6-1-2008

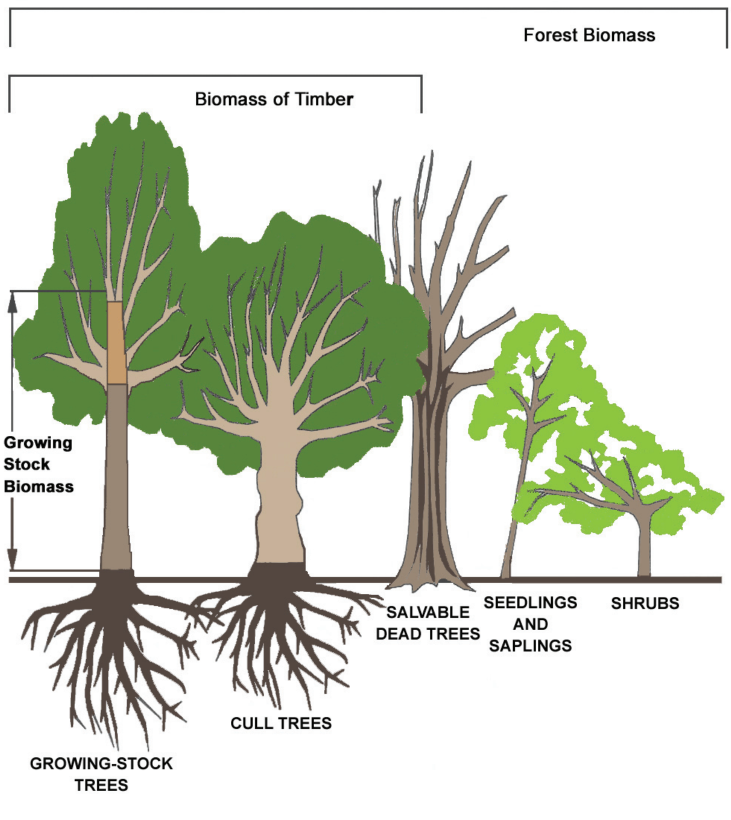
TB197: Forest Biomass Estimates in Maine:Statewide, County, and Spatial

Kenneth M. Laustsen

ISSN 1070–1524

Forest Biomass Estimates in Maine: Statewide, County, and Spatial

Kenneth M. Laustsen



Technical Bulletin 197

June 2008

MAINE AGRICULTURAL AND FOREST EXPERIMENT STATION
THE UNIVERSITY OF MAINE

Forest Biomass Estimates in Maine: Statewide, County, and Spatial

Kenneth M. Laustsen
Maine Forest Service, Augusta, Maine

A publication prepared by the Maine Forest Service in cooperation with University of Maine

FOREST BIOPRODUCTS RESEARCH INITIATIVE

Maine Agricultural & Forest Experiment Station
5782 Winslow Hall
University of Maine
Orono, Maine 04469-5782

Cover graphic credit: Wharton, Eric H.; Griffith, Douglas M. 1998. Estimating total forest biomass in Maine, 1995. U.S. Department of Agriculture, Forest Service, Northeastern Research Station Resource Bulletin NE-142. Radnor, PA. p. 5.

Contents

Figures

Tables

EXECUTIVE SUMMARY

Statewide biomass estimates have increased from 752 million dry tons in 1982 to 980 million dry tons in a more recent 2003 estimate. These estimates are produced using Forest Inventory & Analysis (FIA) data collected during Maine's periodic and now annualized inventory design.

Biomass has both a suite of aboveground components (bole, foliage, limbs and tops, and saplings) and a suite of belowground components (stumps and coarse roots). The contribution of the major pieces has been fairly steady over the years with boles contributing in the range of 45% to 51%, saplings in the range of 15% to 19%, and stumps and roots a consistent 15%.

The Maine Forest Service began tracking and reporting on wood flows of biomass in 1986. For the last 20 years (1986–2005) the total annual harvesting of all products has ranged between 6 and 7 million cords, extracted from a standing inventory that is currently estimated to be 277 million cords.

Deriving three estimates of available and additional biomass products was done using slightly different techniques and data sources. The first assumes that additional biomass can be obtained as a proportionate and companion removal during existing harvest operations. Each biomass estimate came from specific counties and was attributed to a specific pulp and paper mill. The eight estimates ranged from 0.3 to 1.9 million dry tons and totaled a maximum availability of 6.6 million dry tons within Maine on a sustainable basis. The second process created three wood-drain polygons, spatially specific, representing an approximate 60-mile-drain radius, and drawing on current inventory data from Maine and New Hampshire. These estimates ranged from 0.9 to 3.0 million dry tons and suggested a total available biomass volume of 6.4 million dry tons. The third estimate used the most recent 2003 FIA inventory data and recognized that available volumes in various components (branches, cull trees, salvable dead trees, and saplings) might need to address other ecological, sustainable, or wildlife habitat concerns. The range in availability then is from the current biomass harvest of 0.6 million dry tons to a potential maximum of 6.4 million dry tons. Saplings alone represent 57% of the potential available and additional biomass volume.

In conclusion, there is a need to continue the triad of research, development of estimation tools, and harvesting techniques to better inform the discussion of biomass allocation and to benchmark availability in Maine.

INTRODUCTION

Recent years have seen a dramatic increase of interest in Maine's forest biomass resource. This interest in forest biomass inventory and availability, however, is not unprecedented over the last 40 years. The first wave of interest occurred during the 1970s when whole-tree chipping was introduced as an alternative for producing pulp-quality chips from a variety of new raw material sources and sizes. The University of Maine led major research efforts at the time to find ways to convert traditional wood volume measurements of cords or board feet into biomass for various tree components (Young 1964; Young et al. 1964; Young 1965; Young and Chase 1965; Young and Carpenter 1967; Chase et al. 1973; Chase and Young 1978; Young et al. 1980).

The second wave of interest occurred during the late 1980s, following the first major rise in world crude oil prices during the late 1970s and early 1980s when federal legislation was passed that favored the development and construction of new biomass energy plants as generation sources of electricity for regional grids.

The current heightened interest in forest biomass supplies is again in response to supply/demand changes in the global market for petroleum products. Crude oil is currently selling in excess of $100 per barrel, which is favoring the expanded development of alternative fuel sources, including ethanol from corn or new bio-based products from the cellulosic materials in plants and trees. The recent "Billion Ton Report" has substantiated that the land resources of the United States are capable of producing a sustainable supply of biomass to displace 30% or more of the nation's present petroleum consumption and that one-quarter of the amount could come from woody biomass resources (Perlack et al. 2005).

Maine was recently identified by Milbrandt (2005) as one of the highest biomass-producing locations in the United States (Figure 1). This information coupled with the University of Maine's new Forest Bioproducts Research Initiative (FBRI) and other bioenergy/bioproduct interests by forest industry across the state has increased the need for accurate and spatially specific standing inventory estimates. In addition, an estimate of annual sustainable harvest levels and the biomass availability of specific tree species, tree sizes, and/or tree components are also needed. Finally, the most recent report on Maine's forest inventory is now nearly five years old. This combined with the availability of new data and questions about Maine's forest biomass resource suggest the need for a more comprehensive analysis.

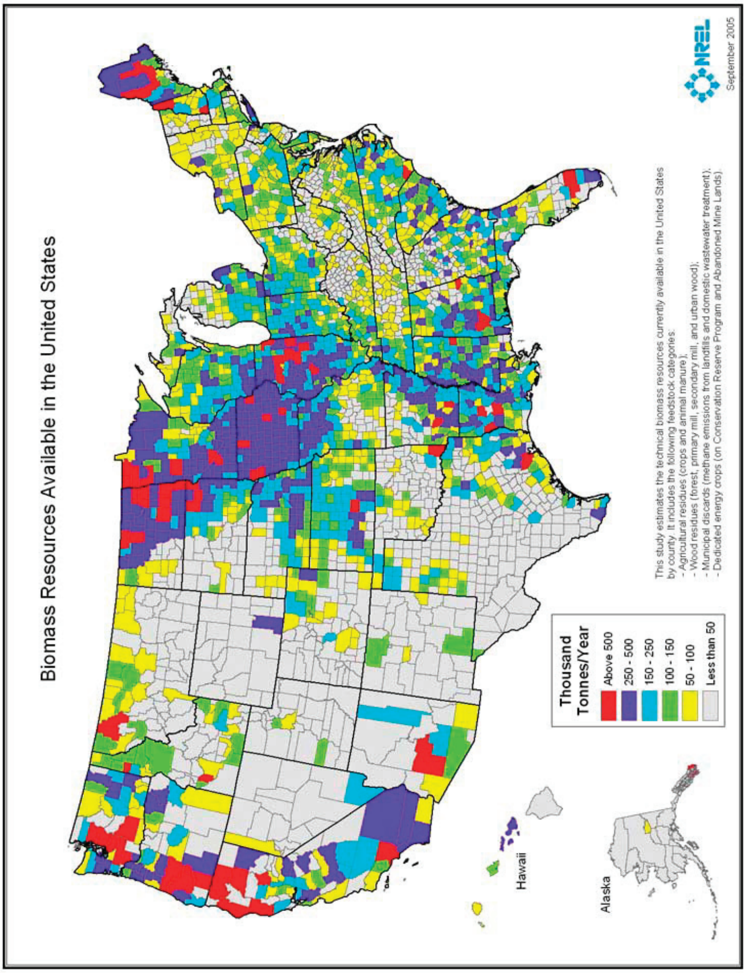


Figure 1. Total biomass resources available in the United States by county. Source: Milbrandt (2005).

