

# **A Review of Biomass Harvesting Best Management Practices Guidelines**

North East *State* Foresters Association

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# Contents

Executive Summary -----	4
I. Introduction -----	5
II. Biomass Harvesting Guidelines and the Use of Science	6
III. Existing Biomass BMP Guidelines review -----	8
Sources -----	37
Appendix – Federal Programs -----	41

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## Executive Summary

The North East *State* Foresters Association (NEFA) conducted a thorough review of all the biomass harvesting guidelines that have been developed at the state level in the U.S., in other countries, and also within the existing forest certification systems.

Many states have some form of harvesting guidelines for protection of water quality (Best Management Practices or BMPs), but these do not usually cover biomass harvesting explicitly. Therefore, standard BMPs are not covered in this review.

It is evident that peer reviewed scientific research forms the basis of the biomass harvesting guidelines that have been published to date, but only to a limit. The science has revealed areas where biomass harvesting must be conducted judiciously due to the fragile nature of the resource, but the research rarely provides a sure-bet metric to guide field harvesting activities.

Two examples demonstrate this important point:

- There are many recommendations in the various biomass harvesting guidelines about leaving both large and small sized harvested woody biomass (woody debris) on the site during and after the harvest. However, none of the research behind this recommendation quantifies the minimum amount that is necessary to assure invertebrate populations and their habitat are maintained.
- As a second example, biomass harvesting guidelines often refer to the notion of leaving biomass material on the site in order to assure that soil nutrients are replenished over time, but no research to date definitively confirms the amount of material that must be left to avoid the degradation of soil nutrients. The metric of leaving “a third” of the harvested tops is a common recommendation, but there is no evidence supporting whether this amount is effective for protecting soil fertility.

NEFA recommends continued research on these issues to help refine the field practices. Despite the lack of definitive and prescriptive scientific research to

guide biomass harvesting, significant agreement exists on the following tenets for biomass harvesting, in most of the guidelines reviewed:

- The most central concern with biomass harvesting is the potential loss of soil nutrients needed for plant growth.
- Extra care in harvesting must be taken when sensitive or low nutrient soils are present.
- Harvesting should not result in the removal of soil, roots or stumps on harvested areas.
- Coarse and fine woody debris should be maintained on the site during and after biomass harvesting to assure soil nutrients are maintained and to provide habitat for invertebrates.
- Harvesting should follow state Best Management Practices for protection of water quality in forested areas.
- When harvesting using whole tree harvesting equipment, leave at least 1/3 of the biomass portion of the harvest on the site.
- To maintain wildlife habitat and structural diversity, assure that standing live trees and snags, as well as coarse and fine woody debris remain on the site.

### **Lastly, two other points are worth mentioning:**

1) the term "biomass harvest" is not defined well, or at all, in many of the existing guidelines and the high variability in what a biomass harvest is, is lost (e.g.--some biomass harvests as they affect the overall forest site can be the same as or have significant overlap with a pulpwood harvest, except the product harvested is burned rather than fabricated into paper).

and;

2) there is no discussion in any of the guidelines on how different intensities of harvest removals, cutting cycles, and products removed, among other factors, should influence the targets for retained tops, coarse woody debris, fine woody debris, etc.



## I. Introduction

As a response to renewed interest in the use of biomass for energy in the northeast U.S., the state foresters from Maine, New Hampshire, Vermont and New York, through their organization the North East *State* Foresters Association (NEFA), decided to conduct a review of the forest biomass harvesting guidelines that have been published to date. Most of the guidelines have been published at the state level, along with several others from non-profit organization, and some from outside the borders of the U.S.

Most states already have some form of timber harvesting guidelines, which are aimed at protecting water quality. These guidelines, usually called Best Management Practices (BMPs), can be usefully applied to all timber harvesting activities, but they are not specifically designed to address the special issues associated with biomass harvesting, i.e., the full suite of sustainability issues. As a

result, this review does not address the state BMP for water quality guidelines.

NEFA believes each state should decide what is best for the development of biomass guidelines intended for use within its borders. Additionally, NEFA believes it is important for states to understand the similarities and differences among the various biomass guidelines. Knowing what others are doing in this regard may be useful in the spirit of continual improvement.

This review provides significant detail about the various biomass harvesting guidelines in existence. Further detail can be found by reviewing the actual biomass harvesting guidelines document(s) from which this review was conducted.



## II. Biomass Harvesting Guidelines and the Use of Science

In most, if not all, of the biomass harvesting guidelines reviewed for this paper, recommendations are made regarding specific harvesting practices. While scientific research underlies most of these recommendations, it is clear that there is very little exact science behind the specifics. For instance, there are many recommendations about leaving harvested woody biomass (woody debris), of both large and small size, on the site during and after the harvest. While the notion of making sure that biomass material is available on the site to assure that soil nutrients are nourished and re-supplied over time is a reasonable one, no research to date definitively confirms that the often cited metric of leaving “a third” of the harvested tops, or any other amount for that matter, will protect soil nutrient degradation or provide adequate habitat for wildlife following a harvest.

The Minnesota biomass harvesting guidelines make this point well:

“There is an abundance of literature that shows the importance of standing and down CWD [coarse woody debris] in providing habitat for vertebrate species. However, small life forms related to fine woody debris (FWD), particularly fungi, lichens, bryophytes, and arthropods, which are central to the health and productivity of forest ecosystems (Crow 1988; 1990), have not been as well studied. Woody debris, both CWD and FWD, provides habitat for many of these species (Samuelsson et al. 1994). Those relatively few studies of the importance of woody debris for invertebrates often reveal an immense diversity of species that require woody debris. For example, one three-year study in the Canadian boreal forest reported that 257 taxa (mostly species) of saproxylic beetles utilized decaying aspen logs (Hammond et al. 2004). However, few studies have quantified amounts of woody debris needed

to maintain specific populations, much less whole communities.

Although a certain amount of woody debris retention is essential for sustaining biodiversity and wildlife populations, science does not tell us how much woody debris can be sustainably removed from forest harvest sites. The science is clear, however, that natural disturbances create and retain considerably more woody debris than commercial timber harvest and that this difference is increased by woody biomass harvest. ”

In the Forest Guild’s *Forest Biomass Retention and Harvesting Guidelines for the Northeast*, May, 2010, the authors write:

“Wherever possible we base our recommendations on peer-reviewed science. However, in many cases research is inadequate to connect practices, stand level outcomes, and ecological goals. Where the science remains inconclusive, we rely on field observation and professional experience.

A review of scientific literature suggests that biomass harvesting is unlikely to cause nutrient problems when both sensitive sites (including low-nutrient sites) and clearcutting with whole-tree removal are avoided (see Evans and Kelty 2010 for a more detailed discussion of the relevant scientific literature).”

And further from the Forest Guild:

“Although there is too much scientific uncertainty to provide specific targets for each forest type, the research described below may help landowners and foresters interested in additional tree, snag, and downed woody material (DWM) retention tailored to specific forest types. We hope the need to better quantify decaying tree, snag, and DWM retention requirements will catalyze new research efforts and the retention target can be updated based on new science.”

From the Vermont Biomass Energy Development Working Group:





“Scientific support for provisions that address soil productivity and biodiversity is based on the concept that harvest residues and residual vegetation provide organic matter and nutrients that sustain productivity. Consistent and quantifiable data on the relationship between removals and residuals and the resulting inputs and outflows on forest soils is lacking, or at times conflicting. Scientific support for retaining forest structure such as snags, cavity trees and down material is based on research that evaluates the role these elements provide for a variety of wildlife and ecological functions. While data may be limited in certain areas, there are studies to draw upon and forest managers should strive to implement the best science available and practice adaptive management as new science emerges.”

And lastly, from “Promoting Ecological Sustainability in Woody Biomass Harvesting”, an article in the January, 2010 Journal of Forestry by Maria Janowiak and Christopher Webster:

“A review (Johnson 1992) and metaanalysis (Johnson and Curtis 2001) determined that, although studies varied widely in terms of both site conditions and research methodologies, no overall alteration of soil carbon was evident as a result of forest harvesting except when there was intense burning, mechanical disturbance, or soil tillage. Whole-tree harvesting resulted in slight decreases of soil carbon in the A horizon, while the effects of stem-only harvesting varied by species composition (Johnson and Curtis 2001). More intensive actions, such as substantially shortening rotations, removing coarse woody debris, and/or harvesting of submerchantable trees and brush, would be more likely to reduce soil carbon and organic matter. Increased carbon

accumulation was observed after reforestation of formerly agricultural lands as well as through nitrogen fertilization or fixation, which affects organic matter content by increasing primary production and generating greater inputs to the soil from leaf fall and root turnover (Johnson 1992, Johnson and Curti 2001)... Models of forest nutrient budgets suggest that intensive, whole-tree harvesting has the potential to remove enough nutrients to cause long-term productivity declines (e.g., Boyle et al. 1973, Pare´ et al. 2002), although actual evidence is rare and frequently confounded by other factors, such as site or management differences (Powers et al. 1990, Morris and Miller 1994). Reviews of research investigating stem-only and whole-tree harvesting systems have found few long-term impacts on soil nutrients or future biomass production under more intensive management (Morris and Miller 1994, Fox 2000, Hakkila 2002).”

As a result of these writings and others, we should be cautious about relating cause and effect for individual forest practices. While implementing harvesting practices recommended in the various guidelines will likely help address issues of concern (like downed woody debris benefiting soil nutrients and invertebrates), it is not clear at what levels these practices will absolutely bring desired benefits (or if at all). This is not to say that practices should not be implemented because of this uncertainty. Instead, it reinforces the notion that harvesting practices guidelines should be voluntary and, ultimately, adaptable as new science is conducted and the results made available to practitioners.

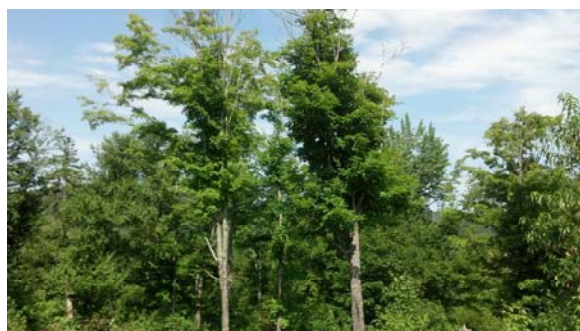
NEFA encourages continued research in these areas and sharing of the findings with those who have developed the various guidelines and, more importantly, practitioners in the field.



### III. Existing Biomass BMP Guidelines review

Many voluntary biomass harvesting guidelines have been produced to date in the U.S., Canada and abroad. As part of this analysis, we review the highlights of many of them in the following narrative and summarize the major similarities in the table immediately below. There are several over-arching premises worth mentioning here. First, all the guidelines recognize that, except in rare cases, harvesting of woody biomass is not a solitary function of timber harvesting, but rather, is an integrated approach as part of timber harvesting that also results in the harvesting of pulpwood, sawlogs and other forest products. Therefore, the recommended practices cannot and should not be viewed in isolation.

