



Michigan Woody Biomass Harvesting Guidance



Photos by Dave Kenyon, DNRE

**Michigan Department of Natural Resources and Environment
Forest Management Division**

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FOREWORD

Dear Reader and User:

The Woody Biomass Harvesting Guidance provides technical information related to the removal of wood from forest settings using sustainable forest management principles and practices. While the products that are harvested from the forest have many values and benefits, this document focuses on woody material that can remain in the forest after a harvest, and the services and benefits that the retained biomass provides. Forests protect air, soil and water quality, support biodiversity, fish and wildlife populations, and provide recreational opportunities, wood and other forest products for current and future generations.

The use of this document is voluntary—its use is not required by any statute. However, a key influence in the development of this guidance has been the widespread adoption of forest certification standards that emphasize sustainable forestry principles and practices, which include conservation of biodiversity, protection of soil resources, and measures to ensure sustainable growth and regeneration of forests. Application of these recommendations in conjunction with generally accepted forest management practices can enhance long term forest health and sustainability. The recommendations do not cover all situations, as conditions vary from site to site.

I wish to thank the Michigan Forest Finance Authority, the Forest Management Advisory Committee, and the Woody Biomass Harvesting Guidance Workgroup for their collaborative work writing, editing, and reviewing this guidance.



Lynne M. Boyd, Chief
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Preface and Acknowledgements

Recent interest in diversifying energy sources by expanding production of alternative fuels and renewable energy has led to increased attention on wood-based bioenergy as one component of a sustainable energy portfolio. As an extension of ongoing efforts related to biodiversity conservation, and soil and water protection, the Michigan Department of Natural Resources and Environment (DNRE) and stakeholders formed a workgroup in 2008 to develop guidance that would be available for biomass harvesting in forests throughout Michigan. Development of the Michigan Woody Biomass Harvesting Guidance (WBHG) is an initiative supported in part by a Michigan Forest Finance Authority grant, using 21st Century Jobs Funds. The WBHG workgroup included:

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During 2008 and 2009, the WBHG workgroup worked on, and provided a guidance document for woody biomass harvesting to, (then) Forest, Mineral and Fire Management Division (FMFM). The WBHG work group provided both substantive and

insightful discussion, ideas and concerns related to biomass harvesting. The draft they produced was a collective effort and did not necessarily reflect any one organization's viewpoints. In October 2009, FMFM prepared and submitted a final draft to the Forest Management Advisory Committee (FMAC) for review and comment. In May 2010, the Woody Biomass Harvesting Guidance was approved by the Chief of the Forest Management Division.

Michigan has a rich history of utilizing wood for bioenergy and bio-based products including lumber, pulp and paper, composites, and heat and electrical generation. Current and developing technologies are addressing the production of heat and electricity through new uses of biomass such as cellulosic ethanol and other biofuels. These technologies provide opportunities to reduce reliance on fossil fuels, and reduce the amount of wood products entering waste streams and landfills. As interest continues to grow and market opportunities expand for woody biomass, it is crucial that harvesting and removal be done using sustainable forest management principles and practices.

Sustainable forest management can be described as the “practice of meeting the forest resource needs and values of the present without compromising the similar capability of future generations.”¹ The application of this concept is codified in federal and state statutes², as well as in voluntary forest certification systems, including the American Tree Farm System (ATFS), the Forest Stewardship Council (FSC), the Sustainable Forestry Initiative (SFI), and Master Logger Certification (MLC) for harvesting practices. Statutes and voluntary forest certification systems recognize that there are social, economic, and biological considerations associated with sustainable forest management.

The purpose of the WBHG is to provide a broad context for harvesting woody biomass from forest land within a sustainable forest management framework, as well as specific technical recommendations. It is expected that this guidance will be revised as research, practices, science, technology, practical experience, and knowledge add to the understanding of woody biomass harvesting/processing in a forest setting. From this perspective, the WBHG should be reviewed and updated in three years and at regular intervals thereafter. Further, the WBHG is intended to be used in compliance with applicable state and federal statutes, and in conjunction with the recommendations in Michigan's Sustainable Soil and Water Quality Practices on Forest Land manual to help safeguard water, soil, habitat, and ecological processes in our forest systems.