The objectives of this current study were (1) to document historic estimates of forest biomass; (2) to outline the current estimation process; and (3) to estimate availability of various forest- and tree-based biomass components at a variety of scales. This analysis uses a variety of data including previously published reports, current Maine Forest Service wood processor reports, and the latest USDA Forest Service Forest Inventory and Analysis (FIA) data.

METHODS AND RESULTS

Historic Estimates of Forest Biomass

The first published biomass estimate for the state is Aboveground Tree Biomass Statistics for Maine: 1982 (Wharton et al. 1985), and it provides an initial accounting of volume in the total aboveground wood resources, using the FIA data collected in the 1980–1982 periodic inventory of Maine. Sections of this report ("Foreword," "Background," and "Reliability of the Estimates") provided additional detailed information on the data collection, compilation, and error sources, and readers are urged to peruse these sections for important details. In this report, aboveground tree biomass consisted of the following tree components:

- Stump—biomass contained in the stump between the ground level and a 1-ft stump height.
- Merchantable stem—biomass contained in the bole between a 1-ft stump height and a 4-inch diameter outside bark (DOB) top, for trees that have a ≥5.0-inch diameter at breast height (DBH). This component can be subdivided into several other biomass volumes:
    - a sawtimber component for qualified trees is to a 7- or 9-inch top;
    - an upper stem component is that portion above sawtimber top to a 4-inch top;
    - a poletimber component for qualified trees is to a 4-inch top;
    - cull trees are rough or rotten quality and are estimated to a 4-inch top.
- Salvable dead trees—the entire tree above a 1-foot stump.
- Saplings—trees with between 1.0- and 4.9-inch DBH, and their biomass estimate is for the entire tree above the ground.

- Tops and branches—the biomass above a 4-inch DOB, exclusive of foliage for merchantable stems.

The report estimated an approximate 1.5 billion green tons of aboveground biomass in Maine with an average of 88.2 green tons per timberland acre. Most of the biomass was in the merchantable stems of growing stock trees (51%), tops and branches (23%), and saplings (15%).

The second major publication and estimate of biomass for the state, Estimating Total Forest Biomass in Maine, 1995, was developed using FIA data from the 1995 periodic inventory of Maine's forest resources (Wharton and Griffith 1998). This publication contains several sections of very detailed descriptions on parts of the estimation process. In the section "Procedures for Estimating Green Weight," the use of regional regression equations, and development of a total tree height regression model are explained. The section "Procedures for Estimating Dry Weight" explains in detail how biomass is calculated for different timber/nontimber trees and the various parts of trees. This publication is a more expansive documentation of timber and nontimber components, adding foliage, seedlings, and shrubs, plus new estimates of belowground components, stumps and roots of trees that are ≥5.0-inch DBH. The estimation also switched to a dry-weight basis, citing its better consistency over time, comparability to other vegetation, and the easier conversion to other important environmental metrics, like carbon. This report estimated 900 million dry tons of biomass on timberland. The major components were growing stock boles (45%), saplings (17%), and the combination of stumps and roots (15%).

The newest inventory report for the state, The Forests of Maine: 2003 (McWilliams et. al. 2005) contains a brief description of the current status and distribution of biomass (p. 47 and Figure 55). In the appendix, there is an additional suite of tables including A16 and A40 through A46. The estimation procedures for the 2005 report follow the same process as outlined in the 1998 report. This report estimates a total biomass of 980 million dry tons, with growing stock stems representing 47%, saplings 19%, and stumps and roots 15% of the total biomass on timberland.

Figure 2 displays the three statewide inventory estimates of biomass on a nearly equivalent basis (million dry tons) for both above- and belowground components.

The most recent estimate in 2003 is 9% and 11% higher for above- and belowground components, respectively, than the comparable 1995 estimate.

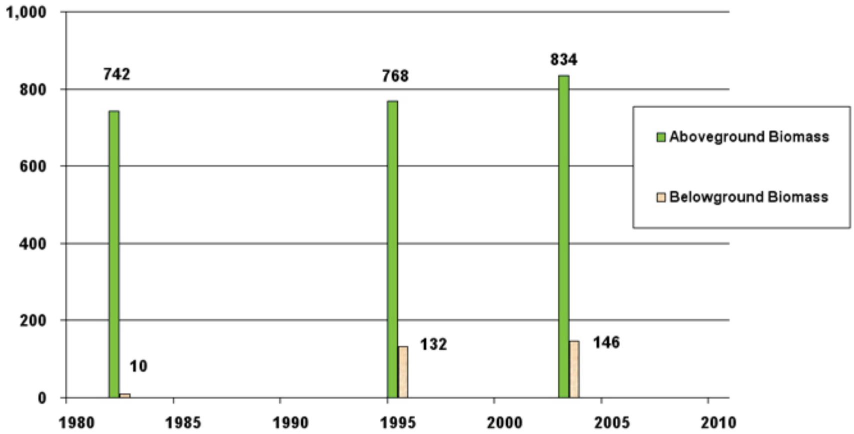


Figure 2. Inventory of major biomass components, Maine,1982, 1995, and 2003 (million dry tons).

The three published biomass reports all contain additional tables and levels of detail not herein described. By using these, other evaluations of inventory and estimates can be extracted and summarized by various aggregations of area, including county, FIA unit, or other multi-county regions. In addition, estimates by different cross-tabulations of species or specific biomass components can also be obtained. The only constraint is that these are static estimates of standing volume, providing no indication of potential extractable and sustainable harvest volumes or of the willingness of the underlying landowners in marketing a potential new resource.

Current Estimation Techniques

The current USDA Forest Service, Northern Research Station FIA has been actively monitoring Maine's forest resources on both a periodic and/or annual basis since before 1959. These inventories and their companion reports (1959, 1971, 1982, 1995, and 2003) are based on a multi-phased systematic sampling approach, consisting of aerial photography/remote sensing, on-the-ground forest inventory sampling, and on-the-ground forest health sampling. Though the plot design, sample intensity, and variables collected have continually changed to some degree over the nearly 50-year period, each estimate and report was statistically sound with known levels of confidence and estimates of standard error. Above- and belowground estimates of biomass can be obtained with the use of regional allometric equations recently complied by Jenkins et al. (2004).

Current Estimates of the Forest Biomass Availability

Maine Forest Service wood processor reports

Using data submitted by Maine's primary wood processors, the Maine Forest Service (MFS) collects, collates, and reports on an annual calendar-year basis, the species, products, and the processing destination of wood flows in Maine. These Wood Processor Reports detail in-state harvesting, import and export information, and processing by county, products, and species. Reported products include sawlogs, pulpwood, sawmill residue, biomass chips, hog fuel, and construction and demolition (C and D) waste. The products that are directly removed from Maine's timberlands include sawlogs, pulpwood, and biomass chips. Adding in an assumed volume of 400,000 cords to represent firewood consumption, Figure 3 displays that for the last 20 years, the reported annual harvest volume has been within the range of 6.0 to 7.0 million cords (Figure 3).

Over a similar period, Maine's standing inventory of pulpwood quality or better has ranged in volume from 313 million cords in 1982 to latest estimate of 277 million cords in 2003, with the estimated inventory being statistically equivalent for the entire 1995–2003 timeframe (Figure 4).

Figure 3. Total harvest (million cords), 1986–2005 (sawlog, pulpwood, firewood, biomass chip) (displayed as a 5-year trailing average).

