Data Collection Report for Woody Biomass Products and a Feasibility Research Report for Insuring Fast Growing Trees (such as Poplar & Willow) and other Woody Biomass Products

Deliverable 1: Data Collection Report for Woody Biomass Products

Contract Number: D11PX18878

W&A Crop Insurance

Submitted to:
USDA-RMA
COTR: Quintrell Hollis
6501 Beacon Drive
Kansas City, Missouri 64133-4676
(816) 926-3270

Submitted by:
Watts and Associates, Inc.
4331 Hillcrest Road
Billings, Montana 59101
(406) 252-7776
twatts@wattsandassociates.com

Due Date: November 28, 2011

Table of Contents

List of Tables

List of Appendices

SECTION I. EXECUTIVE SUMMARY

The Statement of Work (SOW) for Project Number D11PX18878 identifies the objectives of the Data Collection portion of the contracted project as “to obtain information and data on grown woody biomass crops [related to insuring] willow, poplar trees, and other woody biomass products as bio-fuel feedstock.” The United States Department of Energy (DOE) defines biomass as “organic matter available on a recurring basis.” For the purposes of this report, “woody biomass” is defined as “organic matter available on a recurring basis derived from willow, poplar trees, and other perennial trees and shrubs.” Plant-derived materials such as woody biomass are used as a primary energy source for heating and electrical generation and as a feedstock for gasification and production of liquid biofuels. Direct combustion of biomass resources is common. In the production of biofuels from woody biomass, refinery operations are used to extract sugars from the biomass feedstocks; in turn these sugars are converted to alcohols. The alcohols are combined with petroleum refinery outputs to produce fuels that can be used for industrial, commercial, and transportation applications.

The Food, Conservation, and Energy Act of 2008 (2008 Farm Bill) (Title XII, section 15322) calls for research activities addressing federally subsidized insurance for “dedicated” energy crops. The bill defines a dedicated energy crop as an *“annual or perennial crop that (i) is grown expressly for the purpose of producing a feedstock for renewable bio-fuel, renewable electricity, or bio-based products; and is not typically used for food, feed, or fiber.”* Plans of insurance based on market prices and yields as well as approaches based on “weather or rainfall indices” are to be evaluated to assess their potential efficacy in providing protection for production losses, revenue losses, or both.

This data collection study focuses on woody biomass products for use as biorefinery feedstocks that are or can be commercially grown in the United States. The resulting report is designed to assist RMA in determining if it is practical to proceed with a feasibility study on federal insurance of woody biofuel feedstock.

All told, the literature on woody biomass resources is vast. An internet search on the term “forest” produces 728,000,000 hits; a search on “tree farms” produces more than 1.5 million hits. Adding the term “yields” to the tree farm search cuts the number of pages in half. Adding the term “biomass” (or alternatively bio-mass) drops the count to just over 7,000. Of these, just a handful include any quantitative data and even fewer include empirical data .[1] The dearth of useful quantitative information available on the internet is broadly indicative of the literature on purpose-grown woody biomass crops as a bioenergy feedstock. A large volume of topical reports are available, but the Contractor was unable to identify any time-series quantitative data of the type frequently relied on for development of data-driven yield-based crop insurance instruments. Many of the values presented in these reports are extrapolations from small experiments to a state, industry or nationwide scale or predictive forecasts based on limited historical data. There are also numerous research journals addressing tree production (and consequently the production of woody biomass). Few of the articles in these journals address woody biomass crop production from an agronomic perspective. Most of the focus on biomass

[1] In this context, quantitative data are defined as data assigned a numeric value. The Contractor uses this construct to contrast with empirical data, which are quantitative data derived by some measurement of the identified attribute.

yields in the articles in these print journals is documentation of one-off, small-plot field trials and/or on predictive forecasts.

Due to their rapid growth, short-rotation woody types for biomass production might include birch, Douglas fir, *Eucalyptus*, juniper, larch, *Magnolia*, poplar, Norway spruce, pine, and willows. The economic potential for short-rotation woody crop species is enhanced by use of improved genetics and management practices. Based on a search of the literature and interaction with crop experts, it appears the most likely candidates for purpose-grown woody biomass crops are poplars and willows in the northern states and pines, poplars, and *Eucalyptus* in the southern states.

The Contractor examined potential data for development of insurance products from government and private sources. Government sources included United States Department of Agriculture (USDA) National Agricultural Statistics Service (NASS), Economic Research Service (ERS), the Farm Service Agency (FSA), and Forest Service (FS), as well as the DOE. Potential private data sources examined included biorefineries using woody biomass as a feedstock, producer organizations, and business intelligence services. The Contractor also reviewed the academic literature to identify sources of time-series data addressing number of producers, planted acreage, harvested acreage, total production, value, or yield of woody biomass crops.

NASS is the primary data collection and statistical estimating service of the USDA. The Contractor was not able to identify any annual NASS production or pricing data dealing with woody biomass crops, firewood, or pulpwood. The Census of Agriculture does report on sales of forest products (excluding short rotation woody crops) and on agronomic characteristics of Christmas trees and short rotation woody crops collectively. Inasmuch as the woody biomass crops are excluded in the former and aggregated with irrelevant data in the latter, these census data cannot be used to identify number of producers, planted acreage, harvested acreage, total production, value, or yield of woody biomass crops.

ERS collects data and provides analysis on crop product supply and demand, as well as information on industry structure, pricing, trade, production policies, production systems, and processing. FSA provides financial assistance to producers facing losses from natural disaster (i.e., drought, flood, fire, freeze, tornadoes, pest infestation, and other “calamities”). The Contractor was not able to identify any ERS or FSA reports or analyses dealing with woody biomass crops, firewood, or pulpwood.

The Quantitative Sciences section of the Research and Development branch of the FS maintains forestry data in some ways comparable to NASS agricultural data. FS activities include maintenance of the Forest Inventory and Analysis (FIA) Program. Forest Inventory Data Online (FIDO), a data-mining tool, provides public access to the terabytes of data in the FIA databases. While there are no data in this system on yield, production, or price, there are related data including tree biomass removal and tree mortality by species group and size class. Unfortunately, the mortality data do not document the death of trees in small size classes (e.g., trees during the entire production cycle of shrub willow bioenergy crops). Instead, the focus is on mortality of trees larger than five inches in diameter at breast height (DBH). Furthermore, the species groups and geographic areas are aggregated at levels that would not allow the data to be used for an insurance risk analysis.

The DOE Office of Energy Efficiency and Renewable Energy (EERE) manages data that address biomass, biorefineries, and bioenergy. The focus of EERE reports is on cost competitiveness of biomass feedstocks rather than agronomic production. Furthermore, feedstock supplies from purpose-grown trees represent a tiny portion of the currently available cellulosic feedstocks. The Contractor was not able to identify any empirical EERE data concerning the number of producers, planted acreage, harvested acreage, total production, value, or yield of woody biomass crops.

The Contractor explored the possibility of collecting data from organizations whose membership is comprised of agricultural producers of woody biomass. No such organization could be identified.

The Contractor also explored the possibility of collecting data through biorefineries that use woody biomass as a feedstock. Most biorefineries using cellulosic feedstocks are recently commissioned or still under construction. Furthermore, most commissioned biorefineries are non-commercial[2] scale operations or operations that use multiple feedstock sources depending on availability and price. Consequently, meaningful data regarding purpose-grown woody biomass for bioenergy feedstock from are not available from the latter group. As cellulosic biofuel refineries come online, it is possible that they can assist in collection of data regarding woody biomass yield, production, and pricing. However, incentivizing their participation in such data collection may be challenging.

Pulpwood was considered as a proxy for woody biomass biorefinery feedstocks. The Contractor identified more than 100 pulpwood producers and consolidators. Despite assurances of confidentiality, none of the producers or consolidators the Contractor contacted was willing to share any data with the Contractor. This behavior is easily understood when the highly competitive nature of the paper industry is examined. The industry is characterized by numerous producer organizations and business intelligence services. These organizations do not have data on production of biomass feedstock. However, they have data for sale on pulpwood feedstocks. No reported available pulpwood data series addresses yield or production (in the sense of the words as used for crop insurance). Pulpwood price data are available.

In the academic literature, extremely limited production and yield data on cropped woody biomass species exist. These data address field trials rather than commercial production. Often the empirical data are used by academic and government researchers to estimate potential commercial yields or production. There are data from which maximum prices at national and regional levels can be inferred because of the fungibility of feedstock materials used in biorefineries.

Despite extensive research, the Contractor did not identify any source of empirical data on the number of producers, planted acreage, harvested acreage, total production, value, and yield of

[2] Most existing facilities are pilot, demonstration, or research and demonstration scale operations that have required limited input from their feedstock sources when compared to the requirements of an operational commercial biorefinery.

woody biomass crops. Data on woody biomass resources are sporadic. The few government data that exist do not address purpose-grown woody biomass crops. Extrapolations of empirical data from small plot trials to estimate potential yields and production are much more common. Any private data on woody biomass crops are closely held and proprietary. More likely, as the DOE reports, ―There is … no nationwide source of information on woody or herbaceous crops being used for energy since this is occurring only on a very small scale in a few isolated experimental situations."[3]

The Government could choose to begin a systematic collection of actual yield and production data for purpose-grown woody biomass biorefinery feedstock crops for the purpose of insurance development. However, even the shortest production cycles (those for shrub willows) require four to five years. Eight to ten year production cycles are not unusual. Consequently, decades of data collection would be necessary to accumulate the requisite data for a non-parametric crop insurance yield plan development effort.[4] Moreover, testimony suggests there are very few risks affecting production of woody biomass crops. The significant risks are major catastrophic events (wild fires, hurricanes, tornadoes, etc.). The infrequent nature of these risks would require an even longer historical database for rating purposes for a specific location, such as a county. Fortunately, data addressing these events do exist, including data from government sources, albeit not in a form that supports non-parametric development efforts. These data, combined with experiential data for forest resources more generally (particularly the FS data in the FIDO system) and expert judgment about agricultural risks (like the process used in the development of premium rates in the Quarantine Pilot Program) constitute an attractive alternative to a protracted data collection on a rapidly evolving industry. If crop insurance development is to be undertaken in the next five years, it will almost certainly be based on unique development approaches rather than on time-series yield data analyses.

[3] U.S. DOE, 2010, Biomass Energy Data Book: Edition 3, http://cta.ornl.gov/bedb/download.shtml, accessed August, 2011.
[4] The Contractor uses the term non-parametric to reference a program development effort in which the rating is based on empirical data.

SECTION II. INTRODUCTION

This is the data collection report required by the Statement of Work (SOW) for the United States Department of Agriculture (USDA) Risk Management Agency (RMA) project entitled ―Data Collection Report for Woody Biomass Products and a Feasibility Research Report for Insuring Fast Growing Trees (such as Poplar & Willow) and other Woody Biomass Products" (Project Number D11PX18878). The SOW identifies the objective of the data collection portion of the contracted project as ―to obtain information and data on grown woody biomass crops [related to insuring] willow, poplar trees, and other woody biomass products as bio-fuel feedstock." The government indicated to the Contractor that ―other woody biomass crops" should include, at a minimum, *Eucalyptus* and pine species.

Biomass is biological material derived from living, or recently living organisms.[5] It is composed of a mixture of organic (carbon-based) molecules containing hydrogen and usually including oxygen. Biomass also generally includes molecules containing nitrogen and small quantities of sulfur, phosphorus, and metals. The carbon in biomass is derived from atmospheric carbon dioxide by plants during the process of photosynthesis.

The United States Department of Energy (DOE) further characterizes biomass as organic matter available on a recurring basis.[6] Consequently, this characterization includes plants, plant-derived materials (e.g., logs, seeds, etc.), animal manure, and municipal residues. Plant biomass can be derived from agricultural crops, trees, native grasses, and aquatic plants (including single-celled algae as well as more complex organisms). Plant biomass is of particular interest because the organic chemicals in plants (carbohydrates, proteins, and lipids) directly store energy captured during photosynthesis. Biomass energy can subsequently be used by humans either by direct combustion (burning) or by conversion to solid, liquid, or gaseous fuels.[7]

The carbohydrate components of plants include simple sugars and starches in the body of the cell and cellulose,[8] hemicellulose,[9] and lignin[10] in the cell walls. Starches can be converted to sugars through digestion. The sugars, in turn, can be converted to alcohol by the process of fermentation.[11] The digestion of starches to sugars and fermentation of sugars is the principal process by which corn grain ethanol (a biofuel) is produced. The cellulose, hemicellulose, and lignin in the cell walls, the principal biomass constituents of woody species, are less easily converted to biofuels.

Biofuels are fuels derived in some way from primary biomass. In energy economics, a primary energy source is the energy form used by an energy sector to generate a supply of energy for human use. So, for example, if wood is burned for heating a home or business, the primary

---

5 Fossil fuels also have a biological origin, but its origin is much older and the chemicals have been changed by the geological processes involved in the ―fossilization" of the raw materials used to prepare fossil fuels.
6 United States Department of Energy, 2010, Biomass Energy Data Book: Edition 3.
7 It is also used by humans when they eat plant matter, but that use of plant biomass is not the subject of this report.
8 A linear carbohydrate polymer made of glucose molecules.
9 A carbohydrate polymer made of a mixture of simple sugars which forms an amorphous and random mass in the cell wall.
10 A complex cross-linked polymer made of cyclical alcoholic subunits.
11 Alternative chemical pathways exist for conversion of sugars to alcohols. In particular, biorefinery processes that convert sugars to organic acids and organic acids to alcohols have been developed. The simple fermentation processes capture a smaller portion of the energy embodied in the sugars, but require less complex refinery processes.

energy source is the wood. The energy for human use is the heat derived from the combustion of the wood. Energy from primary sources is often converted to other forms (e.g., electricity or liquid and gaseous fuels). The conversion may be undertaken to simplify storage or transportation of the energy. Furthermore, some energy forms are easier to use than others. For example, alcohol-based biofuels are more conveniently used as motor fuels than the biomass from which they are derived. They require little or no modification of the technology and infrastructure used in fueling existing motor vehicles.

The most common biofuels are ethanol and biodiesel. However, raw biomass itself, liquid fuels refined from biological materials, and biogases can all be used as fuels. In 2008, approximately 35 percent of the primary biomass energy produced in the United States was converted to biofuels.[12] From 2005 to 2010, production of biofuels in the United States nearly tripled.

Initially in the production of biofuels from woody biomass, the biomass is chipped to reduce the particle size and increase surface area. The hemicelluloses in the wood chips are extracted by hydrolysis. This can be accomplished enzymatically, or through a non-enzymatic process when dilute mineral acids (particularly sulfuric acid) are mixed with the biomass feedstock. During the hydrolysis, the complex chains of sugars in the hemicellulose are broken down, releasing simple sugars including xylose and arabinose (both five-carbon sugars), and mannose and galactose (six-carbon sugars).

The simple sugars released by the hydrolysis of hemicelluloses can be broken down by a variety of microorganisms (or by enzymes derived from these organisms) to produce organic acids and/or alcohols. Fermentation of the five-carbon sugars is less efficient than fermentation of the six-carbon sugars.[13] Consequently, alternatives to fermentation have been one goal of biorefinery development projects. Following the hydrolysis of hemicelluloses, the remaining plant materials include the cellulose and lignin from the cell walls of the woody biomass.

Cellulose is digested by microorganisms or by solutions of commercial enzymes derived from microorganisms to produce glucose (the most common six-carbon sugar). The glucose solution can be fermented anaerobically using brewer‘s yeast (*Saccharomyces cerevisiae*) to produce ethanol, water, and carbon dioxide. However, due to the energy released during the fermentative production of the carbon dioxide, this classical fermentation is not particularly efficient. Alternatively, refinery processes based on other microorganisms (or enzymes derived from those organisms) can be used to convert the glucose to organic acids. These in turn can be converted to alcohol-based biofuels including ethanol and butanol.

The principal constituent of the solids remaining after the extraction of hemicelluloses and cellulose is lignin. The lignin can be burned to produce electricity without additional purification or can be further purified for use in pharmaceutical and cosmetic products.

---

12 U.S. Department of the Interior, 2011, The National Atlas of the United States of America, Renewable Energy Sources in the United States, http://nationalatlas.gov/articles/people/a_energy.html, accessed September, 2011.

13 Ferrari, M.D., E. Neirotti,.C. Albornoz, and E. Saucedo, 1992, Ethanol production from eucalyptus wood hemicellulose hydrolysate by *Pichia stipitis*, Biotechnology and Bioengineering 40: 753-759, Gregg, D.J. and J.N. Saddler, 1996, Factors affecting cellulose hydrolysis and the potential of enzyme recycle to enhance the efficiency of an integrated wood to ethanol process, Biotechnology and Bioengineering 51: 375-383; Sun, Y. and J. Cheng, 2002, Hydrolysis of lignocellulosic materials for ethanol production: a review, Bioresource Technology 83: 1-11.

For comparison purposes, primary energy production from a source is converted into a common unit (for example, a British thermal unit (BTU)). According to the DOE, 75.06 quadrillion (75,060,000,000,000,000) BTU of energy were produced in the United States in 2010. Of this total, 4.32 quadrillion (4,320,000,000,000,000) BTU were produced from biomass (Table 1). This represented a ten percent increase in biomass energy production over the previous year (Table 2). The share of primary energy production from biomass has been increasing.

