S1 and S2 native plant communities that are forest, woodland, or savanna, according to s-ranks at the time of editing. ETS species and S-ranks change over time and must be updated occasionally. This may be a time to do that. Better yet, with a digital document we could do more frequent updates as they occur. This also applies to the pages 19-24 in the rationale section (yellow section) of the guidebook.

On-site Infrastructure

Equipment traffic can compact and rut soil. It can also damage or remove vegetation and associated root systems, which 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.

One 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 (i.e., infrastructure). The FMGs recommend:

- *Sites less than 20 acres should have 1 acre or less of the harvest site in infrastructure.*
- *Sites 20-30 acres should have less than 5% of the harvest area in infrastructure.*
- *Sites greater than 30 acres should have 3% or less of the harvest area in infrastructure.*

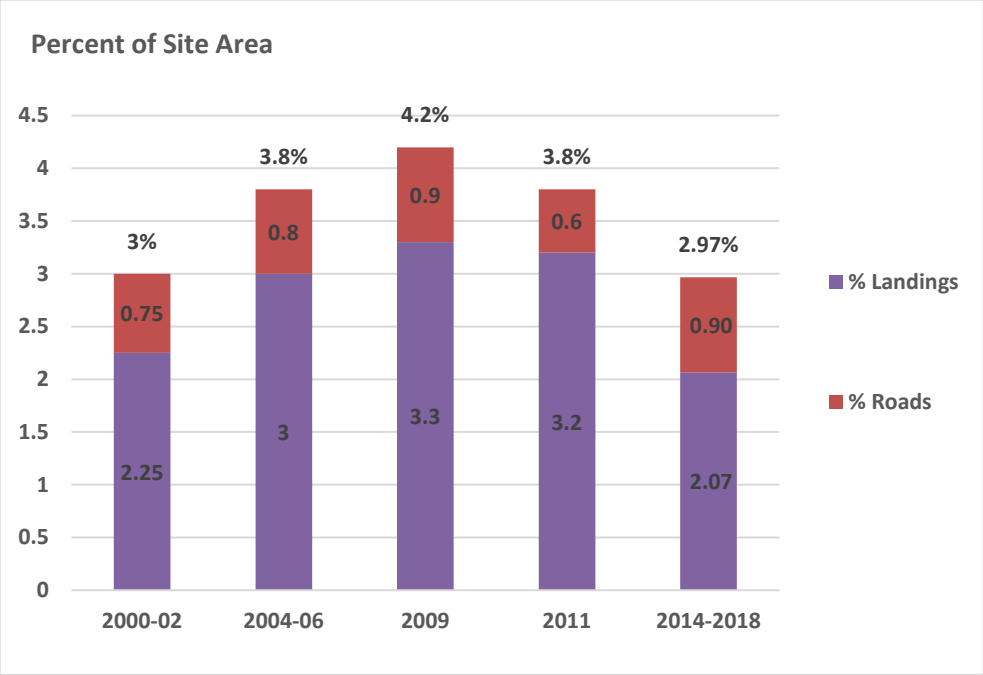


Figure 7. Percent of Site Area Occupied by Infrastructure Statewide (2000-2018).

Monitoring contractors determined total on-site infrastructure by measuring area occupied by landings and roads within the site. The estimated mean infrastructure per site is 2.97% (Figure 14), reflecting a decrease in infrastructure since the reported high of 4.2% in 2009. The variability in percent infrastructure from past reports appears to occur primarily in landing infrastructure, with road infrastructure remaining relatively stable ranging from 0.6 to 0.9 percent while percent landing infrastructure has ranged from a high of 3.3% to a low of 2.07%. Mean on-site landing area per site in this reporting period is 0.79 acres. Mean on-site road acreage for this period is 0.39 acres.

From a watershed perspective: The mean percent infrastructure by watershed sample unit ranged from a low of 0.3% in SEMN to a high of 5.4% in LRRR. The LRRR watershed sample unit had both the highest mean acres of sites in landings, and the third highest in roads. SEMN had the lowest amount of acres in landing and roads. These two sample units represent very different terrain and challenges for managing landings. While sites in SEMN are frequently located on steep terrain, or in narrow valleys, with cropland occupying most flat ground, the LRRR is nearly level topography dominated by wetlands and offering few good landing opportunities. Further, due to the flat landscape and frequency of winter harvests in LRRR, infrastructure tends to sprawl across the site. Additional effort should be made to limit the footprint of on-site infrastructure in this watershed unit.