Use of the Woody Biomass Harvesting Guidance is voluntary. As with all forest management activities, landowners and managers are strongly encouraged to work with natural resource professionals to develop and implement sustainable forest management principles and practices on the ground. The amount and type of woody biomass designated for retention should reflect sustainable forest management principles, reflect landowner goals and objectives, and be linked to forest management and harvest plans as appropriate. Woody biomass is a renewable resource that can be derived from a number of sources, including: wood that is harvested from rural and

¹ Helms, J.A. 1998. The Dictionary of Forestry. Society of American Foresters, Bethesda, MD. 210 pp

² PA 451 1994, as amended, Michigan Natural Resource and Environmental Protection Act, Parts 5, 515, 525. National Environmental Policy Act of 1969, as amended, Cooperative Assistance Act of 1978, Farm Bill 2008.

urban forests; shrub lands and other lands; mill residues (material that is produced during the processing of wood products); materials from land planted specifically to provide fuel for energy production; or from products made of wood that no longer serve their primary purpose (e.g., discarded pallets, construction materials, and demolition waste).

Although there are a variety of woody biomass sources, this document will focus on woody biomass derived from forest lands that are managed for, and retained in, forest cover. **For the purpose of this document, woody biomass is defined as “the trees and woody plants, including stem, limbs, tops and other woody parts, tree needles, leaves, or cones grown in a forest or woodland environment.”**³ This includes live material as well as standing dead (culls), and downed dead material. These materials may be in the overstory, understory, or on the ground. Note that this definition does not address all of the ecological and biological functions that woody biomass fulfills or aspects related to resource availability, economic feasibility, landscape planning, or landowner objectives.

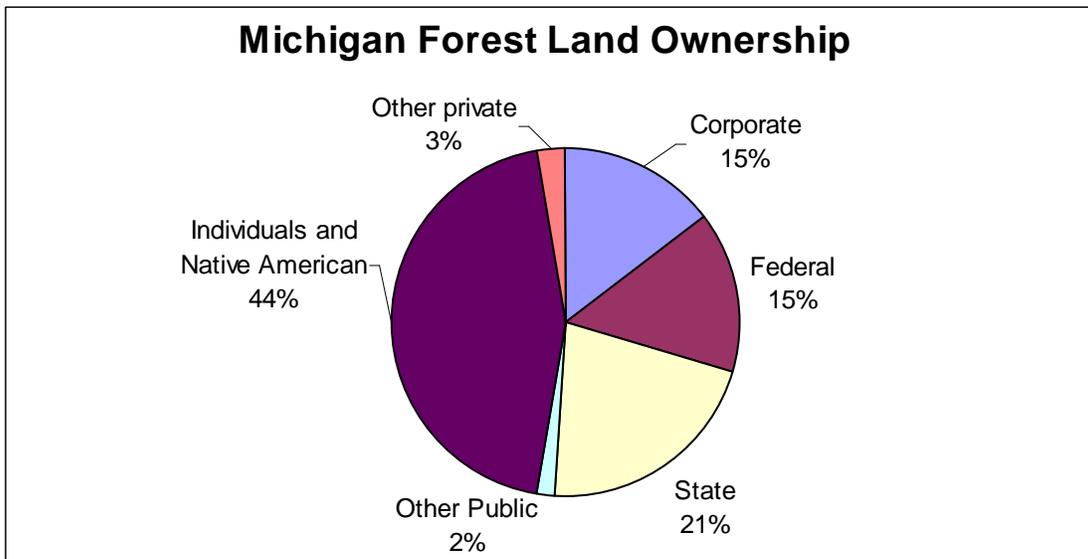
Introduction

Michigan’s forests provide numerous ecological functions including water, soil and air quality protection, biodiversity, carbon sequestration, and fisheries and wildlife habitat. They offer recreational opportunities, landscape diversity, and cultural and spiritual experiences. Forests also support viable, stable rural and urban communities, and supply society with forest based products and services.

Michigan has a broad forest base, 19.7 million acres of forest land, which can provide additional opportunities for the use of woody biomass. Approximately two-thirds (12.3 million acres) of Michigan’s forests are privately owned by nonindustrial landowners, corporate owners such as Real Estate Investment Trusts (REITs), Timberland Investment Management Organizations (TIMOs), forest industries, and others. The remaining one-third (7.5 million acres) is held in public ownership (state, federal, and municipal).