Table 1. 2010 United State Primary Energy Production by Source

Total Fossil Fuels	58.54
Nuclear Electric Power	8.44
Hydroelectric Power	2.51
Geothermal Energy	0.21
Solar/Photovoltic Energy	0.11
Wind Energy	0.92
Biomass Energy	4.32
Total Primary Energy Production	75.06

Source: U.S. Energy Administration, 2011, Total Energy: 1011 Monthly Energy Review: 1.2: Primary Energy Production by Source, http://www.eia.gov/totalenergy/data/monthly/pdf/mer.pdf, accessed September 2011.

Table 2. United State Biomass Energy Production and Total Primary Production (1975-2010)

Year	Biomass Energy Production (Quadrillion BTU)	Total Primary Energy Production (Quadrillion BTU)	Proportion from Biomass (Percent)
1973	1.53	63.56	2.4
1974	1.54	62.34	2.5
1975	1.50	61.32	2.4
1976	1.71	61.56	2.8
1977	1.84	62.01	3.0
1978	2.04	63.10	3.2
1979	2.15	65.90	3.3
1980	2.48	67.18	3.7
1981	2.60	66.95	3.9
1982	2.66	66.57	4.0
1983	2.90	64.11	4.5
1984	2.97	68.84	4.3
1985	3.02	67.70	4.5
1986	2.93	67.07	4.4
1987	2.87	67.54	4.2
1988	3.02	68.92	4.4
1989	3.16	69.32	4.6
1990	2.74	70.70	3.9
1991	2.78	70.36	4.0
1992	2.93	69.96	4.2
1993	2.91	68.32	4.3
1994	3.03	70.73	4.3
1995	3.10	71.17	4.4
1996	3.16	72.49	4.4
1997	3.11	72.47	4.3
1998	2.93	72.88	4.0
1999	2.97	71.74	4.1
2000	3.01	71.33	4.2
2001	2.62	71.73	3.7
2002	2.71	70.77	3.8
2003	2.81	70.04	4.0
2004	3.00	70.19	4.3
2005	3.10	69.43	4.5
2006	3.23	70.79	4.6
2007	3.49	71.44	4.9
2008	3.87	73.11	5.3
2009	3.92	72.60	5.4
2010	4.32	75.06	5.8

Source: U.S. Energy Administration, 2011, Total Energy: 1011 Monthly Energy Review: 1.2: Primary Energy Production by Source, http://www.eia.gov/totalenergy/data/monthly/pdf/mer.pdf, accessed September, 2011.

The DOE defines primary biomass as the biomass produced directly by photosynthesis. The department further defines primary biomass feedstocks as primary biomass harvested for conversion to solid, liquid or gaseous fuels. Common primary biomass feedstocks includes grains; oilseeds; crop residues such as stover, straw, orchard trimmings, and nut hulls, wood, and forestry wastes. Regardless of the source, the primary energy embodied in a dry unit weight of plant biomass is approximately the same (Table 3).

Table 3. Energy Content* of Biomass Feedstocks

Feedstock	Scientific Name	BTU/lb		
American Sycamore	*Platanus occidentalis*	8354	to	8481
Black Locust	*Robinia pseudoacacia*	8409	to	8582
Corn Stover	*Zea mays*	7697	to	7967
Eastern Cottonwood	*Populus deltoides*		8431	
Eucalyptus	*Eucalyptus spp.*	8384	to	8432
Hybrid Poplar	*Populus spp.* X	8384	to	8491
Monterey Pine	*Pinus Radiata*		8422	
Sericea Lespedeza	*Lespedeza cuneata*	8289	to	8570
Sugarcane Bagasse	*Gramineae saccharum*	8149	to	8349
Switchgrass	*Panicum virgatum*	7886	to	8233
Wheat Straw	*Triticum aestivum*		7481	

* Moisture Free High Heating Value (HHV) determined using ASTM D-2015 procedures.
Source: U.S. Department of Energy, 2006, Biomass Feedstock Composition and Property Database: All Sample Types, All Heat Properties, http://www1.eere.energy.gov/biomass/feedstock_databases.html, accessed September, 2011.

As a result of the similarities in embodied energy in the cellulosic biomass feedstocks, many biorefinery managers consider the feedstocks to be fungible. Inasmuch as the fixed cost of the biorefineries is substantial, they are operated around the clock and throughout the year. Consequently, the managers of biorefineries are first concerned with the cost of the feedstock and then with a readily and dependably available supply.

In the United States, wood and wood-derived products are the largest source of biomass-derived energy (Table 4). While direct combustion of wood is the oldest method for extraction of biomass energy, a wide variety of alternative extraction mechanisms are available. Most wood and wood-derived energy products are used in the generation of electricity and industrial-process heat and/or steam (or in hybrid plants which use a combination of these extraction processes). The largest source of energy from wood is pulping liquor (black liquor) from the paper and paperboard industry. Fuel wood, chips, pellets, compressed logs, and charcoal are alternate forest-derived energy sources. In spite of all these energy products, most of the biomass harvested from the forests is used for lumber rather than energy. Substantial energy embodied in forests is also lost *in situ* as the result of bacterial and fungal decay.

Table 4. 2008 United States Biomass Energy Utilization by Energy Sources and Energy Utilization Sector*

	Residential	Commercial	Industrial	Transportation	Electrical Generation		Total
					Commercial	Independent	
Biofuels		0.002	0.544	0.827			1.373
Waste		0.034	0.144		0.018	0.240	0.436
Wood and Wood-derived Fuels	0.420	0.073	1.344		0.029	0.148	2.014
Total Biomass	0.420	0.109	2.031	0.827	0.047	0.388	3.822

*Rounding errors are evident in total biomass sums. A small fraction of the biomass energy identified as produced in Table 2 is not accounted for in this utilization analysis.
Source: U.S. Energy Information Administration, 2010, Renewable Energy Annual 2008, http://205.254.135.24/cneaf/solar.renewables/page/rea_data/rea.pdf, accessed September, 2011.

As documented in Table 4, biomass energy is also extracted from organic wastes. These can include municipal solid wastes, landfill gas, sludge waste from municipal wastewater treatment, tires, and agricultural byproducts.

While most currently used biofuels feedstocks in the United States are starches from grains or oils and fats derived from the agricultural products, whole plants and plant residues are gaining importance as feedstock for cellulosic biofuels. The SOW for the Combined Synopsis/ Solicitation (Solicitation) focuses on the feasibility of insuring biorefinery feedstocks derived from fast growing woody species. As the Solicitation notes, the ―bio-fuels industry could be best described as at an infant stage currently…. Research indicates that further studies need to be conducted to improve technology and efficiency before bio-fuel crops could be considered for commercial production.”[14]

The DOE Biomass Program (http://www1.eere.energy.gov/biomass/) began supporting the development of integrated biorefineries using cellulosic biomass in 2007. As of December, 2010, there were 6 commercial biorefineries, 12 pilot biorefineries, 9 demonstration biorefineries and 2 research and development biorefineries supported under this program (Appendix A).

In spite of the DOE efforts to support biorefining, data on cellulosic feedstocks are quite limited. According to the DOE: ―It would be desirable to include information on the amount and types of crop residues and forest logging, or pulp fiber residues currently being used for energy on a state by state basis, but that information is not readily available….There is also no nationwide source of information on woody or herbaceous crops being used for energy since this is occurring only on a very small scale in a few isolated experimental situations.”[15]

The SOW points out, ―the Energy Policy Act of 2005 required 7.5 billion gallons of renewable fuel to be produced annually by 2012. More recently, Congress passed the Energy Independence and Security Act of 2007 …. [which] specifies that 21 billion gallons, of the 36 billion gallon 2022 target, must be ‗advanced bio-fuels'.”[16] Production of cellulosic ethanol, one advanced biofuel, is projected to increase fivefold by 2022. This drastic increase is proportionally higher than that of any other biofuel. Crop residue and woody biomass are the two major feedstocks from agriculture for the cellulosic biofuel industry.[17] A 2005 study projects approximately 25 percent of the renewable energy biomass will come from crop residues by 2022.[18] Based on these projections, woody biomass crops grown as bioenergy feedstocks will need to increase significantly to provide the raw material for a substantial proportion of the remaining cellulosic ethanol. However, it is important to remember the potential contributions of waste. Forestry residue and mill wastes can be baled or chipped for transport to biorefineries. Additional woody biomass can be collected from orchard prunings and urban wood waste.

Fast growing trees include willows, hybrid and native poplars, birch, Douglas fir, Norway spruce, larch, a variety of pine species in the northern states and willows, poplars, pines,

[14] Solicitation (page 45)
[15] DOE, 2010, Biomass Energy Data Book: Edition 3, http://cta.ornl.gov/bedb/download.shtml, accessed August, 2011.
[16] Advanced biofuels must embody no more than 50 percent of the greenhouse gas (GHG) emissions, on a life cycle basis, of the gasoline or diesel fuels they replace.
[17] DOE and USDA, http://www1.eere.energy.gov/biomass/pdfs/final_billionton_vision_report2.pdf, accessed March 21, 2011.
[18] DOE and USDA, http://www1.eere.energy.gov/biomass/pdfs/2007ethanolreview.pdf, accessed March, 2011.

junipers, eucalyptus and magnolia species in southern states. Many of these species are currently grown as windbreaks, for horticultural use, and/or for pulpwood.

As a biofuels feedstock, woody crops have the distinct advantage over crop residues of being ―self storing" (i.e., the trees can be left standing until needed) and have the potential advantage of year-round harvest. However, field conditions affect when a harvest can actually occur. Trees grown to produce woody biomass feedstocks can be harvested using various heavy machinery types. For example, the willow and young poplar can be harvested using a biomass baler that cuts the trees and bundles the material into a bale or using a forage harvester with a short rotation coppice woody crop header. The forage harvester mulches the trees and deposits the chips into a cart.

Perlack, et. al. (2005) estimate the contiguous United States can produce 368 million dry tons of woody biomass annually. This projection includes 52 million dry tons of fuel wood harvested from forests, 145 million dry tons of residues from wood processing mills and pulp and paper mills, 47 million dry tons of urban wood residues (construction and demolition debris), 64 million dry tons of residues from logging and site clearing operations, and 60 million dry tons of biomass removed to reduce fire hazards.[19] It is important to note these estimates do not include woody biomass purposefully grown as a biorefinery feedstock crop. Although data are sparse, an average woody biomass yield is expected to be approximately 8 dry tons per acre;[20] the non-cropped biomass therefore provides the equivalent of the harvest from 46 million acres of farmed woody biomass crops.

According to DOE, a 20 million gallon/year ethanol facility requires 775 dry tons/day of woody biomass for optimal operation.[21] Consequently, the above estimate of potential woody biomass production could support about 1,300 biomass processing facilities. There are currently only five commercial scale biomass refineries using woody biomass feedstocks in operation or under construction. One facility, located in Soperton, Georgia, is in operation and processes woody biomass, forest residues, and thinning residues from forests. A second facility located in Fulton, Mississippi, will process un-merchantable lumber and logging residues. The third facility located in Kinross Charter Township, Michigan will process hardwood pulpwood. A fourth facility located in Park Falls, Wisconsin, will process un-merchantable lumber and logging residues and other woody biomass. The fifth facility, located in Hugoton, Kansas, will process stover, switchgrass, and woody biomass. Current commercial scale starch bioethanol facilities, the vast majority of the existing ethanol biorefining industry, are not capable of converting woody biomass into ethanol without substantial additional equipment and retrofitting under current technology regimes.

In an effort to encourage the growth of second generation biofuels feedstock production, such as perennial grasses, crop residues, forestry products, and waste, Congress established the Cellulosic Biofuel Producer Tax Credit (CBPTC). The CBPTC, created under the Food,

---

[19] Perlack, R.D., L.L. Wright, A.F. Turhollow, R.L. Graham, B.J. Stokes, and D. C. Erbach, DOE and USDA, 2005, http://www1.eere.energy.gov/biomass/pdfs/final_billionton_vision_report2.pdf, accessed, March, 2011.
[20] SunGrant Initiative, North Central Biomass Energy Feedstock Partnership, http://bio-energy.ornl.gov/main.aspx, accessed March 21, 2011.
[21] DOE and USDA, http://www1.eere.energy.gov/biomass/integrated_bio-refineries.html, March 21, 2011.

Conservation, and Energy Act of 2008 (2008 Farm Bill), provides producers of ethanol from cellulosic feedstocks an income tax credit of up to $1.01 per gallon of the ethanol produced. However, the CBPTC expires December 31, 2012.[22] The USDA Biorefinery Assistance Program provides loan guarantees for the development and construction of commercial-scale biorefineries or for retrofitting existing facilities using eligible technologies.

The DOE contracted with Oak Ridge National Laboratory to prepare a document called the Biomass Energy Data Book. Now in its third edition, the Biomass Energy Data Book incorporates DOE Energy Information Administration (EIA) estimates of biomass energy utilization and availability along with data from industry groups. The Biomass Energy Data Book states:

> *"Since most of the biomass resources currently being used for energy are residuals from industrial, agricultural or forestry activities, there is no way to systematically inventory biomass feedstock collection and use and report it in standard units. All biomass resource availability and utilization information available in the literature are estimates, not inventories of actual collection and utilization. Biomass utilization information is derived from biomass energy production data, but relies on assumptions about energy content and conversion efficiencies for each biomass type and conversion technology. Biomass availability data relies on understanding how much of a given biomass type (e.g., corn grain) is produced, alternate demands for that biomass type, economic profitability associated with each of those alternate demands, environmental impacts of collection of the biomass, and other factors such as incentives.... In all cases it should be recognized that estimates are not precise and different assumptions will change the results."*

Finally, the solicitation and contract address woody biomass ―crops." Much of the woody biomass available for energy is not purpose grown. Construction debris, woodlot trimmings, stumps, and other byproducts have been used for energy. However, these materials are not crops and consequently have not been addressed as such in this report. Instead, the Contractor has focused efforts on obtaining data on purpose-grown woody biomass crops grown for any purpose, and not just on such crops grown for energy.

II.A. Congressional Mandated Biomass Activities

The 2008 Farm Bill (Public Law 110-234) was a $288 billion, five-year agricultural policy bill enacted in June 2008. The bill continues many elements of the 2002 Farm Bill, and substantially increases support for the production of cellulosic ethanol. The 2008 Farm Bill creates and funds programs to support production of biomass crops while providing matching payments to producers for harvest, transportation, and storage of biomass delivered to refineries. The bill also provides for loan guarantees for commercial scale and funding for grants to support retrofitting existing biorefineries for production using biomass feedstocks.

[22] DOE and USDA, http://www1.eere.energy.gov/biomass/pdfs/current_state_of_the_us_ethanol_industry.pdf.

The bill continues funding for the Biomass Research and Development program.

SEC. 15322. COMPREHENSIVE STUDY OF BIO-FUELS.

(a) Study- The Secretary of the Treasury, in consultation with the Secretary of Agriculture, the Secretary of Energy, and the Administrator of the Environmental Protection Agency, shall enter into an agreement with the National Academy of Sciences to produce an analysis of current scientific findings to determine--

(1) current bio-fuels production, as well as projections for future production,

(2) the maximum amount of bio-fuels production capable in United States forests and farmlands, including the current quantities and character of the feedstocks and including such information as regional forest inventories that are commercially available, used in the production of bio-fuels,

(3) the domestic effects of an increase in bio-fuels production levels, including the effects of such levels on--

(A) the price of fuel,

(B) the price of land in rural and suburban communities,

(C) crop acreage, forest acreage, and other land use,

(D) the environment, due to changes in crop acreage, fertilizer use, runoff, water use, emissions from vehicles utilizing bio-fuels, and other factors,

(E) the price of feed,

(F) the selling price of grain crops and forest products,

(G) exports and imports of grains and forest products,

(H) taxpayers, through cost or savings to commodity crop payments, and

(I) the expansion of refinery capacity,

(4) the ability to convert corn ethanol plants for other uses, such as cellulosic ethanol or biodiesel,

(5) a comparative analysis of corn ethanol versus other bio-fuels and renewable energy sources, considering cost, energy output, and ease of implementation,

(6) the impact of the tax credit established by this subpart on the regional agricultural and silvicultural capabilities of commercially available forest inventories, and

(7) the need for additional scientific inquiry, and specific areas of interest for future research.

(b) Report- The Secretary of the Treasury shall submit an initial report of the findings of the study required under subsection (a) to Congress not later than 6 months after the date of the enactment of this Act (36 months after such date in the case of the information required by subsection (a)(6)), and a final report not later than 12 months after such date (42 months after such date in the case of the information required by subsection (a)(6)).

Under Title XII, section 15322, the 2008 Farm Bill calls for research activities addressing federally subsidized insurance for energy crops. Section 522(c) of the Federal Crop Insurance Act (7 U.S.C.1522) is amended—

(11) ENERGY CROP INSURANCE POLICY.—

(A) DEFINITION OF DEDICATED ENERGY CROP.—In this subsection, the term 'dedicated energy crop' means an annual or perennial crop that—

(i) is grown expressly for the purpose of producing a feedstock for renewable bio-fuel, renewable electricity, or biobased products; and

(ii) is not typically used for food, feed, or fiber.

(B) AUTHORITY.—The Corporation shall offer to enter into 1 or more contracts with qualified entities to carry out research and development regarding a policy to insure dedicated energy crops.

(C) RESEARCH AND DEVELOPMENT.—Research and development described in subparagraph (B) shall evaluate the effectiveness of risk management tools for the production of dedicated energy crops, including policies and plans of insurance that—

(i) are based on market prices and yields;

(ii) to the extent that insufficient data exist to develop a policy based on market prices and yields, evaluate the policies and plans of insurance based on the use of weather or rainfall indices to protect the interests of crop producers; and

(iii) provide protection for production or revenue losses, or both.