Overall, 78.6% of sites monitored from 2014-2018 met the recommended infrastructure amounts based on 2012 guidelines. When comparing on-site infrastructure with site size, compliance was highest for larger than average sites. Compliance was lowest for sites less than 24 acres. Mean site size (41.8 acres) was smaller for watersheds summarized in this report compared to the long-term average (55 acres), but overall compliance was similar.

FMG Stakeholder Survey Results

- 88% reported sufficient or better effectiveness of the FMGs related to this topic
- 73% of respondents reported these FMGs do not need to be modified, 10% reported that they should be modified
- 5% of respondents indicated that FMGs related to this topic are not being implemented well or are being implemented too narrowly in the forest.
- Survey respondent recommendations for potential revision: limit landing and/or road size, improve education on culvert placement and proper erosion control to meet MN Wetland Conservation Act requirements and forestry exemption criteria, address the design and usage of seasonal roads (e.g., ice roads, winter-use roads) to ensure they are used as intended

GMP Recommendation

The GMP agrees with most respondents to the survey that the infrastructure guidelines have a relatively high level of compliance and have shown improvement. Commonsense revisions made in the 2012 FMG updates helped clarify recommendations.

- As indicated above, one area of opportunity for improved infrastructure management relates to location of landings in wetlands, filter strips and RMSs where other opportunities (upland areas) exist. In some instances such as on page TH22of TH guidelines, the avoidance statement does not include specific avoidance of infrastructure in wetlands where upland opportunities exist. Language that explicitly states "avoid locating landings or allowing landings to spread into filter strips, wetlands or RMZs", may help implementation of the intent of this guideline. Alternative wording may include "Avoid the expansion of landing operations into filter strips, wetland, or RMZs"
- Upland slash and logging debris that is concentrated or located in a wetland and is harvested from an upland is considered fill in the Wetlands Conservation Act (WCA). In locations where the SLGs refer to regulations such as WCA consider inserting a symbol "R" rather than a check mark, as seen in the field pocket guide. This helps clarify and emphasize these points as regulatory
- Additional language that clarifies which high traffic areas should be considered as "infrastructure" may help improve implementation of guideline intent. Areas of high traffic that may not be considered by all users as infrastructure may include the confluence of skid trails leading into landing areas, high traffic areas at hot loading sites, staging and decking areas etc.
- A suggested revision related to the definition of infrastructure might include "Areas of concentrated equipment usage where the impact to forest soils and vegetation can be seen on return visits one or more years later."

Rutting

The FMGs 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 tears the root mat when the soil is not strong enough to support the vehicle load.

The presence or absence of repeated rutting ≥6 inches deep was recorded for a variety of features. In previous reports we have focused on the occurrence of rutting by various feature types (such as crossings, approaches, landings) across all sites. For this report, we also assessed the cumulative amount of rutting identified on all features of sites including the general harvest area. When evaluated at the site level, rutting is clearly focused on a minority of monitored sites and minor amounts when compared to the entire site (14% of sites had rutting > 6" deep) (Table 10).

From the watershed perspective; some rutting occurred in all watersheds. The number of sites with rutting

ranged from one each in CRW, SCN, and SEMN, to eight in MGR and ten in MH. The MFRC has established no guidelines related to the percent rutting on a site or specific features on a site. Guidelines recommend avoiding rutting through careful planning related to season of operation and monitoring of day to day conditions. However, a relative rutting severity measure is presented in Table 10 (0 = Low Severity, 6 = High Severity). Anecdotally, operations on sites with rutting at multiple feature locations (especially in the general harvest area) likely occurred because operating conditions, including season of harvest and hydro-geomorphological risk, were conducive to rutting. In these situations, guidelines recommend changing operations or curtailing operations until conditions improve.

Table 10. Rutting Distribution and Severity on Monitored Sites.