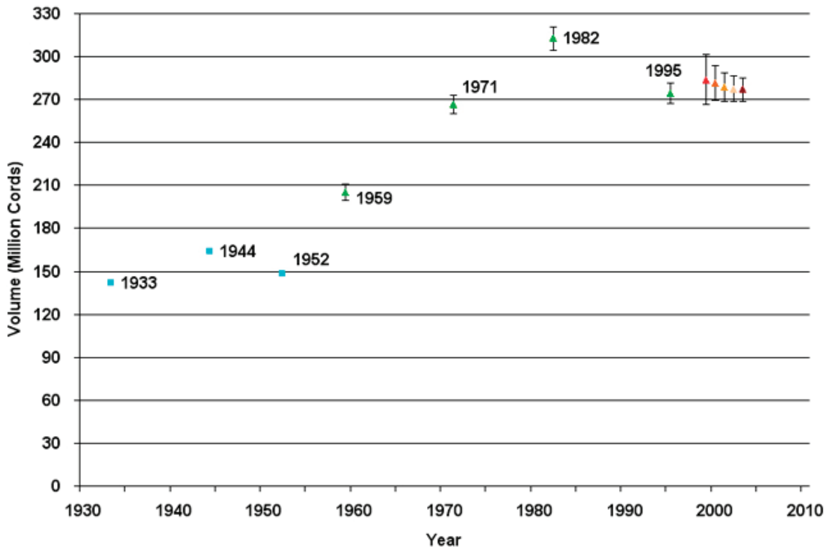


Figure 4. Volume estimates of pulpwood quality or better trees and the 95% confidence interval. Pulpwood quality or better trees contain the tree classes of growing stock and rough cull.

The initial premise in estimating annual availability is that as Maine's timberlands are accessed on an annual basis for the ongoing harvest of sawlogs, pulpwood, and biomass chips, the volume of these removals represent an annual percentage of the standing inventory, a value that is approximately 2%. Add to this the further acknowledgement that inventory and harvest have been relatively stable for at least the last 10 years, it can be promulgated that our forest resources are approximating a sustainable situation where annual growth and removals are in balance. Therefore, to derive an estimate of available and additional biomass products initiatives, it is currently assumed that the same percentage of normal product removal can be extended to other biomass components occurring on same landscape and project their concurrent removal as part and parcel of the ongoing harvest, thereby delivering new biomass volumes roadside for either further processing or transporting to a bio-refinery. This proportionate method of acquiring additional biomass components can be readily estimated on an individual county basis or for groups of counties.

The initial assessment using this proportionate approach began early in 2003. The first step is converting the published wood processor county-level tables into the preferred unit of dry tons (Table 1).

Table 1. Converting MFS wood processor reported products to a dry ton basis.

Species Group	MBF to Cords (Multiply by)	Cords to Green Tons (Multiply by)	Green Tons to Dry Tons (Multiply by)
Spruces and Fir	2.0	2.25	0.5633
Hemlock	2.0	2.70	0.5633
White & Red Pine	2.0	2.50	0.5633
Cedar	2.0	2.00	0.5633
Other Softwoods	2.0	2.00	0.5633
Tolerant Hardwoods	2.0	2.80	0.5633
Intolerant Hardwoods (Aspen and White Birch)	2.0	2.60	0.5633
Biomass Chips			0.5633

As published, sawlogs are reported in MBF (thousand board feet), pulpwood is reported in cords, and biomass chips are reported in green tons. To convert everything to a dry-ton basis, the following species, product, and moisture conversions, drawn from published sources, were used. This conversion process can undoubtedly be enhanced with finer-scale conversion values for individual species, especially in converting cords to green tons and then a green ton to its dry-ton basis.

Average harvest volumes for softwood, hardwood, and biomass chips were calculated for the six-year period of 1996–2001. For example, Aroostook County averaged 1,093 thousand dry tons (MDT) of softwood products, 854 MDT of hardwood products, and 121 MDT of biomass chips for the period of interest (Appendix Table A2.).

The then Northeastern Research Station (NERS) provided a preliminary biomass estimate based on the first four panels of Maine's new annualized inventory (1999–2002) (Table 2) that was further delineated into softwood and hardwood species groups.

The next step then linked, at the time, specific counties to existing pulp and paper mills. This county-to-mill linkage was based on the idea that existing pulping facilities were already permitted and could easily integrate a new bio-refinery within their mill complex and brownfield footprint. Therefore in a somewhat crude and maybe arbitrary fashion, the 13 mills were assigned counties in the following manner:

- International Paper Co. in Jay linked to Androscoggin, Kennebec, Lincoln, and Sagadahoc counties;
- Fraser Paper in Madawaska linked to Aroostook County;

Table 2. Biomass of all trees and shrubs on timberland, by county and component, dry weight basis, Maine 2002. (Preliminary estimate based on combined Panel #1 (1999 data), Panel #2 (2000 data), Panel #3 (2001 data), and Panel #4 (2002 data) of Maine's Annualized Inventory.) (In thousands of dry tons.)

	Timber Components									Nontimber Components				
	Growing Stock[4]													
County	Pole-timber[1]	Saw-timber[2]	Upper Stem[3]	Total Growing Stock Timber	Branches	Foliage	Stumps and Roots	Cull Trees[5]	Total Timber	Salvable Dead Trees	Sapl-ings[6]	Seed-lings[7]	Shrubs	Grand Total by County
Androscoggin	3,154	3,060	545	6,759	973	456	2,126	1,123	11,437	92	1,922	-	64	13,515
Aroostook	40,038	40,405	7,784	88,227	13,260	6,862	28,307	13,155	149,810	2,203	42,731	-	2,467	197,211
Cumberland	5,648	8,173	1,442	15,263	2,267	1,107	4,834	2,216	25,686	359	2,281	-	126	28,453
Franklin	15,659	10,889	2,322	28,870	4,100	1,897	9,115	2,949	46,930	525	10,194	-	313	57,963
Hancock	12,545	10,180	1,886	24,611	3,754	1,985	7,896	5,548	43,795	1,564	9,107	-	385	54,851
Kennebec	6,067	6,321	1,161	13,549	1,940	895	4,245	2,401	23,030	187	4,008	-	106	27,330
Knox	2,124	1,875	344	4,343	644	334	1,372	467	7,160	183	1,762	-	43	9,148
Lincoln	3,547	3,794	592	7,933	1,201	605	2,525	1,081	13,345	225	2,023	-	65	15,658
Oxford	21,244	20,884	4,165	46,293	6,531	2,957	14,487	8,316	78,584	713	11,892	-	1,188	92,377
Penobscot	22,847	19,353	3,638	45,838	7,036	3,697	14,860	7,710	79,141	1,348	20,520	-	334	101,342
Piscataquis	23,883	27,514	5,253	56,650	8,418	4,258	18,047	8,187	95,560	1,476	24,442	-	874	122,352

Table 2. Continued

County	Timber Components									Nontimber Components				
	Growing Stock[4]													
	Pole-timber[1]	Saw-timber[2]	Upper Stem[3]	Total Growing Stock Timber	Branches	Foliage	Stumps and Roots	Cull Trees[5]	Total Timber	Salvable Dead Trees	Sapl-ings[6]	Seed-lings[7]	Shrubs	Grand Total by County
Sagadahoc	2,033	2,004	352	4,389	665	338	1,406	937	7,735	77	1,043	-	34	8,889
Somerset	28,713	29,404	5,892	64,009	9,146	4,306	20,189	7,841	105,492	1,038	23,839	-	835	131,203
Waldo	5,753	5,551	1,045	12,349	1,788	846	3,905	3,179	22,066	484	3,443	-	147	26,140
Washington	14,477	10,085	1,733	26,295	4,311	2,582	8,667	5,184	47,039	1,017	19,665	-	429	68,151
York	7,833	9,540	1,649	19,022	2,772	1,295	5,983	2,314	31,385	252	4,126	-	129	35,892
Total, all counties	215,565	209,032	39,803	464,400	68,804	34,419	147,964	72,608	788,195	11,743	182,998	-	7,539	990,474

[1]Poletimber is merchantable sized trees that are 5.0–8.9 inch dbh for softwood species and 5.0–10.9 inch dbh for hardwood species.

[2]Sawtimber is merchantable sized trees that are ≥9.0-inch dbh for softwood species and 11.0"+ dbh for hardwood species.

[3]Upper stem is that remaining portion of the bole above the useable sawlog length, i.e., topwood.

[4]Growing stock are trees that are sawtimber quality and size or are currently sawtimber quality and prospectively sawtimber size.

[5]Contains both rough trees of poor form and rotten trees with excessive defect that are not sawtimber quality, but contain merchantable material.

[6]Saplings are trees that are 1.0–4.9 inch dbh.

