

Revised Assessment of Biomass Harvesting and Retention Guidelines

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1. Introduction

Interest in removing wood with a historically low economic value from forests has increased because of rising fossil fuel costs, concerns about carbon emissions from fossil fuels, and the risk of catastrophic wildfires.^{1, 19} Most existing forest practice rules and recommendations did not anticipate this increased extraction of woody biomass and offer no specific guidance on how much removal is healthy for ecosystems. Intensification of biomass utilization, particularly for energy and fuel needs, presents a range of potential environmental risks.^{34, 31} This report provides a review of guidelines put forth by states and other entities to avoid these environmental risks and promote the ecological sustainability of forest biomass utilization.

1a. Woody Biomass

While definitions of biomass are usually similar, there can be surprising differences. For instance, the definition of biomass in New Brunswick, Canada's guidelines excludes pulpwood fiber from whole-tree chipping.⁴⁵ Technically, the term woody biomass includes all the trees and woody plants in forests, woodlands, or rangelands. This biomass includes limbs, tops, needles, leaves, and other woody parts.⁴⁷ In practice, woody biomass usually refers to material that has historically had a low value and cannot be sold as timber or pulp. Biomass harvesting might even remove dead trees, down logs, brush, and stumps.⁴⁰ Markets determine which trees are considered sawtimber material and which are relegated to the low-value biomass category. Changing markets and regional variations determine the material considered biomass, but in general it is a very low quality product. In some cases, woody biomass is defined by how the material is used. For example, in Pennsylvania any material burned for energy is defined as biomass.⁴⁹

In this report, the term **biomass** refers to *vegetation removed from the forest, usually logging slash, small-diameter trees, tops, limbs, or trees not considered merchantable in traditional markets*. Similarly we use the phrase **biomass harvesting** to refer to the *removal of logging slash, small-diameter trees, tops, or limbs*.



Photo: Zander Evans

Biomass can be removed in a number of ways. Some harvests remove only woody biomass, some combine the harvest of sawtimber or other products with biomass removal, and some remove biomass after other products have been removed. This report focuses on post-harvest forest conditions and not on the type of harvest. The goal is to ensure the forest can support wildlife, maintain biodiversity, provide clean water, sequester carbon, protect forest soil productivity, and continue to produce income after a biomass harvest or repeated harvests. In some regions, current wood utilization is such that very little woody material is available for new markets such as energy. For these high-utilization areas, application of these guidelines may result in more biomass being left in the forest.

1b. Coarse Woody Material

Woody material is sometimes divided into coarse woody material (CWM) and fine woody material (FWM). CWM has been defined as more than 6 inches in diameter at the large end and FWM that is less than 6 inches in diameter at the large end.⁴⁰ The USDA Forest Service defines CWM as downed dead wood with a small-end diameter of at least 3 inches and a length of at least 3 feet, and FWM as having a diameter of less than 3 inches.⁶⁵ FWM has a higher concentration of nutrients than CWM. Large downed woody material, such as logs greater than 12 inches in diameter, is particularly important for wildlife. In this report, we use the term **downed woody material (DWM)** to encompass all three of these size classes, but in some circumstances we discuss a specific size of material where the piece size is particularly important.

1c. Why “Biomass” Guidelines?

*Good biomass harvesting practices can enhance and improve forest land; poor practices can damage and devalue it.*⁴⁹

In the United States, forestry on private and state forests is regulated primarily at the state level. At least 276 state agencies across the country have some oversight of forestry activities, including agencies focused on forestry and other state agencies, such as wildlife or environmental protection.¹⁷ Federal law requires states to address non-point source pollution of waterways. All 50 states have Best Management Practice (BMP) programs that are intended to protect water quality and other values. The programs usually include sections on timber harvesting, site preparation, reforestation, stream crossings, riparian management zones, prescribed burning and fire lines, road construction and maintenance, pesticides and fertilizers, and wetlands. Programs in states vary from laws that prescribe mandatory practices to states that use voluntary BMPs and education and outreach programs. These programs can be categorized in four ways: non-regulatory with enforcement, regulated, and combination of regulatory and not regulatory. In the northeast, Massachusetts and Connecticut are considered regulated, Vermont and New Hampshire are non-regulated with enforcement and Rhode Island, New York, and Maine use a combination of approaches. These programs are routinely monitored and literature suggests that when these BMPs are properly implemented they do protect water quality.⁵⁴ With so much existing regulation, why are additional biomass harvesting guidelines necessary? Reasons for biomass harvesting guidelines are likely to mirror the reasons forestry is regulated in general, which include¹⁶

- general public anxiety over environmental protection,
- the obligation to correct misapplied forestry practices,
- the need for greater accountability,
- growth of local ordinances,
- landscape-level concerns, and
- following the lead of others.

More specifically, biomass harvesting guidelines are designed to fill the gaps where existing BMPs and forest practice regulations may not be sufficient to protect forest resources under new biomass harvesting regimes. In other words, BMPs were developed to address forest

management issues at a particular point in time; as new issues emerge, new guidelines may be necessary. Existing guidelines did not anticipate the increased rate or new methods of biomass removal and offer no specific guidance on the amount of extraction that is acceptable for meeting a range of forest management objectives. For example, Pennsylvania's old BMPs encouraged operators "to use as much of the harvested wood as possible to minimize debris," while the new guidelines recommend leaving "15 to 30 percent of harvestable biomass as coarse woody debris."^{49, 6}

Michigan's guidelines point out that while the state "has a rich history of utilizing woody biomass for bioenergy and biobased products such as lumber, pulp and paper, composites,

heat and electrical generation," as "market opportunities expand for woody biomass, it is crucial that harvesting and removal of woody biomass be done using sustainable forest management principles and practices that are ecologically, economically, and socially appropriate."³⁹

Concerns about long-term site productivity, biodiversity, and wildlife populations drove the Minnesota state legislature to call for biomass harvesting guidelines, and the resulting guidelines are intended to be implemented in close conjunction with the existing Minnesota forestry guidelines, which cover a range of additional management considerations.⁴⁰ More generally, biomass guidelines focus on DWM levels, wildlife and biodiversity, water quality and riparian zones, soil productivity, silviculture, and, in some cases, other issues. For example, Maine's guidelines focus "on the amount of biomass that should be left on-site after harvest and the effect on soil productivity, water quality, and biodiversity."⁷



Photo: Zander Evans

1d. An Examination of Current Guidelines

This report reviews the existing state biomass harvesting or retention guidelines, parts of Canada, Northern European countries, and other organizations, including the U.S. federal government and certification groups. Our review also examines state rules and recommendations that might effect biomass harvesting in the Northeast. In some biomass guidelines are still under review at the time of this writing and subject to change. Readers are encouraged to use the links in Appendix II to check the latest drafts of the guidelines.

The examples in this report detail the status of rules and recommendations for removing biomass from our forests. Entities interested in addressing concerns about biomass removal have taken at least three different approaches. One is to verify that existing forest practice regulations cover the issues raised by biomass harvests, obviating the need for new guidelines. In instances where existing rules or recommendations are found to be insufficient, some entities—including Minnesota, Missouri, Pennsylvania, Wisconsin, and Maine—have taken a second type of approach and chosen to craft separate biomass guidelines that augment existing forest practice guidance. In the third case, entities such as the Forest Stewardship Council (FSC) have chosen to address concerns particular to biomass harvests by revising existing rules or recommendations.