Second, as referenced in the previous section, the science is not absolute in determining the best practices for desired outcomes when woody biomass is harvested. All the guidelines reviewed were developed with science as the background, but, except in rare cases, they rely on experts to make “best-guess” or “educated” recommendations on actual metrics for harvesting practices.



Third, the term "biomass harvest" is not defined well, or at all, in many of the existing guidelines and the high variability in what a biomass harvest is, is lost (e.g.--some biomass harvests as they affect the overall forest site

can be the same as or have significant overlap with a pulpwood harvest, except the product harvested is burned rather than fabricated into paper).

Fourth, there is no discussion in any of the guidelines on how different intensities of harvest removals, cutting cycles, and products removed, among other factors, should influence the targets for retained tops, coarse woody debris, fine woody debris, etc.



Lastly, given the uncertainty around the science of the forest practices articulated in the guidelines, we believe that the practices are voluntary and are best implemented as such. While still remaining as voluntary standards, we also believe that the implementation of certain biomass harvesting guidelines could be made part of traditional harvesting agreements. They should not, at least at this time, be codified in state or local laws or regulations. Similar to the way the wave of forest certification since the mid-1990s has changed the culture of forest practices in the U.S., voluntary use of biomass harvesting guidelines can do the same if significant and persistent education is utilized to promote these practices.



**Table 1 - Biomass Harvesting Guidelines – Summary Table of Recommended Practices**

	Topic	Maine	Michigan*	Minnesota	Missouri	Pennsylvania	Wisconsin	New Hampshire*	Vermont** z	California**	Oregon**	Washington**	New Brunswick	Finland	Sweden	Denmark	United Kingdom	Sustainable Forestry Initiative	Forest Stewardship Council	Tree Farm	Forest Guild
	Coarse Woody Debris	X	X	X	X	X	X	X		X	X	X		X				X	X		X
Dead Wood	Fine Woody Debris	X	X	X	X	X	X	X		X	X	X	X					X	X		X
	Stumps, roots & soil	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X
	Snags	X	X	X	X	X	X	X		X	X	X						X	X		X
	Planning	X		X	X	X	X	X		X	X	X			X			X	X	X	X
Silviculture	Regeneration			X		X		X		X	X	X						X	X	X	X
	Residual	X		X	X	X	X	X		X	X	X						X	X	X	X
	Aesthetics					X	X	X		X	X	X						X	X	X	
	Post Operation				X	X	X	X		X	X	X						X	X		
Soils	Roads/skid trails				X	X	X	X		X	X	X	X					X	X	X	X
	Nutrients	X	X	X	X	X	X	X		X	X	X		X	X	X	X	X	X		X
	Compaction				X	X	X	X		X	X	X	X					X	X		
	Biological				X	X	X	X	X	X	X	X						X	X		X
Water Quality/Riparian	Water Quality	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X
	Riparian Zones	X		X	X	X	X	X		X	X	X		X				X	X	X	X
	Non-point Polution					X															
Wildlife/Biodiversity	Erosion				X	X	X	X		X	X	X	X					X	X	X	
	Wetlands				X	X	X	X	X	X	X	X						X	X		
	Wildlife	X		X	X	X	X	X		X	X	X						X	X	X	X
	Sensitive Species	X		X		X	X	X		X	X	X						X	X	X	X
Other	Biodiversity	X		X		X	X	X		X	X	X						X	X	X	X
	Plants of Special Concern			X	X		X	X	X	X	X	X						X	X		
	Sensitive Areas							X		X	X	X		X	X	X	X	X	X	X	
	Insects			X		X	X	X		X	X	X				X		X	X	X	
	Disease			X		X	X	X		X	X	X				X		X	X	X	
	Fire					X	X	X		X	X	X							X	X	
	Fuel Reduction				X					X	X	X									
	Pesticides							X		X	X	X						X	X	X	
	Invasives			X			X	X		X	X	X						X	X	X	X
	Site Re-entry				X	X	X	X													X
	Conversion							X											X		
	Carbon									X	X	X						X			X
* Relies on the state's BMPs for water quality manual to cover many of the other topics.																					
** In state law.																					
z biomass harvesting guidelines being developed 2012, draft unavailable as this publication was completed																					



## Biomass Harvesting Guidelines

The summaries below are intended to give the reader a clear sense of the content of the various biomass harvesting guidelines so that easy comparisons can be made. It is recommended that the full guidelines be reviewed by anyone wanting more detail. The list begins with the U.S. states that have recommended guidelines, followed by certification programs, other private guidelines, and foreign governmental programs.

### A. Maine

*Title:* Woody Biomass Retention Guidelines: Considerations and Recommendations for Retaining Woody Biomass on Timber Harvest Sites in Maine *Date:* January, 2010

Woody biomass retention guidelines were developed for Maine's forest industry as part of a two-year effort led by the University of Maine, Maine Forest Service, and the Trust to Conserve Northeast Forestlands. The initiative involved a multi-stakeholder consultation process and a review of scientific studies relevant to impacts from biomass harvesting. The Maine Guidelines focus on the amount and type of woody biomass that should be retained in the forest after a harvest operation to protect soil productivity, water quality, and site-level biodiversity. Further, the document seeks to recommend guidelines for retention of woody biomass on harvest sites from both a general perspective and also with more specific regard to soil productivity, water quality, and site-level biodiversity.

Maine's biomass harvesting guidelines have recommended practices relative to:

- Pre-harvest planning and the importance of understanding the productivity and special features of the site that might be affected by biomass harvesting;
- Retaining biomass on the site and the positive effects on soil productivity of doing so;
- Fine woody biomass retention and its importance to soil nutrients and to biodiversity at many levels;
- Not disturbing forest floor materials: leaves, organic layer, stumps, etc.
- Leaving as many tops and branches as possible on low productivity sites, as well as those sites that are poorly or excessively drained;
- Leaving woody biomass (tops) on site especially in skid trails to minimize erosion potential;
- Leaving as much dead wood on the site as possible (standing and on the ground) for biodiversity purposes;
- Leaving live wildlife (cavity) trees throughout the harvest site;
- Leaving mast producing trees as their fruit is highly nutritious to a wide range of animal species;
- Varying the amount and number of snags, wildlife trees, and woody debris across the site.



## B. **Maryland**

*Title:* A Guide to Forest Biomass Harvesting and Retention in Maryland *Date:* September, 2010

As with other states, new interest in the use of woody biomass for energy production from Maryland's forests spurred the development of guidelines for harvesting forest biomass. The Maryland Department of Natural Resources Forest Service believed that new emphasis on good forest practices related to biomass harvesting would also encourage cautious practices overall that would help conserve forest resources. The guidelines are based on a comprehensive review of the potential ecological risks associated with biomass harvesting and a review of Maryland's existing forest management programs. The guidelines are meant to work in concert with existing forest management plans (FMPs), Best Management Practices (BMPs), and other natural resource management programs to provide for the protection of environmental quality, forest health and productivity through the use of scientifically credible management practices.

Paraphrased from the document's foreword, the Maryland guide was developed through a consultative process that was funded by the Harry R. Hughes Center for Agro-Ecology, Inc., and facilitated by the Pinchot Institute for Conservation. Participants contributed their technical expertise, practical knowledge, and real world experiences to shape these guidelines. Participants in this process included the Maryland Department of Natural Resources Forest Service, the Maryland Department of the Environment, the Maryland Energy Administration, the Baltimore County Department of Environmental Protection & Resource Management, the University of Maryland Extension Service, the University of Maryland

Department of Agricultural and Resource Economics, the Nature Conservancy, the USDA Natural Resources Conservation Service, private forest landowners, and consulting foresters.

The Maryland guidelines cover the topics in great detail – more detail than most of the other guidelines reviewed (except for those of The Forest Guild). These include:

### **Forest Soils**

- If harvests occur on nutrient rich soils and remove a relatively small percentage of the stand's basal area, it is generally acceptable to remove more fine woody debris (FWD) because the remaining trees will likely continue to contribute to soil nutrient pools;
- In general, the removal of FWD should be avoided on sites with low-fertility, shallow-to-bedrock soils, coarse sands, poor drainage, and sites prone to erosion (i.e., exposed soil, steep slopes);
- To a degree feasible, retain pre-harvest coarse woody debris (CWD). This includes avoiding crushing pre-harvest CWD with equipment, except in instances where forest health, safety, and feasibility concerns prevail;
- The forest litter layer, stumps, and root systems should not be removed. Exceptions may be made in instances where scarification is needed for forest regeneration (i.e., in some plantation forests), or in instances where removal is called for to prevent disease;
- Avoid harvesting when the ground is water saturated;
- Minimize the number of passes over the harvest area with heavy equipment. Properly written harvest plans that include detailed site maps can help ensure that multiple passes are avoided, and that road and trail systems are well utilized. Some exceptions can be made if soil scarification is the preferred site



preparation technique. Flagging skid trails in appropriate locations is also necessary;

- Minimize soil compaction and rutting by using low-impact and appropriately sized equipment. Low ground pressure tires or tracked equipment is preferable in areas not directly on forest roads.

### **Wildlife Habitat and Biodiversity Conservation**

- When planning a harvest of any kind, inventory key habitat features at the site (e.g., wildlife trees, early successional clearings, and water resources), and note the relationship with the surrounding landscape. This inventory can be easily incorporated into a forest management plan;
- Avoid biomass harvests in rare and sensitive forest types (i.e., High Conservation Value Forests (HCVF) (e.g., old growth forests, riparian areas, and areas where sensitive native plant communities or endangered or threatened plant and animal communities are known to exist). Such HCVF forest types and their associated management techniques are best identified through consultation with Maryland's Natural Heritage Program regional staff and/or a licensed professional forester;
- If the harvest is to be undertaken within the Chesapeake Bay Critical Area, follow all applicable rules and regulations, including Maryland's guidelines for the conservation of forest interior dwelling species (FIDS): *A Guide to the Conservation of Forest Interior Dwelling Birds in the Chesapeake Bay Critical Area*;
- In order to help maintain site-level biodiversity, retain as much existing pre-harvest CWD of all diameter and decay classes as possible, and avoid crushing pre-harvest CWD with equipment, except in instances where forest health, safety, and feasibility concerns prevail;
- Follow the guidelines for protection of soil resources that pertain specifically to retention

of limbs and tops, as these materials also provide significant biodiversity benefits;

- While likely to fluctuate based on site conditions, the retention of at least 2 – 5 wildlife trees per acre is recommended as an average range across the harvested area. It is also preferable that at least two of these wildlife trees be snags greater than 12 inches DBH. Identify and consider retaining trees with evidence of interior defect or advanced decay and signs of wildlife use;
- Do not high grade and do not harvest all mast trees (e.g., oaks, hickories, walnut, and cherry) within the harvest block. In even-aged management, mast trees can be retained in patches;
- If harvesting understory vegetation (e.g., shrubs and saplings), it is recommended that a portion be left standing in several clumps across the site. This is often beneficial to do in retention patches around snags and other wildlife trees. Wildlife habitat in even-aged harvest blocks can be enhanced by retaining patches of understory vegetation in conjunction with seed trees and wildlife trees;
- When possible, avoid timber harvests during times of the year where nesting birds and denning animals will be disturbed. Consult the FIDS guidelines and Maryland Natural Heritage Program regional staff as appropriate.