³ Modified from the Federal Regulation 48 C.F.R. § 1437.7203

Figure 1 Michigan 2008 forest land estimates by landowner group⁴



Ownership	Acres	Percent
Corporate (Industry, REIT, TIMO)	2,927,032	14.8
Federal	2,953,014	14.9
State	4,192,036	21.1
Other Public (county and municipal)	357,993	1.8
Individuals and Native American	8,892,732	44.9
Other private	498,549	2.5
Total	19,821,356	100.0

Statewide annual net growth has been approximately 3% of the growing stock volume since 1993; just over 1% of growing stock volume is removed annually to provide wood for lumber, veneer, paper, furniture, hardwood floors, pallets, heat, electricity, and an array of other products.⁵

Opportunities for woody biomass harvesting should be considered in the context of how landscapes and ecosystems function. Collectively, stands are part of healthy, resilient ecosystems and landscapes, and over time contribute a range of products, services and values to economic stability, environmental quality, and community wellbeing. It is useful for landowners and managers to understand how stand-level biomass harvesting decisions may affect the larger landscape.

Each landowner and manager will approach biomass harvesting differently, depending on how they weigh the ecological, social and economic benefits that can be derived from their resources. A number of other factors will influence opportunities for woody biomass harvesting. Each landowner and manager has goals and objectives that guide

⁴ Pugh, Scott A. 2008 Forest Inventory and Analysis data, *personal communication*. U.S. Department of Agriculture, Forest Service, Northern Research Station

⁵ Forests have a current growing stock of 28 billion ft.³ The estimated net increase in forest volume has been approximately 430 million ft.³ annually. Pugh, Scott A. 2007. Michigan's Forest Resources 2006. Res. Note. NRS-6. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 4 p. <http://www.treesearch.fs.fed.us/pubs/12491>

management decisions, including what activities are undertaken, and how and when they are conducted. The WBHG provides information to landowners and managers related to management and biomass harvesting.

It is important to acknowledge that although there are significant forest resources in Michigan, not all forest acreage is available for harvest. Availability is contingent on numerous factors including value for ecological functions (including water quality, air quality, and nutrient cycling), wildlife habitat, biodiversity, accessibility, landowner willingness to harvest, harvesting costs (including transportation), and markets for products. Technological and equipment advances, changes in harvesting and processing, transportation, and new markets for wood products all affect market conditions and demand. It is not the intent of this document to suggest guidance on the economics of biomass harvesting. Rather, this document provides an overview of concerns related to woody biomass harvest activities and recommendations for sustainable resource use.

General Guidance

The guidance detailed in this document supports generally accepted sustainable forest management principles. Landowners and natural resource professionals are encouraged to apply sustainable forest management principles in all phases of management, from the development of forest management plans to implementation on the ground. A variety of resources are available for landowners and managers to help with silviculture and forest management, including: Forest Management Guidelines for Michigan by the Michigan Society of American Foresters; USDA Forest Service Northeastern Area's Woodland Owners Guide to Internet Resources: States of the Northeast (<http://na.fs.fed.us/pubs/misc/flg/>); and silvicultural guidelines used by the Michigan DNRE (<http://www.michigan.gov/dnr/> search: management guidelines and requirements).

Not every recommendation listed in this guidance can, or should apply to every situation. Landowners and natural resource professionals should consider which recommendations are appropriate for their specific site, goals, objectives, and planned management activities. Deviation from the guidance presented here may be appropriate in some cases to address specific site conditions, operations, or management objectives. For example, it may not be appropriate to retain additional trees in harvests where reserving standing live or dead trees increases potential habitat for insect populations that can pose a significant forest health risk. Figure 2 describes potential sources of forest biomass and some of their functions in a forest stand.

