

Revision of MN FMGs: Results of call for FMG research citations

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Summary of online bibliography submissions

Solicitation and review of recent advances in relevant peer-reviewed scientific literature was conducted as part of the current Forest Management Guideline (FMG) revision process. A stakeholder and online call for FMG research was solicited for input from stakeholders and subject experts. In total, thirty-nine citations were included for the review to the FMG bibliography from December 6th, 2021 through April 30th, 2022 during the open submission period. In the case that FMG page numbers were not provided with citations submitted online, the “FMG page numbers” section under each citation is left blank below.

Filter Strips & Water Quality

1. Richard Cristan, W. Michael Aust, M. Chad Bolding, Scott M. Barrett, John F. Munsell, Erik Schilling. 2016. Effectiveness of forestry best management practices in the United States: Literature Review. *Forest Ecology and Management* 360, pp. 133-151.
 - a. FMG page numbers:
 - b. Provided description: Forestry BMPs protect water quality when implemented.
2. Edwards, Pamela J.; Wood, Frederica; Quinlivan, Robin L. 2016. Effectiveness of best management practices that have application to forest roads: a literature synthesis. Gen. Tech. Rep. NRS-163. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 171 p.
 - a. FMG page numbers: R 1-49
 - b. Provided description: Literature describing the effectiveness of best management practices (BMPs) applicable to forest roads is reviewed and synthesized. Effectiveness is considered from the perspective of protecting water quality and water resources.
3. Slesak, R. A., Corcoran, J., & Rossman, R. (2018). A Holistic Monitoring Approach for Water Quality BMP and Forest Watershed Risk Assessment. *Journal of Forestry*, 116(3), 283–290. <https://doi.org/10.1093/jofore/fvy005>
 - a. FMG page numbers:
 - b. Provided description: Literature review of the implementation of water quality BMPs - BMP implementation is variable and monitoring of the impacts of forest management activities needs to occur on the watershed level

Riparian Management Zones

4. Kastendick, D. N., Zenner, E. K., Palik, B. J., Kolka, R. K., & Blinn, C. R. (2012). Effects of harvesting on nitrogen and phosphorus availability in riparian management zone soils in Minnesota, USA. *Canadian Journal of Forest Research*, 42(10), 1784–1791. <https://doi.org/10.1139/x2012-127>
 - a. FMG page numbers: YRA 1-13, TH 22, 26, 34-35, GG 14, 20, 22, 25-27, 80
 - b. Provided description: Supports current RMZ guidelines - RMZs sustain riparian soil nutrient availability, nutrient pulse after harvesting upland does not move far into uncut RMZ

Visual Quality

No citations related to visual quality were submitted to the online bibliography.

Cultural Resources

5. Chamberlain, J.; Small, C.; Baumflek, M. Sustainable Forest Management for Nontimber Products. *Sustainability* 2019, 11, 2670. <https://doi.org/10.3390/su11092670>
 - a. FMG page numbers: GG 10-12, 17, 20, 68-69, 80-81
 - b. Provided description: Review of research relating to nontimber products, cultural resources of forests

Spill Kits

No citations related to spill kits were submitted to the online bibliography.

