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Ecological Implications of Biomass Policies for Private Forests in the United States

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Summary

Private forest owners are the leading producers of biomass feedstock for renewable energy and materials in the United States. Increasing the extent and productivity of “working forests” in the US is a practical strategy for increasing biomass supplies, controlling greenhouse gases, and improving important aspects of forest ecosystem health. Ecological risks associated with this strategy are mitigated by established legal and socioeconomic frameworks that encourage sustainable management of forest resources. Unfortunately, some current themes in US biomass policy have potential to impede sustainable development of the US forest sector and encourage conversion of private forestland to non-forest uses.

Background

Forests occupy more than 700 million acres in the United States. Total forest area declined substantially during the 18th and 19th centuries as a result of forest clearing for agriculture. In addition, livestock grazing and unsustainable harvesting of timber for energy and building materials degraded many of the remaining forests (Smith et al. 2009, MacCleery 1992).

During the past 100 years, total forest area has been stable (Figure 1) and the amount of carbon stored in forests has been increasing (Birdsey et al. 2006). These trends are attributable to improvements in agricultural productivity; reversion of cropland and pasture to forest; displacement of wood by fossil fuels in energy markets; and investments in forest management and conservation (MacCleery 1992). Current threats to forest sustainability include invasive pests and pathogens, conversion of forests to non-forest uses, and increasing wildfire hazard (NCSSF 2005, 2008).

Forests on private lands produce most of the biomass that is used to make renewable materials and renewable energy in the United States (Table 1). Simultaneously, these forests provide many co-benefits including clean water, habitat for wildlife, carbon sequestration, and recreation (Smith et al. 2009).

Figure 1. Forest Area Trends in the United States by Major Region, 1630-2007 (from Smith et al. 2009, p. 13)

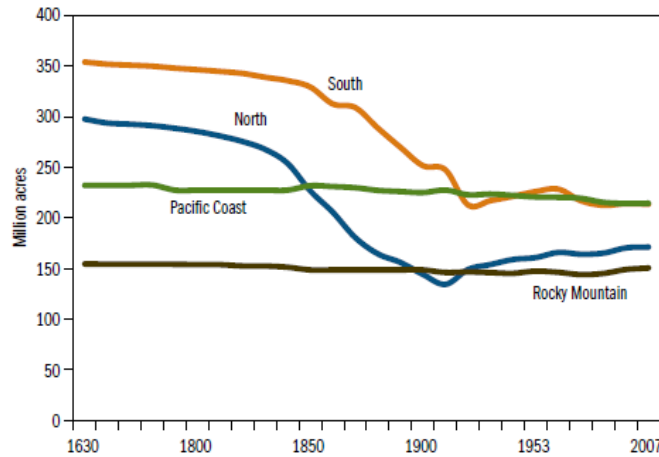


Table 1. Annual U.S. Production of Renewable Materials and Biomass Energy¹

Production Category	Dry Weight in Millions of Tons
Forest Products from Private Land ²	236
Forest Products from Public Land ²	23
Urban Wood, Food and Other Process Residues Used for Energy ³	35
Biomass Converted to Liquid Biofuels ³	18
Biomass Converted to Bioproducts ³	6
Cotton Lint ⁴	4
Total	322

¹ Production circa 2005. Renewable materials do not include food. ² Calculated from data in table 8a in Howard (2007) and Figure 2 in Perlack et al. (2005) using estimate in Smith (2009) that private lands accounted for 91% of harvest removals from forests in 2007. Forest products include fuel wood production as reported by Howard (2007) and manufacturing byproducts used for energy in the forest products industry as reported in Figure 2 in Perlack (2005). ³ Data from Figure 2 in Perlack et al. (2005). Corn is the primary biomass feedstock for biofuels in the U.S. Bioproducts include materials such as plastics made from cornstarch. ⁴ Based on data in Womach (2004).

Private forest owners have diverse reasons for keeping trees on their lands (Birch 1996, Bulter 2008). For many, the primary reasons are aesthetics, privacy, family legacy, and nature protection. Such owners may harvest timber rarely if ever. Consequently, production of timber and other biomass is concentrated on a subset of private forests. Owners of these “working forests” include families, tribes, corporations, real estate investment trusts, and institutional investors such as pension funds and university endowments.