Figure 2 Potential Sources of Forest Biomass

Source	Functions Associated with Woody Biomass Harvest
Bole or trunk to 4" diameter top	Same functions as traditional removals; also a source for Coarse Woody Debris (CWD).
Limbs > 4" diameter	Same as traditional removals; also a source for CWD.
Tops and limbs < 4" top	Contribute to nutrient cycling; help stabilize soil, provide wildlife habitat and Fine Woody Debris (FWD).
Vines and shrubs	Important food source for pollinators. Some invasive and/or exotic species shrubs are detrimental and removal may be beneficial to native vegetation. Removal of vines or shrubs that restrict tree growth or compete for nutrients and sunlight (to the detriment of primary regeneration/trees) may also be beneficial to the remaining vegetation.
Standing dead (snags)	Provide wildlife habitat, nutrients, and are important to ecological processes (energy exchange, decomposition, nutrient cycling).
Leaves, needles, cones	Contribute to nutrient cycling, provide wildlife habitat, soil protection, and are a seed source for the next generation of trees.
Seedlings/saplings <4" diameter	Provide future stand components and soil stabilization. Can be important to future stand establishment. In some cases, removal of some elements (poor form, undesirable species) can increase stand health, vigor and value, or in a clearcut treatment assist in natural or artificial regeneration efforts.
Downed dead <4" diameter (FWD)	Fine woody debris (FWD) provides wildlife habitat, nutrients that are important to ecological processes.
Downed dead >4" diameter (CWD)	Coarse woody debris (CWD) provides wildlife habitat, nutrients that are important to ecological processes.
Below ground stumps and roots	Contribute to soil structure, stabilization, and below ground ecological processes.
Forest litter layer and floor	Contribute to soil structure, stabilization, nutrient cycling, and other ecological processes.

It is important to consider retaining tree tops or limbs (residues) from a portion of the harvested trees to maintain both wildlife habitat and soil productivity. The specific recommendations for the retention of tree tops, limbs and branches, will vary by site and by situation. General guidance is listed below for situations where biomass harvesting should not occur or where it may be necessary to retain additional amounts of woody material:

1. Under most conditions in Michigan, it is advisable to retain approximately 1/6 to 1/3 of the harvested tree residues (tree tops, limbs less than four inches in diameter). Note that this recommendation is intended as a general guide, not as a precise measurement. Also:
 - a. Where practical, residues should be returned to the harvest area and dispersed rather than accumulated at the landing.
 - b. The level of existing woody debris present prior to harvest can be considered when planning how much of the harvested tree residue to retain on site. In stands with little woody debris on site prior to harvest, consider a greater level of retention, e.g., retaining 1/3 or more of the tops of harvested trees. If the stand contains a moderate amount of preexisting woody debris on site,

retention closer to the lower end of the range may be appropriate (i.e. retain around 1/6 of the tops of harvested trees).

2. Avoid woody biomass harvesting or limit these harvests to bole wood only in high quality natural communities⁶, or on sensitive sites. For example, a harvest in Alvar grassland with an extremely thin soil layer over calcareous bedrock, and scattered trees and shrubs.
3. Avoid woody biomass harvesting near known occurrences of state and federally listed threatened, endangered, or species of greatest conservation need, unless removal will improve habitat for the species.⁷
4. Avoid removal of the forest litter layer, forest floor or below-ground biomass, including stumps and roots.
5. On shallow, nutrient poor soils, consider leaving additional residue; that is, more than 1/3 of harvested tops, limbs, and branches. An exception for jack pine stands is noted in the "Site or Situation Specific Woody Biomass Harvesting Considerations" section.
6. To the extent possible, retain existing coarse woody debris. Coarse woody debris is an important forest ecosystem component (e.g., for wildlife habitat and nutrient cycling). The variation in length and diameter of coarse woody debris on site is an important habitat factor. Size, stage of decomposition, and quantity of this debris contributes significantly to microhabitat. Consider the following:
 - a. Augment coarse woody debris if there is little on site prior to harvest. For example, consider felling some trees and leaving them on site.
 - b. Move coarse woody debris to allow for safer equipment operations in the harvest area, i.e. off roads, skid trails, and landings.
 - c. Leave tops, limbs and branches that are used to stabilize soil on roads or skid trails in place following harvest operations.
7. Retain some snags or culls to benefit wildlife where they do not pose a safety risk.

Site or Situation Specific Woody Biomass Harvesting Considerations

Listed below are some examples of situations that may modify the General Guidance recommendations. Landowners and managers may encounter circumstances where the quantity and type of biomass removed should be modified; for example, when removing invasive or exotic species from a stand. There are also situations as described below where woody biomass harvesting should not be employed.

- Riparian Management Zones require additional precautions that are noted in the 2009 Sustainable Soil and Water Quality Practices on Forest Land (IC 4011) manual.