### **Water Quality and Aquatic Resources**

- Follow all Maryland Best Management Practices (BMPs) contained in the Maryland Standard and/or Custom Plan for Sediment and Erosion Control. A well planned harvest will result in the greatest prospect for successful installation and maintenance of BMPs;
- Follow all applicable existing state and local regulations (e.g., Maryland Critical Areas Law and Non-Tidal Wetlands Law);





- Follow the guidance for the protection of forest soils during biomass harvests;
- The removal of tops and limbs in an amount that is greater than what would normally be removed under regular timber harvests should be avoided in riparian buffers when performing a harvest under a buffer management plan (part of a custom plan attached to a standard sediment and erosion control plan);
- Avoid biomass harvesting in highly erosion-prone sites (e.g., sites with slopes greater than 40% and sites with exposed soil) and take care to leave appropriate amounts of limbs and tops on the ground, especially in sites with slopes greater than 20%;
- If fertilizing, consult appropriate resources (e.g., Maryland extension publications on fertilization of plantation forests and regional extension agents focused on forestry) with regard to appropriate fertilization techniques.





### C. Michigan

*Title:* Michigan Woody Biomass Harvesting Guidance  
*Date:* May 5, 2010.

The work on Michigan's biomass harvesting practices came about as a result of increasing interest in forest certification in the state and a desire to encourage adherence to the more sensitive practices associated with certification even on non-certified lands, through a voluntary approach. The Michigan Department of Natural Resources and Environment's desire to further its mission "...to conserve, manage, protect, and promote accessible use and enjoyment of the state's environmental, natural resource, and related economic interests for current and future generations" also played a part in the effort.



The introduction to the Michigan document also states, "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."

The focus of the Michigan Guidance is on the retention of biomass on the site after timber harvesting is completed.

Michigan's biomass BMPs have recommended practices relative to:

- Retention of woody biomass on the site – between 1/6 and 1/3 of the residues from a harvest (limbs, tops, branches) should generally be left on the site;
- Avoiding woody biomass harvesting on sensitive sites;
- Avoiding removing forest floor biomass;
- Retaining existing coarse woody debris found on the site before the harvest begins;
- Retaining snags or culls when they pose no safety risk;
- Conducting biomass harvesting carefully in riparian areas.

Additional guidance can be found in the Michigan BMP for water quality manual - *Sustainable Soil and Water Quality Practices on Forest Land*. As a result, most other areas of biomass BMPs are not mentioned specifically in the Guidance document.

#### **D. Minnesota**

*Title:* Biomass Harvesting on Forest Management Sites in Minnesota

*Date:* May 16, 2007.

In Minnesota, biomass harvesting guidelines were developed as a result of an act of the state legislature. In response to concerns about increases in demand for woody biomass for energy, the Minnesota State Legislature required the Minnesota Forest Resources Council (MFRC) and the Minnesota Department of Natural Resources (DNR) to develop guidelines or best management practices for “sustainably managed woody biomass” (MN Statute 216B.2424). The legislation specifically states that:

"Guidelines ...must be adopted....for logging slash, using the most recent available scientific information regarding the removal of woody biomass from forest lands, to sustain the management of forest resources as defined by section 89.001, subdivisions 8 and 9, with particular attention to soil productivity, biological diversity as defined by section 89A.01, subdivision3, and wildlife habitat."

The focus of these guidelines is to incorporate natural disturbance patterns and processes into harvesting practices. This can be accomplished by maintaining biological legacies through leave tree clumps, and

maintaining structural complexity throughout the harvest area by retaining a level of snags, down CWD, and slash (or fine woody debris).

Minnesota biomass BMPs have recommended practices relative to:

- Sensitive sites – Reduce or eliminate harvesting from certain sites;
- Riparian areas and water related sites – Reduce harvest intensity or eliminate in certain instances;
- Soils – Prohibit or limit biomass harvesting in forests with certain extremely poor soils (Ombrotrophic - bogs). Leave at least 1/3 of the tops, branches and leaves on other poor soil sites. Do not remove the topsoil, forest floor/leaf litter or roots as biomass;
- Re-entry on sites previously harvested for roundwood for biomass – Do not enter if regeneration is established;
- Wildlife habitat and structural diversity – Leave-tree, snag and coarse woody debris recommendations. Leave at least 1/3 of tops on the site;
- Fuel reduction harvests – Leave understory and patches of material;
- Biomass Harvest Considerations as a tool for Silviculture Management – Considerations for artificial and natural regeneration, thinning, soil exposure, browse reduction.



## E. Missouri

*Title:* Missouri Woody Biomass Harvesting Best Management Practices Manual

*Date:* 2008

Due in large part to the increased interest and demand for woody biomass for energy production in Missouri, the Missouri Woody Biomass Harvesting Best Management Practices Manual was produced by a team of government and private sector individuals and organizations in 2007 and 2008 led by the Missouri Department of Conservation. The best management practices (BMPs) in the Missouri manual are intended to help forest owners and loggers carry out woody biomass harvesting using sustainable management techniques that are designed to protect the state's natural resources while providing a locally derived fuel for energy production.

While many of the other biomass BMP manuals are directed at issues specific to biomass harvesting (generally whole tree harvesting with feller bunchers), the Missouri BMP manual is a more general review of good timber harvesting practices, regardless of whether the harvesting is done in a whole tree fashion or whether the resulting products include wood destined for energy production or not. While the document could distinguish which of the practices recommended are specific to harvesting where energy biomass is harvested, it does not.

Missouri's biomass harvesting BMPs include:

- Before harvesting trees, a written management plan should be completed by a professional forester that addresses all of the natural features and the forest owner's objectives;
- Logging crews should always be required to follow BMPs in a written sale contract;
- All harvesting should be done at a time when soil is firm to minimize rutting,

compacting, and erosion which damages the soil and reduces water quality;

- Damage to crop/leave trees left to grow should not exceed 10 percent by number. Excess damage may result in insect or disease infection leading to loss of volume, quality, and value;
- In thinning and commercial harvests with a chainsaw, retain a minimum of the harvest residue (tops, branches, etc.) on site, distributed throughout the harvest area. In thinning and commercial harvests using a feller buncher or other mechanized harvester, leave 1/3 of treetops from sawtimber harvest and 1/3 of the typical size small trees cut on the site, distributed throughout the harvest area;
- Woody biomass should be harvested at the same time as sawlog timber to avoid re-entry. This is also the most economical approach;
- When harvesting woody biomass in sapling-size stands (5 inches DBH or less), identify a minimum of 200 crop trees (healthy trees that should be left) scattered uniformly per acre on a spacing of at least 15 feet by 15 feet;
- When harvesting woody biomass from pole-size stands (5 to 10 inches DBH), identify and retain no fewer than 150 crop trees (healthy trees that should be left) distributed uniformly per acre on a spacing of at least 17 by 17 feet;
- Any thinning operation in a sawtimber-sized stand (11 inches DBH or greater) that produces woody biomass will ideally leave between 80-100 crop trees per acre scattered uniformly throughout the stand (tree spacing of approximately 21 feet by 21 feet);
- Use of prescribed fire after a woody biomass harvest for site preparation can cause erosion if not properly planned and conducted. Only professional foresters and wildlife biologists trained to use fire in critical habitats should attempt this practice.





## F. New Hampshire

*Title:* Good Forestry in the Granite State

*Date:* 1997 and 2010

New Hampshire has had an overall set of voluntary forest management practices guidelines since 1997. This document, called *Good Forestry in the Granite State*, was first developed as a result of a law that came into being in 1996 that reads:

“The director [of the division of forests and lands] shall coordinate an effort to produce educational tools that identify recommended voluntary forest management practices for sites or practices which are ecologically sensitive due to soils, wildlife habitat, and other unique natural features such as high elevations, steep slopes, deer wintering areas, riparian zones, sensitive soils, and clearcutting.”

An update of the document was completed in late 2010 by a stakeholder group led by agency personnel. While not all of the recommended practices are specifically related to timber harvesting where biomass is removed, many of them are. Key recommendations in the *Good Forestry in the Granite State* document related to biomass harvesting include:

- Aesthetics – be aware and implement practices that are aesthetically pleasing when it comes to harvest layout, leaving slash on site, yard location, patch and clearcut locations, access road location and angle relative to public ways, stumps and blocks on landings and other considerations;
- Recreation use areas – adopt practices that are sensitive to recreation users in areas of high recreation use such as, crossing trails at a right angle, leaving large aesthetically pleasing trees, leaving tree buffers; and placing signs that alert recreation users among other practices;
- Soil productivity – leave as much of tops and branches on site during harvesting as possible especially on marginal soils, limit disruption of soil organic layer; harvesting on frozen ground where possible, especially on sensitive sites;
- Water quality – follow BMPs for protection of water quality on all harvests, pay particular attention to stream and other water crossings and follow all BMPs for those activities; be careful of landing and skid trail placement to assure runoff does not contaminate water resources; take special care to avoid chemical/fuel/oil spills and make sure clean up is rapid and thorough where this does occur, take particular care with operations in riparian areas - assure proper buffers near streams, ponds, lakes and wetlands;



- Insects and disease – take care in bringing in equipment from areas infested by harmful insects or tree diseases to avoid spreading diseases and insects that are harmful; take care and try to avoid harvests when an insect infestation is in the forest or make a plan to completely remove the stand; in areas with limited infestation (particular trees) removing whole trees may be beneficial to the health of the forest;
- Invasive species – take care to not spread invasives from site to site with harvesting equipment; locate skid trails, truck roads and landings in invasive-free areas, make sure to use native species when seeding following harvest for soil stabilization;
- Ice and wind damage – avoid practices that make the remaining stand(s) susceptible to ice and wind damage;
- Logging damage to residual stand – take care in harvest layout to avoid damaging remaining stand by proper placement of bumper trees and diagonal placement of skid trails to avoid right-angle turns; avoid harvesting during spring period when bark is sensitive; use slash and branches as protector of skid trail areas and areas around turns in trails; take extra care around areas of advanced regeneration, avoiding such areas if possible;
- Wildlife – take extra care to allow hard and soft mast trees that are producing mast well to thrive; leave at least six live or snag trees to the acre (especially large ones over 12 inches in diameter) or, in evenaged management, uncut areas, avoid damaging already downed woody material and leave large downed material (especially 18” or larger) where such material does not exist; keep or actively regenerate softwood inclusions in hardwood stands, maintain or create permanent openings of 5 acres or more where such openings do not exist and create temporary openings as part of forest management prescriptions; maintain or expand aspen type stands; maintain deer wintering areas where they exist; identify and maintain trees with raptor nests and bald eagle winter roosting sites; research and plan harvesting practices accordingly when threatened and endangered or species of greatest conservation need are identified on the harvest area;
- Sensitive areas – research and plan practices accordingly if the forest to be harvested contain natural communities of concern and/or protected plants, take care not to harvest in or near seeps or vernal pools – keeping large buffers around these habitats, identify and protect old growth stands and high elevation forests and take in harvesting on steep slopes.