Owners of working forests in the United States meet high standards of environmental performance through compliance with environmental laws and voluntary participation in stewardship programs sponsored by government agencies and non-governmental organizations (Lucier and Shepard 1997). Federal environmental laws (Table 2) apply to working forests throughout the country. States have important roles in implementing federal laws and have their own regulations tailored to circumstances and needs that vary among the states (Ellefson et. al 2006). Voluntary stewardship programs help owners of working forests achieve conservation objectives that meet or exceed legal requirements (Cubbage et al. 2007, Kilgore and Blinn 2004, NCASI 2008a).

Table 2. Principal Federal Laws That Regulate Environmental Performance of Working Forests on Private Lands in the United States (adapted from Lucier and Shepard 1997).

Federal Environmental Law	Forestry Practices Regulated
Clean Air Act	Prescribed burning
Clean Water Act ¹	Operations in wetlands and at “silvicultural point sources” ² ; some pesticide applications
Federal Insecticide, Fungicide and Rodenticide Act	Pesticide applications
Endangered Species Act	Any activity that harms a protected species

1. In addition to regulating certain forestry practices, the Clean Water Act requires that states develop nonpoint source control programs under the supervision of US Environmental Protection Agency. State nonpoint source control programs for forestry operations are described in NCASI (2009a).
2. EPA regulations at 40 CFR 122.27 define silvicultural point source as “any discernible, confined and discrete conveyance related to rock crushing, gravel washing, log sorting, or log storage facilities which are operated in connection with silvicultural activities and from which pollutants are discharged into waters of the United States.”

Ecological Consequences of Increasing Forest Biomass Production

Public policies and market forces are encouraging efforts to reduce fossil fuel consumption by increasing supplies of renewable energy and materials made from trees and other sources of biomass. In response, owners of working forests have identified several options to increase their biomass output.

1. Increase the extent of working forests.
2. Increase the productivity of working forests.
3. Find markets for lower-value biomass such as logging residuals (e.g., tree branches) and small trees harvested during forest thinning operations.

Implementing these options in accordance with established environmental guidelines could have substantial ecological benefits in many circumstances. For example, increasing the extent and productivity of working forests is a cost-effective strategy for mitigating human emissions of greenhouse gases (GHG) (Sampson and Hair 1992). The GHG benefits provided by working forests are associated with forest regrowth after harvest; production of energy-efficient materials and biomass energy; and carbon sequestration in forests and wood products (IPCC 2007, Marland and Schlamadinger 1997, Schlamadinger and Marland 1996).

Ecological benefits may also be substantial where new markets for lower-value biomass enable thinning of forests in which trees are in declining health due to overcrowding. Thinning is often ecologically beneficial because it typically reduces wildfire hazard, improves wildlife habitat, and / or increases forest resistance to pests and drought (SAF 2005).

Ecological risks associated with increasing forest biomass production include adverse effects on wildlife, biodiversity, water quality and long-term site productivity. Risks depend on factors such as site conditions, landscape context, and whether management is conducted in accordance with appropriate environmental guidelines (NRC 1998).

Managing tradeoffs among ecological benefits and risks is an important aspect of sustainable forest management. For example, utilization of logging residues as biomass feedstock can facilitate reforestation and mitigate greenhouse gas emissions, but can have adverse effects on wildlife, water resources and soil productivity (NCASI 2004, 2008b, 2008c, 2009b). The balance of positive and negative effects depends on quantities of residues removed and on site-specific conditions (Table 3).