WSU	Total Sites (n)	Rutted Sites (n)	Non-open Water Wetland	Crossing	Landing	Skid Trail	Road	Rutted Features (n)	Average Percent of Feature Rutted	Rutting Severity*
CWR	31	1	0	1	0	0	0	1	30	**0.97**
LLP	32	2	3	3	0	1	0	7	30.7	**3.36**
LRRR	31	5	2	4	0	1	0	7	11.4	**0.51**
MGR	29	8	1	3	2	3	3	12	7.4	**0.38**
MH	35	10	6	18	2	0	2	29	37.7	**3.12**
MRBS	34	3	1	4	0	0	0	5	48.3	**2.37**
RLB	36	4	3	3	0	1	0	7	5	**0.24**
RLCW	24	6	1	2	0	2	4	9	28.2	**1.76**
ROL	15	2	1	2	0	0	0	3	45	**4.50**
RR	28	2	2	1	0	0	0	3	33.7	**1.81**
SCKS	34	5	4	4	1	1	2	12	44.5	**3.14**
SCN	37	1	0	2	0	0	1	3	75	**6.08**
SEMN	12	1	0	0	0	1	0	1	0	**-**
SUP	30	7	0	13	2	0	1	16	10.9	**0.83**
VRR	26	4	0	8	0	1	1	10	33.4	**3.21**
Total	**434**	**61**	**24**	**68**	**7**	**11**	**14**	**125**	**29.41**	

* Relative rutting severity is calculated as:

$$\frac{\left(\frac{Rutted\ Features}{Rutted\ Sites}\right)(\%\ Feature\ Rutted)}{Total\ Sites}$$

FMG Stakeholder Survey Results

- 81% reported sufficient or better effectiveness of the FMGs related to this topic
- 63% of respondents reported these FMGs do not need to be modified, 18% reported that they should be modified
- 7% of respondents indicated that FMGs related to this topic are not being implemented well or are being implemented too narrowly in the forest.
- Survey respondent recommendations for potential revision: improve/clarify the definitions of rutting and compaction (including setting measurable levels), improve enforcement of guidelines, emphasize avoidance of saturated soils, and provide tools/information for identifying prime opportunities for management activities (e.g., soil maps, frost depth information), adapt guidelines to warming winters and the impacts of climate change.

GMP Recommendations

The GMP generally agrees that rutting compliance is relatively high on most sites. The most common feature where rutting is documented in monitoring data is on crossings. However, occasional sites will exhibit rutting on various features including the general harvest area which usually suggests that the operation occurred during poor operating conditions.

- Regarding the recommendation from the survey to improve/clarify definitions of rutting the GMP suggests a review of the DNR rutting metric (MN DNR State Land Rutting Guidelines and Decision Tree: Intranet). This standard establishes definitions and acceptable limits of rutting on timber harvest sites. Alternatively, a review of the protocols that the GMP provides the monitoring contractors related to definitions of how to measure and document rutting may be helpful.

- Because the most common feature with rutting is crossings, stronger encouragement to utilize various crossing structures such as wood mats on page 28 of TH section along with highlighting the importance of freezing down crossings may reduce rutting occurrence. Considering current and expected climate change (e.g., a shift to warmer winters), a greater emphasis on utilization of crossing structures may be appropriate. Additionally, avoidance of unnecessary crossings would reduce the occurrence of rutted crossings simply by reducing the number of crossings. Many crossings deemed avoidable occurred in situations where operators could have easily driven around the wetland. This also supports the need for better delineation of wetland boundaries as recommend above in the filter strips and water quality section.

- An area of concern is our ability to measure or document the occurrence of compaction on guideline monitoring sites. Currently the only measurable guideline related to compaction is the recommendation to focus skid trails on a well laid out pattern of trails and minimizing traffic to other areas of the site – essentially limiting the surface area of a site that receives traffic. The bulk of information designed to avoid compaction is focused in the planning considerations part of the GGs and the TH guidelines. It is difficult to measure how well soil susceptibility to compaction and seasonal limitations are "considered" when monitoring a site, however indications from our pre-site questionnaires suggests that soil survey data is not a common resource, but ECS data is.
  Soils information is more readily available now than at the time of the original guideline development. Links to NRCS soils data (Web Soil Survey) and MNDNR Native Plant Community Silviculture Guides may increase the use of soils information. Additionally, the hydrologic risk assessment modeling discussed in the recent 5-year monitoring report (and more fully presented in an upcoming user's guide – DRAFT available from David Wilson) may provide better predictability of the extent to which erosion control measures will be needed on a site. These resources could be referenced in locations such as page 12 in TH section.

Erosion Control

Recommendations on the use of erosion control (EC) have been a primary component of the forest management guidelines related to maintaining water quality. In particular, use of EC at areas in close proximity to water resources is important in minimizing sedimentation of wetlands and streams. Approaches are the portion of a skid trail or road immediately leading into a wetland or waterbody, making them a key feature when assessing the use of erosion control. Approaches have a high potential to funnel surface water, sediment, organic debris, and contaminants into the water. Guidelines recommend that water diversion/erosion control practices be installed immediately when approaches are created and then maintained until the location is stabilized.