The existing guidelines cover topics such as dead wood, wildlife and biodiversity, water quality and riparian zones, soil productivity, silviculture, and disturbance. Appendix I lists the commonly used subtopics for each and identifies which are covered in a given set of guidelines. In some cases, a subtopic is noted as covered because it appears in another set of forestry practice rules or recommendations instead of that state's biomass guidelines. The list of subtopics was developed from section headings in all the various existing guidelines and is similar to other criteria for sustainable production and harvest of forest biomass for energy.³⁴ It should be noted that each set of guidelines takes a slightly different approach, addressing topics with a greater or lesser degree of specificity. The precepts of sustainable forest management call for identifiable criteria and indicators, such as those identified through the Montreal Process, for the purpose of benchmarking and measuring forest practices. The critique that follows does not always address why topics are covered with more or less specificity, but presumes that more specificity will increase the likelihood that guidelines will encourage sustainable management.

2. Rules and Recommendations Effecting Biomass Harvesting in the Northeast

2a. Maine

In Maine, “guidelines specific to woody biomass retention are missing from existing best management practices and regulations.”⁴³ Therefore, the state undertook a collaborative effort between the Maine Forest Service, the University of Maine, and the Trust to Conserve Northeast Forestlands to develop woody biomass retention guidelines. Participating committee members included Manomet Center for Conservation Sciences, the Forest Guild, the Maine Forest Products Council, and other forestry professional and environmental organizations. After a multi-year process and several drafts, *Consideration and Recommendations for Retaining Woody Biomass on Timber Harvest Sites in Maine* was released in 2010.⁷ The project's goal was to address the growing interest in woody biomass and concerns about long-term sustainability of biomass harvesting by developing guidelines for the retention of woody biomass. The Maine guidelines define woody biomass as “logging residues, previously un-merchantable stems, and other such woody material harvested directly from the forest typically for the purposes of energy production.”⁴³ These new guidelines augment the current Water Quality BMPs, which are effectively applied in most harvests (77 percent of stream crossings and 89 percent of approaches to the crossings⁴²).

The biomass harvesting recommendations report includes an extensive background section and literature review, including three key documents:

- *Best Management Practices for Forestry*,⁴¹
- *Site Classification Field Guide*,⁹ and
- *Biodiversity in the Forests of Maine: Guidelines for Land Management*.¹⁸

It also includes appendices that summarize regional recommendations pertaining to wildlife trees and biomass harvesting. The background section covers soil productivity, water quality, and forest management, as well as forest biodiversity; at the end of each section are voluntary guidelines. In earlier drafts, the voluntary guidelines offered after each section were more specific and stringent, but the final version lacks specific targets. Earlier drafts referred to the entire effort as “Guidelines,” but the reframing of the title indicates the struggle the committee members had in agreeing on specific targets and the vagueness of the final product. For example, the voluntary guidelines for soils indicate forest litter should be left on-site “to the extent possible” and that operators should “minimize removal” of FWM on low-fertility sites.

This lack of specificity is found in other sections as well. The commentary on setting targets for the Forest Biodiversity section helps shed light on the decision-making dynamics that led to the dilution of the final product. The background information for the Forest Biodiversity section draws heavily on *Biodiversity in the Forests of Maine*. This report, a comprehensive manual outlining recommended guidelines for maintaining biodiversity in the forests of Maine, was the culmination of a multi-year process in the 1990s that included a wide range of stakeholders, including industry representatives, forest professionals, and environmental organizations. Originally published by Flatebo and colleagues²², it was updated by Elliot¹⁸. Although the final version of the current biomass retention report utilizes the recommendations from the biodiversity report as background information and indicates that woody biomass harvesting practices “will have to comply with established recommendations for biodiversity as defined for non-biomass harvests,”⁷ the specific targets listed in the biodiversity report are never incorporated as guidelines. The report indicates that since there was “not widespread acceptance of those guidelines within Maine’s forest industry, specific targets for maintenance of site-level biodiversity are not included” in the relevant section.⁷

The result for the Forest Biodiversity section is that the Voluntary Guidelines call for leaving “as much fine woody material as possible” without the specific guidelines for DWM retention found in some other state guidelines. The guidelines also call for leaving “some wildlife trees” without incorporating targets for numbers of trees per acre suggested in *Biodiversity in the Forests of Maine*. The report indicates that this vagueness in the guidelines reflects the challenges of setting specific targets at site levels¹⁸ and that although science can direct selection of biological indicators, it is still weak in selecting specific target levels.²⁶

2b. New Hampshire

While New Hampshire currently has no specific biomass harvesting guidelines, existing recommendations and rules address the major biomass harvesting topics. New Hampshire’s Slash Law (RSA 227-J:10) focuses on “debris left after a timber harvest” and states that “these branches, leaves, stems, unmerchantable logs, and stumps may take several years to decompose. Slash represents a fire hazard and, often, a messy appearance.” The Slash Law sets a limit on the height of slash that can be left on-site, but does not set any minimum to retain on site.

New Hampshire's Basal Area Law (RSA 227-J:9) states that no more than 50 percent of the basal area can be cut near streams, water bodies, and public roads. Intensive biomass removal may decrease this law's ability to prevent erosion, provide wildlife habitat, protect stream temperature and aquatic life, and preserve the aesthetics of the landscape, because removal of DWM is not regulated by a basal area restriction. In New Hampshire, BMPs are voluntary, but the guide *Good Forestry in the Granite State: Recommended Voluntary Forest Management Practices for New Hampshire* includes sections on soil productivity, DWM, and retention of forest structures for wildlife habitat.¹³ *Good Forestry* does not provide specific guidance on retention of tops and limbs, though it does recommend leaving "some cull material" in the woods after a biomass harvest. The section on soil productivity provides recommendations that would limit biomass removal on sites with nutrient-poor soils:

- Identify low fertility soils from maps and descriptions.
- Use bole-only harvesting (taking out the main portion of tree only, leaving branches and limbs in the woods) on low-fertility soils, or where fertility is unknown, as a precaution against nutrient loss.
- If whole-tree harvesting hardwoods, try to plan harvests during leaf-off periods to retain leaves and nutrients on site.
- Limit disruption of soil organic layers except when needed to accomplish silvicultural objectives (such as regeneration of species that need a bare mineral soil seedbed).¹³

Similarly, the Habitat section recommends retention of cavity trees and snags:

- In areas under uneven-aged management, retain a minimum of 6 secure cavity and/or snag trees per acre, with one exceeding 18 inches DBH and 3 exceeding 12 inches DBH. In areas lacking such cavity trees, retain trees of these diameters with defects likely to lead to cavity formation.
- In areas under even aged management, leave an uncut patch for every 10 acres harvested, with patches totaling 5 percent of the area. Patch size may vary from a minimum of 0.25 acre. Use cavity trees exceeding 18 inches DBH or active den trees as nuclei for uncut patches. Remember, the larger the tree, the more species that can use it. Riparian and other buffers can help to satisfy this goal.
- Retain live trees with existing cavities.¹³

The *Good Forestry in the Granite State* guide also has recommendations for retention of DWM:

- Avoid damaging existing downed woody debris, especially large (18+ inches) hollow or rotten logs and rotten stumps during harvesting operations (including tree falling, skidding, and road and skid trail layout).
- Leave cull material from harvested trees, especially sound hollow logs, in the woods. Some cull material should be left behind during whole-tree or biomass harvesting



Photo: Christopher Riely

operations that may otherwise utilize this material. Large pieces of cull material bucked out on the landing should be returned to the woods.

- Avoid disrupting downed logs in and adjacent to streams, ponds, and wetlands.
- Avoid disrupting upturned tree roots from May to July to protect nesting birds.
- Maintain or create softwood inclusions in hardwood stands to provide a supply of longer-lasting down woody material.¹³

A revision of *Good Forestry in the Granite State* is currently underway and the recommendations for DWM in the draft are similar to the existing language.