II.B. Research Approach

In general, the Contractor sought first to develop an understanding of relevant literature on short-rotation woody species, current economic conditions, available government and private data, and characteristics of the industry sectors. After systematic analysis, the Contractor organized this report on quantitative data availability for short-rotation woody species. The focus of the research is to provide information about woody biofuel feedstock data. The data collection study focuses on woody biomass products that are or can be commercially grown in the United States. The resulting report is designed assist RMA in determining if it is practical to proceed with a feasibility study on federal insurance of woody biofuel feedstock.

All told, the research literature available is vast. An internet search revealed relatively little relevant data, offering a poor starting point for an exhaustive literature review. A search on ―forest" produces 728,000,000 hits; a search on ―tree farms" produces more than 1.5 million hits. Adding the term ―yields" to the tree farm search cuts the number of relevant pages in half. However, many of the referenced yields focus on ornamental nursery or Christmas tree production, which do not provide data on biomass. Adding the term ―biomass" or ―bio-mass" drops the count to just over 7,000. Of these, very few include any quantitative data.

There are also numerous professional journals addressing tree production, including:

- *Forestry,* published since 1927 and described at http://forestry.oxfordjournals.org/,
- *Journal of Forestry*, published since 1903 and described at http://www.safnet.org/publications/jof/,

- *Forest Science,* published since 1955 and described at http://www.safnet.org/publications/forscience/index.cfm, and
- *Journal of Sustainable Forestry*, published since 1992 and described at http://www.tandfonline.com/action/aboutThisJournal?show=aimsScope&journalCode=wjsf20.

Additional resources are found in the more recent literature addressing biomass production for energy, including journals such as *Biomass and Bio-energy* (published since 1991 and described at http://www.journals.elsevier.com/ biomass-and-bio-energy/), and online Journals like *Bio-fuels* (published since 2010 and described at http://www.future-science.com/loi/bfs). Again, few of the articles in these journals address woody biomass crop production from an agronomic perspective; most of the focus on yields is on predictive forecasts and/or one-off, small-plot field trials.

The information explosion threatens to swamp the limited quantitative information available in a flood of other material that has no meaningful quantitative content. Most issues of many journals addressing forestry and biomass production contain no relevant data. Consequently, the Contractor needed to develop a strategy to collect any meaningful data for this report. The Contractor therefore focused on identifying the available data addressing the following concepts relevant to crop insurance development:

1) **Production:** The amount of a crop grown and harvested in a given time period. The units of production for woody biomass are generally cubic feet; cords (128 cubic feet); cubic yards or meters (generally for chips); green tons; and short, long, or metric tons dry weight. For the purpose of insurance development the Contractor determined a time period longer than five years is not useful. For example, knowing that a certain number of dry weight tons were harvested after 50 years of growth provides no information useful to the development of insurance. For the purpose of insurance development, the Contractor also considered the possibility that changes in standing inventory per unit time represents an alternative measure of production.
2) **Yield:** The amount of a crop grown and harvested in a given unit of area. The units of yield for woody biomass are generally cubic feet (yards, meters, etc.) per acre; cords per acre; green tons per acre; and short, long, or metric tons dry weight per acre. For the purpose of insurance development, the Contractor also considered the possibility that changes in standing inventory per unit area represents an alternative measure of yield.
3) **Price:** The cost to purchase a given unit volume of the crop. The units of price for woody biomass in the United States are generally expressed in dollars per cubic foot (yard, meter); dollars per cord; dollars per green ton; and dollars per short, long, or metric ton dry weight. Contract and open market prices have been consistent and relatively stable, although regional differences have been noted.

The Solicitation requires the data report include crop descriptions that include both the common and scientific names for the crop, the crop's life cycle, and the parts of the cropped plants to be used as a biorefinery feedstock. The Contractor also sought data on the number of producers, planted acreage, harvested acreage, total production, value, yield, and prices received for the last five crop years at national, state, and county levels. The Contractor was unable to identify any sources for such data. If they exist, they are closely-held and proprietary.

The energy utilization of the woody biomass crops (i.e., for biofuel, electricity, or biobased products), as the DOE Biomass Report explains, is poorly documented. Processing infrastructure locations and capacity of biorefineries that can handle woody biomass are documented in Appendix A. However, it is important to note that most of the refineries listed have either only recently gone online or are still under development. These refineries cannot yet supply information relevant to their pricing mechanisms and the market dynamics of their feedstock materials.

Only limited production and market data on cropped woody biomass species from acceptable sources exist. Consequently, the Contractor provides an overview of the missing data. This provides the reader with an understanding of the information constraints of the individual crops, perhaps the single most important aspect of assessing feasibility of using quantitative data for non-parametric development of crop insurance for an emerging crop. Should the Government choose to further pursue an insurance development, this information could be used to establish new data collection efforts that could eventually provide a path to insurance feasibility for these data-sparse crops.

SECTION III. SHORT-ROTATION WOODY SPECIES

Short-rotation woody biomass species are grown to produce large quantities of biomass in a short period. The economic potential for these short-rotation species is enhanced by use of improved genetics and management practices. Due to their rapid growth, short-rotation woody species might include birch, Douglas fir, *Eucalyptus*, juniper, larch, *Magnolia*, poplar, Norway spruce, pine, and willows.

Birch

Birch trees are small to medium sized, perennial, deciduous, broadleaf trees in the genus *Betula* (Family Betulaceae). The genus includes 30 to 60 species widely distributed in the Northern Hemisphere. Most of these birch species grow in temperate environments, although some are boreal. The rapid growth characteristic of birch produces wood that contains less lignin than many hardwoods, resulting in a relatively weak structure. Consequently, birches are more susceptible to damage due to physical stress (e.g., icing or winds). This creates a dilemma for crop production, since rapid growth is desirable for accumulation of biomass, while slower growth results in desirable tolerance of stressful conditions.

Birch trees have been cultivated as an energy crop, although most available data are from sample plots in northern European locations.[23] Species with documented potential as an energy crop include *Betula nigra, Betula pendula*, and *Betula pubescens*. Birch for energy is generally planted as seed or nursery seedlings and is ready for harvest in 8 to 15 years. Most of the above-ground biomass can be harvested for its embodied energy. The birch trees can be coppiced[24] after the first harvest, with a second harvest accelerated by 2 to 3 years. Generally, after the coppice harvest, the field must be reconditioned and replanted. Depending on the reconditioning processes, biomass in the root system may be available for harvest during the reconditioning.

Douglas Fir

Douglas fir range from medium to large size, perennial, evergreen, coniferous trees in the genus *Pseudotsuga* (Family Pinaceae). The genus includes five species: three in North America and two in Asia. Most of these species grow in temperate forests, primarily in moist mountainous environments. The wood of Douglas fir contains substantial quantities of lignin, terpenes,[25] and resins. These compounds improve the quality of the wood for use as lumber. The terpenes and resins complicate the processes for production of biofuels from the Douglas fir biomass.

[23] Vande Walle, I., N. Van Camp, L. Van de Casteele, K. Verheyen, and R. Lemeu. 2007, Short-rotation forestry of birch, maple, poplar and willow in Flanders (Belgium) I—Biomass production after 4 years of tree growth, Biomass and Bio-energy 31: 267-275.
Aylott, M.J., E. Casella, I. Tubby, N.R. Street, P. Smith, and G. Taylor, 2008, Yield and spatial supply of bio-energy poplar and willow short-rotation coppice in the UK, New Phytologist 178: 358–370; Hytönen, J. and L. Aro, 2010, Biomass production of birch on cut-away peatlands – energy wood with short rotation?, http://www.metla.fi/hanke/3479/doc/posteri.pdf, accessed September, 2011.
Mola-Yudego, B. and P. Aronsson, 2008, Yield models for commercial willow biomass plantations in Sweden, Biomass and Bio-energy 32: 829–837.

[24] Coppicing is the process of allowing stumps to regenerate stems which can be harvested for their energy content. Biomass accumulation is facilitated by the growth of coppice stems from an existing root system.

[25] Terpenes are a class of organic compounds found in abundance in conifers. They are generally volatile hydrocarbons, and are also found are as constituents of essential oils.

Douglas fir from natural stands and plantations have been harvested for lumber. The wood is dense and has relatively high energy content per wet weight unit; this limits the costs for drying and transportation. To date, most Douglas fir wood for energy has been derived from forest thinning and lumber yard wastes. These wastes have been converted to clean-burning fuel pellets with a high embodied heat content and relatively little ash.[26] The value of the lumber for construction may limit the potential for use of Douglas fir for biomass feedstock.

Douglas fir trees have historically been cultivated to replace harvested lumber trees and are among the most commonly grown Christmas tree species. The trees used for Christmas tree production have been selected for their uniform and rapid growth, but not necessarily for production of biomass. Douglas firs are generally planted as nursery seedlings and are ready for harvest as an energy crop in 10 to 25 years.[27] Plantation Douglas firs can be harvested for lumber after 30 to 40 years, although much of the harvested lumber wood is from older plantations. Mill wastes from these harvests can be diverted to provide biomass as a biofuels feedstock.

Conifers have little or no potential for coppicing. Consequently, following harvest, Douglas fir fields must be reconditioned and replanted. While biomass in the root system would technically be available for harvest during the reconditioning, removal of these root systems has not been reported as a management practice.[28]

Eucalyptus

The genus *Eucalyptus* is in Family Myrtaceae. The genus includes about 700 perennial, woody species occurring primarily in Australia. While some of the species are shrubs, many are trees with single or multiple boles. The mature trees vary in height, with the largest growing to over 200 feet.

Eucalyptus plantations have been established outside their native range in many tropical and subtropical regions. Extensive plantations have been established in South Africa, Brazil, Chile, India, Spain, and Portugal. Industrial plantations of *Eucalyptus* have been established on a modest scale in Florida.[29] *Eucalyptus* has been cultivated as an energy crop in Hawaii.[30] Species shown to have potential as an energy crop include *Eucalyptus ampifolia, E. grandis, E. robusta E. saligna, and E. urophylla*. A highly productive hybrid, *E. grandis* x *E. urophylla*, modified

[26] Armstrong Pellets, Inc., 2011, Armstrong Premium Wood Pellet Fuel, http://www.armstrongpellets.com/pellets.html, accessed September, 2011.

[27] Mitchell, C.P., 1984, An Experimental Study of Short Rotation Forestry for Energy, in Solar Energy R & D in the European Community, Reidel, 5: 88-95, http://books.google.com/books?id=lXBhn2RPIvEC&pg=PA89&lpg=PA89&dq=douglas+fir+for+energy+short+rotation&source=bl&ots=UpJ642T87s&sig=TCVL_e3JaTvgh8c7NAmm_t4Tts8&hl=en#, accessed September, 2011;
Zumrawi, A.A. and D.W. Hann, 1993, Diameter Growth Equations for Douglas-fir and Grand Fir in the Western Willamette Valley of Oregon, Research Contribution 4, Oregon State University, Forest Research Laboratory, http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/7618/RC4.pdf;jsessionid=4D7BC90BE6FE98BBDBA9E66899939603?sequence=1, accessed September, 2011.

[28] Talbert, C., and D. Marshall, 2005, Plantation Productivity in the Douglas-Fir Region Under Intensive Silvicultural Practices: Results from Research and Operations, Journal of Forestry 103: 65-70, http://courses.washington.edu/esrm427/Talbert_Marshall_Plantations.pdf, accessed November, 2011.

[29] Segrest, S.A. Rockwood, D.L. Stricker, J.A. Green, A.E.S. (1998). Energy crop yields for Eucalyptus and cottonwood, http://www.treepower.org/yields/main.html

[30] Whitesell, C.D., D.S. DeBell, T.H. Schubert, R.F. Strand, and T.B. Crabb, 1992. Short-rotation management of Eucalyptus: guidelines for plantations in Hawaii. Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; http://www.fs.fed.us/psw/publications/documents/psw_gtr137/psw_gtr137.pdf, Accessed September, 2011.

through biotechnology to tolerate freezing, allows production in areas of the southeastern United States that would otherwise be too cold. The yields obtained from cold-tolerant *Eucalyptus* are predicted to meet targets set by the DOE for long-term energy production. *Eucalyptus* for energy is generally planted as asexually propagated nursery cuttings and is ready for harvest in five to eight years. It can be coppiced after the first harvest, with a second harvest accelerated by one to three years. There has been some success with second coppice harvests, although growth during this third cycle is slower than if the field is reconditioned and replanted after the coppice harvest.

Inasmuch as most *Eucalyptus* species produce substantial quantities and varieties of aromatic compounds, disease and insect problems are limited. However, the tropical origin of these species makes them particularly susceptible to cool and cold temperature damage. While the Contractor was not able to find information focused on replanting harvested *Eucalyptus* plantations, it seems logical that the biomass in the root system would be available for harvest during the field reconditioning process.

Juniper

Junipers are small to medium in size, perennial, evergreen, coniferous trees and shrubs in the genus *Juniperus* (Family Cupressaceae). The genus includes more than 50 species, widely distributed in North and South America, Eurasia, and Africa. The wood of junipers contains substantial quantities of aromatic compounds that tend to color the wood in shades of red. Natural stands of junipers have been harvested for fuel, lumber, and craft woods. The wood is dense and has a relatively high energy content. Most cultivated junipers are grown for horticultural purposes. As a conifer, junipers have limited potential for coppicing. Consequently, following harvest, replanted of fields would be required. The Contractor found no reference to junipers being used as a short-rotation biomass or bioenergy crop.

Larch

Larches are medium to large in size, perennial, deciduous, coniferous trees in the genus *Larix* (Family Pinaceae). The genus includes at least ten species growing primarily in the northern portions of the Northern Hemisphere. Larches are particularly common in Canada and Russia. Most of these species grow in boreal forests, often in moist environments otherwise not suitable for agricultural production. Larch is an unusual conifer; it is deciduous, whereas most plants in the family are evergreen. The wood of most larch species contains relatively low amounts of terpenes and resins. Natural stands of larch trees have been harvested for lumber and fuel. Some plantation growth of larches in Asia and Europe is documented, but despite a substantial effort, the Contractor did not identify any data on the use of larch as a short-rotation biomass or bioenergy crop.

Magnolia

Magnolia are small to large sized, perennial, deciduous, flowering trees and shrubs in the Family Magnoliaceae. The genus includes approximately 200 species growing throughout the temperate world. *Magnolia* have been propagated primarily for horticultural purposes. They hybridize freely. Despite a substantial effort, the Contractor did not identify any data on the use of *Magnolia* as a short-rotation biomass or bioenergy crop.

Norway Spruce

Norway spruce trees (*Picea abies* in the family Pinaceae) are large, perennial, evergreen, coniferous trees native to Europe. Norway spruces are widely planted in the northeastern, Pacific Northwestern, and Rocky Mountain states. As a result of early plantation plantings, naturalized populations have developed in the northeastern quarter of the United States.[31]

While the wood of Norway spruce contains substantial quantities of lignin, terpenes, and resins, these compounds improve the quality of the wood for use as lumber. Nonetheless, the terpenes and resins complicate the processes for production of biofuels from the Norway spruce biomass. To date, most Norway spruce wood for energy has been derived from forest thinning and lumber yard wastes. These wastes have been converted to clean-burning fuel pellets with a high embodied heat content and relatively little ash.

Norway spruces are planted as nursery seedlings. They have been cultivated to replace harvested lumber trees. Plantation Norway spruce can be harvested for lumber after 50 to 75 years, although older plantations exist. Mill wastes from harvests of Norway spruce can be diverted to provide biomass as a biofuels feedstock. Since the most rapid period of growth occurs during the first 15 to 25 years, biomass harvests would likely occur earlier than lumber harvests. Norway spruce cannot be coppiced. Therefore, Norway spruce fields must be reconditioned and replanted following harvest. While field reconditioning would provide the opportunity to harvest biomass from the root system, to date it appears biomass and biofuels from Norway spruce are produced from forest and mill wastes.

Pine

Pines are small to large in size, perennial, coniferous trees and shrubs in the genus *Pinus* (Family Pinaceae), valued as a source of wood pulp and lumber. The genus includes more than 100 species. Most of these species grow in temperate or boreal forests throughout the world, often in mountainous environments. The wood of pines, like the wood of most conifers, contains substantial quantities of lignin, terpenes, and resins. In temperate and tropical plantations, they grow rapidly and can be grown in relatively dense stands. The wood of pines grown in plantations is more dense and resinous than the wood of spruce, but less dense than the wood of Douglas fir. To date, most pine wood for energy has been derived from forest thinning and lumber mill wastes.[32]

Pines are planted to replace harvested lumber trees and some species are grown as Christmas tree species. The trees for Christmas tree production have been selected for uniform and rapid growth, but biomass production is selected against in this practice. Pines are generally planted as

[31] Sullivan, J, 1994, Picea abies. In: Fire Effects Information System, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/, accessed November, 2011.

[32] Eisenbies, M.H., E.D. Vance, W.M. Aust, and J R. Seiler, 2009, Intensive Utilization of Harvest Residues in Southern Pine Plantations: Quantities Available and Implications for Nutrient Budgets and Sustainable Site Productivity, Bio-energy Research 2: 90-98, http://ddr.nal.usda.gov/bitstream/10113/36119/1/IND44249891.pdf, accessed November, 2011.

seedlings and would be ready for harvest as an energy crop in 15 to 20 years.[33] Seedlings from tissue culture modified using biotechnological processes are expected to accelerate growth rates and reduce rotation times. A doubling of typical normal biomass production is expected. Loblolly pine (*Pinus taeda*) and slash pine (*Pinus elliottii*) are among the more common species planted in southern states for pulp and are expected to be among the common biomass species as well.[34] A large variety of species are used in northern plantations where growth is slower.