[7]Current sampling frame does not allow an estimation of seedlings per acre and their representative biomass volume.

[8]For a more detailed explanation of the development of these estimates and for a previous published set of biomass components please refer to Wharton and Griffith (1998). Publication can be ordered online at www.fs.fed.us/ne/newtown_square/publications/order_copies/order-copies-1998.shtml

- SAPPI mill in Westbrook linked to Cumberland and York counties;
- Madison mill in Madison or the SAPPI mill in Hinckley linked to Franklin and Somerset counties;
- International Paper Co. in Bucksport linked to Hancock, Knox, and Waldo counties;
- MeadWestvaco mill in Rumford linked to Oxford County;
- Eastern Fine Paper mills in Brewer or Lincoln, or the Georgia-Pacific mill in Old Town, or the Katahdin Paper mills in Millinocket and East Millinocket linked to Penobscot and Piscataquis counties;
- Domtar mill in Woodland linked to Washington County.

The linking of candidate mills to specific county or multi-county biomass estimates and average harvest history allowed the estimation of the proposed available biomass components (branches, cull trees, salvable dead trees, and saplings) that could be harvested annually at the same time as ongoing operations and potentially transported to the associated mill. The development of availability is a simple proportioning process. For York and Cumberland counties, the softwood harvest of pulp and sawlogs is an annual 292 MDT out of an estimated inventory of 13,509 MDT, an annual removal rate of 2.16%. This percentage is then applied to other viable biomass components in the softwood inventory for a deduced estimation of their annual availability. The identical process is done separately for the hardwood harvest and inventory. The harvest of biomass chips are already sourced from in-the-woods whole-tree chipping, and it was deemed that this product provided limited additional opportunity for an estimation of new component volumes. The eight estimates ranging in annual availability from a low of 194 MDT from Cumberland and York counties to the SAPPI mill in Westbrook (Table 3 and Appendix Table A3) to a high of 1,905 MDT from Penobscot and Piscataquis counties to either mills in Brewer, Old Town, Lincoln, East Millinocket, or Millinocket (Appendix Table A7).

The second biomass assessment was a more targeted approach and a cooperative effort, working with NERS to spatially group pulp and paper mills into unique regions. For Maine's timberland the source was the same FIA data as the first estimate, but this assessment was enhanced with addition of New Hampshire FIA data. Each of the then existing 11 mills had a wood-drain circle established around their GPS location (radius = 60 miles). Intersecting arcs were dissolved until three spatially explicit regions remained (Figure 5.).

Table 3. Proposed availability to the SAPPI Mill, located in Westbrook, Maine. Inventory estimates of biomass components for Cumberland and York counties, dry weight basis, 2002 (thousand dry tons).

	Timber Sized (≥5.0 in. dbh)					
	Growing Stock					
Species Group	Bolewood	Branches	Foliage	Stump and Roots	Cull Total	Timber Total
Softwoods	13,509	2,530	1,672	4,548	1,471	23,730
Hardwoods	20,776	2,508	729	6,269	3,059	33,341
Annual Harvest						
Softwoods	292	55			32	
Hardwoods	112	14			16	
Biomass Chips	71					
		68			48	

	Nontimber						
Species Group	Salvable Dead Trees	Saplings	Seedlings	Shrubs	Nontimber Total	Grand Total	
Softwoods	384	2,077	-	27	2,488	26,218	
Hardwoods	227	4,331	-	227	4,785	38,126	
Annual Harvest							Ann. Biomass Availability
Softwoods	8	45					140
Hardwoods	1	23					55
	10	68					194

Proposed biomass components available for annual recovery along with existing harvest activities. (dark shading)

1996–2001 average harvest of pulpwood, sawlogs, sawmill residues, hog fuel, biomass chips. (light shading)

Biomass chips are already a whole-tree chipping activity and provide limited additional opportunity for new available volumes.

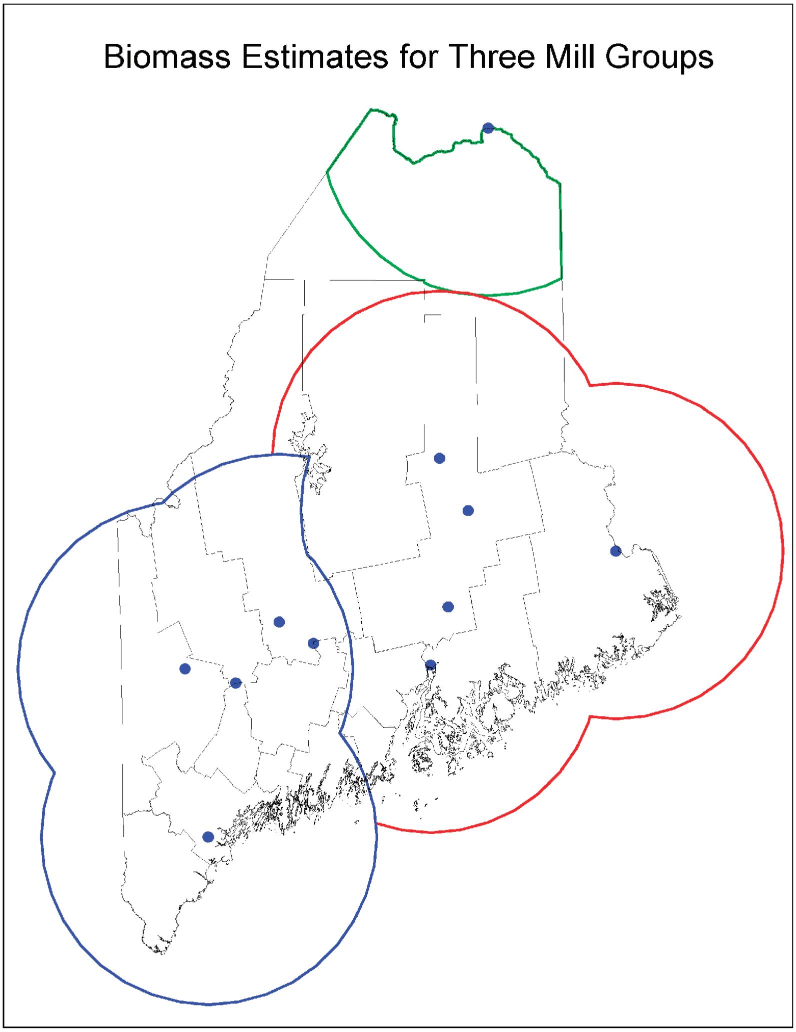


Figure 5. Circular drain areas (radius = 60 miles) and resultant polygons for three pulp and paper mill groupings used to develop a spatial biomass estimate. Southwest Maine—five mills within the blue polygon; Downeast Maine—five mills within the red polygon; northern Maine—one mill within the green polygon.

NERS then selected all timberland FIA plots, by their exact GPS location, that fell within each of the drain polygons. This spatial selection included plots from both Maine and New Hampshire. NERS processed the plots, producing unique biomass estimates for each of the three regions. Each region then had an biomass availability estimate developed using the same proportioning technique of harvest to inventory as described previously in the first assessment. An example of the estimated availability on an annual basis for the southwest region is a total of 2,500 MDT, being recovered as part of ongoing harvest operations (Table 4). These three spatial estimates also nicely convey the idea that there might be competition for procuring these biomass components amongst the existing facilities, both within and between the three regions (Appendix Tables B1–B3).

Forest Inventory and Analysis (FIA) data

The third assessment of biomass availability was a combination of an update using the newer and a more complete FIA sample and the idea that not all additional biomass components have equal availability. Extraction of the various biomass components can be facilitated by existing harvest operations or restricted because certain components have other operational, biological, or ecological uses and values that are deemed more important. Maine completed it first complete measurement of the new annualized FIA panel design in the fall of 2003. The data from those plots were available for generating revised biomass estimates in early 2005. The same concept and technique as outlined in the first assessment was followed with some revisions. The average annual harvest for each county was recalculated to encompass the period of 1996–2003, representing an equal temporal timeframe measured by the FIA plot data. NERS supplied new county-level estimates of biomass, as of 2003, using the entire timberland sample from Maine's fifth cycle inventory (McWilliams et al. 2005: 137–143, Tables A40–A46). The estimation of extractable biomass components was expanded to separately present softwood, hardwood, or biomass chips sources.