## G. Pennsylvania

*Title:* Guidance on Harvesting Woody Biomass for Energy in Pennsylvania

*Date:* 2009.

As with other states, the Pennsylvania Department of Conservation and Natural Resources (DCNR) was prompted to explore the sustainability issues surrounding harvesting timber for energy purposes, as a result of the recent interest in exploring additional opportunities to use biomass from Pennsylvania's 17 million acres of forests for producing fuel, heat, electricity and combinations of these while lowering greenhouse gas emissions. In 2008 the DCNR undertook a review of the state's public and private forest resources to develop guidance on biomass harvesting that would balance the need for alternative energy sources with the need to protect forest resources for all citizens and future generations.

The Pennsylvania effort looked at "sustainability" as an ambiguous term in the context of biomass because it has at least two definitions. When energy entrepreneurs speak of "sustainability," they are referring to the need for a reliable supply of cellulosic materials to fuel their bioenergy production operations. When foresters and conservationists speak of "sustainable" resources, they want to ensure that any existing and new uses of Pennsylvania's forests preserve its full range of benefits and functions, and its capacity to regenerate a healthy future forest. The guidance for harvesting biomass in the Pennsylvania work attempts to address both supply and conservation concerns.

In Pennsylvania, interest in biomass harvesting for energy is fueled in large part by passage of Pennsylvania's Alternative Energy Portfolio Standards Act (Act 213 of 2004), which "requires all load-serving energy companies in the state to provide 18 percent

of their electricity using alternative sources by the year 2020." It is within this and the national security context that the Pennsylvania guidance was written.

The Pennsylvania document was written with two audiences in mind and in two sections. The first half is a policy overview of issues, trends, concerns and opportunities designed for policymakers, potential investors and general audiences. The second half, written for forest products industry stakeholders and non-industrial forestland owners, summarizes existing harvest practices on state-owned forestlands and best management practices on private forestlands. The best management practices are largely taken from an existing publication entitled *Best Management Practices for Pennsylvania's Forests* published in 1997.

The major conclusions and recommendations for biomass harvesting BMPs in Pennsylvania's guidance document include:

- Harvesting woody biomass from Pennsylvania's forests could help meet the demand for alternative sources of energy and reduce greenhouse gas (GHG) emissions, but should not compromise other important forest functions and values – including protecting water quality, critical natural areas and communities, biodiversity, recreational opportunities, and wildlife habitat;
- Private forestland owners should follow accepted best management practices for timber harvests when implementing biomass harvesting on their lands, and involve resource professionals who can provide technical expertise. These include:
  - Landowners should undertake basic harvest planning before undertaking any cutting. This should include inventory, goals and objectives, marking boundaries, management plan, map making to identify resources, etc.;



- As part of planning and execution, identify regeneration needs and opportunities and plan for operations that result in desired regeneration;
  - Plan and execute harvesting operations to assure minimal damage to residual stands;
  - In stands damaged by insects or diseases, plan harvest to rid the stands of injured or dead trees;
  - To minimize soil damage, assure harvests are conducted at the proper time of the year and that the machinery is suited to the soils and forests to be harvested;
  - Use all regular BMPs for water quality when harvesting for biomass;
  - Assure that information about important wildlife habitat and threatened/endangered plants and animals is available before executing harvesting operations to assure minimizing effects on important areas;
  - Take care in leaving harvested sites aesthetically pleasing using all normal aesthetic practices;
  - Always leave 15 to 30% of harvestable biomass as coarse woody debris;
  - Do not re-enter stands for biomass after they have been harvested for regular forest products – conduct biomass harvests as part of normal operations.
- Small-scale biofuel operations (requiring under 2,000 tons of biomass/year) such as the “Fuels for Schools and Beyond” program are more economically viable for Pennsylvania than large-scale operations that require larger volumes of feedstock (300,000 tons or more) annually and entail higher transportation costs;
  - The forest floor, including roots, stumps and below-ground biomass, should always be off-limits to biomass harvesting. This material provides too many irreplaceable functions to sustaining a healthy forest, including nutrients essential for tree growth and maintaining biodiversity;
  - Agroforestry operations should never replace existing natural forest. The state forest system in Pennsylvania has 98% of its land base in natural forest and thus would be off-limits to biomass plantations. Abandoned or poorly reclaimed mine sites on state forest land could be appropriate sites for plantation biofuel crops. Private lands will offer more potential for plantation biomass production but should not convert forestland or highly erodible lands;
  - A range of 15-30% of pre-harvest biomass – depending on soil type, forest composition and other factors – should always be left on site to buffer against nutrient depletion, erosion, loss of wildlife habitat and other factors. This would translate, for example, into leaving one out of every 3 to 6 harvested trees per acre on the forest floor;
  - Whole-tree harvesting may offer the potential to improve forest regeneration, aesthetics, and reduce fire hazards, but should be done with extreme care to avoid damage to the remaining forest during harvesting;
  - Studying Pennsylvania’s existing forest products procurement stream and forest landownership patterns and preferences should be a prerequisite before initiating biomass energy operations to ensure that sustainable quantities of biomass exist to support them;
  - The best opportunities for biomass harvest in Pennsylvania may be natural-event driven. Disturbance from fire, wind, ice storms, insect damage and other events can create harvest opportunities that complement good silvicultural management. Biomass harvest should always include and advance practices that lead to healthy forest regeneration.



H. **Vermont** – no official guidelines as of this date

Vermont has not yet officially developed a formal set of guidelines for sustainable biomass harvesting, but passed, in 2012, a law under Sec. 16a. 10 V.S.A. Chapter 87 under the title “Harvesting Guidelines and Procurement Standards”. Under this new law, the Commissioner of the Vermont Department of Forests, Parks and Recreation is charged with a number of tasks, including developing “...voluntary harvesting guidelines that may be used by private landowners to help ensure long-term forest health.” These harvesting guidelines have yet to be developed

This law further requires that timber harvesting conducted on state-owned forest land, private lands under the State’s use value program, and on lands from which wood products or biomass energy feedstock is purchased for use in state buildings, be conducted using the to-be-developed guidelines.





## **I. Wisconsin**

*Title:* Wisconsin's Forestland Woody Biomass Harvesting Guidelines

*Date:* December, 2008

In Wisconsin, increased demand for biomass resources for energy production prompted concerns related to forest sustainability issues. As a result, the Wisconsin Council on Forestry, a governor appointed body that advises the Wisconsin Dept. of Natural Resources, agreed that a set of management guidelines were needed to assure biomass harvests occur in a sustainable manner. The guidelines were drafted at the request of the Council by a technical team comprised of Wisconsin Dept. of Natural Resources staff using best available information. Draft guidelines underwent technical review by a select group of experts, and a stakeholder review by an Advisory Committee selected by the Wisconsin Council on Forestry. After review and approval by the Advisory Committee, the guidelines were presented to the Wisconsin Council on Forestry, and the Council elected to solicit public input prior to final approval. Work began on this document in 2007 and was completed in late 2008. A field guide for practitioners has been developed from the report, which was adopted by the Wisconsin Council in late 2008. Additional work is being carried out through an implementation plan, to ensure that the guidelines are being utilized to their fullest extent.

The Wisconsin guidelines focus on the sustainable harvest of woody biomass from forested areas within the context of generally accepted forestry practices, and provide considerations and recommendations applicable to stand and site-level management based on best available information. The guidelines, when applied in concert with other forest management guidelines (*Wisconsin Forest Management Guideline's, BMPs for Water Quality, and Silviculture Handbook*), address potential impacts of increased biomass harvesting on

biodiversity conservation, soil nutrient depletion, physical properties of soil, and water quality. The objective is to provide guidance to forest resource managers, loggers, equipment operators, contractors, and landowners in Wisconsin, and to facilitate sustainable harvests when biomass is a part of the operation.

The guidelines are a tool to enable sustainable forest management by presenting users with practical and reliable recommendations that are easy to understand and implement. Implementation of the Wisconsin Forestland Woody Biomass Harvesting Guidelines is voluntary. The guidelines are intended to be updated as new information is available.

The recommended practices for the Wisconsin guidelines include the following, under two broad classifications:

### **General –**

- Retain and limit disturbance to down coarse woody debris (CWD) already present, except on skid trails and landings.
- Retain down fine woody debris (FWD) on site following harvest:
  - Retain down FWD already present (before cutting), except on skid trails and landings, to the extent feasible;
  - Retain FWD resulting from incidental breakage of tops and limbs in the general harvest area;
  - Retain and scatter tops and limbs (<4" diameter) from 10% of trees in the general harvest area (e.g. one average-sized tree out of every 10 trees harvested);
  - Fine woody debris (FWD) on site following harvest is a combination of pre-existing down FWD, along with wood that was cut or broken during harvest operations and left on the ground.



- Do not remove the forest litter layer, stumps, and/or root systems.



- ✓ Element Occurrences (EO) of Wisconsin Natural Heritage Inventory (WNHI) Community Types
- ✓ Designated High Conservation Value Forests (HCVF)
- ✓ Communities demonstrating exceptional composition or structure, and sensitive sites.

- Consult specialists, management guides, and databases to assess occurrence, habitat requirements, community characteristics, potential impacts of proposed management activities, and management alternatives and recommendations.

- For complete salvage operations, following severe disturbance (e.g. crown fire or complete blowdown), implemented on areas >10 acres under one ownership, that include the harvest of fine woody material retain at least 5% of area in unsalvaged (no harvest) patches at least 0.1 acres in size. These should include large diameter reserve trees, mast trees, cavity trees, snags, and down coarse woody debris if present.