2c. Vermont

Although Vermont's guide to *Acceptable Management Practices for Maintaining Water Quality on Logging Jobs in Vermont* is in its ninth printing, there is very little in the guide that would affect biomass harvesting or retention.⁶³ The guide's intent is to prevent discharges of mud, petroleum, and wood debris from getting into waterways. These BMPs are not mandatory unless a landowner is participating in Vermont's Use Value Act. The state's two wood-powered power plants in Burlington and Ryegate are required by the Public Service Board to ensure that their wood supply comes from sales with a harvest plan cleared by the Vermont Department of Forests, Parks and Recreation. The main focus of the review of harvest plans is to protect deer wintering areas. Related rules include the Heavy Cutting rules (Act 15), which require clearcuts (a reduction of basal area below the C-level) larger than 40 acres to have a permit (Title 10 V.S.A. Chapter 83, Section 2622). Another regulation that has some relevance to biomass harvesting is the requirement that whole-tree chip harvesters obtain a license (Title 10 V.S.A. Chapter 83, Section 2648).

An act of the Vermont Legislature created a Biomass Energy Development Working Group in 2009. That group is meeting regularly in a two-year initiative to address the major charges of (1) enhancing and developing Vermont's biomass industry while (2) maintaining forest health. As part of its process, subgroups are addressing issues such as economic incentives, supply models, available technology, and workforce availability. A Forest Health subgroup will consider guidelines for retention of woody biomass, forest health indicators, and emerging research on carbon and biomass harvesting issues.

2d. New York

New York's forest practice regulations are based the Environmental Conservation Law (§ 9-0105), though the regulations appear to only cover prescribed fires. The *Best Management Practices for Water Quality* has no recommendation about retention of DWM, snags, or other elements specific to biomass harvesting.⁴⁸ These BMPs cover planning, landings, stream crossings, roads and trails, vernal pools, erosion control techniques, and post-harvest considerations. This document is under revision and will include expanded sections on riparian and wetland zone management but nothing on the ecological or silvicultural aspect of biomass harvesting. New York currently has no immediate plans to develop biomass harvesting guidelines. They are monitoring developments in other states and a biomass study now taking place at the Adirondack Research Consortium.

However, when New York initiated its renewable portfolio standard, it established an eligibility procedure for electrical power generators utilizing forest biomass. The resulting requirements are modeled after Vermont's and include procurement plans for each facility to include forest management plans for source forests and harvest plans filed for all harvests. Adherence to these standards is monitored periodically by state foresters. New York varied slightly from Vermont's approach by providing exemptions to properties that are accredited by FSC, Sustainable Forestry Initiative, or Tree Farm.

2e. Rhode Island

Rhode Island's BMP guidance is encapsulated in the document *Rhode Island Conservation Management Practices Guide*.¹² The Guide includes water-quality protections such as filter strips between harvested areas and streams or ponds. Rhode Island does require the registration of "woods operators" with the Division of Forest Environment and notification of intent to harvest timber (RI State Statutes, Title 2, Chapter 2-15, Sections 1 and 2). Rhode Island has no current intentions to develop biomass harvesting guidelines, although it is aware of the issue and may address it in the future.

2f. Connecticut

Connecticut's BMP field guide was revised in 2007 and focuses specifically on water-quality issues.¹⁵ This guide, like New York's and Rhode Island's, has little effect on biomass removals or DWM retention.^{12, 15, 48} Connecticut is now seeking funding to address biomass harvesting guidelines. Current BMPs recommend keeping slash out of water bodies and vernal pools. Connecticut's BMPs do suggest that "brush and slash may be placed in skid trails and on slopes to slow water flow and retain sediment."¹⁵ One layer of protection is the state's certification program for foresters and loggers. Connecticut is watching the development of the biomass market carefully and would like to have some guidelines in place. It is now looking for funding for developing guidelines, possibly through a joint project between the state forestry department and the Connecticut Forest and Parks Association.

2g. Massachusetts

The Massachusetts Department of Energy Resources (Mass DOER) commissioned a team of researchers to produce a comprehensive report on forest biomass harvesting and its potential carbon and ecological impact. The team was led by the Manomet Center for Conservation Sciences and includes the Forest Guild and the Pinchot Institute among others. The report, submitted to Mass DOER in May, recommended the state adopt guidelines similar to those identified for regional forest types in the *Biomass Retention and Harvesting Guidelines for the Northeast*.²⁴ Massachusetts is now reviewing that report and considering the introduction of biomass guidelines as part of a revision of Chapter 132, the state forest practices act.

3. Biomass Harvesting and Retention Guidelines

3a. Michigan

Since 2008, the Michigan Department of Natural Resources has worked with a stakeholder group drawn from academia, environmental groups, forest industry, and state and federal agencies to develop biomass harvesting guidelines.³⁹ These guidelines were designed to be used in conjunction with Michigan's *Sustainable Soil and Water Quality Practices on Forest Land* manual.³⁸ They emphasize that "not every recommendation listed in this guidance can or should apply to every situation." While the Michigan guidelines provide a list of scientific references, there are no specific citations to support the retention or removal of forest biomass.

Topics such as riparian zones and pesticide use are covered by *Sustainable Soil and Water Quality Practices* and not in the biomass harvesting guidelines. Though brief, Michigan's biomass guidelines, in combination with *Sustainable Soil and Water Quality Practices*, cover most of the major biomass harvesting topics (see Appendix I). However, there is little guidance on retention of snags. Michigan's guidelines also lack specificity in some areas. For example, they suggest retention of anywhere from one-sixth to one-third of material less than 4 inches in diameter from harvested trees.

3b. Minnesota

The Minnesota state legislature directed the Minnesota Forest Resources Council (MFRC) and the Minnesota Department of Natural Resources (DNR) to develop guidelines for sustainably managed woody biomass.⁴⁰ The goal of the guidelines was to help natural resource managers, loggers, equipment operators, contractors, and landowners make decisions about biomass harvesting. With the support of the DNR's Ecological Services, Fisheries and Wildlife, and Forestry divisions, the MFRC directed the guideline development process. The 12-member interdisciplinary technical committee developed separate guidelines for brushland as well as for forestland. The technical committee reflected a range of expertise deemed pertinent to the development of these guidelines, including soil science, wildlife biology, hydrology, forest management, and silviculture. Meeting summaries were provided online, and the committee's work was peer-reviewed and open to public comment. Minnesota's biomass harvesting guidelines were crafted to be part of the MFRC's 2005 forest management guidebook, *Sustaining Minnesota Forest Resources*, and the existing guidelines were integrated into the new biomass recommendations.

Minnesota's biomass harvesting guidelines are rooted in precepts of ecological forestry. For example, the guidelines recommend emulating natural disturbances with silviculture and maintaining biological legacies after harvest.



Photo: Eli Sagor

The guidelines make the case that, in Minnesota, biomass harvesting increases the disparity between managed stands and their natural analogs because it reduces the biological legacies left after harvest, such as slash and fallen logs. The guidelines cover almost all of the topics and subtopics related to biomass harvesting we considered in our analysis (see Appendix I). The only topics not obviously included or referenced were aesthetics, forest diseases, and land conversion.

A recent field test—an experimental biomass harvest—suggests that the harvesting practices utilized for biomass harvest in Minnesota can remove woody biomass without significant negative impacts on snags and DWM. The test harvest had a small effect on the number of snags and on the amount of DWM. Reductions in DWM were small (2 tons per acre or less) and one site showed an increase in DWM.⁵ In addition, of the seven test sites where snags were measured, only three had a lower number of snags after harvest.⁵

3c. Missouri

The catalyst for the development of biomass harvesting guidelines in Missouri was state legislation introduced in February 2007 concerning cellulosic ethanol.³⁷ In response to the lack of BMPs for biomass harvests, the Top of the Ozarks Resource Conservation and Development (RC&D), in partnership with Big Springs RC&D, Bootheel RC&D, the Eastern Ozarks Forestry Council, and the Missouri Department of Conservation, applied for and received a grant from the Northeastern Area State and Private Forestry branch of the U.S. Forest Service to develop BMPs for biomass harvesting. The BMPs development process continued to emphasize participation through a stakeholder meeting for a cross-section of interested parties to discuss issues and possible criteria to be addressed in the BMPs for harvesting woody biomass. A technical committee brought expertise on soil science, wildlife biology, hydrology, forest management, and silviculture to the process. Meeting announcements and notes were provided online to allow for transparency in the development of BMPs.