Plantation pine can be harvested for lumber after 30 to 40 years. Mill wastes from these harvests can be diverted to provide biomass as a biofuels feedstock. Conifers have little or no potential for coppicing; consequently, following harvest, pine fields must be reconditioned and replanted. In southern plantations where the soil is loose, pines planted for pulp can be pulled from the ground, capturing the biomass in the root system.

Poplar

Poplars are small to medium sized, perennial, deciduous, broadleaf trees in the genus *Populus* (Family Salicaceae). The genus includes more than 20 species widely distributed in the Northern Hemisphere including plants identified by the common names poplar, aspen, and cottonwood. The species hybridize freely and have been manipulated as a fuelwood genus for more than 50 years.[35] Most poplar species grow readily in a variety of temperate settings, with slower growth in boreal environments.

Hybrid poplars have been cultivated as an experimental energy crop in Europe and North America, although most of the available data are from small sample plots.[36] Hybrids with documented potential as an energy crop are produced from *P. tremuloides, P. maximowiczii, P. nigra,* and *P. trichocarpa*. Poplars grown for energy or biomass are generally planted as nursery seedlings derived clonally, often from tissue cultures that have been genetically modified. Several genes brought into the poplar hybrids have increased growth as much as 20 to 40 percent through a variety of mechanisms.[37] Clonal hybrid poplars are ready for harvest in five to ten years. Most of the above-ground biomass can be harvested for its embodied energy. The trees

[33] Mitchell, C.P., 1984, An Experimental Study of Short Rotation Forestry for Energy, in Solar Energy R & D in the European Community (Reidel) 5: 88-95, http://books.google.com/books?id=lXBhn2RPIvEC&pg=PA89&lpg=PA89&dq =douglas+fir+for+energy+short+rotation&source=bl&ots=UpJ642T87s&sig=TCVL_e3JaTvgh8c7NAmm_t4Tts8&hl=en#, accessed September, 2011;
Zumrawi, A.A. and D.W. Hann, 1993, Diameter Growth Equations for Douglas-fir and Grand Fir in the Western Willamette Valley of Oregon, Research Contribution 4, Oregon State University, Forest Research Laboratory, http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/7618/RC4.pdf;jsessionid=4D7BC90BE6FE98BBDBA9E668999 39603?sequence=1, accessed September, 2011.

[34] Vermis, W. 2008, Genetic Improvement of Bio-energy Crops, Springer-Verlag, New York, p. 397.

[35] Frysville Farm, 2011, History of Hybrid Poplar, http://www.frysvillefarms.com/history.htm, accessed November, 2011.

[36] Vande Walle, I., N. Van Camp, L. Van de Casteele, K. Verheyen, and R. Lemeu. 2007, Short-rotation forestry of birch, maple, poplar and willow in Flanders (Belgium) I—Biomass production after 4 years of tree growth, Biomass and Bio-energy 31: 267-275;
Aylott, M.J., E. Casella, I. Tubby, N.R. Street, P. Smith, and G. Taylor, 2008, Yield and spatial supply of bio-energy poplar and willow short-rotation coppice in the UK, New Phytologist 178: 358–370, http://onlinelibrary.wiley.com/doi/10.1111/j.1469-8137.2008.02396.x/full, accessed October and November, 2011;
Hytönen, J. and L. Aro, 2010, Biomass production of birch on cut-away peatlands – energy wood with short rotation?, http://www.metla.fi/hanke/3479/doc/posteri.pdf, accessed September, 2011;.
Mola-Yudego, B. and P. Aronsson, 2008, Yield models for commercial willow biomass plantations in Sweden, Biomass and Bio-energy 32: 829–837.

[37] Shani, Z., M. Dekel, G Tsabary, R. Goren, and O. Shoseyov, 2004, Growth enhancement of transgenic poplar plants by over expression of *Arbidopsis thaliana* endo-1,4-β–glucanase, Molecular Breeding 14:¨321-330.

can be coppiced after the first harvest, with a second harvest accelerated by two to three years. Generally, after two coppice harvests, the stumps have grown too large for efficient biomass production. Consequently, the field is reconditioned and replanted. Depending on the reconditioning processes, some biomass in the root system may be available for harvest during the reconditioning.

Willows

Willows are small to large in size, perennial, deciduous, broadleaf trees in the genus *Salix* (Family Salicaceae). The genus includes 200 species widely distributed in the Northern Hemisphere. In contrast to the other types discussed, willows are a fast growing woody shrub. Initial field trials with Salix biomass production were conducted as early as the mid-1970's in Sweden.[38] More than 400 hectares (approximately 1,000 acres) of commercial willow biomass crops were under production in Sweden by 2006.

Willows can be grown on agricultural land, including land with limited production potential for other crops in the northeastern, midwestern, and parts of the southeastern United States. If weeds are controlled by chemical and/or mechanical means, high yields of *Salix* spp. can be sustained on three to four year rotations. Once a suitable variety has been selected, the crop can be propagated by planting dormant stem cuttings. Young trees are coppiced to stimulate branch formation. The shrubs then grow for three to five years. Forage harvesters with specially-engineered heads cut the crop two to four inches above the ground, feeding the harvested material into a chopper to produce chips that are collected immediately after cutting.

Research is underway to refine agronomic practices for new willow varieties. *Salix* shrubs, with the ability to re-sprout even after several harvest cycles, have been selected for biomass production. Willow is being cropped on a commercial scale in Sweden[39] and in other countries commercial production is being encouraged through initiatives such as the Willow Biomass Project in the United States and the Energy Coppice Project in the United Kingdom.

Most of the available data for willow are from small sample plots.[40] Clonal hybrid willows are ready for harvest in three to five years. Most of the above-ground biomass can be harvested for its embodied energy. The trees can be coppiced after harvest, with the next harvest accelerated by one to three years. As many as half a dozen coppice harvests might be possible before the stump structure becomes limiting. Then the field needs to be replanted. Depending on the field

---

38 Volk, T.A., L.P. Abrahamson, C.A. Nowak, L.B. Smart, P.J. Tharakan, and E.H. White, 2006, The development of short-rotation willow in the northeastern United States for bio-energy and bioproducts, agroforestry and phytoremediation, Biomass & Bio-energy 30: 715-27, http://www.mendeley.com/research/development-shortrotation-willow-northeastern-united-states-bio-energy-bioproducts-agroforestry-phytoremediation-1/, accessed November, 2011.

39 Mola-Yudego, B. and P. Aronsson, 2008, Yield models for commercial willow biomass plantations in Sweden Biomass and Bio-energy 32: 829–837, http://www.sciencedirect.com/science/article/pii/S096195340800007X, accessed November, 2011.

40 Vande Walle, I., N. Van Camp, L. Van de Casteele, K. Verheyen, and R. Lemeu. 2007, Short-rotation forestry of birch, maple, poplar and willow in Flanders (Belgium) I—Biomass production after 4 years of tree growth, Biomass and Bio-energy 31: 267-275;
Aylott, M.J., E. Casella, I. Tubby, N.R. Street, P. Smith, and G. Taylor, 2008, Yield and spatial supply of bio-energy poplar and willow short-rotation coppice in the UK, New Phytologist 178: 358–370, http://onlinelibrary.wiley.com/doi/10.1111/j.1469-8137.2008.02396.x/full, accessed October and November, 2011;
Hytönen, J. and L. Aro, 2010, Biomass production of birch on cut-away peatlands – energy wood with short rotation?, http://www.metla.fi/hanke/3479/doc/posteri.pdf, accessed September, 2011;.

preparation processes, biomass in the root system may be available for harvest during the reconditioning.

SECTION IV. GOVERNMENT DATA

The Contractor examined potential data from government and private sources for use in the development of insurance products. The government sources examined included NASS, ERS, FSA, and FS, as well as the DOE.

IV.A. USDA Data

NASS is the primary data collection and statistical estimating service of the USDA. Its data series are widely used by producers, businesses, and researchers. Major commodity crop data are collected both annually and as an element of the Census of Agriculture. The Contractor was not able to identify any NASS production or pricing data dealing with woody biomass crops, firewood, or pulpwood. The Contractor‘s search of NASS documents on forests, pulpwood, and firewood did not identify any relevant empirical data for the development of crop insurance for woody biomass crops grown as biofuel feedstocks. From an extensive search of available data, it does not appear time-series data relevant to woody biomass crops are maintained by NASS.

The Census of Agriculture does report on sales of forest products (excluding short-rotation woody crops) (see for example Tables 7, 58, 59, and 60 in Chapter 1, Volume 1 of the 2007 Census of Agriculture[41]) and on agronomic characteristics of Christmas trees and short rotation woody crops collectively (see for example Tables 2, 7, and 40 in Chapter 1, Volume 1 of the 2007 Census). Inasmuch as the short-rotation woody crops are excluded in the first instance and aggregated with irrelevant data in the second, these Census data are not useful for the development of insurance. Tables 38 in Chapter 1 and 37 in Chapter 2 (Appendix B, Exhibit 1) provide some data about number of producers, planted acreage, harvested acreage, total production, value, or yield of short-rotation woody crops. However, the Census defines these crops as ―crops that grow from seed to a mature tree in 10 years or less. These are trees for use by the paper or pulp industry or as engineered wood. This does not include lumber. Acres in production were included in Cropland harvested in the ―Land" section of the report form." Consequently, based on this definition, the values concerning producer populations in these tables included producers who do not grow biorefinery feedstocks and most likely exclude some who do.

The USDA Economic Research Service (ERS) collects data and provides analysis on crop product supply and demand, as well as information on industry structure, pricing, trade, production policies, production systems, and processing. The ERS reports regarding this sector focus on biofuels, biorefinery activities, and woody biomass in general, rather than documenting yield, production, or markets for woody biomass quantitatively based on empirical data. The Contractor‘s search for ERS documents on pulpwood and firewood did not identify any empirical data relevant to the development of crop insurance for woody biomass crops grown as biofuel feedstocks.

FSA provides financial assistance to producers facing losses from natural disaster (i.e., drought, flood, fire, freeze, tornadoes, pest infestation, and other ―calamities"). The SOW requires documentation of ―NAP payments, disaster program payments, and other government payments" made for woody biomass crops in the last five years, by state and county. To address this

[41] USDA, 2009, 2007 Census of Agriculture, http://www.agcensus.usda.gov/Publications/2007/Full_Report/usv1.pdf.

requirement, the Contractor made a FOIA request for these data to the USDA FSA.[42] The Contractor also made a general request for information about disaster payments for woody biomass crops to state FSA offices (Appendix C). No data documenting such disaster payments were provided under either the national or state-level requests. Many of the responding FSA offices also indicated they had no data on production, yield, or price of woody biomass crops.

FSA's Noninsured Crop Disaster Assistance Program (NAP) provides payments to producers of non-insurable crops when low yields, loss of inventory, or prevented planting occur due to a natural disaster. The Contractor was not able to identify any use of the NAP program to indemnify against losses of woody biomass intended for use as biorefinery feedstock. This is not surprising for a number of reasons. First, consider the extremely limited incorporation of woody biomass as biorefinery feedstock into producers' cash crop portfolios. Second, the structure of NAP records does not identify the intended use of an indemnified crop. Finally, eligible crops under the NAP do not include woody biomass crops. Trees are specifically excluded under the fiber crop category.[43] Other FSA disaster programs are generally linked to the NAP program or to existing insurance under the RMA crop insurance programs. As a result, it would be surprising if any "NAP payments, disaster program payments, and other government payments" were made to address losses of production or revenue.

Research has been part of the FS mission since the service was founded in 1905; the research covers all states, territories, and commonwealths administered to by the federal government. The FS research focuses on "informing policy and land management decisions."[44] The information derived from this research, including aggregated data, is publicly available. Every five years the FS prepares national reports describing current conditions and recent trends in the health, diversity, and productivity of forests, along with related socioeconomic information about forests. Prospective reports that look ahead 50 years are also produced.

The Quantitative Sciences section of the Research and Development branch of the FS maintains forestry data for the FS. The Quantitative Sciences section activities include maintenance of the Forest Inventory and Analysis (FIA) Program (http://www.fia.fs.fed.us/). The FIA dataset is the most comprehensive dataset for woody biomass in existence, containing terabytes of data.[45] Forest Inventory Online (FIDO), a data-mining tool, provides public access to the data in the FIA databases. FIDO creates both standard and customizable reports on public and private forest land. (Standard reports are located at the following web address: http://apps.fs.fed.us/fido/standardrpt.html, while customizable reports are at: http://apps.fs.fed.us/fido/customrpt.html)

FIA origins can be found in the McSweeney-McNary Forest Research Act of 1928 (P.L. 70-466 45 stat. 699). That act authorized a nationwide survey of all acreage of forest land under all

[42] Sue Ellen Sloca, FOIA Advisor, USDA, FSA, 1400 Independence Ave. SW, Room 3617, Mailstop 0506, Washington, D.C. 20250, 202-720-1598, sueellen.sloca@wdc.usda.gov.

[43] USDA FSA, 2009, Program Fact Sheet: Noninsured Crop Disaster Assistance Program for 2009 and Subsequent Years, http://www.fsa.usda.gov/Internet/FSA_File/nap09.pdf, Accessed October, 2011.

[44] USDA, FS, 2005, Forest Service Research and Development: Science You Can Use, FS-832. inside cover.

[45] Dr. Richard Guldin, Director, Quantitative Sciences, USDA, FS, 1400 Independence Ave., S.W., Washington, DC 20250-1120, 1-703-605-4177, rguldin@fs.fed.us.

types of ownership. The first FS survey, begun in 1930, was completed in 1947. Current inventories are based on technology rather than survey instruments, such as questionnaires.

FIA incorporates data on public and private forestry resources including species (or species grouping), size (linear and volume measurements), health, growth, mortality, production, harvest, as well as utilization rates and ownership. These can be parsed temporally and geographically to at least the county level.

The initial data currently used for the FIA inventories are satellite imagery. The data are parsed using a hexagonal geographic grid system with 250 acre –tiles." Computer analyses develop inventory elements for each grid hexagon first by classifying the scenes into forest and non-forest categories. Field locations with a sample distribution of approximately one for every 6,000 acres are visited by field crews to collect forest ecosystem data. Over the years, these data have been used to develop algorithms to generate analyses of the satellite imagery. FIA program personnel develop ground-truth for a sample of the inventoried grids to assure the efficacy of the algorithms. Verification of the ground-truthing is performed by a second FIA team on a sub-sample of the ground-truthed tiles.

On site ground-truthing does occur on private and state lands, but only with the permission of the owners. Alternate proximal ground-truthing locations are chosen if permission is not obtained. To protect privacy, FIA reports aggregate data in much the same way that NASS does. Consequently, the smallest standard reporting area is a county. Custom data reports for specific geographic locations are also controlled[46] to assure no proprietary or private data are revealed in these reports. A Freedom of Information Act (FOIA) shield is in place to further protect private data. Consequently, no –farm-level" data for insurance development will be available from this dataset.

Recently, the FS has enhanced the FIA program by changing from a periodic to an annual digital survey. However, it is important to note the ground-truthing protocol is repeated on a five-year cycle in the eastern part of the United States and a ten-year cycle in the western parts of the United States.

Despite the limitations of the FS data, the Contractor extracted inventory data on birch, Douglas fir, *Eucalyptus*, juniper, larch, *Magnolia*, poplar, Norway spruce, pine, willows. The FS inventories include data on both natural and managed forests. However, data are aggregated to protect confidentiality of individuals (including corporations). Data were available in most states for some years between 2000 and 2010 (See Table 5). The more frequent reporting of some data in recent years is also evident in these data (Appendix B Exhibit 2). However, it is important to note the ground-truth activities are still constrained by the scope of this project and the enormous expanses of forested land in the United States.

[46] Dr. Richard Guldin of the FIA project with the FS, described this as making geographic extractions –fuzzy."

Table 5. Availability of Net Tree Volume Data for Birch, Douglas fir, *Eucalyptus*, Juniper, Larch, *Magnolia*, Poplar, Norway Spruce, Pine, and/or Willow in the USDA FS FIA FIDO System by State and Years.

State	Years Data are Available
Alabama	2000 - 2010
Alaska	2003, 2009
Arizona	2008, 2009
Arkansas	2005 - 2010
California	2009
Colorado	2008, 2009
Connecticut	2005 - 2010
Delaware	2004 - 2010
Florida	2004, 2007, 2009, 2010
Georgia	2000 - 2010
Idaho	2008, 2009
Illinois	2003 - 2009
Indiana	2003 - 2010
Iowa	2003 - 2010
Kansas	2003 - 2009
Kentucky	2004 - 2010
Louisiana	2005
Maine	2003, 2005 - 2010
Maryland	2004 - 2009
Massachusetts	2005 - 2010
Michigan	2003 - 2010
Minnesota	2003 - 2010
Mississippi	2006, 2010
Missouri	2003 - 2010
Montana	2008, 2009
Nebraska	2003 - 2010
Nevada	2005
New Hampshire	2005 - 2010
New Jersey	2004 - 2010
New Mexico	none
New York	2005 - 2009
North Carolina	2002 - 2010
North Dakota	2003 - 2010
Ohio	2004 - 2009
Oklahoma	2008, 2010
Oregon	2009
Pennsylvania	2004 - 2009
Rhode Island	2005 - 2010
South Carolina	2001 - 2010
South Dakota	2003 - 2010
Tennessee	2000 - 2010
Texas	2003 - 2010
Utah	2008, 2009
Vermont	2005 - 2010
Virginia	2001 - 2003, 2005 - 2010
Washington	2009
West Virginia	2000, 2004 - 2009
Wisconsin	2003 - 2010
Wyoming	2000

Source: The Contractor's Research Department after USDA, FS, FIA, FIDO search by state for birch, Douglas fir, *Eucalyptus*, juniper, larch, *Magnolia*, poplar, Norway spruce, pine, and willow data.