For example, again selecting the Westbrook Mill and Cumberland and York counties, the same mill/county association as was done in the first availability assessment, the average harvest has decreased from a total of 475 MDT in 2002 (Table 3) to 472 MDT in 2003 (Table 5). However, due to an increased estimate in biomass, the annual biomass availability marginally increases from 194 MDT (Table 3) to 196 MDT (Table 5). Table 5 further accumulates the maximum biomass components that are potentially available on an

Table 4. Proposed biomass availability for five pulp and paper mills located in southwest Maine. Inventory estimates for an approximate 60-mile-drain radius of the inclusive mills, dry weight basis, 2002 (thousand dry tons).

	Timber Sized (≥5.0 in. dbh)					
	Growing Stock					
Species Group	Bolewood	Branches	Foliage	Stump and Roots	Cull Total	Timber Total
All Species	274,544	39,074	17,843	86,240	40,596	458,297
Annual Harvest						
All Species	2%	643			668	

	Nontimber					
Species Group	Salvable Dead Trees	Saplings	Seedlings	Shrubs	Nontimber Total	Grand Total
All Species	5,316	66,918	-	43	72,277	530,574
Annual Harvest						Ann. Biomass Availability
All Species	88	1,102				2,500

Dark shading: Proposed biomass components available for annual recovery along with existing harvest activities.
Light shading: 1996–2001 Average harvest proportion of particpating Maine counties.

Table 5. Inventory and maximum extractable biomass components for Westbrook, ME (Cumberland and York counties), dry weight basis, 2003 (thousand dry tons).

	Timber Sized (≥5.0 in. dbh)					
	Growing Stock					
Species Group	Bolewood	Branches	Foliage	Stump and Roots	Cull Total	Timber Total
Softwoods	13,277	2,490	1,651	4,476	1,304	23,198
Hardwoods	21,466	2,598	757	6,488	3,268	34,577
Annual Harvest						
Softwoods	294	55			29	
Hardwoods	108	13			17	
Biomass Chips	70					
		68			45	

	Nontimber						
Species Group	Salvable Dead Trees	Saplings	Seedlings	Shrubs	Nontimber Total	Grand Total	Ann. Biomass Comp. Extractable
Softwoods	346	2,311	-	29	2,686	25,884	
Hardwoods	238	4,493	-	239	4,970	39,547	
Annual Harvest							
Softwoods	8	51					143
Hardwoods	1	23					54
	9	74					196

Proposed biomass components extractable for annual recovery along with existing harvest activities.
1996–2001 average harvest of pulpwood, sawlogs, sawmill residues, hog fuel, biomass chips.
Biomass Chips are already a whole-tree chipping activity and provide limited additional opportunity

annual basis in a series of steps, recognizing that the maximum limit needs to be discounted for other holdbacks relative to wildlife, ecological, and sustainability concerns.

- Current harvest of 472 MDT already includes some portions of the biomass components of branches, cull trees, salvable dead trees, and saplings.
- Branches are the most likely additional and available biomass component deliverable roadside with existing equipment and represent a total of 68 MDT. This value needs to be discounted because branches are already used in the harvest operation in a haul-back to minimize skid trail erosion and rutting.
- Cull trees are the next most likely and available biomass component and could provide a total of 45 MDT annually. This component is also needed to meet Sustainability benchmarks for wildlife trees and is the source for future large dead snags (>16 inches DBH)
- While dead trees only make up a minor source of biomass, a total of 9 MDT, this component also needs some on-site reservation to meet existing sustainability benchmarks.
- Saplings represent the largest pool of potentially available biomass, a total of 74 MDT. But it is critical that sufficient post harvest stocking be retained for continued and sustained stand development.
- The best estimate of real, additional, and extractable biomass lies somewhere between the current annual harvest of 472 MDT and 669 MDT, after adding in the maximum of all equivalent additional biomass components without their individual discounts (Table 5).

CONCLUSIONS

The new annualized design of the FIA inventory provides a more real-time estimation capability to Maine's forest resources, providing both a static estimation of various inventory attributes and the dynamic changes in attributes through the remeasurement of the same plot every five years. Use of this data and other sources of information suggest that Maine's forest resources are approximating a sustainable situation where annual growth and removals are in balance. The continued collection and use of this information as demonstrated in this report will be an important source for addressing the emerging questions regarding the state of Maine's forest biomass resource.

The USDA Forest Service, the Northern Research Station, and others are continuing to conduct research on methods to improve the volumetric estimation of the various biomass components of standing trees. In particular, new research is needed to derive the production and cost efficiencies of existing harvesting equipment, or the development of new equipment, to deliver appropriate and various biomass components roadside.

Finally, a very large cooperative effort is needed to address the concerns, examine, and balance the utility of these various biomass components. With an end result of providing a compromise allocation to their potential and multiple endpoints, i.e., a harvested product being sourced for a new biorefinery process, wildlife habitat, ecological service, or sustainability benchmarks.

LITERATURE CITED

Chase, A.J., F. Hyland, and H.E. Young. 1973. The commercial use of puckerbrush. Life Sciences and Agricultural Technical Bulletin 65.

Chase, A.J., and H.E. Young. 1978. Pulping, biomass, and nutrient studies of woody shrubs and shrub sizes of tree species. Life Sciences and Agriculture Experiment Station Bulletin 749.

Jenkins, J.C., D.C. Chojnacky, L.S. Heath, and R.A. Birdsey. 2004. Comprehensive database of diameter-based biomass regressions for North American tree species. General Technical Report NE-319. U.S. Department of Agriculture, Forest Service, Northeastern Research Station, Newtown Square, PA.

McWilliams, W.H., B.J. Butler, L.E. Caldwell, D.M. Griffith, M.L. Hoppus, K.M. Laustsen, A.J. Lister, T.W. Lister, J.W. Metzler, R.S. Morin, S.A. Sader, L.B. Stewart, J.R. Steinman, J.A. Westfall, D.A. Williams, A. Whitman, and C.W. Woodall. 2005. The forest of Maine: 2003. Resource Bulletin NE-164. U.S. Department of Agriculture, Forest Service, Northeastern Research Station. Newtown Square, PA.

Milbrandt, A. 2005. Geographic perspective on the current biomass resource availability in the United States. National Renewable Energy Laboratory, NREL Report No. TP-560-39181. http://www.nrel.gov/gis/images/biomass.jpg

Perlack, R.D., L.L. Wright, A.F. Turhollow, R.L. Graham, B.J. Stokes, and D.C. Erbach. 2005. Biomass as feedstock for a bioenergy and bioproducts industry: The technical feasibility of a billion-ton annual supply. U.S. Department of Energy, Office of Scientific and Technical Information, Oak Ridge National Laboratory. DOE/GO-102005-2135 or ORNL/TM-2005/66. 59 pp.

Wharton, E.H., T.S. Frieswyk, and A.M. Malley. 1985. Aboveground tree biomass statistics for Maine: 1982. Resource Bulletin NE-86. U.S.

Department of Agriculture, Forest Service, Northeastern Forest Experiment Station, Broomhall, PA.
Wharton, E.H. and D.M. Griffith. 1998. Estimating total forest biomass in Maine, 1995. Resource Bulleting NE-142. U.S. Department of Agriculture, Forest Service, Northeastern Research Station. Radnor, PA.
Young, H.E. 1964. The complete tree concept—a challenge and an opportunity. Proceedings 1964 Society of American Foresters annual meeting.
Young, H.E., L. Strand, and R.A. Altenberger. 1964. Preliminary fresh and dry weight tables for seven tree species in Maine. Maine Agricultural Experiment Station Technical Bulletin T-12.
Young, H.E. 1965. The complete tree concept – a challenge and an opportunity. In: Forestry at the Top of the Nation: Proceedings 1964 Society of American Foresters Meeting of Division of Forest Mensuration; 1964 September 27-October1; Denver, CO. Society of American Foresters, Washington, DC. 231-233.
Young, H.E., and A.J. Chase. 1965. Fiber weight and pulping characteristics of the logging residue of seven tree species in Maine. Maine Agricultural Experiment Station Technical Bulletin T-17.
Young, H.E., and P.N. Carpenter. 1967. Weight, nutrient element and productivity studies of seedlings and saplings of eight tree species in natural ecosystems. Maine Agricultural Experiment Station Technical Bulletin 28.
Young, H.E., J.H. Ribe, and K. Wainwright. 1980. Weight tables for tree and shrub species in Maine. Life Sciences and Agriculture Experiment Station Miscellaneous Report 120.

APPENDICES

Table A1. Proposed availability to the International Paper Co. Mill in Jay, Maine. Inventory estimates of biomass components for Androscoggin, Kennebec, Lincoln, and Sagadahoc counties, dry weight basis, 2002 (thousand dry tons).