Photo: Zander Evans

The Missouri guidelines cover the major biomass harvesting topics (see Appendix I). Subtopics not covered in the Missouri guidelines include regeneration, removal of litter and forest floor, and fuel reduction. A section on pesticides was included in an early version of the biomass guidelines, but was later dropped because of its lack of relevance to biomass.

3d. Pennsylvania

Pennsylvania's guidelines are a direct result of increased interest in woody biomass for energy. The passage of Pennsylvania's Alternative Energy Portfolio Standards Act (Act 213 of 2004) helped drive that interest by requiring "all load-serving energy companies in the state to provide 18 percent of their electricity using alternative sources by the year 2020." In response to the

interest in using Pennsylvania's forests to help meet alternative energy goals, the Department of Conservation and Natural Resources (DCNR) created biomass harvesting guidelines, intending to balance the need for alternative energy sources with the need to protect forest resources for all citizens and future generations. Pennsylvania's guidelines include short-term rotational biofuel crops that might not traditionally fall under forest management guidelines.

Harvests on state forests are required to follow Pennsylvania's guidelines. The guidelines also supply recommendations for private lands; these are drawn from *Best Management Practices for Pennsylvania's Forests*, which was published by the Forest Issues Working Group in 1997. However, the new biomass guidelines did not draw on wider stakeholder participation, in part because of the time pressure to produce guidelines before forest-based energy projects were initiated. Pennsylvania's guidelines are also unusual in that they include comments on biomass policy and a supply assessment. For example, the guidelines suggest that facilities requiring 2,000 tons per year are better suited to Pennsylvania than larger facilities. The guidelines also make a case for woody biomass as a carbon-neutral fuel source.

Since Pennsylvania's state forestlands are certified as meeting the standards of FSC, their biomass harvesting guidelines directly reference FSC standards. Pennsylvania's DCNR uses the FSC's Appalachia Regional Standard, but the state biomass harvesting guidelines provide greater specificity on woody biomass removals. For example, the FSC standard requires that "measures to protect streams from degradation of water quality and/or their associated aquatic habitat are used in all operations." The Pennsylvania biomass guidelines extend this idea by adding "biomass harvesting of any materials along stream and river banks or along bodies of water is unacceptable." The Pennsylvania biomass guidelines cover the range of potential biomass harvesting subtopics. Non-point source pollution and pesticides are not dealt with in the biomass harvesting guidelines, but these are covered in general forestry guidelines for Pennsylvania.

3e. Maryland

Maryland is currently in the process of developing biomass harvesting guidelines. The Pinchot Institute for Conservation is facilitating a committee of individuals representing state forestry, environmental and energy agencies, cooperative extension, private landowners, non-profit conservation organizations, and local governments. Specialists in ecology, forest hydrology, forestry, economics, and other disciplines are included on the advisory committee. The guidelines will address the charge of the *Maryland Climate Action Plan*, which states, "All biomass will be sustainably harvested without depriving soils of important organic components for reducing erosion, but will maintain soil nutrient structure, and will not deplete wildlife habitat or jeopardize future feedstocks in quantity or quality." As such, Maryland's biomass guidelines will address the protection of forest soils, water quality and aquatic resources, wildlife habitat and biodiversity, and silviculture and vegetation management. Other topics may also be included in the final version of the guidelines document. This guideline document is also linked to a technical support document that addresses the potential impacts associated with forest biomass harvesting in Maryland and a review of relevant statutes and regulatory and non-regulatory programs that operate within the state.

3f. Wisconsin

Wisconsin's biomass guidelines were motivated by new price incentives to produce wood-based renewable energy and concerns about the environmental impacts of increased woody biomass removal.²⁸ The Wisconsin Council on Forestry created an advisory committee with members from tribal, state, non-profit, and private forestry organizations. The guidelines were also reviewed by subject experts.

The guidelines cover much of the same ground as the other state guidelines (Table 1). They take advantage of the existing guidance provided by Wisconsin's *Silviculture and Forest Aesthetics Handbook* and *Forestry Best Management Practices for Water Quality*.

Issues such as regeneration, water quality, and aesthetics are dealt with in the existing manuals rather than the new biomass guidelines. A major focus of the Wisconsin guidelines is the identification of soil types, such as shallow, sandy, or wetland, that are most at risk of nutrient depletion.



Photo: Zander Evans

3g. California

California has some of the most comprehensive forest management regulations in the world. While there are currently no rules designed to specifically address intensive removal of forest biomass, the existing regulations address all of the main topics and most of the subtopics of woody biomass removal (Appendix I). For example, the *California Forest Practice Rules* point out that snags, den trees, and nest trees are a habitat requirement for more than 160 species and play a vital role in maintaining forest health. The importance of snags translates into regulations that require retention of all snags except where specific safety, fire hazard, insect, or disease conditions require they be felled.¹¹

California's regulations demonstrate the tradeoffs between the ecological benefits and the potential fire hazards of retaining dead wood on-site in fire-adapted ecosystems.¹⁰ For example, the *California Forest Practice Rules* emphasize the ecological importance of DWM for soil fertility, moisture conservation, and the support of microorganisms, but regulations dictate slash removal rather than retention. However, in riparian areas the Forest Practice Rules require operations to "protect, maintain, and restore trees (especially conifers), snags, or downed large woody debris" that provide stream habitat.¹¹

A technical team of the Interagency Forestry Working Group is currently reviewing whether forest practice regulations in the state assure the ecological sustainability of forest biomass production and harvest. This technical team will also examine the carbon sequestration and storage impacts of both forest management and catastrophic fires.

3h. Other State Activities

Other states are discussing or working toward biomass harvesting or retention guidelines. For example, in Oregon a Forest Biomass Working Group was established in 2005 because of a state law that directs the State Forester and Oregon Department of Forestry to increase the utilization of forest biomass.²³ The Forest Biomass Working Group is particularly focused on federal lands within the state, but also includes tribal, state and private forests. Oregon's biomass goals are part of the governor's Renewable Energy Action Plan. Washington's Governor Christine Gregoire signed into law a bill that encourages the Department of Natural Resources to supply 'green' biomass from 5.4 million acres of state-owned forests to the biomass energy economy (Chapter 126, Laws of 2010). The law stipulated that by the end of 2010, the Department of Natural Resources should evaluate how biomass supply agreements can ensure environmental compliance with all pertinent state and federal laws and provide for ecologically and operationally sustainable biomass removal.

Biomass harvesting and retention guidelines are being discussed in the southeast as well. Alabama released recommendations for forest owners that include many of the same elements detailed in other guidelines.³² For example, Alabama's guidelines recommend use of written management plans, following existing BMPs, avoiding re-entry, Protect sensitive sites, and retention of key structural features such as snags, DWM, and mature live trees. A project was recently funded through US Forest Service State and Private Forestry's competitive grants program to create biomass harvesting guidelines specific to southern forests.

4. Biomass Guidelines and Policy in Canada

As with state biomass guidelines in the U.S., woody biomass policy and guidelines in Canada are designed and implemented at the provincial level, not by the central government. Another similarity between the U.S. and Canada is the shift from a greater proportion of private holdings in the East to greater government (i.e., Crown) land ownership in the West. While provincial biomass guidelines would apply to public land and not private land, private landowners in eastern Canada are asking provincial governments for guidance on how best to manage their private land for bioenergy.