Dr. Richard Guldin, Director of Quantitative Sciences, USDA, FS, with primary responsibilities for the FIA dataset, indicated during a discussion that the natural mortality of inventoried trees documented by the FIA project was quite low (averaging less than 0.75 percent per year, with a range of 0.73 percent to 0.79 percent). This raised the possibility that FIDO data might be used as a proxy for actual plantation mortality data. To explore this possibility, the Contractor examined data for species or species groups within FIDO that parallel potential biorefinery feedstocks plant types. The Contractor mined data on Periodic Annual Mortality, the measure of mortality available through FIA FIDO standard reports. The FS defines Periodic Annual Mortality as:

> *"an estimate of the average annual volume of trees dying between two measurements, usually the current inventory and previous inventory, where the same plot is evaluated twice. Periodic annual mortality is the loss of volume between inventories divided by the number of years between each inventory. Periodic average annual mortality is the most common type of annual mortality estimated."*[47]

Examining the mortality by species (or species group) by state, then by year, the Contractor notes remarkable differences between the general levels of mortality described by Dr. Guldin and the specific annual mortalities seen for a species or species group in a particular state (Tables 6-17).

Table 6. Cottonwood and Aspen (Group ID 37)[48] Periodic Annual Mortality Average and Range by Year.

Year	Average Mortality (percent)	Minimum (percent)	Maximum (percent)	Minimum State	Maximum State
2000					
2002	0.55	0.55	0.55	Tennessee	Tennessee
2003	0.11	0.00	0.76	Indiana	Indiana
2004	3.24	0.00	3.66	Georgia	Georgia
2005	2.75	0.00	4.93	Georgia	South Carolina
2006	2.68	0.39	5.27	Illinois	New York
2007	2.47	0.05	4.53	Kentucky	North Carolina
2008	2.60	0.35	7.13	Maryland	Delaware
2009	2.58	0.15	4.20	Virginia	Kentucky
2010	2.74	0.15	16.71	Virginia	Mississippi

Source: The Contractor's Research Department after USDA, FS, FIA, FIDO search by for Periodic Annual Mortality data by state and year.

[47] Woudenberg, S.W., B.L. Conkling, B.M. O'Connell, E.B. LaPoint, J.A. Turner, and K.L. Waddell, 2010, The Forest Inventory and Analysis Database: Database Description and Users Manual Version 4.0 for Phase 2, page 36, http://www.fs.fed.us/rm/pubs/rmrs_gtr245.pdf, accessed November, 2011.
This attribute is blank (null) for a plot if the plot does not contribute to the mortality estimate.

[48] The FS type categories reflect regional differences in species groupings. So, for example, the Type 37 cottonwoods and aspens are species growing in the moister eastern environments while Type 44 cottonwoods and aspens are found in the dryer mountainous environments (Appendix Appendix B, Exhibit 3).

Table 7. Cottonwood and Aspen (Group ID 44) Periodic Annual Mortality Average and Range by Year.

Year	Average Mortality (percent)	Minimum (percent)	Maximum (percent)	Minimum State	Maximum State
2000	0.88	0.88	0.88	Wyoming	Wyoming
2002					
2003					
2004					
2005	2.98	2.98	2.98	Nevada	Nevada
2006					
2007					
2008	1.01	0.77	2.19	Utah	Arizona
2009	1.00	0.71	2.51	Utah	Arizona
2010					

Source: The Contractor's Research Department after USDA, FS, FIA, FIDO search by for Periodic Annual Mortality data by state and year.

Table 8. Douglas Fir (Group ID 10) Periodic Annual Mortality Average and Range by Year.

Year	Average Mortality (percent)	Minimum (percent)	Maximum (percent)	Minimum State	Maximum State
2000	1.03	1.03	1.03	Wyoming	Wyoming
2002					
2003					
2004					
2005	5.10	5.10	5.10	Nevada	Nevada
2006					
2007					
2008	1.52	0.98	2.25	Colorado	Arizona
2009	1.52	0.97	2.51	Colorado	Arizona
2010					

Source: The Contractor's Research Department after USDA, FS, FIA, FIDO search by for Periodic Annual Mortality data by state and year.

Table 9. Loblolly and Shortleaf Pine (Group ID 2) Periodic Annual Mortality Average and Range by Year.

Year	Average Mortality (percent)	Minimum (percent)	Maximum (percent)	Minimum State	Maximum State
2000					
2002	9.12	9.12	9.12	Tennessee	Tennessee
2003	2.48	1.81	8.34	Alabama	Tennessee
2004	1.53	0.42	8.52	Missouri	Tennessee
2005	1.32	0.27	8.97	Missouri	Tennessee
2006	0.87	0.23	6.50	Missouri	Tennessee
2007	1.03	0.21	21.33	Missouri	Ohio
2008	0.99	0.35	10.65	Missouri	Ohio
2009	0.93	0.34	15.10	Missouri	Pennsylvania
2010	0.90	0.42	2.88	Delaware	Kentucky

Source: The Contractor's Research Department after USDA, FS, FIA, FIDO search by for Periodic Annual Mortality data by state and year.

Table 10. Longleaf and Slash Pine (Group ID 1) Periodic Annual Mortality Average and Range by Year.

Year	Average Mortality (percent)	Minimum (percent)	Maximum (percent)	Minimum State	Maximum State
2000					
2002					
2003	1.24	1.24	1.24	Alabama	Alabama
2004	0.71	0.57	1.10	Georgia	Alabama
2005	0.73	0.60	1.06	Georgia	Alabama
2006	0.57	0.57	0.86	Texas	Alabama
2007	0.73	0.30	1.26	North Carolina	Alabama
2008	0.88	0.66	2.21	Georgia	Texas
2009	0.95	0.33	2.81	North Carolina	Texas
2010	0.88	0.38	3.24	North Carolina	Texas

Source: The Contractor's Research Department after USDA, FS, FIA, FIDO search by for Periodic Annual Mortality data by state and year.

Table 11. Other Eastern Soft Hardwoods (Group ID 41) Periodic Annual Mortality Average and Range by Year.

Year	Average Mortality (percent)	Minimum (percent)	Maximum (percent)	Minimum State	Maximum State
2000					
2002	1.59	1.59	1.59	Tennessee	Tennessee
2003	1.08	1.51	1.59	Tennessee	Alabama
2004	2.08	1.32	4.52	Indiana	Iowa
2005	2.05	1.22	3.22	South Carolina	Iowa
2006	1.75	0.29	4.89	Rhode Island	Nebraska
2007	2.17	0.50	4.45	Texas	Nebraska
2008	2.23	0.34	4.25	Rhode Island	Iowa
2009	2.17	0.55	4.35	Delaware	Nebraska
2010	2.22	0.84	4.85	Oklahoma	Iowa

Source: The Contractor's Research Department after USDA, FS, FIA, FIDO search by for Periodic Annual Mortality data by state and year.

Table 12. Other Eastern Softwoods (Group ID 9) Periodic Annual Mortality Average and Range by Year.

Year	Average Mortality (percent)	Minimum (percent)	Maximum (percent)	Minimum State	Maximum State
2000					
2002	0.98	0.98	0.98	Tennessee	Tennessee
2003	0.70	0.57	0.90	Alabama	Tennessee
2004	0.62	0.23	1.24	Missouri	Georgia
2005	0.75	0.18	1.58	Missouri	South Carolina
2006	0.77	0.20	2.23	Missouri	New Hampshire
2007	0.78	0.16	3.88	Texas	North Carolina
2008	0.74	0.05	5.29	Maryland	Connecticut
2009	0.84	0.18	3.73	Texas	Connecticut
2010	0.92	0.23	10.21	Missouri	Florida

Source: The Contractor's Research Department after USDA, FS, FIA, FIDO search by for Periodic Annual Mortality data by state and year.

Table 13. Other Western Softwoods (Group ID 24) Periodic Annual Mortality Average and Range by Year.

Year	Average Mortality (percent)	Minimum (percent)	Maximum (percent)	Minimum State	Maximum State
2000	0.74	0.74	0.74	Wyoming	Wyoming
2002					
2003					
2004					
2005					
2006					
2007					
2008	2.07	0.36	2.70	Colorado	Montana
2009	2.32	0.59	3.08	Colorado	Montana
2010					

Source: The Contractor's Research Department after USDA, FS, FIA, FIDO search by for Periodic Annual Mortality data by state and year.

Table 14. Other Yellow Pines (Group ID 3) Periodic Annual Mortality Average and Range by Year.

Year	Average Mortality (percent)	Minimum (percent)	Maximum (percent)	Minimum State	Maximum State
2000					
2002	9.01	9.01	9.01	Tennessee	Tennessee
2003	7.92	5.76	10.07	Alabama	Tennessee
2004	6.40	1.13	11.47	Minnesota	Tennessee
2005	4.89	0.27	14.90	Wisconsin	Tennessee
2006	3.57	0.10	28.99	New Hampshire	Connecticut
2007	3.80	0.17	47.14	Minnesota	Missouri
2008	3.77	0.24	75.90	Rhode Island	Nebraska
2009	3.18	0.12	87.07	Minnesota	Nebraska
2010	2.82	0.10	74.34	Minnesota	Nebraska

Source: The Contractor's Research Department after USDA, FS, FIA, FIDO search by for Periodic Annual Mortality data by state and year.

Table 15. Sweetgum (Group ID 34) Periodic Annual Mortality Average and Range by Year.

Year	Average Mortality (percent)	Minimum (percent)	Maximum (percent)	Minimum State	Maximum State
2000					
2002	0.61	0.61	0.61	Tennessee	Tennessee
2003	0.87	0.66	0.99	Tennessee	Alabama
2004	0.86	0.38	1.23	Missouri	Indiana
2005	0.85	0.49	1.00	Virgina	Indiana
2006	0.56	0.13	1.59	Illinois	Indiana
2007	0.83	0.13	1.50	Illinois	Indiana
2008	0.73	0.31	1.32	Maryland	Indiana
2009	0.82	0.27	1.20	Illinois	Louisiana
2010	0.78	0.28	1.25	Illinois	Missouri

Source: The Contractor‘s Research Department after USDA, FS, FIA, FIDO search by for Periodic Annual Mortality data by state and year.

Table 16. Yellow Birch (Group ID 30) Periodic Annual Mortality Average and Range by Year.

Year	Average Mortality (percent)	Minimum (percent)	Maximum (percent)	Minimum State	Maximum State
2000					
2002	0.41	0.41	0.41	Tennessee	Tennessee
2003	0.50	0.50	0.50	Tennessee	Tennessee
2004	0.63	1.06	1.06	Tennessee	Tennessee
2005	1.03	0.25	1.63	Minnesota	Wisconsin
2006	1.03	0.37	6.81	Massachusetts	New Jersey
2007	1.15	0.47	3.58	Minnesota	Georgia
2008	1.27	0.44	11.17	Minnesota	Ohio
2009	1.17	0.19	9.10	Tennessee	Ohio
2010	1.16	0.22	3.94	Connecticut	Virginia

Source: The Contractor‘s Research Department after USDA, FS, FIA, FIDO search by for Periodic Annual Mortality data by state and year.

Table 17. Yellow Poplar (Group ID 39) Periodic Annual Mortality Average and Range by Year.

Year	Average Mortality (percent)	Minimum (percent)	Maximum (percent)	Minimum State	Maximum State
2000					
2002	0.39	0.39	0.39	Tennessee	Tennessee
2003	0.45	0.36	0.87	Tennessee	Alabama
2004	0.55	0.32	0.74	Tennessee	Georgia
2005	0.47	0.34	0.83	Virginia	Indiana
2006	0.35	0.04	0.63	New York	Indiana
2007	0.43	0.04	0.64	Illinois	Indiana
2008	0.40	0.03	1.09	Michigan	Delaware
2009	0.42	0.03	1.01	Michigan	Delaware
2010	0.53	0.06	3.39	Michigan	Florida

Source: The Contractor‘s Research Department after USDA, FS, FIA, FIDO search by for Periodic Annual Mortality data by state and year.

To understand this pattern, the Contractor examined county-level net tree volume data to further understand the FS FIA data available through FIDO. Tree types that may prove useful as biorefinery feedstocks in three representative counties are presented in Tables 18 through 20.

Table 18. Net Tree Volume by Tree ID and Year in Chippewa County, Michigan

Species	2003	2004	2005	2006	2007	2008	2009	2010
Balsam Poplar (741)	35,794,181	31,091,209	30,923,040	31,747,307	31,704,033	25,531,921	28,812,146	27,837,526
Bebb Willow (923)		54,087	63,183	76,422	76,485	67,332		
Bigtooth Aspen (743)	17,677,960	19,018,792	19,990,918	19,460,688	16,931,968	20,443,038	19,978,337	22,636,419
Eastern Cottonwood (742)	59,442	47,654						
Eastern White Pine (129)	43,453,005	42,731,728	45,996,809	41,082,541	25,430,862	49,316,613	56,684,001	57,223,177
Jack Pine (105)	55,425,078	52,540,711	53,649,692	51,836,700	47,514,199	40,106,314	39,080,230	36,687,289
Larch spp. (70)	42,608	34,159		83,390	83,459	73,472	87,019	109,389
Paper Birch (375)	58,315,320	55,652,328	51,410,857	47,678,500	54,995,633	49,195,797	50,957,461	46,509,971
Peachleaf Willow (921)	25,993	21,338	24,231					
Quaking Aspen (746)	112,221,680	112,731,898	127,473,145	120,074,896	101,843,967	113,201,856	124,415,037	142,119,108
Red Pine (125)	65,412,105	74,621,113	73,506,264	69,814,975	71,353,767	91,699,974	94,622,887	97,757,049
Scotch Pine (130)	6,195,370	5,380,815	6,357,912	6,844,240	6,013,810	377,071		
Tamarack (Native) (71)	16,223,543	19,104,995	21,514,159	22,594,046	20,035,186	20,537,351	19,299,234	20,896,507
White Spruce (94)	50,675,514	45,919,700	49,190,522	46,679,080	47,045,855	43,686,815	48,871,184	51,567,995
Yellow Birch (371)	17,888,706	18,502,316	17,946,389	17,490,910	15,353,561	16,710,034	17,889,995	16,946,489

Source: The Contractor's Research Department after USDA, FS, FIA, FIDO search by for Periodic Annual Mortality data by state and year.

Table 19. Net Tree Volume by Tree ID and Year in Glade County, Florida

Species	2004	2007	2009	2010
Eucalyptus spp. (510)	348,906	333,780		
Grand Eucalyptus (513)	1,692,582	1,619,202	1,313,526	1,558,854
Longleaf Pine (121)	3,925,823	3,755,623	3,046,630	4,136,154
Slash Pine (111)	775,744	7,679,841	9,299,003	9,672,768

Source: The Contractor's Research Department after USDA, FS, FIA, FIDO search by for Periodic Annual Mortality data by state and year.

Table 20. Net Tree Volume by Tree ID and Year in Sterns County, Minnesota

Species	2003	2,004	2,005	2006	2007	2008	2009	2010
Bigtooth Aspen (743)	3,349,094	2,991,449	2,851,042	2,728,690	2,868,743	2,867,560	3,104,954	3,173,564
Paper Birch (375)	3,790,714	3,561,992	3,396,773	3,435,626	3,131,580	3,372,073	3,476,664	3,339,862
Quaking Aspen (746)	1,218,543	1,338,312	4,133,879	4,157,637	7,384,925	7,346,019	7,172,072	5,960,317
Tamarack (Native) (71)	201,111	198,212	317,364	310,954	383,982	343,804	435,733	470,809
Yellow Birch (371)	430,782	379,175	372,331	405,988	422,968	443,524	445,170	444,630

Source: The Contractor's Research Department after USDA, FS, FIA, FIDO search by for Periodic Annual Mortality data by state and year.