⁶ High quality natural communities are classified and ranked by Michigan Natural Features Inventory using global and state community ranking and element occurrence measures (A, B or A/B). <http://web4.msue.msu.edu/mnfi/>

⁷ Identified in Michigan's Wildlife Action Plan at <http://www.michigan.gov/dnrwildlifeactionplan>

- Stands that have been severely disturbed or damaged should be evaluated individually (e.g. fires, blow-downs, and insect/disease infestations). Biomass retention should be modified based on the specific site. A blow-down may improve habitat for some bird species, but it may also increase the risk of destructive forest pests. For example, a salvage or sanitation harvest to remove infested or recently killed pine trees may be appropriate in areas that have high risk for bark beetle outbreaks. If the blow-down is in a low risk area, the trees might be left for wildlife habitat.
- Lower biomass retention may be appropriate for jack pine stands on nutrient poor sites due to its lower demand for nutrients. Because tops from harvested trees may impede planting, greater utilization of harvested tree residues (tree tops, limbs >4 inch diameter) and coarse woody debris may facilitate stand regeneration. However, some fine woody debris should be retained on these sites. If natural regeneration of jack pine is planned, more tops (and cones) should be retained to provide an adequate seed source.
- Biomass retention can be modified in stands where the retention itself may be a threat to human health and safety. Examples include removing snags that are within striking distance of heavily used recreational facilities and reducing fuel loads to lower fire risk for adjacent stands.
- When intermediate harvests are conducted, such as thinning and selection treatments, the residual stand contributes to stand structure, nutrients pools, and wildlife habitat. These contributions can be taken into account as part of biomass retention for the stand.
- In some circumstances, complete removal of invasive or exotic plants, such as glossy buckthorn, autumn olive, or honeysuckle on a site, could increase native plant and animal diversity.

Additional Guidance

Harvesting, including woody biomass harvesting, should follow the guidance in Michigan's 2009 Sustainable Soil and Water Quality Practices on Forest Land (IC 4011) manual. This document contains essential material related to protecting soil, water, wildlife habitat, biological elements and ecological processes.

The Sustainable Soil and Water Quality Practices on Forest Land manual covers:

- Legal requirements and regulations related to:
 - ♦ Soil and sedimentation
 - ♦ Stream crossings
 - ♦ Wetlands
 - ♦ Threatened and endangered species
 - ♦ Cultural and archaeological resources
 - ♦ Spills
- Riparian Management Zones (RMZ): areas in which extra precaution should be used in harvesting timber or for other forest management activities.
 - ♦ Michigan's standard RMZ minimum width is 100 feet or 30 meters, measured from the top of the bank, or the ordinary high water mark for lakes or streams.

The recommended minimum width increases where there is a slope of 10% or greater.

- ♦ Specifications to maintain the water quality function of an RMZ.
- Forest road placement and management.
- Recommendations related to skidding and landings.
- Guidance relative to soil rutting.
- Information regarding vernal pools, seeps, intermittent streams, fens and bogs.

The DNRE uses the Within-Stand Retention Guidance (IC 4110) document to provide direction to State Forest managers on stand-level retention elements. The direction found in this manual for activities on the State Forest system may be useful to other forest landowners and managers.

Retention guidance for State Forest management includes retaining a combination of scattered live trees and snags for habitat, food sources and nutrient cycling. When choosing trees for retention, where possible:

- Retain a few mast producing trees (beech, hickory, ironwood, oak).
- Retain at least one large/super-canopy tree per acre.
- Leave trees in clumps, strips, or islands.
- Leave a mix of hardwood and conifer species in varying sizes.
- Leave tree species that are under-represented in the stand for additional diversity.

The woody biomass harvesting guidance and other references listed above, and in the Bibliography and References can assist landowners and managers with their forest management decisions.

Glossary

The Glossary provides a short list of select terms used in this document. Definition sources are attributed at the end of each entry with the full reference sources at the end of the Glossary.