A total of 1,592 approaches were identified and evaluated by monitoring contractors. The vast majority (94%) of these approaches were in good condition and did not require further EC practices for sediment control. Generally, EC is not needed on approaches that have low slope (<2%), little or no exposed mineral soil, or where natural roughness and/or breaks in terrain negate the need. The high estimate of approaches not needing EC may reflect high levels of guideline implementation through good selection of crossing locations, or may be associated with the relatively forgiving operating conditions that occur in much of the state (e.g., winter harvesting, relatively level topography, etc.). However, for the 97 approaches where EC was deemed necessary, only 23 (24%) had practices appropriately installed. More importantly, erosion was frequently (59% of the time) observed when EC practices were needed but not installed. Additionally, in 61% of instances when erosion was occurring on approaches to a waterbody (Total Volume = 3,621 cubic feet from 57 approaches), contractors found evidence of sediment reaching the associated waterbody. Utilization of soil and slash water bars or scattered slash on approaches would reduce potential impacts to wetlands and surface water, but the establishment of vegetation appears to play an even larger role in minimizing erosion (Slesak et al. 2016, McEachran et al. 2018).

These results reinforce the need to emphasize the importance of EC practices on approaches to minimize erosion potential, and a need to identify when EC practices are needed during training programs for loggers, land managers, and landowners. For example, all but one (RR) of the watershed units had sites with approaches needing EC. Targeted outreach on how to identify the need for EC installation, and what practices to install, would help to increase guideline implementation and reduce the potential for water quality impacts.

FMG Stakeholder Survey Results

- 81% reported sufficient or better effectiveness of the FMGs related to this topic
- 70% of respondents reported these FMGs do not need to be modified, 12% reported that they should be modified
- 5% of respondents indicated that FMGs related to this topic are not being implemented well or are being implemented too narrowly in the forest.
- Survey respondent recommendations for potential revision: improve education on the implementation of these guidelines, stronger emphasis on using native materials, emphasize how to control road erosion.

GMP Recommendations

Erosion control is one area where the GMP measures effectiveness of specific guidelines and practices. During field monitoring, contractors identify approaches to crossings where erosion control practices are needed and if the practices are properly installed. Additionally contractors documents occurrence of erosion and estimate volumes as well as document if there is evidence that sediment was deposited into a waterbody. This process provides evidence as to whether installed practices are effective against preventing sediment from reaching a stream, lake, or wetland.

The primary issue is the proper installation of erosion control practices. Low compliance to implementing erosion control practices has been identified in past reports as an opportunity for improvement via increased outreach and education. The GMP believes that this would increase implementation of these practices, but also feels that greater emphasis on some practices within the guidelines themselves may also improve implementation. Guideline language should be reviewed to determine if key components of erosion control can be more clearly stated. Keys to erosion control include; maintaining surface vegetation, reducing the volume and velocity of runoff moving down an approach into a wetland or waterbody. Not directing runoff completely off the road or skid trail and allowing water to flow through breaks in diversion structures or materials appear to be major components of failed application. Recent research including Slesak et al. 2016, and McEachran et al. 2018 should be reviewed to aid in developing potential language.

Language was added in 2012 to clarify where/when soil erosion practices were needed. (See below). This language appears in the GGs page 56 under the general heading of post-operational activities and follow-up visits. I believe that we need similar language in the operational sections of the timber harvest and the roads sections (such as page 32 TH) with a focus on installing these practices as soon as disturbance occurs and maintaining the practices throughout the operation – not just at the time of harvest completion. Timber harvests can be stretched out over a period of years and if erosion control is only implemented at the conclusion of a harvest, then erosion could be occurring over a period of several years.

- Add the following to page 56 GGs and page 32 TH
  ✓ *Water diversion and erosion control practices should be implemented ASAP after soil disturbance and maintained throughout the operation.*

Slash, Coarse Woody Debris, and Snags

Coarse woody debris (CWD) provides important habitat for forest animals, plants, fungi, and micro-organisms, and contributes important elements to forest soils (Harmon et al., 1986). The FMGs recommend creating or retaining two to five bark-on down logs (pieces >6 ft. long and > 6 inches diameter) per acre in the general harvest area and at least four bark-on down logs per acre in riparian areas. General harvest areas met the guideline of two or more “sound” down logs per acre 96% of the time (Figure 8). High compliance results may be partially due to a change in plot measurement protocols in 2014 for CWD which includes large branches as CWD rather than just logs (boles). Slash or fine woody debris (FWD) retained on harvest sites further helps to sustain soil productivity and stability, and provides habitat for small mammals, amphibians, and other organisms. Guidelines recommend practices that disperse slash relatively evenly over the site if it does not conflict with management objectives, rather than piling slash. The distribution of sites retaining slash and FWD on biomass harvest is shown in Table 11.