While these tables illustrate the depth of the FIA data, they also demonstrate a characteristic consistent with NASS data: the sampling regime is intended to minimize the error of the estimate at the national level. In other words, the big picture (state or national) is more precise and accurate than the county-level data; aggregate data on all trees are more precise and accurate than data for a species group. The FS addresses this pattern in its discussion of accuracy standards:

> *"Forest inventory plans are designed to meet sampling error standards for area, volume, growth, and removals provided in the Forest Service directive (FSH 4809.11) known as the Forest Survey Handbook (U.S. Department of Agriculture 2008). These standards, along with other guidelines, are aimed at obtaining comprehensive and comparable information on timber resources for all parts of the country. FIA inventories are commonly designed to meet the specified sampling errors at the State level at the 67 percent confidence limit (one standard error). The Forest Survey Handbook mandates that the sampling error for area cannot exceed 3 percent error per 1 million acres of timberland. A 5 percent (Eastern United States) or 10 percent (Western United States) error per 1 billion cubic feet of growing-stock on timberland is applied to volume, removals, and net annual growth. Unlike the mandated sampling error for area, sampling errors for volume, removals, and growth are only targets.*
>
> *FIA inventories are extensive inventories that provide reliable estimates for large areas. As data are subdivided into smaller and smaller areas, such as a geographic unit or a county, the sampling errors increase and the reliability of the estimates goes down.*
>
> - *A State with 5 million acres of timberland would have a maximum allowable sampling error of 1.3 percent (3% x (1,000,000)0.5 / (5,000,000)0.5).*
> - *A geographic unit within that State with 1 million acres of timberland would have a 3.0 percent maximum allowable sampling error (3% x (1,000,000)0.5 / (1,000,000)0.5).*
> - *A county within that State with 100 thousand acres would have a 9.5 percent maximum allowable sampling error (3% x (1,000,000)0.5 / (100,000)0.5) at the 67 percent confidence level".*[49]

In summary, there are several limitations that stand in the way of using these FS data to address the number of producers by the crop year, planted acreage, harvested acreage, total production, value, prices received, or yield of woody biomass crops. In the first place, none of these categories, as they are construed for insurance purposes, are documented in the FIDO system. It might be possible to extrapolate a measure of production from inventories. However, the basis for changes in inventories is not limited to productive growth. Reductions in inventory due to harvests, along with increases in inventory due to growth and losses due to a wide variety natural causes (e.g., fire, disease, and landslides) would all contribute to changes in inventory. Consequently the variation in inventories from year to year is enormous. Furthermore, the data in the FIDO system are extrapolations that have undergone significant manipulation. They are

[49] Woudenberg, S.W., B.L. Conkling, B.M. O'Connell, E.B. LaPoint, J.A. Turner, and K.L. Waddell, 2010, The Forest Inventory and Analysis Database: Database Description and Users Manual Version 4.0 for Phase 2, page 36, http://www.fs.fed.us/rm/pubs/rmrs_gtr245.pdf, accessed November, 2011.

not direct measures of productivity. FIDO values have been aggregated and at times even blended across substantial geographic distances to maintain confidentiality. Finally, as a forest (as opposed to a plantation) inventory, the FIA reports do not generally represent intensively managed commercial farming operations; therefore, even when plot-level risk can be extrapolated, it offers an imperfect proxy to farm-level risk.

The FS does support occasional research on prices for forest products. Several time-series studies on stump prices were identified, although none specifically addressed short-rotation woody biomass crops.[50] Nonetheless, due to the fungibility of biorefinery feedstocks, these data may prove useful in the development of woody biomass price models for crop insurance.

IV.B. DOE Data

The DOE is a cabinet-level department of the United States government concerned with energy policies. Its responsibilities include the nuclear weapons program, nuclear reactor production for the U.S. Navy, radioactive waste disposal, energy conservation, energy-related research, and domestic energy production.

The DOE‘s Office of Energy Efficiency and Renewable Energy (EERE) works with partners in industry, academia, and the national laboratories on research concerning biomass feedstocks and conversion technologies. The Biomass Program supports research, development, and demonstration activities addressing development of integrated biorefineries. The Biomass Program primarily focuses on research and development efforts to ensure cellulosic ethanol is price competitive by 2012 and that bio-based aviation fuel, diesel fuel, and gasoline are price competitive by 2017.

The DOE Biomass Energy Data Book, now in its third edition, incorporates DOE Energy Information Administration (EIA) estimates of biomass energy utilization and availability and data from industry groups. Chapter Five of this report documents DOE information on biomass feedstocks. There is no information on *Eucalyptus*, poplar, pine and willow in this chapter. There are data on mill residues and forest harvest wastes. There are no data for purpose-grown woody biomass crops.

The editors of the DOE Biomass Energy Data Book note the data in the book does not *"systematically inventory biomass feedstock."* Instead, the data are derived and rely *"on assumptions about energy content and conversion efficiencies for each biomass type and conversion technology…In all cases it should be recognized that estimates are not precise and different assumptions will change the results."*[51] While most of the values in the Biomass Energy Data Book are extrapolated, they are updated frequently. The first edition of the Data Book was published in 2006, the second in 2009. The DOE is currently preparing a fourth edition, portions of which are available online at http://cta.ornl.gov/bedb/download.shtml. The Contractor did not

[50] Irland, L.C., P.E. Sendak, and R.H. Widmann, 2001, Hardwood pulpwood stumpage price trends in the northeast, http://www.fs.fed.us/ne/newtown_square/publications/technical_reports/pdfs/2001/gtrne286.pdf, accessed November, 2011; Wagner, J.E. and P.E. Sendak, 2005, The annual increase of Northeastern regional timber stumpage prices: 1961 to 2002. Forest Products Journal 55:36-45.

[51] U.S. DOE, 2010, Biomass Energy Data Book: Edition 3, http://cta.ornl.gov/bedb/download.shtml, accessed August, 2011.

find DOE data on the number of producers, planted acreage, harvested acreage, total production, value, or yield of woody biomass crops.

SECTION V. PRIVATE DATA

The Contractor examined potential data from private sources for use in the development of insurance products. The private sources examined include biorefineries, producer organizations, pulpwood producers/processors, and pulpwood industry business intelligence firms.

The Contractor explored the possibility of collecting data from biorefineries using woody biomass as a feedstock. These efforts were hampered by three insurmountable barriers. In the first place, virtually all the biorefinery projects are either under construction or only recently commissioned. Consequently, this source has no data on production or yield and no credible time-series data on price. Furthermore, the limited data on price are considered proprietary. Finally, since the woody biomass feedstocks are fungible, refinery input data does not distinguish between waste wood feedstocks and purpose-grown crops. It is possible as cellulosic biofuel refineries come online that they can assist in collection of data regarding woody biomass yield, production, and pricing. Most likely some incentives will be needed to encourage such cooperation. The incentive with the greatest likelihood of encouraging participation might be the validation of a crop insurance model for producers.

The Contractor explored the possibility of collecting data from organizations whose membership is comprised of agricultural producers of woody biomass. Despite an exhaustive effort, the Contractor was unable to identify any such association or organization. It appears there are organizations in development that will support the managers of biorefineries in the United States (such as the Renewable Fuels Association), and similar associations in Europe (e.g., European Biomass Industry Association).

The Contractor identified more than 100 pulpwood producers and consolidators (Appendix D). The Paperwork Reduction Act constrains government contractors' use of survey instruments, therefore it was not possible to systematically survey this industry to collect data that might be used as a proxy for woody biomass biorefinery feedstock producers. Instead, the Contractor sought to identify any pulpwood producer or consolidator who would share any agronomic information (e.g., production, yield, and prices) or any producer demographic information (e.g., producer population, plantation size, etc.). None of the producers or consolidators the Contractor contacted expressed a willingness to share information with the Contractor, despite assurances of confidentiality.

This behavior is easily understood when the highly competitive nature of the paper industry is examined. The industry is characterized by numerous producer organizations and business intelligence services. The dynamics of these organizations seem quite different from that of most agricultural producer organizations; rapid changes in the organizations appear to be influenced by changes in the paper industry as domestic and foreign competition, and competition among the alternate feedstock resources within the U.S. paper industry effect changes in the markets.

<u>Associations</u>

The Contractor identified several national associations that might serve as a proxy for elements of data for insurance development for woody crops grown as biorefinery feedstocks. These include the American Forest & Paper Association,[52] the American Forest Foundation (and the American Tree Farm System),[53] the American Forest Resource Council,[54] the Association of Consulting Foresters,[55] the Bioenergy Development Consortium,[56] and Forest Resources Association, Inc.[57]

The American Forest & Paper Association (http://www.afandpa.org/) addresses education and advocacy issues related forestry and paper manufacturing. It maintains some proprietary data on pulpwood prices available to members, however, these data are reported to be derived from public reports and do not appear to have been collected by an independent survey. The reports are sporadic and not necessarily collected by a uniform methodology.

The American Forest Foundation addresses conservation, education, and advocacy issues related to private and public forests; it does not maintain data on production, yields, pricing or other agronomic characteristics of any segment of the forest industry that might be useful in this study. The American Tree Farm System operates from the same offices with a different Web presence (info@treefarmsystem.org).

The American Forest Resource Council supports producers in the forest products industries in the states of California, Idaho, Oregon, Montana, and Washington. It is primarily an advocacy group.

The Association of Consulting Foresters was founded in 1948 to advance the professionalism, ethics, and interests of professional foresters whose primary work was consulting to the public. This organization is the only national association for consulting foresters and does not maintain a database on forestry.

The Bioenergy Development Consortium was spun off from the Biorefinery Deployment Collaborative. The Collaborative helps commercialize energy conservation and renewable energy technologies. The Consortium provides educational programs addressing energy more generally.

The Forest Resources Association, Inc. is an educational and advocacy organization with a focus on industry practices. The association has six regional offices that encompass the 49 continental United States. It does not maintain a dataset relevant to this study.

In summary, although a number of associations exist whose membership is comprised of stakeholders in various sectors of the forestry industry, the Contractor did not identify any association that might have data that is useful toward insurance development for woody biomass crops grown as biorefinery feedstocks (either directly or as proxy crops).

[52] American Forest & Paper Association, 1111 19th Street, NW, Suite 800, Washington, DC 20036, 202-463-2700.
[53] American Forest Foundation, 1111 19th Street, NW, Suite 780, Washington, DC 20036, 202-463-2460.
[54] American Forest Resource Council, 5100 SW Macadam, Suite 350,Portland, OR 9739, 530-222-9505.
[55] Association of Consulting Foresters, 312 Montgomery Street, Suite 208, Alexandria, VA 22314, 703-548-0990.
[56] Bioenergy Development Consortium;176 Jonathan Court; Glen Ellyn, IL 60137; 630-858-4897.
[57] Forest Resources Association Inc., 2129 Electric Road, SW, Suite 205, Roanoke, VA 24018, 540-989-4171.

Business Intelligence Organizations

The Contractor identified several business intelligence organizations that maintain data on the pulpwood industry. These include Forest2Market,[58] RISI,[59] Timber Mart South,[60] and Wood Resources International LLC.[61]

Forest2Market is a wood product and fiber consultancy that maintains timber price and benchmark databases with transaction-level data from actual contracts. It collects and analyzes quantitative information about the wood supply chain to create information/intelligence products and services for the industry. Its products include price series for timber, logs, wood fiber, lumber, and feedstocks; price and cost benchmarking services; timber price forecasts; and price indices for supply and purchase agreements.

RISI produces a monthly Wood Biomass Market Report. RISI was founded in 1985 as Resource Information Systems, Inc. In 2000, RISI was acquired by Paperloop, the leading pulp and paper industry data aggregator. The Wood Biomass Market Report provides market information and woody biomass feedstock pricing for the North American market. In addition, the report documents biomass business developments, capital investments, government incentives, regulations, and policies, and feedstock availability. Regional reports for the United States address the Northeast, Southeast, South Central, and Pacific Northwest markets. The current annual cost of reports is $597. While RISI has developed price indices for North American woody biomass generally and for pellet grade wood,[62] most of the RISI data are business intelligence. The Contractor found no evidence RISI can provide producer-level data including acreage and production. The nature of the business data it sells focuses on inventory and sales rather than production and yield.

Timber Mart-South, owned by the Frank W. Norris Foundation, provides forest and forest product price reports, trend analysis, and history. The foundation contracts with the Daniel B. Warnell School of Forest Resources at University of Georgia to compile, publish, and distribute Timber Mart-South publications. These include quarterly and annual reports addressing market prices in the U.S. South. Timber Mart-South has been surveying timber prices since 1976. The reports are available by subscription or by individual issue and provide information on timber market changes as well as average prices in 22 southeastern timber markets.

Wood Resources International, LLC is a consulting firm that publishes two quarterly price reports tracking delivered wood costs in North America and internationally. The reports are available by annual subscription. These publications include data and analyses of market prices for woodchips, pulpwood, and sawlogs. The North American Wood Fiber Review (Review) has tracked wood fiber markets in all major regions of the United States and Canada for almost 30 years. It covers both pulpwood and biomass markets. The report provides updates of softwood and hardwood prices, (average and range) for all major U.S. markets.

---

[58] Forest2Market, Inc., 14045 Ballantyne Corporate Place Suite 150, Charlotte, NC 28277-2845, 704-540-1440.
[59] RISI, info@risi.com, no published physical address, 866-271-8525
[60] Timber Mart-South, Center for Forest Business, Daniel B. Warnell School of Forestry & Natural Resources, University of Georgia, Athens, GA 30602-2152.
[61] Wood Resources International LLC, P.O. Box 1891, Bothell, WA, 9804, USA 425-402-8809
[62] Pellet grade wood is used to create fuels for direct combustion and for gasification.

In summary, there are several business intelligence firms that might serve as a source for data and indices that could be used in a development effort. Data supplied by these firms are all available by subscription. The costs for access to the reports are relatively modest. Excepting the data in the Review, the data available would be a proxy for bioenergy feedstock data rather than data directly addressing bioenergy feedstocks. However, it is important to note, bioenergy feedstock data in the North American Wood Fiber Review are summary data (i.e., not raw data) and are reported following an analysis of raw data by Wood Resources International LLC, the publisher of the Review.

SECTION VI. ACADEMIC DATA

There is rich literature addressing cellulosic ethanol production. This reflects the wide range of technologies and industries involved, as well as rapidly changing perceptions in developed economies concerning economic and environmental constraints on energy consumption.

The technologies involved in harvesting energy contained in plant cell walls include agriculture and forestry on the one hand and fermentation/refinery operations on the other. The refinery processes have engaged researchers in biology, biochemistry and chemistry. Chemical, industrial, materials, and systems engineering are all required to implement improvements in the technologies used to develop the biorefineries. Consequently, there is a wide range of treatises addressing the topic of cellulosic ethanol production from quite different perspectives. Some focus almost exclusively on the chemistry and chemical engineering of the biorefinery processes.[63] Others are focused on the biology of the ethanol production processes.[64] Still others address what might be categorized as the socioeconomic benefits (and problems) associated with the technology.[65] While the Contractor examined this literature to develop a context for the study of woody biomass crops grown as biorefinery feedstocks, reporting on this latter category is far beyond the scope of the contracted work.

The literature is herein reviewed with the goal of accomplishing the Government's stated objectives, which are:

> *"to obtain information and data on grown woody biomass crops and then determine the feasibility of and issues related to insuring those willow, poplar trees, and other woody biomass products as bio-fuel feedstock. The contractor shall initially provide RMA with the results of data collection for the grown woody biomass crops including willow and poplar. Once the data collection is completed, RMA will determine the woody biomass crops that the contractor shall produce a research report that determines the feasibility of developing an insurance program for the willow, poplar trees, and other woody biomass with their recommendation of the most viable type of insurance program, if any are feasible."*[66]

---

[63] Brethauer, S. and C.E. Wyman, 2010, Review: Continuous hydrolysis and fermentation for cellulosic ethanol production, Bioresource Technoligy, 2010, 101:4862-74.

[64] Himmel, M.E., S-Y. Ding, D.K. Johnson, W.S. Adney, M.R. Nimlos, J.W. Brady, T.D. Foust, 2007, Biomass Recalcitrance: Engineering Plants and Enzymes for Biofuels Production Science 315, 804 (2007), http://www.uta.edu/biology/grover/classnotes/5101/Himmel%20et%20al.pdf, accessed October, 2011;
Sticklen, M.B., 2008, Plant genetic engineering for biofuel production: towards affordable cellulosic ethanol Nature Reviews Genetics 9, 433-443.

[65] Kim, S. and B.E. Dale, 2005, Life cycle assessment of various cropping systems utilized for producing biofuels: bioethanol and biodiesel, Biomass & Bioenergy 29:426–39;
Hill, J., E. Nelson, D. Tilman, S. Polasky, and D. Tiffany, 2006, Environmental, economic, and energetic costs and benefits of biodiesel and ethanol biofuels, Proceedings of the National Academy of Science U S A. 103:11206-10;
Hoekman, S.K., 2009, Biofuels in the U.S. – Challenges and Opportunities, Renewable Energy 34: 14–22, http://www.dri.edu/images/stories/editors/receditor/2009_hoekmank_busco.pdf, Accessed September, 2011;
Manomet Center for Conservation Sciences, 2010, Biomass Sustainability and Carbon Policy Study, Commonwealth of Massachusetts; Department of Energy Resources, 182 pp, http://www.manomet.org/sites/manomet.org/files/Manomet_Biomass_Report_Full_LoRez.pdf, accessed September, 2011.

[66] SOW, page 19 of Contract D11PX78748.

Purpose-grown woody biomass crops are grown on plantations. In this report, the term "plantation" will be used to describe an agricultural enterprise on which trees are grown as the crop. This will distinguish the plantation from an orchard or grove, where trees are grown to produce a fruit crop, and from nurseries where trees are grown to be transplanted to plantations, groves, orchards, forests, or landscapes. The plantation is distinguished from a forest by the level of management. Trees in a plantation are generally planted in rows. Soil preparation, including weed management and fertilization preceded planting are common management practices in plantations. Thinning is used to maintain an appropriate ratio of stem to crown for the plantation trees. Pest management (including additional weed management) and fertilization are used to maximize growth which can be measured as accumulation of biomass. In most ways, a biomass plantation appears like a farm field. However, the physical scale of the crop and the length of time to harvest are different. While a forest may be planted (or replanted), with regard to management, growth in a forest is largely left to nature.

Matti Parikka, in a 2004 review of biomass resources available as primary energy sources, estimated just under 0.1 percent of the North American land area and just over a third of one percent of the wooded areas on the continent were plantations.[67] In that review of available resources worldwide, woody biomass crops grown as biorefinery feedstocks were not even mentioned. The biomass resources from woody species included waste wood and roundwood (i.e., logs) from natural forest populations and pulp mill and lumber mill wastes from the processing of natural and plantation-grown trees. The plantations making up such a small element of the landscape were the lumber and pulpwood plantations supplying the mills.