	Timber Sized (≥5.0 in. dbh)					
	Growing Stock					
Species Group	Bolewood	Branches	Foliage	Stump and Roots	Cull Total	Timber Total
Softwoods	12,435	2,328	1,574	4,189	2,111	22,637
Hardwoods	20,195	2,450	720	6,112	3,433	32,910
Annual Harvest						
Softwoods	293	55			50	
Hardwoods	175	21			30	
Biomass Chips	34					
		76			79	

	Nontimber						
Species Group	Salvable Dead Trees	Saplings	Seedlings	Shrubs	Nontimber Total	Grand Total	
Softwoods	383	3,590	-	4	3,977	26,614	
Hardwoods	197	5,404	-	264	5,865	38,775	
Annual Harvest							Ann. Biomass Availability
Softwoods	9	85					198
Hardwoods	2	47					99
	11	131					298

(dark shading) Proposed biomass components available for annual recovery along with existing harvest activities.

(light shading) 1996–2001 average harvest of pulpwood, sawlogs, sawmill residues, hog fuel, biomass chips.

Biomass chips are already a whole-tree chipping activity and provide limited additional opportunity for new available volumes.

Table A2. Proposed availability to the Fraser Mill, located in Madawaska, Maine. Inventory estimates of biomass components for Aroostook County, dry weight basis, 2002 (thousand dry tons).

	Timber Sized (≥5.0 in. dbh)					
	Growing Stock					
Species Group	Bolewood	Branches	Foliage	Stump and Roots	Cull Total	Timber Total
Softwoods	37,538	7,099	5,103	12,840	2,857	65,437
Hardwoods	50,690	6,161	1,758	15,467	10,298	84,374
Annual Harvest						
Softwoods	1,093	207			83	
Hardwoods	854	104			174	
Biomass Chips	121					
		311			257	

	Nontimber						
Species Group	Salvable Dead Trees	Saplings	Seedlings	Shrubs	Nontimber Total	Grand Total	
Softwoods	1,175	26,047	-	43	27,265	92,702	
Hardwoods	1,028	16,684	-	2,424	20,136	104,510	
Annual Harvest							Ann. Biomass Availability
Softwoods	34	759					1,083
Hardwoods	17	281					576
	52	1,040					1,659

Dark shading: Proposed biomass components available for annual recovery along with existing harvest activities.

Light shading: 1996–2001 average harvest of pulpwood, sawlogs, sawmill residues, hog fuel, biomass chips.

Biomass chips are already a whole-tree chipping activity and provide limited additional opportunity for new available volumes.

Table A3. Proposed availability to the SAPPI Mill, located in Westbrook, Maine. Inventory estimates of biomass components for Cumberland and York counties, dry weight basis, 2002 (thousand dry tons).

	Timber Sized (≥5.0 in. dbh)					
	Growing Stock					
Species Group	Bolewood	Branches	Foliage	Stump and Roots	Cull Total	Timber Total
Softwoods	13,509	2,530	1,672	4,548	1,471	23,730
Hardwoods	20,776	2,508	729	6,269	3,059	33,341
Annual Harvest						
Softwoods	292	55			32	
Hardwoods	112	14			16	
Biomass Chips	71					
		68			48	

	Nontimber						
Species Group	Salvable Dead Trees	Saplings	Seedlings	Shrubs	Nontimber Total	Grand Total	
Softwoods	384	2,077	-	27	2,488	26,218	
Hardwoods	227	4,331	-	227	4,785	38,126	
Annual Harvest							Ann. Biomass Availability
Softwoods	8	45					140
Hardwoods	1	23					55
	10	68					194

(dark shading) Proposed biomass components available for annual recovery along with existing harvest activities.
(light shading) 1996–2001 average harvest of pulpwood, sawlogs, sawmill residues, hog fuel, biomass chips.
Biomass chips are already a whole-tree chipping activity and provide limited additional opportunity for new available volumes.

Table A4. Proposed availability to the Madison Mill, located in Madison, Maine, or the SAPPI Mill located in Hinckley, Maine. Inventory estimates of biomass components for Franklin and Somerset counties, dry weight basis, 2002 (thousand dry tons).

	Timber Sized (≥5.0 in. dbh)						
	Growing Stock						
Species Group	Bolewood	Branches	Foliage	Stump and Roots	Cull Total	Timber Total	
Softwoods	29,619	5,556	3,985	10,046	1,812	51,018	
Hardwoods	63,259	7,690	2,218	19,257	8,978	101,402	
Annual Harvest							
Softwoods	810	152			50		
Hardwoods	968	118			137		
Biomass Chips	196						
		270			187		
	Nontimber						
Species Group	Salvable Dead Trees	Saplings	Seedlings	Shrubs		Nontimber Total	Grand Total
Softwoods	801	18,535	-	6		19,342	70,360
Hardwoods	762	15,498	-	1,142		17,402	118,804
Annual Harvest							Ann. Biomass Availability
Softwoods	22	507					730
Hardwoods	12	237					504
	34	744					1,234

Proposed biomass components available for annual recovery along with existing harvest activities.
1996–2001 average harvest of pulpwood, sawlogs, sawmill residues, hog fuel, biomass chips.
Biomass chips are already a whole-tree chipping activity and provide limited additional opportunity for new available volumes.

Table A5. Proposed availability to the International Paper Company Mill, located in Bucksport, Maine. Inventory estimates of biomass components for Hancock, Knox, and Waldo counties, dry weight basis, 2002 (thousand dry tons).

	Timber Sized (≥5.0 in. dbh)					
	Growing Stock					
Species Group	Bolewood	Branches	Foliage	Stump and Roots	Cull Total	Timber Total
Softwoods	17,482	3,281	2,314	5,923	4,162	33,162
Hardwoods	23,821	2,904	850	7,251	5,032	39,858
Annual Harvest						
Softwoods	273	51			65	
Hardwoods	270	33			57	
Biomass Chips	40					
		84			122	

	Nontimber						
Species Group	Salvable Dead Trees	Saplings	Seedlings	Shrubs	Nontimber Total	Grand Total	
Softwoods	1,327	8,784	-	11	10,122	43,284	
Hardwoods	903	5,527	-	564	6,994	46,852	
Annual Harvest							Ann. Biomass Availability
Softwoods	21	137					274
Hardwoods	10	63					163
	31	200					437

(dark shading) Proposed biomass components available for annual recovery along with existing harvest activities.

(light shading) 1996–2001 average harvest of pulpwood, sawlogs, sawmill residues, hog fuel, biomass chips.

Biomass chips are already a whole-tree chipping activity and provide limited additional opportunity for new available volumes.

Table A6. Proposed availability to the MeadWestvaco Mill, located in Rumford, Maine. Inventory estimates of biomass components for Oxford County, dry weight basis, 2002 (thousand dry tons).

	Timber Sized (≥5.0 in. dbh)					
	Growing Stock					
Species Group	Bolewood	Branches	Foliage	Stump and Roots	Cull Total	Timber Total
Softwoods	14,167	2,644	1,828	4,768	1,445	24,852
Hardwoods	32,125	3,887	1,129	9,719	6,871	53,731
Annual Harvest						
Softwoods	365	68			37	
Hardwoods	368	44			79	
Biomass Chips	23					
		113			116	

	Nontimber						
Species Group	Salvable Dead Trees	Saplings	Seedlings	Shrubs	Nontimber Total	Grand Total	
Softwoods	256	4,695	-	15	4,966	29,818	
Hardwoods	457	7,197	-	1,173	8,827	62,558	
Annual Harvest							Ann. Biomass Availability
Softwoods	7	121					233
Hardwoods	5	82					211
	12	203					444

(dark shading) Proposed biomass components available for annual recovery along with existing harvest activities.
(light shading) 1996–2001 average harvest of pulpwood, sawlogs, sawmill residues, hog fuel, biomass chips.
Biomass chips are already a whole-tree chipping activity and provide limited additional opportunity for new available volumes.

Table A7. Proposed availability to the Eastern Fine Paper Mills in Brewer, or Lincoln, or the Georgia-Pacific Mill in Old Town, or the Katahdin Paper Mills in Millinocket/E. Millinocket, Maine. Inventory estimates of biomass components for Penobscot and Piscataquis counties, dry weight basis, 2002 (thousand dry tons).