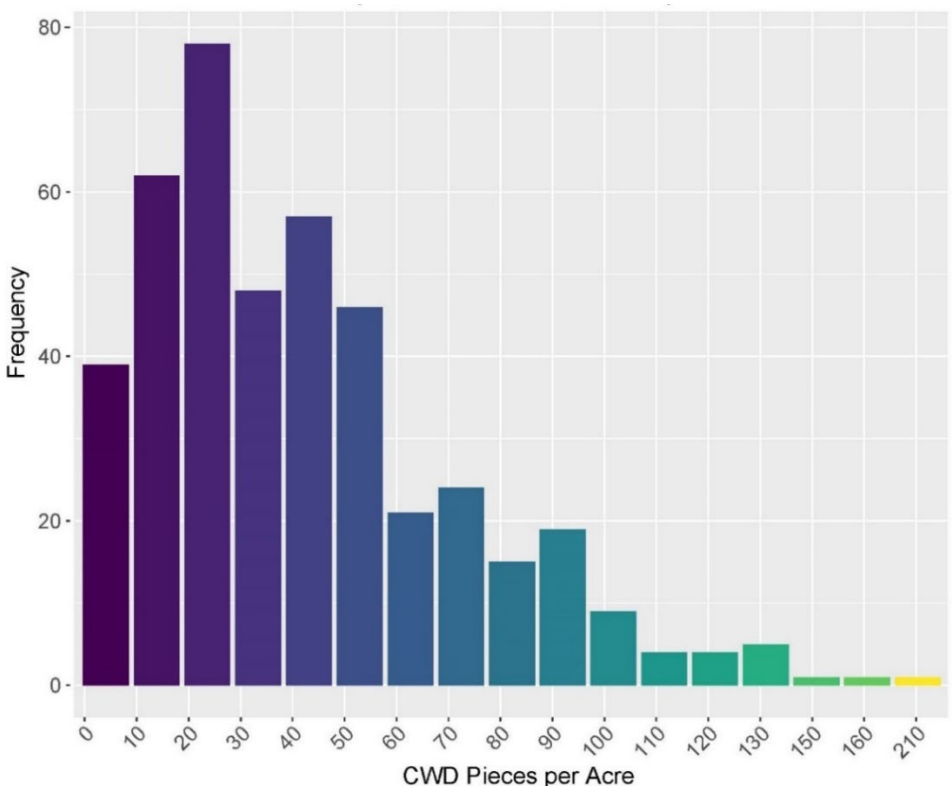


Figure 8. Distribution of Coarse Woody Debris (CWD) Retention on Monitored Sites.

Table 11. Slash and Coarse Woody Debris Retention on Monitored Sites.

WSU	Sites (n)	Sites w/Distributed Slash (n)	Sites w/Biomass Harvest (n)	Biomass Sites w/ FWD Retention Strategy (n)	Average CWD Logs per Acre (n)	Average Snags per Acre (n)
CWR	31	26	10	3	41.6	2.2
LLP	32	26	24	10	20	1.7
LRRR	31	20	4	1	66.3	3.4
MGR	29	27	2	1	37	2.8
MH	35	29	9	4	67.3	5.1
MRBS	34	14	13	5	29.5	1.8
RLB	36	33	2	0	30.7	2.3
RLCW	24	23	0	0	80.2	4.2
ROL	15	15	4	2	12.3	1.9
RR	28	25	7	2	36.4	3.4
SCKS	34	30	22	7	24.1	1.5
SCN	37	30	12	3	15.4	2.3
SEMN	12	12	0	0	25.1	1.7
SUP	30	22	8	1	47.2	4.7
VRR	26	23	4	2	51.2	2
Total	***434***	***355***	***121***	***41***	***36.5***	***2.7***

Half of the sites monitored fell into the range of 16-53 pieces of CWD/ acre in the general harvest area, with a weighted average of 36.5 pieces of CWD per acre. From the watershed perspective, sites in the LRRR (Avg. = 66 logs per acre), RLCW (Avg. = 80 logs per acre), MH (Avg. = 67 logs per acre), and VRR (Avg. = 51 logs per acre) sample units appeared to have higher number of recorded CWD on site (Table 11). One hundred and nine sites had 53 or more pieces of CWD per acre.