#### Site Specific –

- Protect and sustainably manage species of greatest conservation need and sensitive ecosystems:
  - Do not harvest fine woody material from sites where Federal or State Endangered or Threatened Species are known to exist or are discovered during operations.
  - Before harvesting fine woody material, determine the presence (and location) of and potential impacts on:
    - ✓ State Special Concern Species and Species of Greatest Conservation Need (those not listed as Federal or State Endangered or Threatened)
- Do not harvest fine woody material on shallow soils where bedrock is within 20 inches of the surface.
- Do not harvest fine woody material on dry nutrient-poor sandy soils.
- Do not harvest fine woody material on soils classified as dysic Histosols. These are wetland soils with at least 16 inches of organic material that are nutrient-poor with a low pH.





## **J. California, Oregon and Washington**

California, Oregon and Washington states have the most restrictive forest management regulations in the country, if not the world. While forest practices regulations in those states do not specifically list biomass harvesting as a separate category, some of the regulations do cover the same issues that other states are trying to address through the voluntary biomass guidelines they are developing, including: woody debris, soils, wildlife and biodiversity, water quality, and silviculture.

**California** - While there are currently no rules designed to specifically address intensive removal of forest biomass in California, the existing regulations address all of the key topics covered in many of the biomass guidelines developed by other entities. The *California Forest Practice Rules* point out the importance of snags, den and nest trees as critical habitat and require their retention except where there are safety, insect, disease, or fire considerations. California's regulations require consideration of the importance of retaining downed woody debris for ecological reasons, namely the conservation of moisture, soil productivity, and microorganisms. Riparian area regulations require harvesting to "protect, maintain, and restore trees (especially conifers), snags, or downed large woody debris" that provide stream habitat. Slash is treated more like a fire hazard than a benefit to soil nutrient replenishment and, as such, requires removal in most cases.

An agency team began reviewing the regulations in 2010 to see if additional provisions should be added to address the issues surrounding biomass harvesting.

**Oregon** – Oregon's Chapter 629 Forest Practices Act deals with issues that are very similar to those covered in California's *Forest Practice Rules*. Requirements for addressing regeneration, slash, roads, harvesting, riparian areas, biodiversity issues embodied in snags, downed woody material, etc. are also included. The Act does not specifically address biomass harvesting practices.

**Washington** – Washington State also has very restrictive regulations governing forest practices. The Washington Forest Practices Act was signed into law in 1974 and includes many similar provisions to those in Oregon and California for addressing biodiversity, roads, riparian areas, snags and leave trees, regeneration, and water quality.

Additionally, the state of Washington recently developed a Forest Biomass Initiative that is designed to explore some of the policy questions related to the use of woody biomass for energy. The Initiative includes four pilot biomass energy projects and looks at woody biomass supply, biomass carbon issues, and forest practices. To date, the question of biomass-related forest practices has been addressed by including biomass harvesting in the general definition of "forest practices". In August 2010, Washington's Forest Practices Board asked for "forest biomass removal" to be added to the definition of "forest practices," in rules adopted by the Board under the authority of the State's Forest Practice Act. The Board is continuing the discussions as to whether additional rules, addressing specific biomass harvesting practices, should be adopted.



## K. Certification Programs

### 1. Council on Sustainable Biomass Production

The Council on Sustainable Biomass Production (CSBP) released a “Draft Provisional Standard for Sustainable Production of Agricultural Biomass” in April of 2010, after circulating a draft the previous year. The draft document implied that the Standard might apply to forestry biomass operations. However, the final “Provisional” Standard applies only to agricultural biomass, including woody crops, but not those grown in traditional forests. The Council professes to be “a multi-stakeholder organization established in 2007 to develop comprehensive voluntary sustainability standards for the production of biomass and its conversion to bioenergy. CSBP intends for its Standard to serve as the foundation for an independent third-party certification program, which will set the emerging bioenergy industry on a course of continuous improvement.”

The CSBP Standard also mentions that it is reviewing the forest certification standards from the Forest Stewardship Council, Sustainable Forestry Initiative and American Tree Farm System for compatibility issues, implying that a future CSBP Standard might include forestry as well.

At this time, this Standard does not have relevance for this analysis.

### 2. Sustainable Forestry Initiative (SFI)

The SFI 2010-2014 standard includes some language that addresses “bioenergy feedstock” harvesting practices and a series of requirements affecting all timber harvesting. The general timber harvesting requirements that also affect biomass harvesting include:

1. Soils – avoiding compaction of soils, rutting and other techniques to ensure protection of soil productivity.
2. Water – requirements for use of Best Management Practices for water protection on all operations.
3. Riparian areas – requirements for careful harvesting activities in and near riparian areas.
4. Biodiversity – practices and requirements that protect the full suite of biodiversity, from common species and populations as well as threatened and endangered plants and animals.
5. Clearcuts and Retention – requirements limiting clearcuts and retaining forest cover within harvesting regimes.
6. Special sites – protections for areas that contain special ecological, historical and cultural resources.

The more specific requirements relative to biomass harvesting (bioenergy feedstock harvesting) include:

7. Considerations for biomass feedstock as part of analyses surrounding allowable harvest levels and non-timber issues;
8. Requirement that research support include issues relative to biomass;
9. A section (and definition) in the guidance section for the standard defining the term bioenergy feedstock and clarifying that the SFI Standard does not cover short rotation woody energy crops. The Standard covers bioenergy feedstocks from natural or traditional plantation forestry.



### 3. Forest Stewardship Council (FSC)

The FSC standards for the U.S. do not specifically address biomass or whole tree harvests. Biomass harvests are addressed in concert with other types of removals, similar to the way the SFI standard addresses the issue. The FSC U.S. National Standard, released in late 2010, covers biomass harvesting at a more general level than most state guidelines and, like the SFI Standard, addresses it as part of normal harvesting requirements in the Standard.

The main sections of the FSC Standard that affect biomass harvests (as well as regular harvests) are Criterion 6.2 (habitat for rare species), 6.3 (ecological functions), and 6.5 (soils and water quality). For example, Indicator 6.3.f of the guidelines requires that “management maintains, enhances, or restores habitat components and associated stand structures, in abundance and distribution that could be expected from naturally occurring processes”; these habitat components include “live trees with decay or declining health, snags, and well-distributed coarse down and dead woody material.”

This requirement would place some limits on biomass removal, but it is not specific about the amount of downed woody material that should be retained on-site.

Other areas where biomass harvesting is affected include:

- Indicator 6.5.c - limits multiple rotations of whole tree harvesting to sites where soil productivity will not be harmed.
- Indicators 6.3 and 6.5 – addresses issues of compaction and the impacts of other soil disturbing activities in relation to all management activities.

### 4. American Tree Farm System

The American Tree Farm System 2010 Standard is meant to cover smaller forest operations (i.e. family forests) and has a limit of 20,000 acres to qualify. Like the other forest certification systems, the Tree Farm Standard does not specifically address biomass harvesting. The Tree Farm Standard is very basic, lacks the detail found in the FSC and SFI standards and in many cases, relies on the landowner to develop a management plan that covers key topics and then requires that the landowner follow the management plan.

Some areas of the Tree Farm Standard that affect biomass harvesting include:

- Requirement to follow BMPs;
- Minimizing roads and disturbance in riparian areas and wetlands;
- Identifying and managing for threatened or endangered communities and species;
- Identifying high conservation value forests and managing/harvesting in a way to protect those areas.



## H. Other

### 1. The Forest Guild

*Title:* Forest Biomass Retention and Harvesting Guidelines for the Northeast

*Date:* May, 2010

The Forest Guild guidelines are designed to augment and enhance existing Best Management Practices (BMPs) or new state-based biomass guidelines that may, in some cases, leave managers and policy makers looking for more detailed recommendations. The guidelines, as written, also address other non-biomass harvesting practices. They were developed for a wide range of audiences and are based on the Forest Guild's organizational principles, with the intent of encouraging harvesting practices that embrace and mimic the forest's natural processes.

The Forest Guild guidelines were developed by a working group of 23 members from a wide-range of disciplines. The process was led by Forest Guild staff and was supported by two Forest Guild reports: *Ecology of Dead Wood in the Northeast* and *An Assessment of Biomass Harvesting Guidelines*.

The Guild guidelines primarily pertain to issues of sustaining ecological function and productivity; and they are not meant to replace a comprehensive assessment of forest sustainability.

The recommendations include:

#### a. *Guidelines for Biomass Retention and Harvesting for All Forest Types*

According to The Forest Guild, the following recommendations are applicable across a range of forest types in the Northeast. However, different forest types naturally develop different densities of snags, DWM,

and large downed logs. After an exhaustive review of the current science, the Guild concludes that there is too much uncertainty to provide specific targets for each forest type. The recommendations in this section set minimum retention targets necessary for adequate wildlife habitat and to maintain the integrity of ecological process such as soil nutrient cycling. The Guild recommends that wherever possible, exceed the targets as a buffer against the limitations of current research. Section 3 presents research that may help landowners and foresters interested in additional tree, snag, and DWM retention tailored to specific forest types.

#### b. *Site Considerations to Protect Rare Forests and Species*

- Avoid biomass harvests in critically imperiled or imperiled forest types (i.e., globally recognized or listed as S1 or S2 in a State National Heritage Program).
- Biomass harvesting may be appropriate in sensitive sites to control invasive species, enhance critical habitat, or reduce wildfire risk.
- Old growth forest stands with little or no evidence of harvesting are so rare in the Northeast that they should be protected from harvesting, unless necessary to maintain their structure or ecological function.
- Retention of Downed Woody Material (DWM) - Though DWM represents a large pool of nutrients in some ecosystems, it likely plays a relatively small role in nutrient cycling for managed Northeastern forests.
- Maintenance of Soil Fertility -Biomass harvesting on low-nutrient sites is of particular concern.

In areas that do not qualify as low-nutrient sites, where 1/3 of the basal area is being removed on a 15- to 20-year cutting cycle, it is The Guild's professional judgment that retaining 1/4 to 1/3 of tops

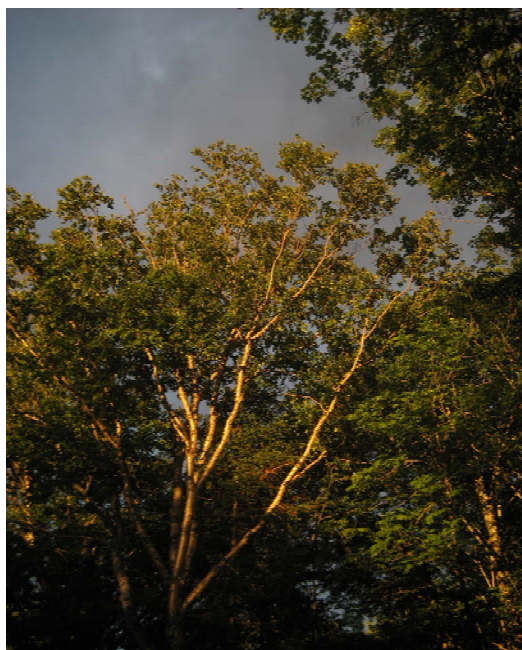




and limbs will limit the risk of nutrient depletion and other negative impacts in most forest and soil types.