Limits to Ecological Risks and Benefits

Established social, economic and legal structures in the forest sector will constrain opportunities to increase biomass production and thus limit ecological risks and benefits. For example, forest owners who are interested primarily in aesthetic and conservation objectives are unlikely to make major changes in their forest management practices in response to higher prices for lower-value biomass. However, such owners may become more willing to invest in

Table 3. Ecological Objectives and Considerations for Site-Specific Evaluations of Management Options for Logging Residues

OBJECTIVES	CONSIDERATIONS
Greenhouse Gas Mitigation	Using residues as feedstock for renewable energy can contribute to greenhouse gas mitigation. Opportunities to use residues for mitigation are limited primarily by economic constraints and greenhouse gas emissions associated with biomass harvesting and transport operations.
Nutrient Conservation	Residue harvesting removes nutrients from forest ecosystems that would otherwise be returned to the soil during biomass decomposition. The ecological significance of nutrient removals depends on factors such as soil properties, forest productivity, and management practices. Where nitrogen (N) limits productivity, cost of fertilizer to replace N removals can be considered in economic analysis of residue utilization.
Reforestation	Residue harvesting can facilitate reforestation success while reducing costs, especially on sites with large amounts of residues. For example, residue removal can reduce wildfire hazard; substitute for mechanical site preparation treatments such as raking and piling; and facilitate tree planting. In some situations, reductions in reforestation costs attributable to residue utilization outweigh the value of residue as a raw material.
Soil and Water Conservation	Logging residue left on the soil surface can reduce soil erosion and thus reduce sediment transport to streams. This ecological function of logging residue is especially important in areas with high erosion potential (e.g., erosive or disturbed soils on steeper slopes).
Wildlife / Biodiversity Conservation	Standing dead trees, logs on the ground, and other forms of “coarse woody debris” (CWD) remaining in the forest after timber harvest can improve habitat conditions for many wildlife species. Existing scientific information is generally not adequate to answer the question “how much CWD is enough?”

thinning and invasive pest control where new markets for biomass create near-term opportunities to recover costs (Koning and Skog 1987).

Among owners of working forests, several factors limit responses to biomass policies. These factors include regulations, voluntary stewardship guidelines, and the fact that the economic sustainability of working forests depends mainly on sales of higher-value biomass (e.g., logs of sufficient size and quality for use in lumber production). Nevertheless, new markets for lower-value biomass can improve economic returns to working forests on the margin and create opportunities to modify management regimes. Thinning to improve the growth and quality of remaining trees may become more attractive. In some circumstances, owners of working forests may be able to improve their cash flow and economic sustainability by growing biomass crops such as poplars and switchgrass on selected areas within land holdings managed primarily for timber.

Ecological Implications of Current Themes in U.S. Biomass Policy

Economic returns to wood production and forest-based manufacturing provide important means and incentives for investments in private forest stewardship in the United States (Wear and Prestemon 2004). Absent these means and incentives, many working forests would be converted to non-forest uses with generally negative consequences for the environment (Lubowski et al. 2006). Therefore, public policies that impair the economic sustainability of timber production and forest-based manufacturing could reduce supplies of ecosystem services provided by working forests.

Biomass policy is a case in point. Current themes in U.S. biomass policy include (a) discourage use of biomass from naturally-regenerated forests, (b) discourage establishment of new forest plantations, and (c) encourage new uses of biomass but not traditional uses (EPA 2010). If continued, these themes have potential to impose high operating and opportunity costs on the forest sector. High costs could discourage investment in forest-based value chains and encourage conversion of working forests to non-forest uses.

Conclusions

America's working forests and allied industries are the nation's leading producers of biomass energy and renewable materials (Table 1). Options for increasing forest biomass production include increasing the extent and productivity of working forests and increasing utilization of lower-value biomass. Potential ecological benefits include greenhouse gas mitigation, reductions in wildfire hazard, improvements in habitat for some wildlife species, and increases in forest resistance to pests and drought. Ecological risks include impacts on wildlife, biodiversity, water resources, and soil productivity. These risks are mitigated by established legal and socioeconomic frameworks that encourage sustainable management of forest resources.

Some current themes in US biomass policy impose special costs and restrictions on forest-based value chains. These costs and restrictions may have unintended consequences including incentives to convert forested land to non-forest uses.

Instead of imposing special costs and restrictions on the forest sector, biomass policy could treat the forest sector as a platform for innovation in bioenergy, biomaterials, and natural resource conservation. Ideally, biomass policies would supplement established laws and conservation programs that encourage sustainable forest management and sustainable growth in forest-based manufacturing of new and traditional products.

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