Snags provide habitat for wildlife requiring tree cavities, perches, and bark foraging or hibernacula sites. For monitoring purposes a snag is defined as a dead tree stem standing at least eight feet tall and ≥6 inches DBH. Snags were commonly recorded at nearly all harvest sites, ranging from 0 to 20 snags per acre (average = 2.7 snags per acre) across watersheds monitored this cycle (Table 11 and Figure 5). MFRC guidelines generally recommend leaving all snags possible, but also have recommendations to remove snags for visual quality concerns in some instances. The suitability of these results is not clear, as the level of snag density needed to support snag-dependent wildlife populations is an active area of research. Based on recent FIA data, mean snag density for timberland in Minnesota is 18 per acre, indicating that levels observed here are generally lower than what exists in intact stands.

FMG Stakeholder Survey Results

- 84% reported sufficient or better effectiveness of the FMGs related to this topic
- 62% of respondents reported these FMGs do not need to be modified, 16% reported that they should be modified
- 4% of respondents indicated that FMGs related to this topic are not being implemented well or are being implemented too narrowly in the forest.
- Survey respondent recommendations for potential revision: unnecessary in the absence of a market for biomass, native plant community classification should influence slash retention rates, emphasize slash retention for wildlife as appropriate

GMP Recommendations

Guideline monitoring indicates a high compliance to retaining CWD and snags. Revisions made in 2012 brought clarity to FWD retention guidelines as well. Two items seem noteworthy regarding guideline revisions:

- Related to the location of landings in filter strips and wetlands discussed in the filter strip section of this report, the apparent deposition of upland slash into wetlands frequently occurs when landings are developed in or adjacent to wetlands on upland harvest sites. This deposition of upland slash into wetlands is considered fill in wetland regulations and is not covered by the forestry exemption. Therefore, this could be highlighted in the timber harvest section such as on page 29. This language could be modified as follows:

  TH page 29

  ✔ Keep logging residue out of all streams, lakes ~~and~~ open water wetlands and seasonal ponds, except in cases where residue placement is specifically prescribed for fish or wildlife habitat. ~~Make reasonable effort to~~ keep upland logging residue out of all seasonal ponds and non-open water wetlands.

  R: Slash from uplands that is concentrated in wetlands is considered "fill" in wetland regulations and is not covered by forestry exemption

- The GMP has collected data on concentrations of dense slash and debris on landings. Findings indicate that a substantial number of landings have 50% or more of the landing piled with dense slash or debris to the degree that it is preventing regeneration of vegetation. Contractors documented

sites where debris (bark, chips, saw dust, slash…) was thick enough and dense enough to prevent regeneration. This may be both a regeneration issue as well as a wetlands issue. If landings are located in a wetland and the slash is from an upland, then there is a potential violation (see above). From a regeneration standpoint, this dense debris will inhibit natural regeneration of the landing and make it difficult to plant. This is not currently addressed in a guideline, but review of this data may be appropriate.

Conclusions

- The GMP is charged with monitoring the implementation of existing guidelines and focusses on that effort. We do not monitor effectiveness of guidelines except for a few items such as effectiveness of erosion control. Therefore, we cannot comment on whether a specific guideline such as leave tree retention is effective in its ability to mitigate the sustainability issue that it was designed to address.
- Most recommendations made in past monitoring reports have dealt with opportunities for improved implementation related to focused outreach and education efforts. However, through the monitoring of almost 700 sites in the last 12 years, observations have been made regarding suggested revisions to language that might improve understanding of the intent of individual guidelines and therefore improve implementation.
- Revisions to the FMGs should consider not only stakeholder and expert input, but the results of research associated with/stemming from MFRC council members and research related to those concerns. (Ex. Grinde, Slesak, McEchcran, Karwan, emerging research on seasonal ponds)
- From an implementation standpoint, an improved format for the guidelines themselves would facilitate on-the-ground interpretation and application of measures intended to enhance sustainability of the forest and associated resources.
- Accessibility (Section 508 of the Americans with Disabilities Act) of the FMG document will be a legal as well as usability issue. Addressing accessibility issues in the document will enhance usability (navigability) for all users and aid in communication and implementation of the FMGs.

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