*c. Guidelines for Downed Woody Material Retention*

- In general, when 1/3 of the basal area is being removed on a 15 to 20 year cycle, retain 1/4 to 1/3 of the slash, tops, and limbs from harvest (i.e., DWM).
- As harvesting intensity increases (and the three preceding factors decrease) more slash, tops, and limbs from harvests should be left on-site and the converse is true too (as harvesting intensity decreases, leave less).
- Avoid harvesting on low-nutrient sites or adjust retention of tops, branches, needles, and leaves.
- Retain DWM of all sizes on-site including Fine Woody Material (FWM), Coarse Woody Material (CWM) and large downed logs.
- In general, leave DWM distributed across the harvest site or piles if re-distribution is problematic.
- Minimize the removal of needles and/or leaves by harvesting in winter, retaining FWM on-site, or leaving felled trees on-site to allow for needle drop.



*d. Retention of Forest Structures for Wildlife and Biodiversity*

- Leave and protect litter, forest floor, roots, stumps, and large downed woody material.
- Leave and protect a wide variety of cavity trees, den trees, other live decaying trees, and snags (i.e., dead standing trees >10”).
- In areas under even-aged management, leave an uncut patch within or adjacent to every 10 acres of regeneration harvest. Uncut patches, including riparian buffers or other set-asides within the management unit, should total 5% to 15% of the harvest area.
- Build retention patches around large legacy trees, den or cavity trees, large snags, and large downed logs, to maximize structural and habitat diversity.
- Management that maintains multiple vegetation layers, from the overstory canopy to the midstory, shrub, and ground layers will benefit wildlife and plant species diversity.

*e. Water Quality and Riparian Zones*

- Follow state water quality best management practices (BMPs) and habitat management guidelines for additional measures to protect streams, vernal pools, and other water bodies.
- DWM retention described above is also important for water quality, because DWM reduces overland flow and holds water.
- Leave and protect existing woody material in streams, ponds, and lakes. DWM in riparian systems provides sites for vegetation colonization, forest island growth and coalescence, and forest floodplain development.
- Leave and protect live decaying trees (e.g., cavity/den trees), snags, and large downed logs in riparian or stream management zones.
- Keep vernal pools free of slash, tops, branches, and sediment from forestry operations. If slash falls into the pool during the breeding season, it is best to leave it in



place to avoid disturbing egg masses or other breeding activity that may already be occurring.

- Within 100 feet of the edge of a vernal pool, maintain a shaded forest floor to provide deep litter and woody debris around the pool. Also avoid ruts, bare soil, or sources of sediment near vernal pools.
- Extra care should be taken working in or around forested wetlands because of their importance for wildlife and ecosystem function. Wetlands are often low-fertility sites and may support rare natural communities, so removal of DWM may be inappropriate.

#### *f. Harvesting and Operations*

- Protect forest land from conversion to non-forest use and native forest from conversion to plantations.
- Involve a professional forester (or a licensed forester in states where available) in development of a long-term management plan and supervision of harvests.
- Engage a certified logger from the Master Logger Certification Program or other similar program when harvesting.
- Follow all best management practices (BMPs) for the state or region.
- Plan and construct roads and skid trails based on professional advice and BMPs.
- Integrate biomass harvesting with other forest operations. Re-entering a site where timber was recently harvested to remove biomass can increase site impacts such as soil compaction and may harm post-harvest regeneration.
- Use low impact logging techniques such as directional felling or use of slash to protect soil from rutting and compaction from harvest machines.
- Use appropriate equipment matched to site and operations.

#### *g. Carbon Considerations and Guidelines*

Protecting forests from conversion to other land uses is the most important forest management measure to implement in order to store carbon and mitigate climate change. Biomass harvests may reduce the incentive to convert forests to other uses by providing additional income to forest landowners, and maintaining the forest industry and availability of markets. This keeps land in forests.

Some forest management strategies can increase carbon sequestration rates and store more carbon over time than others. Silviculture that encourages the development of structural complexity stores more carbon than silvicultural methods that create homogenous conditions. Those should be encouraged.

The use of logging slash for energy production has a lower carbon impact than the use of live trees for energy because logging slash will decay and emit carbon and other greenhouse gases, while live trees will continue to sequester carbon.

In order to determine the carbon impact of a biomass harvest, the analysis must include the following elements:

1. The amount of carbon removed from the site.
2. The amount of carbon used to grow, remove and transport the material to utilization.
3. The efficiency and carbon emissions of the use of forest biomass for energy, compared to business-as-usual (i.e., no biomass harvest) alternatives.
4. Future carbon sequestration rate for the site.
5. The impact of biomass removals on the site's capacity to grow forest products that store carbon or replace other carbon-intensive products.
6. The time required to re-sequester the carbon removed from the site and the



time required to re-sequester the carbon that would have been sequestered in the business-as-usual scenario.

7. The business-as-usual scenario which includes:
  - a. Predicted harvest rates for the forest type and site in question
  - b. Carbon emissions factors for the production, transportation, and use of the business-as-usual fuel, most likely a fossil fuel. A full accounting that includes these elements can help answer complex questions regarding forest management and carbon impacts. For example, logging slash plays a number of functions. It is a valuable source of nutrients, provides biodiversity habitat, stores carbon on-site and is a potential source of renewable energy. Biomass retention guidelines provide targets for how much to retain for ecological reasons. But how much to remove as a renewable fuel versus how much to leave for on-site carbon storage can only be answered by comprehensive modeling of carbon flows over time.
    - When managing for shade-tolerant and mid-tolerant species, a shift from

even-aged to uneven-aged management will increase the retention of carbon on-site.

- When appropriate to the tree species, a shift to regeneration methods that encourage advanced regeneration, such as from clearcut to shelterwood, will retain carbon on-site for longer periods.
- Retain reserve trees or standards or delay their removal.
- Delay regeneration harvests or lengthen harvest cycles to grow trees for longer times and to larger sizes.
- Encourage rapid regeneration.
- Capture natural mortality as efficiently as possible while retaining adequate numbers of snags, decaying trees, and DWM.
- Use biomass harvests to concentrate growth on healthy crop trees that can be used to manufacture products that hold carbon for long periods or replace carbon-intensive products.



## 2. Federal Biomass Policy

No biomass harvesting guidelines have been developed by the federal government in the U.S. at the national scale, but a number of policies enacted in energy legislation may affect biomass harvesting nevertheless. To date, federal policy in the U.S. has focused on simply defining woody biomass for federal programmatic purposes, i.e. what qualifies and

what does not for the purposes of various federal programs. Key federal programs that federally defined biomass can take advantage of can be found in the Appendix. Only a few suggest conditions, criteria or standards associated with the harvesting of the material and, even then, are vague about the standard such as “...harvested sustainably...” or harvested in a “...sustainable manner”.



## IV. Other Countries

### A. Canada

Timber harvesting guidelines in Canada are developed at the provincial level. These guidelines are generally requirements on Crown lands but not on private lands. As with the U.S., most of the privately owned forestland is in the east in Canada and, as yet, no laws specifically govern biomass harvesting.

Most of the provincial guidelines addressing forest management were written before the new interest in biomass and the associated concerns surrounding the removal of some or all of the tops, branches and lower quality bolewood for this purpose. In recent years, provincial natural resource departments have been debating whether these guidelines address the unique issues of biomass harvesting. As a result, some provinces have undertaken formal assessments of the extent to which their existing forestry guidelines are sufficient to respond to the potential environmental impacts of large scale biomass harvesting. A smaller number have actually produced new guidelines for harvesting of biomass.

In a report commissioned jointly by World Wildlife Fund Canada and The Forest Products Association of Canada in 2010<sup>1</sup>, the following was written to describe the general sentiment across the provinces:

The majority of the provinces surveyed are of the opinion that their existing forest

management guidelines do an adequate job of addressing biomass harvesting sustainability concerns, but some have discussed the need for future monitoring to ensure sustainability and soil fertility are not negatively affected.

New Brunswick is the only province to date to have released new guidelines that are specific to addressing biomass harvesting sustainability concerns (see review below). Nova Scotia and Manitoba are developing new guidelines for biomass harvesting. A draft is out for Nova Scotia, but it is not clear when this will be adopted for use. Ontario is consolidating its existing guideline requirements that address biomass harvesting sustainability concerns and will release this re-packaged set of guidelines soon. Quebec is in the process of developing biomass guidelines based on soil properties.

#### New Brunswick

*Title:* New Brunswick Forest Biomass Harvesting

*Date:* October 22, 2008

It is important to note that the New Brunswick Forest Biomass Harvesting guidelines were developed for Crown lands and are not mandatory on private lands. The guidelines focus on the selection of sites for harvesting that are appropriate to biomass harvesting. A Forest Biomass Decision Support System (FBDSS) was developed to identify areas that are ineligible for biomass harvesting due to “high risk”. From this System, specifically, the guidelines include the following:

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<sup>1</sup> A National Scan of Regulations & Practices Relevant to Biomass Harvesting, World Wildlife Fund – Canada and The Forest Products Association of Canada, February, 2010





- Forest biomass harvesting is limited to the harvest of residual tree tops, branches, foliage, non-merchantable woody stems of trees and shrubs, pre-existing dead woody material and flail chipping residue.
- Do not remove the forest floor including, litter layer, soil surface, stumps and root systems.
- Forest biomass harvesting is only to occur in “low risk” or “eligible” areas.
- Harvest systems are to be designed to minimize soil disturbance, including compaction, rutting and erosion.
- As a best practice, foliage should remain on the site following harvest.

Seasonal timing is to be considered in planning a biomass harvest.

- Forest biomass harvesting operations are to be in accordance to the Forest Management Manual, Crown land forest biomass policy, and other related Crown land policies and directives related to forest management.

#### Nova Scotia

In Nova Scotia a harvesting residue moratorium is in place (ending in 2011). The province is awaiting biomass harvesting guidelines that are under development by a multi-stakeholder group.



## B. Northern Europe

Northern Europe obtains a large portion of thermal energy (primarily heat) from biomass. Coal power plants are also co-fired with biomass and use of wood pellets is growing both at the residential level all the way up to the industrial power generation scale.

Though forest management guidelines for biomass harvesting are similar across Northern Europe, their integration under the broader forest management policy is more varied, with some, namely the UK and Finland, providing voluntary guidelines for use by practitioners and others, such as Austria and Sweden, using a regulatory approach.

### Finland

Finland has had guidelines addressing “Energy Wood Harvest from Clear Cuts” since 2005. These guidelines specifically address the intensified harvesting of biomass for energy production following traditional clear-cut treatments and include guidelines for stump and harvest residue collection and storage. The guidelines and associated emphasis on utilization of woody biomass are part of that nation’s efforts to reach goals for renewable energy and reduced carbon emissions.