Seasonal Ponds

6. Hofmeister, Kathryn L.; Eggert, Sue L.; Palik, Brian J.; Morley, David; Creighton, Emily; Rye, Marty; Kolka, Randall K. 2022. The Identification, Mapping, and Management of Seasonal Ponds in Forests of the Great Lakes Region. *Wetlands*. 42(1). 23 p. <https://doi.org/10.1007/s13157-021-01526-2>.
 - a. FMG page numbers: YWH 11, 36-38; GG 13, 23, 26, 46-48; R 10, 13-14, 23, 31, 36, 43; TH 28, 34-35
 - b. Provided description: Updated lit review and support for harvest buffer (RMZ) around seasonal ponds
7. Mui, A.B., Caverhill, B., Johnson, B. et al. 2017. Using multiple metrics to estimate seasonal landscape connectivity for Blanding's turtles (*Emydoidea blandingii*) in a fragmented landscape. *Landscape Ecol* 32, 531–546.
 - c. FMG page numbers: YWH 11, 36-38; GG 13, 23, 26, 46-48; R 10, 13-14, 23, 31, 36, 43; TH 28, 34-35
 - d. Provided description: Support for harvest buffer around seasonal ponds, related to landscape connectivity for Blanding's Turtles
8. Previant, W. J., & Nagel, L. M. (2014). Forest Diversity and Structure Surrounding Vernal Pools in Pictured Rocks National Lakeshore, Michigan, USA. *Wetlands*, 34(6), 1073–1083. <https://doi.org/10.1007/s13157-014-0567-5>
 - e. FMG page numbers: YWH 11, 36-38, GG 12, 22, 25, 71-73
 - f. Provided description: Importance of vernal pools as critical landscape component; maintain tree species diversity surrounding vernal pools
9. Calhoun, A.J.K., Arrigoni, J., Brooks, R.P. et al. Creating Successful Vernal Pools: A Literature Review and Advice for Practitioners. *Wetlands* 34, 1027–1038 (2014). <https://doi.org/10.1007/s13157-014-0556-8>
 - g. FMG page numbers: YWH 11, 36-38, GG 12, 22, 25, 71-73
 - h. Provided description: Authors recommend adaptive approach to managing vernal pools - determine if need for vernal pool creation, desired future conditions
10. Bischof, M.M., Hanson, M.A., Fulton, M.R. et al. Invertebrate Community Patterns in Seasonal Ponds in Minnesota, USA: Response to Hydrologic and Environmental Variability. *Wetlands* 33, 245–256 (2013). <https://doi.org/10.1007/s13157-012-0374-9>

- i. FMG page numbers: YWH 11, 36-38, GG 12, 22, 25, 71-73, TH 28, 34-35
- j. Provided description: Timber harvesting may rapidly modify canopies over vernal pools, litter inputs; but the relationship between seasonal pond communities, groundwater, and other environmental gradients are subtle in forest ecosystems

Leave Tree Distribution

11. Corace III, R. G. (2018). Rethinking forest-bird habitat management guidelines in the northern Lake States. *Wildlife Society Bulletin*, 42(2), 347–357.
<https://doi.org/10.1002/wsb.872>
 - a. FMG page numbers: YWH 7-9, 37, 39, 43
 - b. Provided description: Literature review of forest management guidelines for wildlife (bird) habitat - BMPs should focus on the management of the forest as a whole, not for the management of a specific species. Forest-bird habitat management should account for spatial and temporal variation
12. Alexis R. Grindea, R.A. Slesak, A.W. D'Amato, B.P. Palik. 2020. Effects of tree retention and woody biomass removal on bird and small mammal communities. *Forest Ecology and Management* 465
 - c. FMG page numbers: GG 24, 35, 36, 39, 48-55 TH 14, 19, 32-40 MSP 12 TSI 7 BHF 9, 27&28
 - d. Provided description: Supports benefit of leave tree FMG for birds and small mammals.