	Timber Sized (≥5.0 in. dbh)						
	Growing Stock						
Species Group	Bolewood	Branches	Foliage	Stump and Roots	Cull Total	Timber Total	
Softwoods	44,095	8,304	5,894	14,999	4,633	77,925	
Hardwoods	58,393	7,150	2,061	17,908	11,264	96,776	
Annual Harvest							
Softwoods	1,311	247			138		
Hardwoods	1,083	133			209		
Biomass Chips	108						
		379			347		
	Nontimber						
Species Group	Salvable Dead Trees	Saplings	Seedlings	Shrubs	Nontimber Total	Grand Total	
Softwoods	1,643	24,523	-	19	26,185	104,110	
Hardwoods	1,182	20,440	-	1,211	22,833	119,609	
Annual Harvest							Ann. Biomass Availability
Softwoods	49	729					1,162
Hardwoods	22	379					743
	71	1,108					1,905

Proposed biomass components available for annual recovery along with existing harvest activities.
1996–2001 average harvest of pulpwood, sawlogs, sawmill residues, hog fuel, biomass chips.
Biomass chips are already a whole-tree chipping activity and provide limited additional opportunity for new available volumes.

Table A8. Proposed availability to the Domtar Mill, located in Woodland, Maine. Inventory estimates of biomass components for Washington County, dry weight basis, 2002 (thousand dry tons).

	Timber Sized (≥5.0 in. dbh)						
	Growing Stock						
Species Group	Bolewood	Branches	Foliage	Stump and Roots	Cull Total	Timber Total	
Softwoods	16,083	3,026	2,197	5,475	2,447	29,228	
Hardwoods	10,211	1,285	385	3,192	2,737	17,810	
Annual Harvest							
Softwoods	203	38			31		
Hardwoods	150	19			40		
Biomass Chips	22						
		57			71		

	Nontimber						
Species Group	Salvable Dead Trees	Saplings	Seedlings	Shrubs	Nontimber Total	Grand Total	
Softwoods	756	12,173	-	37	12,966	42,194	
Hardwoods	261	7,492	-	466	8,219	26,029	
Annual Harvest							Ann. Biomass Availability
Softwoods	10	154					232
Hardwoods	4	110					173
	13	264					405

Proposed biomass components available for annual recovery along with existing harvest activities.
1996–2001 average harvest of pulpwood, sawlogs, sawmill residues, hog fuel, biomass chips.
Biomass chips are already a whole-tree chipping activity and provide limited additional opportunity for new available volumes.

Table B1. Proposed biomass availability for five pulp and paper mills located in southwest Maine. Inventory estimates for an approximate 60-mile-drain radius of the inclusive mills, dry weight basis, 2002 (thousand dry tons).

	Timber Sized (≥5.0 in. dbh)					
	Growing Stock					
Species Group	Bolewood	Branches	Foliage	Stump and Roots	Cull Total	Timber Total
All Species	274,544	39,074	17,843	86,240	40,596	458,297
Annual Harvest						
All Species	2%	643			668	

	Nontimber						
Species Group	Salvable Dead Trees	Saplings	Seedlings	Shrubs	Nontimber Total	Grand Total	
All Species	5,316	66,918	-	43	72,277	530,574	
Annual Harvest							Ann. Biomass Availability
All Species	88	1,102					2,500

Proposed biomass components available for annual recovery along with existing harvest activities. (dark shading)

1996–2001 average harvest proportion of participating Maine counties. (light shading)

Table B2. Proposed biomass availability for five pulp and paper mills located in Downeast Maine. Inventory estimates for an approximate 60-mile-drain radius of the inclusive mills, dry weight basis, 2002 (thousand dry tons).

	Timber Sized (≥5.0 in. dbh)					
	Growing Stock					
Species Group	Bolewood	Branches	Foliage	Stump and Roots	Cull Total	Timber Total
All Species	186,481	28,627	15,244	60,182	32,389	322,923
Annual Harvest						
All Species	2%	554			627	

	Nontimber							
Species Group	Salvable Dead Trees	Saplings	Seedlings	Shrubs		Nontimber Total	Grand Total	
All Species	6,577	88,963	-	4,440		99,980	422,903	
Annual Harvest								Ann. Biomass Availability
All Species	127	1,721						3,028

Proposed biomass components available for annual recovery along with existing harvest activities.
1996–2001 average harvest proportion of participating Maine counties.

Table B3. Proposed biomass availability for a pulp and paper mill located in northern Maine. Inventory estimates for an approximate 60-mile-drain radius of the inclusive mill, dry weight basis, 2002 (thousand dry tons).

	Timber Sized (≥5.0 in. dbh)						
	Growing Stock						
Species Group	Bolewood	Branches	Foliage	Stump and Roots	Cull Total	Timber Total	
All Species	52,900	7,763	3,840	16,853	8,109	89,465	
Annual Harvest							
All Species	2%	171			179		

	Nontimber						
Species Group	Salvable Dead Trees	Saplings	Seedlings	Shrubs	Nontimber Total	Grand Total	
All Species	1,244	22,510	-	1,374	25,128	114,593	
Annual Harvest							Ann. Biomass Availability
All Species	27	497					875

Proposed biomass components available for annual recovery along with existing harvest activities. (dark shading)
1996–2001 average harvest proportion of participating Maine counties. (light shading)

Table C1. Inventory and maximum extractable biomass components for Jay/Livermore Falls, ME (Androscoggin, Kennebec, Lincoln, and Sagadahoc Counties), dry weight basis, 2003 (thousand dry tons).

	Timber Sized (≥5.0 in. dbh)					
	Growing Stock					
Species Group	Bolewood	Branches	Foliage	Stump and Roots	Cull Total	Timber Total
Softwoods	12,697	2,379	1,603	4,281	2,124	23,084
Hardwoods	20,110	2,435	712	6,079	3,328	32,664
Annual Harvest						
Softwoods	281	53			47	
Hardwoods	172	21			28	
Biomass Chips	45					
		73			75	

	Nontimber						
Species Group	Salvable Dead Trees	Saplings	Seedlings	Shrubs	Nontimber Total	Grand Total	
Softwoods	374	3,514	-	7	3,895	26,979	
Hardwoods	192	5,287	-	293	5,772	38,436	Ann. Biomass Components
Annual Harvest							Maximum Extractable
Softwoods	8	78					185
Hardwoods	2	45					96
	10	123					282

Proposed biomass components extractable for annual recovery along with existing harvest activities. (dark shading)

1996–2003 average harvest of pulpwood, sawlogs, sawmill residues, hog fuel, biomass chips. (light shading)

Biomass chips are already a whole-tree chipping activity and provide limited additional opportunity for new available volumes.

Table C2. Inventory and maximum extractable biomass components for Madawaska, ME (Aroostook County), dry weight basis, 2003 (thousand dry tons).

Species Group	Timber Sized (≥5.0 in. dbh) Growing Stock Bolewood	Branches	Foliage	Stump and Roots	Cull Total	Timber Total
Softwoods	37,077	7,013	5,035	12,684	2,976	64,785
Hardwoods	48,200	5,854	1,669	14,700	9,653	80,076
Annual Harvest						
Softwoods	1,031	195			83	
Hardwoods	862	105			173	
Biomass Chips	119					
		300			255	

Species Group	Nontimber Salvable Dead Trees	Saplings	Seedlings	Shrubs	Nontimber Total	Grand Total	Ann. Biomass Components Extractable
Softwoods	1,247	25,969	-	37	27,253	92,038	
Hardwoods	1,041	16,392	-	2,635	20,068	100,144	
Annual Harvest							
Softwoods	35	722					1,035
Hardwoods	19	293					589
	53	1,015					1,624

(dark shading) Proposed biomass components extractable for annual recovery along with existing harvest activities.

(light shading) 1996–2003 average harvest of pulpwood, sawlogs, sawmill residues, hog fuel, biomass chips.

Biomass chips are already a whole-tree chipping activity and provide limited additional opportunity for new available volumes.

Table C3. Inventory and maximum extractable biomass components for Westbrook, ME (Cumberland and York counties), dry weight basis, 2003 (thousand dry tons).

	Timber Sized (≥5.0 in. dbh)					
	Growing Stock					
Species Group	Bolewood	Branches	Foliage	Stump and Roots	Cull Total	Timber Total
Softwoods	13,277	2,490	1,651	4,476	1,304	23,198
Hardwoods	21,466	2,598	757	6,488	3,268	34,577
Annual Harvest						
Softwoods	294	55			29	
Hardwoods	108	13			17	
Biomass Chips	70					
		68			45	

	Nontimber						
Species Group	Salvable Dead Trees	Saplings	Seedlings	Shrubs	Nontimber Total	Grand Total	
Softwoods	346	2,311	-	29	2,686	25,884	
Hardwoods	238	4,493	-	239	4,970	39,547	Ann. Biomass Components Extractable
Annual Harvest							
Softwoods	8	51					143
Hardwoods	1	23					54
	9	74					196

Proposed biomass components extractable for annual recovery along with existing harvest activities. (dark shading)

1996–2003 average harvest of pulpwood, sawlogs, sawmill residues, hog fuel, biomass chips. (light shading)

Biomass chips are already a whole-tree chipping activity and provide limited additional opportunity for new available volumes.