Specific guidelines applicable to energy wood harvests from clear cuts in Finland include:

- Large dead wood (standing or on the ground) is not to be collected and should not be damaged (exceptions are made for harvests being conducted in response to storm events and for insect or disease concerns);
- Stumps must not be removed from riparian areas;

- Stumps should not be removed on steep slopes or must be planned so that erosion is avoided;
- A filtering zone of 2 to 10 meters (6 to 30 feet) must be left along riparian zones, with width dependent upon the slope and other watershed characteristics. Equipment may not operate, and no stumps may be pulled in this area;
- Rocky, dry, poor soils, open swamps and other types of sites are not recommended for stump or residue harvest.
- 30% of residues must be left on harvest sites.
- Stumps are not to be lifted if they are decayed, less than 15cm (6 inches) in diameter, on steep slopes, on a site with bedrock near the surface, in riparian zones or nature areas, or near saved trees and snags.
- All stumps larger than 15 cm (6 inches) in diameter should be left (20 such stumps per hectare). Fifty stumps per hectare must be left in clay and silt soils. Stumps from diverse tree species should be left.

### Sweden

Sweden is nearly 70% forested and concern for over-reliance on fossil fuels and nuclear has pushed the country to increased use of biomass for energy since the 1980s. A carbon tax was introduced in the early 1990s on fossil fuels, most of which are imported. As a result, forest biomass use has doubled and overall biomass use for energy in Sweden approaches 30%. Most of Sweden’s forests are privately owned.

Over concerns about soil productivity losses, the Swedish Forest Agency developed a set of



recommendations and good-practice guidelines in 1986 and updated them a decade later. In 2002, the Swedish Forest Act was adopted. This law seeks to control forest practices in order to limit impacts to forest soils, water resources, and long-term site nutrient balances.

Sweden's regulations classify sites according to their risks related to biomass removal. Recommendations, then, are dependent on the specific site in question. The regulations are designed to ensure:

- all forest residues are dried and needles are left on-site before biomass removal,
- sites in northern Sweden with abundant lichens are avoided, and
- sites with acidified soils, peat lands, or sites with a high risk of nitrogen depletion are treated with ash and nitrogen application.

The regulations specify limits for forest residue removal rates in different regions of the country and based on soil issues. The guidelines also stipulate that at least 20 percent of all slash must be left on the ground.

In addition to these site-specific guidelines, Swedish guidelines and regulations include criteria and indicators for sustainable forest management, forest certification, legislation, soil fertility, soil organic matter, wood production, biodiversity and wildlife, insects and fungi, hydrology and water quality, archaeological resources, cultural resources, recreational resources, nature conservation, silviculture, retention of tree species that are less commonly left in the stand, and stump harvesting.

The Swedish Forest Agency also requires additional wood ash to supplement existing requirements for fertilization after certain harvests take place, depending on the amount of biomass is removed.

### Denmark

Denmark has less forestland than Finland or Sweden, but woody biomass is still an important energy source. The Danish biomass harvesting guidelines include:

- soil fertility,
- soil organic matter,
- management of insects and fungi,
- silviculture,
- stump harvesting, and
- production costs.

The Danish guidelines also look carefully at site specific issues to assure that sites that are nutrient poor are not depleted through removal of all biomass. Danish guidelines also state that nutrients lost in logging may be compensated for through fertilization, and that stumps are not to be removed.

### United Kingdom

The United Kingdom (UK) biomass energy sector has also grown substantially in the recent decade. The UK Forestry Commission has released technical reference publications to guide forest managers on the topic of biomass harvesting and the surrounding issues for the soils and forest ecosystem. The UK biomass harvesting guidance encourages managers to first classify sites according to their susceptibility to risks associated with biomass removal. In 2009, the Commission reevaluated the existing system of site classification used to assess the acceptability of biomass harvests. The previous



classification had restricted the overall biomass supply by classifying large portions of the UK as sensitive forestland. The new guidance classifies sites according to soil types as being of low, medium, or high risk and lists associated slash and stump removal management and allows for wider areas to be considered for harvesting than the old system.

In the UK, most harvests are in softwood plantations and include clearcutting for final regeneration. Row thinning is also accomplished at a regular time sequence in the rotation – much like the method used in southern US pine plantations. The UK Forestry Commission has very little concern about the thinnings. The main issue is the final clearcut harvests where the tops and branches are typically windrowed and left to dry before bundling the year or so following harvest. This technique removes most of the biomass from the site. It is this final harvest that the Commission is suggesting should be done with caution depending on the soil quality.

Stump removal is also common in UK final harvests as it is in Scandinavia, thereby exacerbating the concern over nutrient loss to the site. The UK slash removal guidance also states that residue removals are acceptable on all high risk soil types as long as compensatory applications of fertilizer or wood ash are used.

There is no evidence in the literature that guidelines have been developed for biomass harvesting in the developing regions of Asia, Africa or South America. Within these regions, wood is already a primary source of energy and nations are generally seeking ways to increase the efficiency of biomass-to-energy conversion. In most cases, these nations are not looking to forests as sources of new raw materials for energy production. Rather, agricultural energy crops and crop residues, and tree and shrub plantations - especially plantations of oil-producing plants - are the focus of current attention in bioenergy development in these regions. As a result, development of guidelines for harvesting of forest biomass is not viewed as a priority.

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Other international efforts to develop biomass harvesting guidelines have been ongoing with the International Energy Agency, Global Bioenergy Partnership and others. To date, no definitive guidelines have been released from these efforts. As this paper has shown, the most definitive and relevant models for consideration in the northeastern U.S. are those from North America.





## Sources:

Agricultural and Forest Experiment Station, Orono, ME.

Aguilar, F., and H. E. G. Garrett. 2009. Perspectives of Woody Biomass for Energy: Survey of State Foresters, State Energy Biomass Contacts, and National Council of Forestry Association Executives.

Benjamin, J. G. 2010. Considerations and Recommendations for Retaining Woody Biomass on Timber Harvest Sites in Maine. Miscellaneous Publication 761, University of Maine, Maine

Bennett, Karen P. editor. 2010. Good Forestry in the Granite State: Recommended Voluntary Forest Management Practices for New Hampshire (second edition). University of New Hampshire Cooperative Extension, Durham, N.H.

Berg, S. 2003. Harvesting Technology and Market Forces Affecting the Production of Forest Fuels from Swedish Forestry. *Biomass and Bioenergy* 24(4-5):381-388., *Bioenergy* 1(3):211-219.

Biomass Sustainability and Carbon Policy Study, June, 2010, Manomet Center for Conservation Studies

Biomass Sustainability: Biomass no free-for-all, Biomass Canada, Dr. *Evelyne Thiffault of Natural Resources Canada, 2010*

Brown, J. K., Elizabeth D. Reinhardt, and K. A. Kramer. 2003. Coarse Woody Debris: Managing Benefits and Fire Hazard in the Recovering Forest. RMRS-GTR-105, US Forest Service, Rocky California. 2010.

California Forest Practice Rules. *in Title 14, California Code of Regulations. Chapters 4, 4.5 and 10. Appendix: Technical Rule Addendum # 2, B. Canadian Journal of Forest Research* 38(10):2660–2673.

CSBP. 2009. Draft Standard. Council for Sustained Biomass Production, Dillon, CO.

CT DEP. 2007. Best Management Practices for Water Quality While Harvesting Forest Products. Connecticut Department of Environmental Protection, Bureau of Natural Resources, Division of editors. *Bioenergy from Sustainable Forestry: Guiding Principles and Practice*. Kluwer Academic Publishers, Hingham, MA.

Eisenbies, Mark H., Long-Term Timber Productivity Research on Intensively Managed Pine Forests of the South, 2006

Ellefson, P. V., and A. S. Cheng. 1994. State Forest Practice Programs: Regulation of Private Forestry Comes of Age. *Journal of Forestry* 92:34-37.

Ellefson, P. V., M. A. Kilgore, and J. E. Granskog. 2006. State Government Regulation of Forestry Practices Applied to Nonfederal Forests: Extent and Intensity of Agency Involvement. *Journal of* Elliot, C., editor. 2008. Biodiversity in the Forests of Maine: Guidelines for Land Management. University of Maine Cooperative Extension. Bulletin 7174, Orono, ME.

Energy From Woody Biomass: A Review of Harvesting Guidelines and a Discussion of Related Challenges., Dovetail Partners, JULY 29, 2009



environmental impact statement on timber harvesting and forest management in European Countries. *Biomass and Bioenergy* 31:666–684.

Evans, A. M., and A. J. Finkral. 2009. From Renewable Energy to Fire Risk Reduction: A Synthesis of Biomass Harvesting and Utilization Case Studies in US Forests. *Global Change Biology*

Evans, A. M., and G. McKinley. 2007. An Evaluation of Fuel Reduction Projects and the Healthy Forests Initiative. Forest Guild, Santa Fe, NM.  
FCGL008consultation.pdf/\$FILE/FCGL008consultation.pdf

Fernholz, K., S. Bratkovich, J. Bowyer, and A. Lindburg. 2009. Energy from Woody Biomass: A Review of Harvesting Guidelines and a Discussion of Related Challenges. Dovetail Partners, Inc.,

Flatebo, G., C. R. Foss, and S. K. Pelletier. 1999. Biodiversity in the Forests of Maine: Guidelines for Land Management. University of Maine, Cooperative Extension, Orono, ME.  
Forestlands, Orono, ME.  
*Forestry* 104:401-406.  
Forestry, Hartford, CT.

Forest Stewardship Council. 2010. US Forest Management Standard, Forest Stewardship Council, Washington, DC.

Gaitnieks, M. Ingerslev, M. Mandre, R. Ozolincius, A. Saarsalmi, K. Armolaitis, H.-S. Helmisaari, A. Indriksons, L. Kairiukstis, K. Katzensteiner, M. Kukkola, K. Ots, H. P. Ravn, and P. Tamminen.  
Grigal, D.F. 2004. An update of “Forest soils. A technical paper for a generic *Guidelines and Policies*. Sustainable Forest Management Network, Edmonton, AB.

Good Forestry in the Granite State: Recommended Voluntary Forest Management Practices for New Hampshire. (various authors) 1997 & 2010.

Hagan, J. M., and A. A. Whitman. 2006. Biodiversity Indicators for Sustainable Forestry: Simplifying Complexity. *Journal of Forestry* 104(4):203-210.

Hakkila, P. 2006. Factors Driving the Development of Forest Energy in Finland. *Biomass and Bioenergy* 30:281-288.