Leave Tree Clump Characteristics

13. Zlonis, E. J., Berdeen, J. B., & St-Louis, V. (2020). Forest inventory attributes predict the occurrence of cavities suitable for nesting by Wood Ducks (*Aix sponsa*). *Forest Ecology and Management*, 461, 117951. <https://doi.org/10.1016/j.foreco.2020.117951>
 - e. FMG page numbers: YWH 7-9, 37, 39, 43
 - f. Provided description: Declining/dead trees (especially large DBH, deciduous) are most likely to have suitable habitat for cavity-nesting bird species
14. Berg, S. S., Erb, J. D., Spaid, V. T., Dewey, D. L., Coy, P. L., Sampson, B. A., Fieberg, J. R., Arnold, T. W., & Forester, J. D. (2020). The role of local cavity tree density in the selection of den sites by female fishers (*Pekania pennanti*) in northern Minnesota. *Canadian Journal of Forest Research*. <https://doi.org/10.1139/cjfr-2019-0345>
 - g. FMG page numbers: YWH 7-9, 37, 39, 43, TH 33, TSI 7
 - h. Provided description: Fishers (*Pekania pennanti*) exclusively use cavities in large DBH trees; support for the retention of snags and large DBH cavity trees in high-density patches
15. Roth, A. M., Flaspohler, D. J., & Webster, C. R. (2014). Legacy tree retention in young aspen forest improves nesting habitat quality for Golden-winged Warbler (*Vermivora chrysoptera*). *Forest Ecology and Management*, 321, 61–70.
<https://doi.org/10.1016/j.foreco.2013.07.047>
 - i. FMG page numbers: TH 32-40, YWH 7-9, 37, 39, 43

- j. Provided description: Retaining leave trees > 16cm DBH created the highest densities of male golden-winged warblers in aspen forests
- 16. Cooke, H.A., and S.J. Hannon. 2012. Nest-site selection by old boreal forest cavity excavators as a basis for structural retention guidelines in spatially-aggregated harvests. *Forest Ecology and Management* 269:37-51.
- 17. Rossman, R., J. Corcoran, and R. Slesak. 2016. Timber harvesting and forest management guidelines on public and private forest land in various watersheds in Minnesota. 2014 and 2015 monitoring implementation results. Minnesota Department of Natural Resources report to Minnesota Forest Resources Council.
- 18. Squire, K.A., and F.L. Bunnell. 2018. Early breeders choose differently – refining measures of habitat quality for the Yellow-bellied Sapsucker (*Sphyrapicus varius*), a keystone species in the mixed hardwood boreal forest.
- 19. Zlonis, E.J. 2012. Avian communities of managed and unmanaged Minnesota forests. 9th Annual Research Review Symposium, Sustainable Forests Education Cooperative, Cloquet, Minnesota, January 11, 2012.

Invasive Species

No citations related to invasive species were submitted to the online bibliography.

Endangered, Threatened, and Special Concern (ETS) Species

- 20. Conservation Management Guidelines for the Rusty Patched Bumble Bee (*Bombus affinis*), Version 1.6, February 27, 2018
 - a. FMG page numbers:
 - b. Provided description: Removal of foraging habitat that exceeds 2 acres is likely to adversely affect rusty patched bumblebee (federally endangered).
- 21. U.S. Fish and Wildlife Service (USFWS). 2021. Rusty Patched Bumble Bee (*Bombus affinis*) Endangered Species Act Section 7(a)(2) Voluntary Implementation Guidance. Version 3.1. USFWS, Bloomington, MN. 31 p.
 - c. FMG page numbers:
 - d. Provided description: Effects of forage removal, habitat disturbance on rusty patched bumble bee (federally endangered).
- 22. Johnson, C.M. and R.A. King, eds. 2018. Beneficial Forest Management Practices for WNS-affected Bats: Voluntary Guidance for Land Managers and Woodland Owners in the Eastern United States. A product of the White-nose Syndrome Conservation and Recovery Working Group established by the White-nose Syndrome National Plan (www.whitenosesyndrome.org). 39 pp.
 - e. FMG page numbers: YWH 7-9, 37, 39, TH 33, TSI 7
 - f. Provided description: Habitat considerations for WNS-affected bats, including ETS bats
- 23. Aitkin-Carlton Counties Habitat Conservation Plan, Aitkin and Carlton Counties, Minnesota; Receipt of an Application for an Incidental Take Permit, Proposed Habitat Conservation Plan