An overview of biomass policy and guidelines from east to west in Canada reveals variation similar to that in the United States.⁵¹ Nova Scotia has formed a multi-stakeholder biomass committee of government, industry, and environmental groups that is discussing guidelines. There is currently a two-year moratorium on harvesting logging residue there to allow for input from this committee and then the creation of a government policy. In New Brunswick, the Department of Natural Resources has prepared draft guidelines on forest biomass harvesting. New Brunswick's guidelines take advantage of a decision support tool for sustainable biomass allocation that evolved from a model used to predict impacts of atmospheric deposition. The guidelines exclude harvests on high-risk (low-nutrient) areas, and harvest and silviculture planning remain separate processes guided by the Crown land management framework. The policy calls for biomass harvesting sustainability to be assessed over an 80-year time period, which is "equivalent to the life span of an average forest stand."⁴⁵ The New Brunswick guidelines define biomass such that the guidelines do not apply to pulpwood fiber from whole-tree chipping.

Like New Brunswick, Quebec is in the process of developing biomass guidelines based on soil properties. Ontario's policy establishes objectives such as "to improve the utilization of forest resources by encouraging the use of forest biofibre for the production of energy and other value-added bioproducts." However, the management and sustainable use of forest biomass is still guided by existing legislation (e.g., the Crown Forest Sustainability Act and its associated regulated manuals and procedures). In British Columbia, biomass removals during current forest practices (e.g., full-tree with processing at roadside) are already covered under the Forest and Range Practices Act (FRPA). Regulations under the FRPA require the retention of at least 1.6 logs per acre (at least 16 feet in length and 12 inches in diameter on the coast and 6.5 feet in length and 3 inches in diameter in the interior; FRPA §68). In addition, a strategic plan for increased biomass removals is being developed, and scientists have begun to collate data that will be used to formulate guidelines for increased slash harvesting.



Photo: Zander Evans

A 2008 conference entitled "The Scientific Foundation for Sustainable Forest Biomass Harvesting Guidelines and Policies," hosted by Canada's Sustainable Forest Management Network, helped set the stage for future policy development by providing an overview of existing research on biodiversity,³⁶ site productivity considerations for biomass harvests,⁵⁸ and existing knowledge gaps.⁵⁹

5. Biomass Guidelines and Policy in Northern Europe

Woody biomass provides a large contribution to the heat of Northern Europe and is also utilized for co-firing with coal and for straight biopower facilities in some countries such as the Netherlands and in the UK. Though management guidelines are similar across Northern Europe, their integration under the broader forest management policy is more varied. For example, the UK and Finland have determined that biomass harvesting guidelines work best as independent reference documents to help guide practitioners, whereas Austria and Sweden have integrated biomass harvesting protocols directly into their broader forest management protocols and regulations. The following section will review the approach that countries in Northern Europe have taken to biomass harvesting standards.

5a. Sweden

The use of forest-based bioenergy in Sweden increased in the 1980s as a result of growing concern over a reliance on imported oil and nuclear power. In 1991, the Swedish government introduced a carbon tax on fossil fuels used for heat and transportation. Since this time, the use of forest-based biomass for energy generation has more than doubled and forest-based bioenergy now accounts for more than 27 percent of total Swedish energy consumption (Swedish Energy

Agency, 2008). Harvest regimes have responded to this growing demand for biomass by becoming increasingly mechanized, with preference for whole-tree harvesting (WTH) systems for both thinnings and final clearcut harvests.^{4, 8, 53, 35} From 50 to 80 percent of slash is typically removed, depending on site conditions and economic constraints.³⁵ By some estimates, the share of bioenergy in Sweden could feasibly double before environmental and economic considerations fully constrain this supply.⁴⁶

Sweden is 67 percent forested, and the vast majority of these forests are held by private owners with high willingness to manage their forest and harvest timber. The responsibility for ensuring that energy wood harvests are done in a sustainable manner is largely left to individual landowners, and the greatest area of concern that landowners have about the sustainability of biomass harvesting centers on nutrient cycling and site productivity.⁵⁵ WTH clearcutting systems can increase soil nutrient losses by up to 7 percent, lead a reduction in site productivity of up to a 10 percent, and have been linked to an increased rate of loss of biodiversity in managed forests in Sweden.^{57, 8, 52} In an attempt to mitigate these risks, the Swedish Forest Agency developed a set of recommendations and good-practice guidelines for WTH in 1986; these were updated in the 1990s and codified in the Swedish Forest Act of 2002. This legislation seeks to control WTH practices in order to limit impacts to forest soils, water resources, and long-term site nutrient balances.

The general approach of Sweden's guidelines and regulations is to classify different sites according to the risks associated with biomass removal at these sites. Different recommendations are then applied based on these classifications. In Sweden these specifications are to ensure that

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

Like other Nordic countries, Sweden prohibits in-stand drying of forest residues in late spring and early summer to manage risks associated with bark beetle infestations. The guidelines and regulations also specify appropriate forest residue removal rates for different regions of Sweden, based on the risk of soil nutrient loss associated with historic and current patterns of acid deposition in these different regions. WTH clearcut operations are prohibited where they may negatively impact endangered species. The guidelines also stipulate that at least 20 percent of all slash must be left on-site. 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.⁵⁶

To hedge against the risk of soil nutrient depletion, the Swedish Forest Agency introduced additional wood ash recycling requirements in 2008; these supplement existing guidance on fertilization. The updated guidelines and regulations require that ash be applied to sites if the amount of harvest residues removed over the course of a rotation exceeds a half ton per hectare (0.2 tons per acre). For areas where biomass removals do not exceed this limit, ash recycling is deemed unnecessary; however, the regulation stipulates that ash be recycled in areas of high acid

deposition, such as the southwest portion of the country. In Sweden, typical biomass removals are 0.5–1 ton per hectare, so recycling is de facto required on most sites. The prescription is to apply 2–3 tons per hectare every ten years and not to exceed two applications (i.e., 6 tons of ash per hectare). Ash is also supposed to meet certain chemical composition standards and be hardened when applied to facilitate infiltration of nutrients into soils.³⁵ Sweden's guidelines also suggest that it is acceptable to apply ash in stands that have not yet been harvested, as a means to mitigate potential loss of site productivity if whole-tree removals are planned. Sweden is a strong proponent of forest certification, and the Swedish FSC standards specify that the recommendations of the Swedish forest agency are to be followed where biomass is used for energy.

5b. Finland

Finland is 74 percent forested with boreal and sub-boreal mixed softwood forests largely dominated by pine, spruce, and birch species. Upwards of 80 percent of the domestic roundwood supply comes from the three-quarters of the land base that is in private ownership.²⁹ This land base supports a robust bioenergy sector. A full 20 percent of Finland's total energy consumption comes in the form of bioenergy, with 11 percent of the nation's electricity production coming from wood.^{27, 29, 53} Approximately 47 percent of the annual Finnish roundwood supply is consumed in the production of energy.²⁷ Finland also imports an estimated 21 percent of the total wood it consumes for energy.³³ Finnish forest policy has made a goal of increasing the annual use of wood for energy by 5 million cubic meters, or nearly 5 million green tons.⁵⁵

As in Sweden, harvests in Finland are highly mechanized, and WTH clearcuts are common practice. It is estimated that typical harvests of this nature remove between 60 and 80 percent of the total site biomass.^{57, 30, 50, 53, 64} Finnish biomass harvesting guidelines suggest that 30 percent of residue should remain and be distributed evenly over the site following clearcuts. In addition to final harvests, biomass is also produced through early and mid-rotation thinning of small-diameter trees. This activity is not widespread across Northern Europe, due to operational and economic constraints, with the exceptions being Denmark, some Baltic states, and Finland.^{2, 53} Finland subsidizes both early rotation thinnings and the subsequent production of energy in order to support the production of commercial timber products.⁵⁶

The Finnish approach to ensuring forest sustainability is to classify different sites according to the risks associated with biomass removals from these sites and to then apply different management recommendations based on these classifications. Site classifications include: mesic uplands and sites with fertile soils, sub-xeric and xeric sites, barren upland sites with lichens, peatland forest sites, stands with rocky soils, stands with low levels of available nutrients, water conservation areas, managed stands with more than 75 percent spruce, and stands where biomass removals have previously been performed through WTH clearcutting systems.⁵⁶

Finnish guidelines contain operational protocols for site preparation, stump harvests, storing energy wood at roadside, and management of rotten wood.³ Additional issues addressed include wood production, biodiversity, wildlife habitat, insects and fungi, recreational resources, silviculture, stump harvesting, and biomass production costs (Stupak et al., 2008). Specific recommendations include that large dead trees either standing or on the ground should not be collected or damaged. Exceptions can be made for certain salvage harvests in the wake of a

significant disturbance event, and protocols for this are explicit. Riparian areas must be left unharvested, and the requisite width of riparian management zones depends on site characteristics (e.g., slope of harvesting sites and other watershed characteristics).