Herrick, S., J. Kovach, E. Padley, C. Wagner, and D. Zastrow. 2009. Wisconsin’s Forestland Woody Biomass Harvesting Guidelines. PUB-FR-435-2009, WI DNR Division of Forestry

Janowiak, M. K., and C. R. Webster. 2010. Promoting Ecological Sustainability in Woody Biomass Harvesting. *Journal of Forestry* 108:16-23. *Journal of Forestry* 107(6):297-306.

Junginger, M., T. Bolkesj, D. Bradley, P. Dolzan, A. Faaij, J. Heinimo, B. Hektor, O. Leistad, E. Ling, M. Perry, E. Piacente, F. Rosillo-Calle, Y. Ryckmans, P. P. Schouwenberg, B. Solberg, E. K. Raulund-Rasmussen, and I. Stupak, editors. *Sustainable Use of Forest Biomass for Energy*. Springer Netherlands. Roser, D., A. Asikainen, K. Raulund-Rasmussen, and I. Stupak, editors. 2008.

*Sustainable Use of Forest Biomass for Energy—a Synthesis with Focus on the Baltic and Nordic Region*. Springer.

Lattimore, B., C. T. Smith, B. D. Titus, I. Stupak, and G. Egnell. 2009. Environmental Factors in Woodfuel Production: Opportunities, Risks, and Criteria and Indicators for Sustainable Harvesting.



Good-Practice Guidelines for Whole-Tree Harvesting in Sweden: Moving Science into Policy. *Forestry Chronicle* 86(1):51-56.

Mallory, E. C. 2008. Collation of on-Going Canadian Research on Biomass Harvesting and Biodiversity. in *Proceeding of The Scientific Foundation for Sustainable Forest Biomass Harvesting Guidelines and Policies*. Sustainable Forest Management Network, Edmonton, AB.

Missouri Department of Conservation. 2008. Missouri Woody Biomass Harvesting Best Management Practices Manual. Missouri Department of Conservation, Jefferson City, MO.

Michigan Department of Natural Resources. 2007. Sustainable Soil and Water Quality Practices on Forest Land. Michigan Department of Natural Resources, Michigan Department Of Environmental Quality, Lansing, MI.

Michigan Department of Natural Resources. 2009. Michigan Woody Biomass Harvesting Guidance.

Minnesota Forest Resources Council. 2007. Biomass Harvest Guidelines. Minnesota Forest Resources Council, St. Paul, MN.

Maine Forest Service, University of Maine, and Trust to Conserve Northeast . 2008. Biomass Retention Guidelines for Timber Harvesting in Maine.

Maine Forest Service. 2004, 2008. Best Management Practices for Forestry: Protecting Maine's Water Quality. Maine Department of Conservation's Maine Forest Service, August, ME.

New Brunswick Dept. of Natural Resources. 2011. Forest Biomass Harvesting. New

Brunswick Department of Natural Resources, Fredericton, New Brunswick.

Nilsson, L. J., B. Johansson, K. Astrand, K. Ericsson, P. Svenningsson, and P. Borjesson. 2004.

Seeing the Wood for the Trees: 25 Years of Renewable Energy Policy in Sweden. *Energy for*  
Norton, G., S. Abraham, and A. Veneman.

Memorandum of Understanding on Policy Principles for Woody Biomass Utilization for Restoration and Fuel Treatments on Forests, NYSF. 2007. Best Management Practices for Water Quality. New York State Forestry, Albany, NY.

Overview of Biomass Harvesting Guidelines, Pinchot Institute for Conservation, 2008

Pennsylvania Department of Conservation and Natural Resources. 2008. Guidance on Harvesting Woody Biomass for Energy.

Ralevic, P., J. Karau, T. Smith, and J. Richardson. 2008. Iea Bioenergy Task 31 Country Report: Canada. International Energy Agency, Ottawa, Canada.

Raulund-Rasmussen, K., I. Stupak, N. Clarke, I. Callesen, H.-S. Helmisaari, E. Karlton, and I. Varnagiryte-Kabasinskiene. 2008. Effects of Very Intensive Forest Biomass Harvesting

Richardson, R. Bjorheden, P. Hakkila, A. T. Lowe, and C. T. Smith, editors. *Bioenergy from Sustainable Forestry: Guiding Principles and Practice*. Kluwer Academic Publishers, The Netherlands.  
Shepard, J. P. 2006.

Stupak, I., A. Asikainen, M. Jonsell, E. Karlton, A. Lunnan, D. Mizaraite, K. Pasanen, H. P. rn, K. Raulund-Rasmussen, D. R. ser,M.



Schroeder, I. Varnagiryte, L. Vilkryste, I. Callesen, N. Clarke, T. Stupak, I., T. Nordfjell, and P. Gundersen. 2008. Comparing Biomass and Nutrient Removals of Stems and Fresh and Predried Whole Trees in Thinnings in Two Norway Spruce Experiments. *Sustainable Development* 8(1).

Sverdrup, H., and K. Rosen. 1998. Long-Term Base Cation Mass Balances for Swedish Forests and the Concept of Sustainability. *Forest Ecology and Management* 110(1-3):221-236. Swedish Energy Agency, <http://energimyndigheten.se/en/>

Sustainable Utilisation of Forest Biomass for Energy—Possibilities and Problems: Policy, Legislation, Certification, and Recommendations and Guidelines in the Nordic, Baltic, and Other A National Scan of Regulations & Practices Relevant to Biomass Harvesting, World Wildlife Fund – Canada and The Forest Products Association of Canada, February, 2010

Sustainable Forestry Initiative, 2010-2014 Standard

Titus, B. D., S. M. Berch, D. M. Morris, R. L. Fleming, P. W. Hazlett, D. Pare, and P. A. Arp. 2008. Synopsis of on-Going Canadian Research on Biomass Harvesting and Site Productivity.

UK Forestry Commission. 2009. *Forests and Soils Guidelines Consultation Draft, July 2009*. Forest Research, the Research Agency of the UK Forestry Commission.

<http://www.forestry.gov.uk/website/publications.nsf>

UK Forestry Commission. 2009. *Stump Harvesting: Interim Guidance on Site Selection and Good Practice*. Forest Research, the Research Agency of the UK Forestry Commission. [http:// www.biomassenergycentre.org.uk/](http://www.biomassenergycentre.org.uk/)

Vermont Biomass Energy Development Working Group Final Report, January, 2012

Vermont Department of Forests, Parks, and Recreation 1987. 10<sup>th</sup> Printing 2009. Acceptable Management Practices for Maintaining Water Quality on Logging Jobs in Vermont.

Vermont V.S.A. Sec. 16a. 10, Chapter 87

Walmsley, J. D., D. L. Jones, B. Reynolds, M. H. Price, and J. R. Healey. 2009. Whole Tree Harvesting Can Reduce Second Rotation Forest Productivity. *Forest Ecology and Management* 257(3):1104-1111.

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

Woodall, C. W., and V. J. Monleon. 2008. Sampling Protocol, Estimation, and Analysis Procedures for the Down Woody Materials Indicator of the FIA Program. NRS-GTR-22, U.S. Forest Service, Woodlands, and Rangelands. U.S. Forest Service and Bureau of Land Management, Washington, DC.





## Appendix

There are no federal programs that regulate or recommend forest biomass harvesting practices. There are, however, many programs or policies that indirectly affect use of woody biomass for energy production:

- Section 45 of the U.S. Internal Revenue Code defines what kinds of biomass are eligible for producing energy that qualifies for federal tax incentives such as the federal renewable energy production tax credit and investment tax credit. ‘Closed-loop biomass’ is defined as “any organic material from a plant which is planted exclusively for purposes of being used at a qualified facility to produce electricity,” whereas ‘Open-loop biomass’ is “any agricultural livestock waste nutrients...any solid, nonhazardous, cellulosic waste material or any lignin material which is derived from...mill and harvesting residues, pre-commercial thinnings, slash, and brush, [and various] solid wood waste materials,” and agricultural biomass sources.

- Farm Security and Rural Investment Act of 2002 Public Law 107–171—May 13, 2002. This law included both “trees grown for energy production” and “wood waste and wood residues” in its definition of biomass.

- Energy Policy Act of 2005 Public Law 109–58—Aug. 8, 2005. The Energy Policy Act defined biomass to include “any of the following forest-related resources: mill residues, precommercial thinnings, slash, and brush, or non-merchantable material,” as well as “a plant that is grown exclusively as a fuel for the production of electricity.” This definition was more detailed

than the previous 2002 Farm Bill and excluded material that would traditionally sell as timber.

- The Energy Independence and Security Act of 2007 Public Law 110–140—Dec. 19, 2007. The Energy Independence and Security Act included the Renewable Fuels Standard (RFS) and provided the most detailed definition of biomass to date. One of the most important distinctions it made was to separate woody biomass from private and federal lands. Biomass from federal lands was excluded and could not be used to produce renewable fuels. However, an exception was provided for woody biomass removed from the “immediate vicinity of buildings” for fire protection. The RFS also excluded biomass from certain types of forests seen as rare: “ecological communities with a global or state ranking of critically imperiled, imperiled, or rare pursuant to a State Natural Heritage Program, old growth forest, or late successional forest.” The RFS made an effort to discourage conversion of native forests to plantations by excluding woody biomass from plantations created after the enactment of the law. The RFS also established a subsidy of up to \$20 per green ton of biomass delivered for facilities producing electric energy, heat, or transportation fuels.

- Food, Conservation, and Energy Act of 2008 Public Law 110–246—June 18, 2008. The 2008 Farm Bill continued the trend toward great specification in the definition of renewable biomass. This time woody biomass from federal lands was included where it was the byproduct of preventive treatments to reduce hazardous fuels, contain disease or



insect infestation; or restore ecosystem health. On private lands, the definition included essentially all trees and harvest residues. The exclusion for rare forests in the 2007 RFS was not included. The 2008 Farm Bill also initiated the Biomass Crop Assistance Program (BCAP) to improve the economics of establishing and transporting energy crops and collecting and transporting forest biomass. Regarding eligibility requirements for this program, forest lands producing biomass must be covered by a “forest management plan.” The determination of what constitutes an “acceptable plan” is at the discretion of the State Forester. Other legislation has been proposed that includes more specific provisions designed to ensure the sustainability of biomass production. For example, HR 2454 would require that biomass from federal land be “harvested in environmentally sustainable quantities, as determined by the appropriate Federal land manager.” S1733, introduced September 9, 2009, stipulates that biomass be produced while ensuring “the maintenance and enhancement of the quality and productivity of the soil” and promoting the “wellbeing of animals.” The future fate of the federal biomass definition is likely to be part of the large climate-change legislation being debated in Washington. Climate-change legislation may include a national Renewable Energy Standard (i.e., a renewable portfolio standard) that would dictate what kind of woody biomass can be included to meet renewable electricity generation goals. Some proposals would shift the burden of sustainability to the states and require biomass harvesting guidelines or regulations that meet some federal oversight.