- g. FMG page numbers: YWH 7-9, 37, 39, 43
 - h. Provided description: Habitat conservation plan for northern long-eared bat (federally threatened, MN special concern), management recommendations
24. MN DNR. 2020. Minnesota Wood Turtle Conservation Plan.
<https://files.dnr.state.mn.us/eco/nongame/projects/mn-wood-turtle-conservation-plan>
- i. FMG page numbers: YWH: 1-53
 - j. Provided description: MN conservation plan, Increase terrestrial habitat connectivity

On-site Infrastructure

25. Slesak, R. A., & Kaebisch, T. 2016. Using lidar to assess impacts of forest harvest landings on vegetation height by harvest season and the potential for recovery over time. Canadian Journal of Forest Research, 46(6), 869-875. <https://doi.org/10.1139/cjfr-2015-0517>
- a. FMG page numbers:
 - b. Provided description: Landings had reduced growth compared to the general harvest area. Season of harvest had no effect.
26. Lee, M. R., McNeil, D. J., Mathis, C. L., Grozinger, C. M., & Larkin, J. L. (2021). Microhabitats created by log landings support abundant flowers and insect pollinators within regenerating mixed-oak stands in the Central Appalachian Mountains. Forest Ecology and Management, 497, 119472. <https://doi.org/10.1016/j.foreco.2021.119472>
- c. FMG page numbers:
 - d. Provided description: Landings support pollinator habitat - landings had higher densities of pollinators than timber harvest interiors. Additionally, timber harvests with diverse vegetation structure support pollinator habitat.

Rutting/Compaction

27. Miranda T. Curzon, R.A. Slesak, B.J. Palik, J.K. Schwager. 2022. Harvest impacts to stand development and soil properties across soil textures: 25-year response of the aspen Lake States LTSP installations. Forest Ecology and Management 504.
- e. FMG page numbers:
 - f. Provided description: Full tree harvest increases soil compaction and reduces soil carbon and biomass productivity 25 years later.
28. Updated (2018) Michigan Forestry Best Management Practices for soil and water quality.
https://www.michigan.gov/documents/dnr/IC4011_SustainableSoilAndWaterQualityPracticesOnForestLand_268417_7.pdf
- g. FMG page numbers:
 - h. Provided description: Current Michigan BMPs may serve as a relevant comparison to MN FMGs during the revision process.
29. Rittenhouse, C.D.; Rissman, A.R. 2015. Changes in winter conditions impact forest management in north temperate forests. Journal of Environmental Management. 149: 157-167. DOI: <https://doi.org/10.1016/j.jenvman.2014.10.010>.

- i. FMG page numbers: R 19
 - j. Provided description: Warming winter temperatures may reduce the period when harvesting can occur with minimal impacts to soil. Supports climate change adaptations for winter harvesting.
30. Nash, Mohammad; Napper, Carolyn; Page-Dumroese, Deborah; Alger, Russ; Wagenbrenner, Joe; Tirocke, Joanne; Amman, Amy; Courtney, Anna; Griesl, Jim. 2020. Winter logging for mechanical harvesting and fuel treatment operations. 2025-2806-NTDP. Washington, D.C.: U.S. Department of Agriculture, Forest Service, National Technology and Development Program. 40 p
- k. FMG page numbers: R 19
 - l. Provided description: USFS report of research/management guidelines related to winter timber harvesting to reduce soil impacts. Supports climate change adaptations for winter harvesting.

Erosion Control

31. Zachary P. McEachran, R.A. Slesak, D.L. Karwan. 2018. From skid trails to landscapes: Vegetation is the dominant factor influencing erosion after forest harvest in a low relief glaciated landscape. *Forest Ecology and Management* 430 pp. 299-311.
- a. FMG page numbers:
 - b. Provided description: Vegetation is the dominant factor influencing erosion after forest harvest in a low relief glaciated landscape
32. Karen Bennett, J. Frohn. 2018. Emergency Erosion Control Techniques for Dealing with Severe Weather Conditions During an Active Timber Harvest. University of New Hampshire Extension Forestry Field Notes, Dec. 05, 2018
- c. FMG page numbers: GG: 48-50, 55&56, TH: 10, 12,13,26-28,31,32
 - d. Provided description: Supports water quality practices and enhances use of natural and commercial products for erosion control during harvest operations