Table C4. Inventory and maximum extractable biomass components for Madison/Hinckley, ME (Franklin and Somerset counties), dry weight basis, 2003 (thousand dry tons).

	Timber Sized (≥5.0 in. dbh)					
	Growing Stock					
Species Group	Bolewood	Branches	Foliage	Stump and Roots	Cull Total	Timber Total
Softwoods	29,656	5,569	3,994	10,069	1,841	51,129
Hardwoods	64,021	7,761	2,236	19,442	8,851	102,311
Annual Harvest						
Softwoods	817	153			51	
Hardwoods	988	120			137	
Biomass Chips	179					
		273			187	

	Nontimber						
Species Group	Salvable Dead Trees	Saplings	Seedlings	Shrubs	Nontimber Total	Grand Total	Ann. Biomass Components Extractable
Softwoods	798	18,677	-	16	19,491	70,620	
Hardwoods	743	15,430	-	2,132	18,305	120,616	
Annual Harvest							
Softwoods	22	514					740
Hardwoods	11	238					506
	33	752					1,246

Proposed biomass components extractable for annual recovery along with existing harvest activities. (dark shading)

1996–2003 average harvest of pulpwood, sawlogs, sawmill residues, hog fuel, biomass chips. (light shading)

Biomass chips are already a whole-tree chipping activity and provide limited additional opportunity for new available volumes.

Table C5. Inventory and maximum extractable biomass components for Bucksport, ME (Hancock, Knox, and Waldo counties), dry weight basis, 2003 (thousand dry tons).

	Timber Sized (≥5.0 in. dbh)					
	Growing Stock					
Species Group	Bolewood	Branches	Foliage	Stump and Roots	Cull Total	Timber Total
Softwoods	16,080	3,016	2,133	5,445	3,875	30,549
Hardwoods	22,212	2,722	801	6,786	4,774	37,295
Annual Harvest						
Softwoods	235	44			57	
Hardwoods	231	28			50	
Biomass Chips	40					
		72			106	

	Nontimber						
Species Group	Salvable Dead Trees	Saplings	Seedlings	Shrubs	Nontimber Total	Grand Total	
Softwoods	1,149	8,666	-	14	9,829	40,378	
Hardwoods	790	5,809	-	553	7,152	44,447	Ann. Biomass Components Extractable
Annual Harvest							
Softwoods	17	127					244
Hardwoods	8	60					146
	25	187					390

(dark shading) Proposed biomass components extractable for annual recovery along with existing harvest activities.

(light shading) 1996–2003 average harvest of pulpwood, sawlogs, sawmill residues, hog fuel, biomass chips.

Biomass chips are already a whole-tree chipping activity and provide limited additional opportunity for new available volumes.

Table C6. Inventory and maximum extractable biomass components for Rumford, ME (Oxford County), dry weight basis, 2003 (thousand dry tons).

	Timber Sized (≥5.0 in. dbh)					
	Growing Stock					
Species Group	Bolewood	Branches	Foliage	Stump and Roots	Cull Total	Timber Total
Softwoods	14,050	2,621	1,805	4,725	1,255	24,456
Hardwoods	32,167	3,887	1,128	9,722	6,041	52,945
Annual Harvest						
Softwoods	356	66			32	
Hardwoods	361	44			68	
Biomass Chips	27					
		110			100	

	Nontimber						
Species Group	Salvable Dead Trees	Saplings	Seedlings	Shrubs	Nontimber Total	Grand Total	
Softwoods	284	4,308	-	3	4,595	29,051	
Hardwoods	485	6,616	-	461	7,562	60,507	Ann. Biomass Components Extractable
Annual Harvest							
Softwoods	7	109					215
Hardwoods	5	74					191
	13	183					406

Dark shading: Proposed biomass components extractable for annual recovery along with existing harvest activities.

Light shading: 1996–2003 average harvest of pulpwood, sawlogs, sawmill residues, hog fuel, biomass chips.

Biomass chips are already a whole-tree chipping activity and provide limited additional opportunity for new available volumes.

Table C7. Inventory and maximum extractable biomass components for Lincoln/Millinocket/Old Town, ME (Penobscot and Piscataquis counties), dry weight basis, 2003 (thousand dry tons).

	Timber Sized (≥5.0 in. dbh)					
	Growing Stock					
Species Group	Bolewood	Branches	Foliage	Stump and Roots	Cull Total	Timber Total
Softwoods	45,428	8,547	6,062	15,440	4,497	79,974
Hardwoods	56,513	6,908	1,990	17,304	10,837	93,552
Annual Harvest						
Softwoods	1,278	240			126	
Hardwoods	1,072	131			206	
Biomass Chips	121					
		371			332	

	Nontimber						
Species Group	Salvable Dead Trees	Saplings	Seedlings	Shrubs	Nontimber Total	Grand Total	Ann. Biomass Components Extractable
Softwoods	1,643	25,379	-	17	27,039	107,013	
Hardwoods	1,239	19,824	-	1,928	22,991	116,543	
Annual Harvest							
Softwoods	46	714					1,127
Hardwoods	24	376					736
	70	1,090					1,863

Proposed biomass components extractable for annual recovery along with existing harvest activities. (dark shading)

1996–2003 average harvest of pulpwood, sawlogs, sawmill residues, hog fuel, biomass chips. (light shading)

Biomass chips are already a whole-tree chipping activity and provide limited additional opportunity for new available volumes.

Table C8. Inventory and maximum extractable biomass components for Baileyville, ME (Washington County), dry weight basis, 2003 (thousand dry tons).

	Timber Sized (≥5.0 in. dbh)					
	Growing Stock					
Species Group	Bolewood	Branches	Foliage	Stump and Roots	Cull Total	Timber Total
Softwoods	15,803	2,971	2,159	5,377	2,277	28,587
Hardwoods	10,582	1,337	403	3,316	2,517	18,155
Annual Harvest						
Softwoods	216	41			31	
Hardwoods	181	23			43	
Biomass Chips	27					
		64			74	

	Nontimber						
Species Group	Salvable Dead Trees	Saplings	Seedlings	Shrubs	Nontimber Total	Grand Total	Ann. Biomass Components Extractable
Softwoods	685	11,745	-	31	12,461	41,048	
Hardwoods	251	7,615	-	1,241	9,107	27,262	
Annual Harvest							
Softwoods	9	161					242
Hardwoods	4	130					201
	14	291					443

Proposed biomass components extractable for annual recovery along with existing harvest activities.

1996–2003 average harvest of pulpwood, sawlogs, sawmill residues, hog fuel, biomass chips.

Biomass chips are already a whole-tree chipping activity and provide limited additional opportunity for new available volumes.

Table C9. Inventory and baximum extractable biomass components for Maine (summation of county/mill assignments), dry weight basis, 2003 (thousand dry tons).

	Timber Sized (≥5.0 in. dbh)					
	Growing Stock					
Species Group	Bolewood	Branches	Foliage	Stump and Roots	Cull Total	Timber Total
Softwoods	184,068	34,606	24,442	62,497	20,149	325,762
Hardwoods	275,271	33,502	9,696	83,837	49,269	451,575
Annual Harvest						
Softwoods	4,521	850			495	
Hardwoods	3,993	486			715	
Biomass Chips	616					
		1,336			1,210	

	Nontimber						
Species Group	Salvable Dead Trees	Saplings	Seedlings	Shrubs	Nontimber Total	Grand Total	Est. of Ann. Biomass Components Extractable
Softwoods	6,526	100,569	-	154	107,249	433,011	
Hardwoods	4,979	81,466	-	9,482	95,927	547,502	
Annual Harvest							
Softwoods	160	2,470					3,975
Hardwoods	72	1,182					2,454
	233	3,652					6,430

Proposed biomass components extractable for annual recovery along with existing harvest activities. (dark shading)

1996–2003 average harvest of pulpwood, sawlogs, sawmill residues, hog fuel, biomass chips. (light shading)

Biomass chips are already a whole-tree chipping activity and provide limited additional opportunity for new available volumes.

1865 THE UNIVERSITY OF MAINE

Maine Agricultural and Forest Experiment Station
5782 Winslow Hall
Orono ME 04469-5782

5-5-38900

A member of the University of Maine System