In Finland, it is also common and recommended practice to remove stumps and roots in certain circumstances. This is done mainly in spruce stands as a part of preparing the site for the next planting and as a risk-management practice used to avoid root rot.^{29, 55} Stump wood cannot be removed from riparian areas or steep slopes unless “preventative measures” are taken. Stumps are also not to be removed from wetlands, sites with rocky soils, dry soils, or thin soils, or if stumps are less than 6 inches in diameter. Stump removal protocols also recommend leaving a certain target number of stumps per acre for different soil types.²¹ Finland prohibits in-stand drying of forest residues in late spring and early summer to manage risks associated with bark beetle infestations.

While Finland does not require ash recycling through regulations, it is estimated that more than 10 percent of wood ash produced is typically returned to forests, usually in peat soils where it acts as a fertilizer. Finnish guidelines recommend that wood ash be spread on peat land after thinnings to act as a fertilizer, or if logging residues or stumps are extracted from nutrient-poor sites.⁵⁶ Ash is commonly spread with forwarders at a rate of about 3–5 tons per acre every ten years, i.e., slightly more than is recommended in Sweden.^{50, 56}

5c. Denmark

Denmark has less forestland than Finland or Sweden but woody biomass is still an important energy source. The Danish Biomass Agreement of 1993 called for increasing the rate of biomass produced for energy (primarily heating) by 1.4 million tons annually, with woody biomass to contribute 0.2–0.4 million tons annually.⁵⁵

In Denmark, whole-tree chipping of small diameter trees from mid-rotation thinning is common; guidelines for public forestry lands recommend that these materials dry for at least two months before they are chipped, to avoid nutrient losses.⁵⁰ It is not common practice to harvest slash associated with final clearcut harvests because of the logistical constraints in removing this biomass and/or because of concerns about soil nutrient depletion and impacts to plant and animal communities.⁵³ Issues addressed in Danish guidance documents include soil fertility, soil organic matter, management of insects and fungi, silviculture, stump harvesting, and production costs.^{55, 56} Danish guidance documents classify sites according to the dominance of hardwoods or softwoods and recommend that “stand-wise evaluations” be completed prior to harvests and that forest residues are dried for at least two months during the spring or summer. Other recommendations focus on stands of special conservation value for flora and fauna, and others for which wood production is not a primary objective. Guidance recommends avoiding exposed forest edges, nature conservation areas, and rare forest types.

Danish forest policy generally suggests that nutrients lost in logging may be compensated for through fertilization, and that stumps are not to be removed.^{55, 56} Forest policy also suggests that the maximum allowable amount of wood ash that should be applied over ten years ranges from 0.5 to 7.5 tons per hectare, although this depends on the specific chemical composition of the ash.

5d. The United Kingdom

With the UK's biomass-based energy sector growing, the UK Forestry Commission has released a series of technical reference documents designed to help forest managers assess risks associated with biomass harvests.^{44, 62, 60, 61} These documents cover slash removal and stump removal as well as the associated risks to soil fertility, soil organic matter, biodiversity and wildlife, hydrology and water quality, archaeological resources, cultural resources, recreational resources, and nature conservation.

The UK biomass harvesting guidance encourages managers to first classify sites according to their susceptibility to risks associated with biomass removal. In 2009, the UK Forestry 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 classification was implemented to facilitate a more reliable biomass supply without adversely impacting natural resources.⁶¹ The guidance classifies sites according to soil types as being of low, medium, or high risk and lists associated slash and stump removal management actions for each of these soil classifications. The assessment of site suitability for biomass harvests is to be based on the most sensitive soil type that covers greater than 20 percent of the site area. The guidelines suggest that site-specific risk assessments should be carried out before each harvest and should include a soil test. The guidance documents also recognize that there are significant uncertainties about the long-term sustainability of removing these materials and suggests that additional research is required to assess the full range of impacts, including net carbon balance.



Photo: UK Forestry Commission

In the UK, biomass harvests typically occur in conifer plantations where slash is windrowed and left for 3–9 months following final timber harvests. This material is subsequently bailed and collected.⁶¹ Thinnings also supply biomass, but this volume is currently not significant. The guidelines suggest that thinnings pose less of an immediate risk to soil nutrient and base cation balance than do final clearcut harvests. In addition to removing timber harvest residues, there is increased interest in harvesting stumps. The UK Forestry Commission recently released interim guidance on stump removal, which states that in some instances the benefits of stump harvesting will outweigh the potential disadvantages, but that the removal of stumps very much requires a site-by-site evaluation. The report acknowledges that stump removal “poses a number of risks to the forest environment that can threaten both sustainable forest management and the wider environment,” including soil compaction, rutting, sedimentation, soil carbon loss, removal of macro- and/or micronutrients, and loss of soil buffer capacity due to loss of base cations.⁶²

It is important to note that the slash removal guidance states that residue removals are acceptable on all high risk soil types as long as compensatory applications of fertilizer or wood ash are used. The guidelines in turn warn that application of wood ash may induce either nitrogen deficiency on nutrient-poor soils, or leaching of nitrates and/or soil acidification on nitrogen-saturated sites.

The guidelines also point out that the application of fertilizers and wood ash may not be acceptable under forest certification programs that have stringent standards for the application of chemicals.

6. Other Organizations and Certification Systems

6a. International Organizations

A number of international organizations have taken up the issue of biomass harvest and retention. The International Energy Agency (IEA) conducts research through several programs. For example, Task 43 (feedstocks to energy markets) considers environmental issues, establishment of sustainability standards, exploration of supply chain logistics, and appropriate connections between harvesting standards and international trade and energy markets (www.ieabioenergy.com). The Global Bioenergy Partnership (GBEP) seeks to develop a common methodological framework to measure greenhouse gas emissions from biofuels and to developing science-based benchmarks and indicators for sustainable biofuel production. Throughout 2009, a GBEP task force was focused on the development of a set of relevant, practical, science-based, voluntary criteria and indicators as well as examples of best practices for biomass production. The criteria and indicators are intended to guide nations as they develop sustainability standards and to facilitate the sustainable development of bioenergy in a manner consistent with multilateral trade obligations (www.globalbioenergy.org). The Ministerial Conference on the Protection (MCPC) of Forests is a pan-European process to identify criteria and indicators for sustainability and adaptive management. In 2007, the MCPC initiated a special project to assess the need for sustainability criteria given the increased demand for biomass. The implications of carbon balances on biomass energy are also being explored and may impact the EU's 2009 Renewable Energy Directive (www.foresteurope.org).