While substantial research has improved the prospects for plantation-grown biomass production as a biofuels resource, the relationship of these cropped sources of biomass energy to the natural or waste-based energy sources has hardly changed. Commercial plantation acreage for most species can be measured in the hundreds or thousands of acres (by species), which pales in comparison to the approximately 750 million acres of forests in the nation.[68]

For this section of the data report, the Contractor focused the major research efforts on woody biomass production from plantations. A search of the agronomic and extension literature for data addressing number of producers, planted acreage, harvested acreage, total production, value, and yield of woody biomass crops as bioenergy resources was not productive. These operations may not yet be common enough to justify such reports. The focus of the search then turned to academic literature addressing short-rotation woody species targeted as biomass resources, particularly information concerning yield. A portion of the literature addresses special uses of short-rotation species in reclaiming marginal land.[69] Data from such reports are not included in this study, since the focus of the reclamation research is on conservation rather than production. The yields in these studies are influenced by the limitations of the land being reclaimed. Depending on the characteristics of the land, these yields are highly variable and do not reflect

[67] Parikka, M., 2004, Global biomass fuel resources, Biomass & Bioenergy 27: 613–620, http://faculty.washington.edu/stevehar/World%20woody%20biomass.pdf, accessed September, 2011.
[68] U.S. Department of Interior, 2011, National Atlas of the United States: Forest Resources in the United States, http://nationalatlas.gov/articles/biology/a_forest.html, accessed November, 2011.
[69] For example, Böhm, C., A. Quinkenstein, D. Freese, and R. F. Hüttl, 2011, Assessing the short rotation woody biomass production on marginal post-mining areas, Journal of Forest Science, 57: 303-311, http://journals.uzpi.cz/publicFiles/44220.pdf, accessed September, 2011.

agricultural production.” Limited yield data (comparable to data from field trials for row or field crops) are available for moderately dense stands of poplar and *Eucalyptus* and for dense stands of willows and loblolly pine (*P. taeda*).

Poplar

Poplar species and their hybrids are among the most rapidly growing temperate trees. However, the high growth potential of poplars is realized only under favorable weather conditions on good sites; that is to say, under optimal agricultural conditions. Many of the reports on poplar productivity address small to moderate scale field trials of new varieties, [70] not production agriculture. To limit destructive sampling in these field trials, a variety of non-destructive measure of ‗yield‘ are used including measuring basal area (BA) and measuring diameter at breast height (DBH). Estimates of productivity are made by converting area dimensions to volume dimensions (usually reported by using cubic feet per acre) and then converting the volume measures to mass (dry or green tons per acre). When destructive sampling is used, more direct volumetric or mass measurements are made. However, the harvest of poplar essentially resets the production clock in a new system (i.e., under a substantially different management regime), since coppicing is a common practice in field trials addressing productivity.

P. deltoides (Eastern Cottonwood) planted under optimal conditions can produce average yields of three to seven green tons/acre/year.[71] *Populus* clones with greater productivity and greater tolerance of poor environments are being developed commercially and by academic researchers. Productivity of poplar pulp mill feedstock (unselected *P. trichocarpa* varieties) managed with two-year coppice rotations in the Pacific Northwest was 7.7 green tons/acre/year.[72] Further study showed that *P. trichocarpa* yields were maximized during the second two-year coppice or the third four-year coppice rotations at 4.0 and 4.3 oven dry tons/acre/year), respectively.[73] Varieties were tested at a site in western Washington for 4 years in plots established at 1.2 × 1.2 m spacing. Yields of 50 different *P. trichocarpa* clones averaged 5.6 oven dry tons/acre/year and ranged from 2.3 and 10.3 oven dry tons/acre/year. [74] In recent unpublished studies, 3 *P. generosa* hybrid clones had yields between 6.9 and 12.3 oven dry tons/acre/year. However, these more recent productivity values were established on yield plots with just nine trees per replicate.[75]

The yields from field trials of plantation poplars, including clones selected for production of pulp and saw logs, show considerable variation (Table 21). This variation is expected in a long-lived woody species that is substantially affected by growing conditions. Best management practices

[70] Miller, R.O., and B.A. Bender, 2008, Growth and Yield of Poplar and Willow Hybrids In the Central Upper Peninsula of Michigan, http://www.cinram.umn.edu/srwc/docs/Powerpoints/R.Miller_Growth%20and%20Yield%20of%20Poplar%20and%20Willow%20Hybrids.pdf, accessed September, 2011.

[71] Dickens, E.D. B. Borders, and B. Jackson, 2011, Short Rotation Woody Crops Yield Estimates for Georgia Growers, Series Paper 1, http://www.warnell.uga.edu/outreach/pubs/pdf/forestry/SRWB_Growth_and_Yield_Paper_6_July_2011.pdf, accessed October, 2011.

[72] Heilman, P.E., D.V. Peabody, D.S. DeBell, and D.F. Strand, 1972, A test of close-spaced, short rotation culture of black cottonwood. Canadian Journal of Forest Research 2: 456-459.

[73] Heilman, P.E. and D.V. Peabody, 1981, Effect of harvest cycle and spacing on productivity of black cottonwood in intensive culture, Canadian Journal of Forest Research 11: 118-123.

[74] Heilman, P.E. and R.F. Stettler, 1985, Genetic variation and productivity of *Populus trichocarpa* and its hybrids. II. Biomass production in a 4-year plantation, Canadian Journal of Forest Research 15: 384–388.

[75] Unpublished yield data, personal communication, T.A. Volk.

for poplar grown in northern regions have been published.[76] However, as substantial research into the effects of management on yield potential is still in progress, it is not clear that these practices as published reflect the practices actually used in the production of the woody biomass crops.[77]

While meristem cloning technology [78] has allowed plantations to be populated with individuals having uniform genetic characteristic, there is very limited literature addressing yields rather than yield potential of the various clones. The Contractor found limited academic literature documenting commercial yields of any poplar species. This literature that was found does not address bioenergy feedstock production *per se*, but addresses biomass for any use (i.e., pulp, roundwood, or energy).

Table 21. Mean Annual Increment (MAI) Growth Estimates for Poplar (*Populus* spp.)

First Growth Age (years)	MAI (Oven dry tons/acre/year)
2	1.5 to 3.5
4	2.3 to 10.3
9	1.5 to 3.2
10	1.6-3.6
Coppice Rotation Frequency (years)	
2	3.8 to 4.0
4	4.3

Source: The Contractor's Research Department after data in Heilman, P.E., D.V. Peabody, D.S. DeBell, and D.F. Strand, 1972, A test of close-spaced, short rotation culture of black cottonwood. Canadian Journal of Forest Research 2: 456-459; Heilman, P.E. and D.V. Peabody, 1981, Effect of harvest cycle and spacing on productivity of black cottonwood in intensive culture, Canadian Journal of Forest Research 11: 118-123; Heilman, P.E. and R.F. Stettler, 1985, Genetic variation and productivity of *Populus trichocarpa* and its hybrids. II. Biomass production in a 4-year plantation, Canadian Journal of Forest Research 15: 384–388; and Dickens, E.D. B. Borders, and B. Jackson, 2011, Short Rotation Woody Crops Yield Estimates for Georgia Growers, Series Paper 1, http://www.warnell.uga.edu/outreach/pubs/pdf/forestry/SRWB_Growth_and_Yield_Paper_6_July_2011.pdf, accessed October, 2011, and assuming 50 percent of the green tonnage is dry tonnage..

[76] VanOosten, C., SilviConsult Woody Crops Technology, Inc., 2006, Hybrid Poplar Crop Manual for the Prairie Provinces, http://www.poplar.ca/pdf/cropman.pdf, accessed November, 2011;
J.G. Isebrands, 2007, Best Management Practices Poplar Manual For Agroforestry Applications in Minnesota, http://www.extension.umn.edu/distribution/naturalresources/00095.html, accessed September, 2011.

[77] Geyer, W.A., 2006, Biomass production in the Central Great Plains USA under various coppice regimes, Biomass & Bioenergy 30: 778-783, http://www.gpsaf.unl.edu/GPPubs/Coppice%20article%20biomass%20bioenergy.pdf, accessed October, 2011;
Evans, S. (coordinator), M. Baldwin, P. Henshall, R. Matthews, G. Morgan, J. Poole, P. Taylor, P., I. and Tubby, 2007, Final Report: Yield models for Energy: Coppice of Poplar and willow. Volume A – Empirical Models. Report to DTI (B/W2/00624/00/00 URN). Ed: I Tubby and J Poole. 91pp., http://www.biomassenergycentre.org.uk/pls/portal/docs/PAGE/BEC_TECHNICAL/RESEARCH%20AND%20STUDIES/ENERGY%20CROP%20STUDIES/YIELD%20MODELS%20FOR%20SRC%20A.PDF, accessed September, 2011.

[78] Rutledge, C.B., and G. C. Douglas, 1988, Culture of meristem tips and micropropagation of 12 commercial clones of poplar in vitro, Physiologia Plantarum 72: 367-373.

The Contractor was provided unpublished data from field trials conducted from 1996 through 2011. The yields reported from these trials varied by clone, by year, by year within the rotation (Table 22), and by location. The substantial range of annual incremental growth in each year of production would significantly affect the ability of these data to serve as a basis for data-driven crop insurance development. It is further noted, these increments are estimates rather than actual yields harvested.

Table 22. Mean Annual Increment (MAI) Growth Estimates for Poplar (*Populus* spp.) Grown in Field Trials by Year in Rotation

Year within the Rotation	Lowest MAI (Oven dry tons/acre/year	Highest MAI (Oven dry tons/acre/year)
2	0.1	3.8
3	0.2	3.6
4	0.2	4.0
5	0.4	4.6
6	0.9	4.4
7	0.9	4.2
8	0.9	4.1
9	1.0	4.2

Source: The Contractor's Research Department after data provided by W.E. Berguson.

Willow

Extensive work in Sweden and the United Kingdom contributed to the development of commercial willow woody biomass production in North America. The production systems for willow use genetically improved plant material grown on open agricultural land. Production involves intensive site preparation to control weeds, mechanical planting at densities of approximately 6,000 trees per acre, nitrogen fertilization at the beginning of each rotation, and multiple 3 to 4 year rotations.[79]

Earlier studies reported yields of short-rotation willows ranging from three to seven oven-dry tons/acre/year.[80] More recently, after years of selection, only modest improvements in yields have been realized.[81] The yields from field trials of plantation willows, like those for poplars, show considerable variation. The variability is especially noticeable when plantation management practices are examined (Table 23). The effects of irrigation are especially notable, but it is unlikely irrigation will be a commercial management practice. The costs, benefits, and logistics are all likely to contribute to those management decisions. While most willows are

[79] Volk, T.A., L.P. Abrahamson, C.A. Nowak, L.B. Smart, P.J. Tharakanc, and E.H. White, 2006, The development of short-rotation willow in the northeastern United States for bioenergy and bioproducts, agroforestry and phytoremediation, Biomass and Bioenergy 30 (2006) 715–727, http://www.sciencedirect.com/science/article/pii/S0961953406000687.

[80] Mead, D.J., 2005, Forests for energy and the role of planted trees. Critical Reviews in Plant Sciences 24: 407–421; Mercker D., 2007, Short rotation woody crops for biofuels. University of Tennessee Agricultural Experiment Station, http://www.utextension.utk.edu/publications/spfiles/SP702-C.pdf, accessed October, 2011.

[81] T.A. Volk, L.P. Abrahamson, K.D. Cameron, P. Castellano, T. Corbin. E. Fabio, G. Johnson, Y. Kuzokina-Eischen, M. Labrecgue, R. Miller, D. Sidders, L.B. Smart, K. Staver, G.R. Stanosz, K.VanRees, unpublished, Yields of willow biomass crops across a range of sites in North America.

easily propagated using rooted cuttings, meristem culture[82] is useful for clonal propagation on a commercial scale because of the large number of shoots that can be produced. Volk, *et al*. report yields from second and subsequent coppice rotations substantially higher than those from the initial rotations.

Table 23. Mean Annual Increment (MAI) Growth Estimates for Shrub Willow (*Salix* spp.) Based on Plantation Management Practices

Practice	MAI (Oven dry tons/acre/year)
Irrigated Initial Rotation	10.9 to 12.1
Non-irrigated Initial Rotation	3.4 to 4.7
Commercial Yields	3.0

Source, the Contractor's Research Department after data in Volk, T.A., L.P. Abrahamson, C.A. Nowak, L.B. Smart, P.J. Tharakanc, and E.H. White, 2006, The development of short-rotation willow in the northeastern United States for bioenergy and bioproducts, agroforestry and phytoremediation, Biomass and Bioenergy 30 (2006) 715–727, http://www.sciencedirect.com/science/article/pii/S0961953406000687.

The Contractor found limited academic documentation of commercial yields of willow species. Instead the academic literature focuses on field trials of new varieties and management practice studies. This makes it particularly challenging to use academic yield reports to predict commercial yields in different locations and under different practices.

Pine

Loblolly pines are grown on much longer rotations (e.g., 15 to 25 years) than are shrub willows and poplars. Loblolly pine is the most widely planted forestry species in the world. Due to its chemistry, loblolly pine is best suited for direct combustion and/or gasification bioenergy applications. To address this limitation, tree-breeding programs currently underway are using genetic-engineering techniques to develop high-performing seedlings. ArborGen introduced genes into loblolly pine that almost double the biomass production in the first three years of field trials. Even without these improvements, loblolly pines grown in plantation settings can produce about four dry tons/acre/year.[83] However, it is important to note that the range of potential annual incremental growth for pine, like those for poplar and willow, is affected by variety, location, weather, and age.

[82] Beauchesne G., and C. Poulin, 1970, La culture de méristèms, ses possibilitiés et ses limits actuelles pour les plantes ligneuses, Comptes Rendus Academie Sciences: Prosp. Hort. Phytotron 2: 219-231;
Bhojwani, S.S., 1980, Micropropagation method for a hybrid willow *(Salix matsudana × alba*,. New Zealand Journal of Botany 18:209-214.

[83] Mercker D., 2007, Short rotation woody crops for biofuels. University of Tennessee Agricultural Experiment Station, http://www.utextension.utk.edu/publications/spfiles/SP702-C.pdf, accessed October, 2011.

Table 24. Mean Annual Increment (MAI) Growth Estimates for Loblolly Pine (*Pinus taeda*)

Age (years)	MAI (green tons/acre/year)
4	1.7-5.3
5	2.5
6	3.6-3.9
7	7.8
8	8.4 -9.5
9	10.5-12.7
15,19	6.7

Source, the Contractor's Research Department after data in Dickens, E.D. B. Borders, and B. Jackson, 2011, Short Rotation Woody Crops Yield Estimates for Georgia Growers, Series Paper 1, http://www.warnell.uga.edu/outreach/pubs/pdf/forestry/SRWB_Growth_and_Yield_Paper_6_July_2011.pdf, accessed October, 2011.

Eucalyptus

Some species and hybrids of *Eucalyptus* have unusually high biomass productivity. In Brazil, *E. grandis* × *E. urophylla* yield 10 to 12 dry tons/acre/year. *Eucalyptus* species and hybrids with this level of productivity are adapted to the tropics and intolerant to cold temperatures. A study with *E. grandis* in Florida indicated this species might achieve total biomass productivity of 15 dry tons/acre/year,[84] but to date no productivity at that level has been documented in U.S. plantations. In field trials in Florida, yields ranging from 5 to 35 green tons per acre have been reported (Table 25). These vast differences result from differences in planting density and soil amendment treatments and are based on green tons per acre measurements.[85]

Table 25. Mean Annual Increment (MAI) Growth Estimates for *Eucalyptus spp*.

Species	Age (years)	MAI (green tons/acre/year)
Eucalyptus amplifolia	3.5	5.1 – 35.5
Eucalyptus grandis	3.5	10.2 – 31.9

Source, the Contractor's Research Department after data in Dickens, E.D. B. Borders, and B. Jackson, 2011, Short Rotation Woody Crops Yield Estimates for Georgia Growers, Series Paper 1, http://www.warnell.uga.edu/outreach/pubs/pdf/forestry /SRWB_Growth_and_Yield_Paper_6_July_2011.pdf, accessed October, 2011.

Management practices for *Eucalyptus* species have an enormous impact on yields from the field trials. In *E. amplifolia* field trials carried out in 1999 and 2000, weed control using mulching and/or composting increased average yields as much as 4.5 times. However, it is important to note, 32 fold differences in yields between replicates of *E. amplifolia* grown under identical management regimes were observed in this study.[86]

[84] Stricker J.A., D.L. Rockwood, S.A. Segrest, G.R. Alker, G.M. Prine.; and D.R. Carter, 2000, Short Rotation Woody Crops For Florida. University of Florida, http://www.treepower.org/papers/strickerny.doc, accessed November, 2011.
[85] Rockford, D.L., D.R. Carter, and J.A. Stricker, 2008, Commercial Tree Crops for Phosphate Mined Lands: Final report, Publication No. 03-141-225, Univ. of Florida.110 pp.
[86] Planet Power, undated, Energy Crop Yields for Eucalyptus and Cottonwoods, detailed data link, http://www.treepower.org/yields/main.html, accessed November, 2011.