Biomass Harvest/Slash Management

33. Premer, M. I., Froese, R. E., & Vance, E. D. (2019). Whole-tree harvest and residue recovery in commercial aspen: Implications to forest growth and soil productivity across a rotation. *Forest Ecology and Management*, 447, 130–138.
<https://doi.org/10.1016/j.foreco.2019.05.002>
- a. FMG page numbers: GG 22, forest biomass 19-21
 - b. Provided description: The effects of residue removal are site specific, but the quantity of residue remaining after whole tree harvesting was sufficient to prevent any significant declines in soil productivity during a 40 year rotation.
34. Premer, M. I., & Froese, R. E. (2018). Incidental Effects of Cut-to-Length Harvest Systems and Residue Management on *Populus tremuloides* (Michx.) Regeneration and Yield. *Forest Science*, 64(4), 442–451. <https://doi.org/10.1093/forsci/fxx019>
- c. FMG page numbers: GG 22, forest biomass 19-21

- d. Provided description: Retaining residue during cut-to-length harvesting mitigates soil compaction, but excessive residue can negatively impact aspen (POTR) regeneration density and height growth.
35. Curzon, M. T., D'Amato, A. W., & Palik, B. J. (2014). Harvest residue removal and soil compaction impact forest productivity and recovery: Potential implications for bioenergy harvests. *Forest Ecology and Management*, 329, 99–107.
<https://doi.org/10.1016/j.foreco.2014.05.056>
- e. FMG page numbers: GG 9-11, forest biomass 19-21
 - f. Provided description: Supports need for retention of living and dead tree biomass after harvest, minimize soil disturbance. Impacts of biomass removal are site dependent.
36. Premer, M. I., Froese, R. E., Webster, C. R., & Nagel, L. M. (2016). Vegetation response to logging residue removals in Great Lakes aspen forests: Long-term trends under operational management. *Forest Ecology and Management*, 382, 257–268.
<https://doi.org/10.1016/j.foreco.2016.09.048>
- g. FMG page numbers: GG 22, forest biomass 19-21
 - h. Overstory tree communities were not impacted by residue removal, but understory species richness, diversity, and evenness increased with residue removal. Residue removal increases variability in vegetation communities
37. Lewandowski, T. E., Forrester, J. A., Mladenoff, D. J., D'Amato, A. W., & Palik, B. J. (2016). Response of the soil microbial community and soil nutrient bioavailability to biomass harvesting and reserve tree retention in northern Minnesota aspen-dominated forests. *Applied Soil Ecology*, 99, 110–117. <https://doi.org/10.1016/j.apsoil.2015.11.001>
- i. FMG page numbers: GG 22, forest biomass 19-21
 - j. Provided description: Biomass harvesting with tree retention increased mycorrhizal fungi, nitrogen availability
38. Alaina I. Berger, et al. 2013. Ecological Impacts of Energy-wood Harvests: Lessons From Wole-Tree Harvesting and Natural Disturbance. *Journal of Forestry*. 111 (2) 139-153
- k. FMG page numbers: Forest biomass harvesting 8-30
 - l. Provided description: Literature review relating to biomass harvesting guidelines
39. Fauteux, D., Imbeau, L., Drapeau, P., & Mazerolle, M. J. (2012). Small mammal responses to coarse woody debris distribution at different spatial scales in managed and unmanaged boreal forests. *Forest Ecology and Management*, 266, 194–205.
<https://doi.org/10.1016/j.foreco.2011.11.020>
- m. FMG page numbers: TH 32-40
 - n. Provided description: Leave trees/slash retention - high volumes of well decayed CWD can mitigate negative impacts of tree removal