Alvar: Is a grass and sedge dominated community, with scattered shrubs and sometimes trees. Alvar occurs on broad, flat expanses of calcareous limestone or dolomite (dolostone) bedrock covered by a thin veneer of mineral soil, often less than 25 cm deep. Alvars are only known from three areas of the world: the Basaltic region of northern Europe, County Clare of northwest Ireland, and the Great Lakes region south of the Canadian Shield. MNFI 2009

Bioenergy: The production, conversion, and use of material directly or indirectly produced by photosynthesis (including organic waste), to manufacture fuels and substitutes for petrochemical and other energy-intensive products. NREL 2009

Biomass: Any plant-derived organic matter. Biomass available for energy on a sustainable basis includes herbaceous and woody energy crops, agricultural food and feed crops, agricultural crop wastes and residues, wood wastes and residues, aquatic plants, and other waste materials including some municipal wastes. Biomass is a very heterogeneous and chemically complex renewable resource. NREL 2009

Biomass, woody: For purposes of the Michigan Woody Biomass Harvesting Guidance: The trees and woody plants, including stem, limbs, tops and other woody parts, tree needles, leaves, or cones grown in a forest or woodland environment.

Bole: A trunk or main stem of a tree. Note: seedlings and saplings have stems rather than boles. SAF 1998

Coarse (down) Woody Debris (CWD): Dead woody material, greater than or equal to 4 inches in diameter inside bark at the small end, on the ground in forest stands or in streams. WI 2008

Cull tree: Live tree, five inches in diameter at breast height (d.b.h.) or larger, that is unmerchantable for saw logs now, or prospectively because of rot, roughness, or species. RPA 1997

Fine (down) Woody Debris (FWD): Dead woody material, less than four inches in diameter inside bark at the large end, on the ground in forest stands or in streams. WI 2008

Forest Litter Layer: A layer that lies above the mineral soil, made up of organic debris including leaves, needles, bark, and wood, in different stages of decomposition, with a variety of insects, microbes, and fungi that feed on the litter. WI 2008

Growing stock: A classification of timber inventory that includes live trees of commercial species meeting specified standards of quality or vigor. Cull trees are

excluded. When associated with volume, includes only trees five inches in d.b.h. and larger. RPA 1997

Litter: The surface layer of the forest floor that is not in an advanced stage of decomposition, usually consisting of freshly fallen leaves, needles, twigs, stems, bark, and fruits. SAF 1998

Residue: Stems less than four inch diameter, limbs and branches.

Salvage Cutting: The removal of dead trees, or trees damaged or dying because of injurious agents other than competition, to recover economic value that would otherwise be lost. SAF 1998

Sanitation Cutting: The removal of trees to improve stand health by stopping or reducing the actual or anticipated spread of insects and disease. SAF 1998

Shrub: A woody, perennial plant differing from a perennial herb in its persistent and woody stem, and less definitely from a tree in its lower stature and the general absence of a well-defined main stem. SAF 1998

Snag: 1) A standing, generally un-merchantable dead tree from which the leaves and most of the branches have fallen; note for wildlife habitat purposes, a snag is sometimes regarded as being at least 10 inches (25.4 cm) in diameter at breast height and at least six feet (1.8 m) tall; a hard snag is composed primarily of sound wood, generally merchantable, and a soft snag is composed primarily of wood in advanced stages of decay and deterioration; 2) A standing section of the stem of a tree, broken off usually below the crown; 3) A sunken log or a submerged stump or tree; 4) The projecting base of a broken or cut branch on a tree stem. SAF 1998

Tops: The wood of a tree above the merchantable height (or above the point on the stem four inch diameter outside bark [d.o.b.]). It includes the usable material in the uppermost stem. RPA 1997

Wood: A solid lignocellulosic material naturally produced in trees and some shrubs, made of up to 40-50% cellulose, 20-30% hemicellulose, and 20-30% lignin. NREL 2009

Definition Sources:

MNFI: Michigan Natural Features Inventory. 2009. Natural Community Abstracts, <http://web4.msue.msu.edu/mnfi/pub/abstracts.cfm>.

NREL: National Renewable Energy Laboratory, Research and Technology, Biomass Research, Glossary of Biomass Terms, 2009. <http://www.nrel.gov/biomass/glossary.html>.

RPA: Resources of the United States, 1997; a Technical Document Supporting the 2000 USDA Forest Service RPA Assessment NC-219. 1997. W. Brad Smith, John S. Vissage, David R. Darr, and Raymond M. Sheffield, U.S. Department of Agriculture Forest Service.

SAF: Helms, J.A. 1998. The Dictionary of Forestry. Society of American Foresters, Bethesda, MD. 210 pp.

WI: Wisconsin Council on Forestry. 2008. **Wisconsin's Forestland Woody Biomass Harvesting Guidelines.** December 16, 2008.

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