6b. Federal Biomass Policy

U.S. federal policy on the use of woody biomass from forests has focused on how to define biomass and how or if sustainable should be legislated. Key areas of legislative focus are the type of wood that qualifies as renewable biomass, what kinds of ownerships can provide woody biomass, and the types of forest from which woody biomass can be procured. The following summary highlights aspects of federal law and proposed legislation that most directly influence the use of woody biomass from forests for energy.

- **Section 45 of the U.S. Internal Revenue Code**

The tax 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" includes a number of opportunity fuels, such as "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," a variety of "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, pre-commercial 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.” S 1733, 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 “well-being 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.

6c. Forest Stewardship Council: U.S. National Forest Management Standard

The FSC standards for the U.S. do not specifically address biomass or whole tree harvests. In other words, “biomass and whole tree harvests are addressed along with other types of removals.”²⁵ The FSC U.S. National Standard covers biomass harvesting at a more general level than most state guidelines, since they are nationwide. The main sections that affect biomass harvest 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 proposed requirement would place some limits on biomass removal, but it is not specific about the amount of DWM that should be retained on-site. Indicator 6.5.c limits multiple rotations of whole tree harvesting to sites where soil productivity will not be harmed.



Photo: Zander Evans

Since FSC guidelines are not focused solely on biomass harvests, they go beyond other biomass guidelines in areas such as habitat connectivity. By the same token, because FSC guidelines cover many different kinds of harvests in many different forest types with diverse forest management objectives, the standards do not contain many subtopics that are specific to biomass harvest (Appendix I).

The FSC standards are considered “outcome focused.” Rather than prescribing how to achieve desired outcomes, they allow a variety of practices to be used, so long as the management objectives and the FSC standards are not compromised. For example, one element that shows up in some biomass guidelines is re-entry, but FSC does not include this. Missouri’s guidelines advise, “Do not re-enter a harvested area [for the purposes of biomass harvesting] once the new forest has begun to grow,” in order to reduce the risk of compaction, which is a recommendation echoed in the Minnesota and Pennsylvania guidelines. The FSC standards, however, do not specifically advise against re-entering a stand for the purpose of biomass harvesting. Instead, issues of compaction and the impacts of other soil disturbing activities are addressed in relation to all management activities under both 6.5 and 6.3.

6d. Other Voluntary Certification Systems

Other voluntary certification systems have standards which may influence forest biomass harvest and retention. For example, the Council for Sustainable Biomass Production (CSBP) released draft standards in 2009 and plans to release a preliminary standard in 2010.¹⁴ The draft standards were open for stakeholder and expert review and comment. The CSBP standards address soil, biological diversity, water, and climate change. As with FSC standards, CSBP makes general recommendations such as “retain biomass materials required for erosion control and soil fertility” (1.1.S3), but do not provide specific guidance on retention of DWM or snags.

7. Common Elements of Biomass Harvesting Guidelines

Though the existing biomass guidelines cover different ecosystems, they share a number of important elements. The following sections assess the similarities and differences between the guidelines’ recommendations on dead wood, wildlife and biodiversity, water quality and riparian zones, soil productivity, and silviculture. In addition, we compare the process used to develop each set of guidelines.

7a. Dead Wood

One of the central concerns in biomass removal is the reduction of the quantity of dead wood on-site. Maine’s guidelines recommend leaving tops and branches scattered across the harvest area “where possible and practical.” To ensure sufficient DWM debris is left on-site, Michigan’s draft guidelines recommend retention of one-sixth to one-third of the residue less than four inches in diameter. Minnesota guidelines recommend leaving all preexisting DWM and to “retain and scatter tops and limbs from 20 percent of trees harvested.” Wisconsin’s guidelines recommend retaining all pre-harvest DWM and tops and limbs from 10 percent of the trees in the general harvest area, with a goal of at least 5 tons of FWM per acre. Wisconsin’s guidelines also point out that “some forests lack woody debris because of past management,” and that extra DWM should be left in those areas. Pennsylvania’s guidelines suggest leaving 15 to 30 percent of “harvestable biomass” as DWM, while Missouri’s suggest 33 percent of harvest residue (with variations for special locations such as stream sides).

Maine, Minnesota, Pennsylvania, and Wisconsin suggest leaving all snags possible. Except for some hazard exceptions, California requires retention of all snags. Missouri provides an example of clear and specific recommendations by suggesting 6 per acre in upland forests and 12 per acre in riparian corridors. Michigan does not have a specific recommendation for snag retention.

7b. Wildlife and Biodiversity

Many of the potential wildlife and biodiversity impacts stem from leaving too little dead wood on-site. The biomass guidelines reviewed here agree on the importance of avoiding sensitive sites for wildlife. These include areas of high biodiversity or high conservation value such as wetlands, caves, and breeding areas. Obviously, areas inhabited by threatened or endangered animals and plants receive special consideration. However, as the Minnesota guidelines point out, biomass harvesting may still be appropriate if management plans include specific strategies for maintaining habitat for rare species and/or to restore degraded ecosystems. Pennsylvania’s guidelines suggest that biomass removal may be an opportunity to “develop missing special habitats, such as herbaceous openings for grouse and other species, through planting, cutting, or

other manipulations.” Additional suggestions from state guidelines include inventorying habitat features on the property, promoting individual trees and species that provide mast, and retaining slash piles that show evidence of use by wildlife. Missouri’s guidelines make the case against forest conversion in terms of wildlife: “Do not convert natural forests into tree plantations or pasture; natural forests provide more wildlife food and habitat.”

7c. Water Quality and Riparian Zones

In general, water quality and riparian concerns do not change with the addition of biomass removals to a harvest plan. Streams and wetlands tend to be protected by existing regulation. For example, Maine’s guidelines cite the existing laws governing water quality protection as well as the publication *Protecting Maine’s Water Quality*. Where restrictions in wetlands and riparian zones are defined in terms of basal area, more specific guidance may be needed for biomass harvests, which can have a large ecological impact with a small change in basal area. An example of riparian recommendations from Minnesota’s guidelines is to “avoid harvest of additional biomass from within riparian management zones over and above the tops and limbs of trees normally removed in a roundwood harvest under existing timber harvesting guidelines.” Though the *Missouri Watershed Protection Practice* already includes requirements for stream and river management zones, the Missouri biomass guidelines reiterate how to protect streams and rivers during a harvest.



Photo: Zander Evans

7d. Soil Productivity

As with water quality, some aspects of soil productivity are usually included in standard forestry BMPs. For instance, Minnesota’s biomass guidelines point readers to the state’s timber harvesting guidelines, which contain sections titled “Design Outcomes to Maintain Soil Productivity” and “Minimizing Rutting.” However, Minnesota’s biomass guidelines do add warnings about harvesting biomass on bog soils and shallow soils (less than 8 inches) over bedrock. An appendix to Wisconsin’s guidelines lists over 700 specific soil map units which are nutrient poor and unlikely to be able to support sustainable biomass removal. Maine’s guidelines use the Briggs classification of soil drainage classes to identify sites that are more sensitive to biomass removals.⁹ Missouri’s guidelines contain a specific section on sustaining soil productivity, especially on steep slopes and shallow soils. Michigan recommends leaving more than one-third of harvested tops on shallow, nutrient-poor or semi-organic soils. However, Michigan’s guidelines suggest that the amount of retention can be reduced on jack pine stands on nutrient poor sites.

Another concern that arises with biomass harvest is removal of the litter layer or forest floor. Maine, Michigan, Minnesota, Pennsylvania, and Wisconsin's guidelines state that forest floor, litter layer, stumps, and root systems should all be left.

7e. Silviculture

Many silvicultural prescriptions call for the removal of small, unhealthy, or poorly formed trees to open up more growing space for crop trees or regeneration, but these types of removals often cost money rather than generate income. By providing income from the removal of this material, biomass markets can help support good silviculture. At the same time, biomass removals raise some silvicultural concerns. The Minnesota guidelines point out that an increase in the amount of live vegetation removed may cause swamping, i.e., a decrease in transpiration and an increase in soil moisture. Swamping can kill seedlings and negatively impact regeneration. Removal of tree tops and branches may also remove seeds or cones, which may reduce the amount of natural regeneration. Biomass removals can help deal with forest insect problems, but removing the biomass material from the site must be timed to avoid contributing to pest problems such as bark beetles.

Some states have used biomass guidelines to make silvicultural recommendations that may improve stands but are not directly related to biomass harvesting. The Missouri biomass guidelines provide silvicultural suggestions for the number of crop trees per acre for stands in different stages of development. Pennsylvania's guidelines suggest that forest stewards "provide for regeneration each time harvests are made under the uneven-aged system," focus on the residual stand more than the trees being removed, and avoid high grading. Wisconsin's guidelines suggest retaining "reserve trees and patches at 5–15 percent crown cover or stand area" in even-aged regeneration cuts and three or more large-cavity trees, large mast trees, and trees that can become large trees in the future. Maine's guidelines recommend retention of cavity and mast trees while Wisconsin's guidelines recommend retaining five percent of the area unharvested in salvage operations following severe disturbances.

Another operational recommendation that Minnesota, Missouri, and Pennsylvania all make is to avoid re-entering a stand to remove biomass. Re-entering a site where timber was recently harvested can increase site impacts such as soil compaction and harm post-harvest regeneration. For this reason, the Missouri guidelines advise that "woody biomass should be harvested at the same time as sawlog timber to avoid re-entry." Maine's guidelines recommend that woody biomass removal be integrated with traditional forest operations where possible.

7f. Biomass Guidelines Development

The process of developing guidelines can be as important as the specific recommendations. Most guidelines try to draw from the most recent forest science. Developing new biomass guidelines allows states to incorporate new research and ideas. Minnesota used funding from the University of Minnesota Initiative for Renewable Energy and the Environment to conduct a review of the scientific literature on biomass harvests. Other guidelines borrow from existing guidelines. For example, Pennsylvania's guidelines borrow extensively from Minnesota's guidelines and summarize the FSC's standards for the region.

The amount of stakeholder participation varies across the guidelines. While Pennsylvania's guidelines were created from within the DCNR, Minnesota, Missouri, and Wisconsin included public participation and a technical committee from the wider forestry community. Public participation can be unwieldy, but often generates greater public support for forestry projects.²⁰

Some of the biomass guidelines, such as those from New Brunswick, Canada, focus on the identification of geographies where biomass harvesting is most appropriate. Wisconsin takes a complementary approach, identifying soil types where biomass removal is inappropriate. By mapping soil types, guidelines can highlight those areas where concerns about nutrient depletion are lowest. Suitability mapping also permits the consideration of the landscape-scale impacts of biomass harvesting. Pennsylvania's guidelines are notable because they consider the supply of biomass from forests as well as the appropriate scale of utilization. As mentioned previously, Pennsylvania's guidelines make a case for small-scale (less than 2,000 tons of biomass per year) biomass utilization facilities.



Photo: David Hobson

8. Conclusion

The following recommendations for the development of future biomass guidelines are based on the existing guidelines and available science, and will change as more is learned about biomass removals:

- Develop guidelines that are based on sound science and include wide stakeholder engagement. As the Minnesota guidelines describe it, “Provide the best scientific judgment, tempered by the consensus process among a broad group of forest management interests, related to practices that will sustain a high level of biodiversity.”
- Define “woody biomass” and other important terms clearly.
- Base biomass harvesting recommendations on local ecology. They should recognize state or local natural communities, disturbance regimes, and other ecological traits. Technical committees and scientific literature provide a firm base for harvest recommendations.
- Consider developing guidelines for each of the subtopics listed in Appendix I—though not all subtopics will be appropriate for every location.
- Make clear and specific recommendations for the retention of standing dead trees, existing CWM, CWM generated by the harvest, FWM, and forest floor and litter layer. Because reduction of dead wood is one of the key differences between biomass removal and traditional harvest, it should be a focus of future guidelines. Nutrients removed from the site should be replenished. For even-aged systems, nutrients should be replenished to adequate levels by the end of the rotation. Uneven-aged systems should maintain nutrient levels close to the optimum. Nutrient levels may be temporarily reduced after each entry, but should return to adequate levels by the next cutting cycle.
- Make biomass guidelines practical and easy to follow. Where biomass guidelines supplement existing forestry rules and guidelines, the new guidelines should provide clear references to the relevant sections of the existing rules and guidelines both for convenience and to increase the likelihood of implementation.
- Take advantage of the opportunity to create new forestry recommendations that encourage excellent forestry: forestry that goes beyond minimum BMPs and enhances the full suite of ecological values. For example, biomass guidelines may be an opportunity to suggest alternatives to high grading and other practices that damage the long-term health of the forest. Similarly, biomass guidelines can present the chance to advocate for appropriately scaled biomass utilization, as Pennsylvania guidelines already do.

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10. Appendix I: Summary Table of Biomass Guidelines

	ME	MN	MO	PA	WI	FSC
Dead Wood						
Coarse woody material	√	√	√	√	√	√
Fine woody material	√	√	√	√	√	√
Snags	√	√	√	√	√	√
Wildlife and Biodiversity				√		
Wildlife	√	√	√	√	√	√
Sensitive wildlife species	√	√	√	√	√	√
Biodiversity	√	√	√	√	√	√
Plants of special concern	√	√	√	√	√	√
Sensitive areas	√	√	√	√	√	√
Water Quality and Riparian Zones						
Water quality	√	√	√	√	√	√
Riparian zones	√	√	√	√	√	√
Non-point source pollution	√	√	√	√	√	√
Erosion	√	√	√	√	√	√
Wetlands	√	√	√	√	√	√
Soil Productivity						
Chemical (Nutrients)	√	√	√	√	√	√
Physical (Compaction)	√	√	√	√	√	√
Biological (Removal of litter)	√	√		√	√	
Silviculture						
Planning	√	√	√	√		√
Regeneration		√		√	√	√
Residual stands	√	√	√	√	√	√
Aesthetics			√	√	√	√
Post operations	√	√	√	√	√	
Re-entry		√	√	√		
Roads and skid trail layout	√	√	√	√	√	√
Disturbance						
Insects		√	√	√	√	√
Disease			√	√	√	√
Fire		√	√	√		√
Fuel reduction		√		√		√
Pesticides		√		√		
Invasives		√	√	√		
Conversion from forest			√	√		√

11. Appendix II: Links to Biomass Harvesting Guidelines

- Considerations and Recommendations for Retaining Woody Biomass on Timber Harvest Sites in Maine
http://www.maine.gov/doc/mfs/pubs/biomass_retention_guidelines.html
- Minnesota: Biomass Harvesting Guidelines for Forestlands
<http://www.frc.state.mn.us/FMgdline/BHGC.html>
- Missouri: Best Management Practices for Harvesting Woody Biomass
<http://mdc4.mdc.mo.gov/applications/MDCLibrary/MDCLibrary2.aspx?NodeID=2055>
- Pennsylvania: Guidance on Harvesting Woody Biomass for Energy
http://www.dcnr.state.pa.us/PA_Biomass_guidance_final.pdf
- Wisconsin Council on Forestry: Use of Woody Biomass
<http://council.wisconsinforestry.org/biomass/>
- Forest Stewardship Council
http://www.fscus.org/standards_criteria/
- Canada: The Scientific Foundation for Sustainable Forest Biomass Harvesting Guidelines and Policies
http://www.sfmnetwork.ca/html/biomass_workshop_e.html
- New Brunswick: Forest Biomass Harvesting Policy
<http://www.gnb.ca/0078/Policies/FMB0192008E.pdf>