Summing Up the Academic Literature

Candidates for commercial production of woody biomass are typically selected based on projected yields following five to ten years of field testing. The biomass yields achieved in these yield trials are highly variable and may not accurately reflect the yields achieved under commercial production. The variety cultivated, management practices, the geography and weather can all affect these differences (the Contractor believes these are listed in the order of their importance). The biomass yields achieved in northern short-rotation yield trials are similar to those from warmer regions. However, management practices may have a larger effect on northern production, where the risk of cold temperatures and shorter growing seasons can affect production. Among management practices, irrigation, fertilization, spacing, and rotation length appear to have the biggest effects on differences in yield.[87] Lynn Wright, under contract to the Oak Ridge National Laboratory, has compiled many of the data illustrating these differences for willow, poplar, and pine.[88] The data in that report support the conclusion that can be drawn from the sample data presented in this report: the large variability in field trial yields resulting from the relatively small scale of the samples limits the utility of these data for a data-driven crop insurance development effort. Indeed, a parametric assessment of these data would imply high standard deviations in yields, suggesting inappropriately high premium rates. Since new varieties of woody biomass species are still being developed, substantial yield differences within a species are likely to be observed going forward. This argues that a data-driven insurance development approach, even with a reasonable protocol to systematically collect data, will be futile in the near term.

Limited cost of production data are available in the academic literature. Estimates are generally standardized to cost-per-oven dry ton of production. The costs are generally comparable for the various species proposed as woody biomass crops and range from $50 to $70 per ton.[89] These values are generally comparable to the stumpage costs per ton for plantation harvests of pulpwood.[90]

[87] Weih, M., 2004, Intensive short rotation forestry in boreal climates: present and future perspectives, Canadian Journal of Forestry Research 34: 1369–1378, http://research.eeescience.utoledo.edu/lees/papers_PDF/Weih_2004_CJFR.pdf, accessed September, 2011.

[88] Lynn Wright under contract to the Oak Ridge National Laboratory, 2010, US Woody Crop Yield Summary – 2010, http://www.woodycrops.org/NR/rdonlyres/BF9B2067-FDB0-49B0-9543-8EEA03A415FD/2844/USWoodyCropsYieldSummaryOct2010.pdf, accessed October, 2011.

[89] Volk, T.A., L.P. Abrahamson, C.A. Nowak, L.B. Smart, P.J. Tharakanc, and E.H. White, 2006, The development of short-rotation willow in the northeastern United States for bioenergy and bioproducts, agroforestry and phytoremediation, Biomass and Bioenergy 30: 715–727.

[90] Gallagher, T. R. Shaffer and R. Rummer, 2006, An economic analysis of hardwood fiber production on dryland irrigated sites in the US Southeast, Biomass and Bioenergy 30: 794–802, http://www.srs.fs.usda.gov/pubs/ja/ja_rummer016.pdf, accessed November, 2011.

SECTION VII. SUMMARY OF FINDINGS

The Statement of Work (SOW) for Project Number D11PX18878 identifies the objectives of the Data Collection portion of the contracted project as "to obtain information and data on grown woody biomass crops…[related to insuring]…willow, poplar trees, and other woody biomass products as bio-fuel feedstock." The DOE defines biomass as organic matter available on a recurring basis. A complex mixture of organic molecules, biomass is derived from living or recently living organisms. The limitation on the period since the organic matter was formed helps to distinguish biomass from fossil fuels. While fossil fuels had biological origins, they are not derived from "recently living organisms" and their chemical composition has been substantially modified by geological processes.

Plant biomass is of particular interest because the organic matter in plants stores energy captured during photosynthesis, which can subsequently be used by people. The focus of this study is not on the embodied energy in the woody biomass, but instead on yields, prices, and risks of woody biomass crops. These data are crucial to the development of an appropriate, effective, and actuarially sound crop insurance product. The Contractor conducted an extensive study to identify data that might serve as the basis for a development effort for insurance for fast-growing trees managed for production of woody biomass for use as biofuels feedstocks.

The data study was complicated by several factors. First, fast growing trees are an element of many forest populations. A forest incorporates dynamic populations of many species. The composition of the forest changes over time. The forest data may be useful in identifying some of the market and risk characteristics of individual fast growing woody species, but there is no mechanism to extract production data for a species from mixed forest datasets. However, data on the forest growth cannot be assumed to reflect the yield performance (or even the yield potential) of individual species within the forest. The forest environment has a large impact on the growth of a species within that environment. Consequently, data on individual species within the forest cannot be assumed to reflect the yield performance or potential of individual species in a plantation where a single woody species is maintained. Forest data are a poor proxy for plantation data.

In addition, there are multiple approaches to extract biomass energy from woody biomass. In the United States, wood and wood-derived products are the largest source of biomass-derived energy. The most common mechanism of energy extraction is direct combustion. Wood fires have been used as energy sources for light, heat and cooking for hundreds of thousands of years. Recent reports suggest intentional burning of wood for bioenergy began 300,000 to 400,000 years ago.[91] Consequently, there should be data on the value of wood over time. Yet the management practices and processing of wood for combustion is quite different from the management practices and processing of wood as a biofuel feedstock. Consequently, marketing data for fuel wood, with its embodied processing component, is not useful for establishing biofuel feedstock pricing.

[91] Roebroeks, W, and P. Villa, 2011. On the earliest evidence for habitual use of fire in Europe, Proceedings of the National Academy of Sciences 108: 5209-5214, http://www.pnas.org/content/108/13/5209, accessed October, 2011.

The solicitation and contract address woody biomass ―crops.” Much of the woody biomass available for energy is not purpose-grown. Woody biomass for biofuel generation can be derived from waste wood (e.g., construction and demolition debris, mill waste, etc.) as well as from purpose-grown trees. Energy embodied in wastes (solid waste, landfill gas, sludge waste, tires, and agricultural byproducts) is the second largest source of biomass energy, after energy from crops (grain in the United States and sugar cane in more tropical countries). Since availability of biomass feedstocks impacts supply, prices for biofuel feedstocks will be affected by the availability of these alternative biomass sources.

Finally, while direct combustion of wood is the oldest method for extraction of biomass energy (for uses other than as food and feed), a wide variety of mechanisms are available to capture this energy for human use. Much of the wood-derived energy is used to generate electricity and industrial-process heat. The largest source of energy from wood is pulping liquor (black liquor) from the paper and paperboard industry. Native logs, chips, pellets, compressed logs, and charcoal are additional alternate forest-derived energy sources. Yet, in spite of all these energy products, most of the biomass harvested from the forests is used for lumber rather than energy. There are no data from these uses that address ―woody biomass products as bio-fuel feedstock.”

Information on cellulosic feedstocks is currently quite limited. As noted earlier, there is ―no nationwide source of information on woody … crops being used for energy since this is occurring only on a very small scale in a few isolated **experimental** [emphasis added] situations.”[92] From a search of the literature, it appears the most likely candidates as purpose-grown woody biomass crops are poplars and willows in the northern states and pines, poplars, and *Eucalyptus* in the southern states. Woody biomass from these species for use as biorefinery feedstocks will likely become a substantial crop as it provides raw material for the production of cellulosic ethanol. Yet as the SOW notes, ―The biofuels industry could be best described as at an infant stage currently….”[93] The feasibility study that will follow this report is one more step toward ‗improving efficiency‘ of biofuel production, since production of a dependable supply of feedstocks is essential to that efficiency. However, cropping these woody biofuel feedstock species will only be undertaken if producers find an acceptable level of risk in the production process. Consequently, appropriate risk management strategies are essential for the development of a dependable supply of cropped woody biomass feedstocks.

The Contractor examined potential data for development of insurance product available from government and private sources. The government sources examined included NASS, ERS, FSA, and FS, as well as the DOE. Potential private data sources examined include biorefineries using woody biomass as a feedstock, producer organizations, and business intelligence services. The Contractor also reviewed the academic literature to identify sources of time-series data in that literature addressing number of producers, planted acreage, harvested acreage, total production, value, or yield of woody biomass crops.

The NASS Census of Agriculture does report on sales of forest products (excluding short-rotation woody crops) and on agronomic characteristics of Christmas trees and short-rotation woody crops collectively. Inasmuch as the woody biomass crops are excluded in the first

[92] U.S. DOE, 2010, Biomass Energy Data Book: Edition 3, http://cta.ornl.gov/bedb/download.shtml, accessed August, 2011.
[93] SOW (page 18).

instance and aggregated with irrelevant data in the second, these Census data cannot be used to identify number of producers, planted acreage, harvested acreage, total production, value, or yield of woody biomass crops. Furthermore, the Contractor was not able to identify any ERS or FSA reports or analyses dealing with woody biomass crops, firewood, or pulpwood or any DOE data that addressed number of producers, planted acreage, harvested acreage, total production, value, or actual (as opposed to projected) yield of woody biomass crops.

The Quantitative Sciences section of the Research and Development branch of the FS maintains forestry data in some ways comparable to NASS agricultural data. FS activities include maintenance of the Forest Inventory and Analysis (FIA) Program. Forest Inventory Online (FIDO), a data-mining tool, provides public access to the terabytes of data in the FIA databases. While there are no data in this system on yield, production, or price, there are related data including data on tree biomass removal and tree mortality by species group and size class. Unfortunately, the mortality data do not document the death of trees in small size classes (e.g., trees during the entire production of shrub willow bioenergy crops). Instead the focus is on mortality of trees larger than five inches in diameter at breast height (DBH). Furthermore, the species groups and geographic areas are aggregated at levels that would not allow the data to identify differences in insurance risk among smaller geographic areas.

No organization whose membership is comprised of agricultural producers of woody biomass was identified. Since most biorefineries using cellulosic feedstocks are still under construction, recently commissioned, very small, or use multiple feedstock sources depending on availability and price, no meaningful data are available from this sector of the industry. It is possible as cellulosic biofuel refineries using woody biomass cropped species come online they can assist in collection of data regarding woody biomass yield, production, and pricing. However, incentivizing their participation in such data collection may be challenging.

Pulpwood was considered as a proxy for woody biomass biorefinery feedstocks. The Contractor identified more than 100 pulpwood producers and consolidators. Despite assurances of confidentiality, none of the producers or consolidators the Contractor contacted were willing to share any data with the Contractor. The pulpwood industry is characterized by numerous producer organizations and business intelligence services. These organizations do not have data on production of biomass feedstock; however they have data available for sale on pulpwood feedstocks. None reported available pulpwood data series that address yield or production (in the sense of the word as it is used for insurance development). Pulpwood price data are available for purchase.

In the academic literature, extremely limited production and yield data on cropped woody biomass species exist. These data address field trials rather than commercial production. Often the empirical data are used to estimate potential commercial yields or production. However, there are data available from which prices received at national and regional levels can be inferred because of the fungibility of feedstock materials used in biorefineries. In the end, the value of the energy extracted and sold minus the costs of extracting that energy sets an upper limit on the price of any feedstock.

None of the short-rotation tree species grown for energy have all the requisite data from consistent and reliable sources for county-level production and market statistics. Despite extensive research, the Contractor did not identify any source of empirical data on the number of producers, planted acreage, harvested acreage, total production, value, and yield of woody biomass crops of the sort used for insurance development. Data on woody biomass resources are sporadic. The few government data that exist do not address purpose-grown woody biomass crops. Extrapolations of empirical data from small plot trials to estimate potential yields and production are much more common. If private data on woody biomass crops exist, they are closely-held and proprietary. More likely, as the DOE reports, ―There is … no nationwide source of information on woody or herbaceous crops being used for energy since this is occurring only on a very small scale in a few isolated experimental situations.”[94]

The Government could choose to begin a systematic collection of actual yield and production data for purpose-grown woody biomass biorefinery feedstock crops for the purpose of insurance development. However, even the shortest production cycles require four to five years (and eight to ten year cycles are not unusual). Consequently, decades of data collection would be necessary to accumulate time series representative of the life-cycle of these crops. Moreover, testimony suggests there are very few risks to production of woody biomass crops, and the significant risks identified are major catastrophic events (wild fires, hurricanes, tornadoes, etc.). The infrequent nature of these risks argues for an even longer historical database for rating purposes. Fortunately, data addressing these events exist, including data from government sources, albeit not in a form that would traditionally be applied to crop insurance design; there are no field trials or extended insurance experience. These existing data, combined with experiential data for forest resources more generally (particularly the FS data in the FIDO system) and expert judgment about agricultural risks (like that used in the development of premium rates in the Quarantine Pilot Program) constitute an attractive alternative to a protracted data collection on a rapidly evolving industry as the basis for development of risk management tools. In fact, if a crop insurance product is needed in the near term, this is the only approach that has any potential for achieving that goal.

The relevant language in the 2008 Farm Bill focuses on research into the development of data-driven crop insurance instruments for woody biomass bioenergy crops. Consequently, language in the SOW for this project focuses on data of the sorts that would normally be used for development of a risk management tool for a field or row crop. However, purpose-grown woody biomass for use as a biorefinery feedstock, while planted in rows, is in no way a typical crop. It is derived from long-lived perennials. There is no set harvest point or period. For the non-coniferous types, coppicing allows multiple harvests from the same plant. Consequently, the concepts of yield and production as they are used in the development of federally-subsidized crop insurance do not appropriately capture information about risks and risk management.

A feasibility study for the insurance of woody biomass crops for biorefinery feedstocks will need to address the RMA criteria for feasibility, but in the context of an agronomic focus on the losses producers of these crop face (that is, incremental costs associated with replanting, salvage, and/or rehabilitation) rather than in the context of a row or field crop yield. This report has provided an

[94] U.S. DOE, 2010, Biomass Energy Data Book: Edition 3, http://cta.ornl.gov/bedb/download.shtml, accessed August, 2011.

overview of the available data and its constraints. Recognizing these constraints, in light of the Farm Bill mandate, RMA must determine whether an alternative approach is the most likely to achieve successful development.

SECTION VIII. BIBLIOGRAPHY

Aylott, M.J., E. Casella, I. Tubby, N.R. Street, P. Smith, and G. Taylor, 2008, Yield and spatial supply of bio-energy poplar and willow short-rotation coppice in the UK, New Phytologist 178: 358–370.

Beauchesne G., and C. Poulin, 1970, La culture de méristèms, ses possibilitiés et ses limits actuelles pour les plantes ligneuses, Comptes Rendus Academie Sciences: Prosp. Hort. Phytotron 2: 219-231.

Bhojwani, S.S., 1980, Micropropagation method for a hybrid willow (Salix matsudana × alba,. New Zealand Journal of Botany 18:209-214.

Böhm, C., A. Quinkenstein, D. Freese, R.F. Hüttl, 2011, Assessing the Short Rotation Woody Biomass Production on Marginal Post-Mining Areas, Journal of Forest Science 57: 303-311, http://journals.uzpi.cz/publicFiles/44220.pdf.

Brethauer, S. and C.E. Wyman, 2010, Review: Continuous hydrolysis and fermentation for cellulosic ethanol production, Bioresource Technoligy, 2010, 101:4862-74.

Brown, S.L. and P.E. Schroeder, 1999, Spatial Patterns of Above Ground Production and Mortality of Woody Biomass for Eastern US Forests, Ecological Applications 9: 968–980, http://www.winrock.org/ecosystems/files/spatialpatters.pdf.

Buchholz, T. and T. Volk, 2011, Improving the Profitability of Willow Crops – Identifying Opportunities with a Crop Budget Model, BioEnergy Research 4: 85–95, http://www.bionity.com/en/publications/231795/improving-the-profitability-of-willow-crops-identifying-opportunities-with-a-crop-budget-model.html.

Bungart, R. and R.F. Huttl, 2001, Production of biomass for energy in post-mining landscapes and nutrient dynamics, Biomass and Bio-energy 20: 181-187.

Dickens, E.D., B. Borders, and B. Jackson, 2011, Short Rotation Woody Crops Yield Estimates for Georgia Growers, http://www.warnell.uga.edu/outreach/pubs/pdf/forestry /SRWB_Growth_and_Yield_Paper_6_July_2011.pdf.

Dong, J., R.K. Kaufmann, R.B. Myneni, C.J. Tucker, P. Kauppi, J. Liski, W. Buermann, V. Alexeyev, and M.K. Hughes, 2003, Remote Sensing Estimates of Boreal and Temperate Forest Woody Biomass: Carbon Pools, Sources, and Sinks; Remote Sensing of Environment 84: 393–410; http://digitalcommons.unl.edu/cgi/ viewcontent.cgi?article=1042&context=usdafsfacpub&sei redir=1#search=%22Remote%20sensing%20estimates%20boreal%20temperate%20forest%20woody%20biomass%3A%20carbon%20pools%2C%20sources%2C%20sinks%22.

Eisenbies, M.H., E.D. Vance, W.M. Aust, and J R. Seiler, 2009, Intensive Utilization of Harvest Residues in Southern Pine Plantations: Quantities Available and Implications for Nutrient Budgets and Sustainable Site Productivity, Bio-energy Research 2: 90-98, http://ddr.nal.usda.gov/bitstream/10113/36119/1/IND44249891.pdf.

Evans, S. (coordinator), M. Baldwin, P. Henshall, R. Matthews, G. Morgan, J. Poole, P. Taylor, P., I. and Tubby, 2007, Final Report: Yield models for Energy: Coppice of Poplar and willow. Volume A – Empirical Models. Report to DTI (B/W2/00624/00/00 URN). Ed: I Tubby and J Poole. 91pp., http://www.biomassenergycentre.org.uk/pls/portal/docs/PAGE/BEC_TECHNICAL/RESEARCH%20AND%20STUDIES/ENERGY%20CROP%20STUDIES/YIELD%20MODELS%20FOR%20SRC%20A.PDF.

Ferrari, M.D., E. Neirotti,.C. Albornoz, and E. Saucedo, 1992, Ethanol production from eucalyptus wood hemicellulose hydrolysate by Pichia stipitis, Biotechnology and Bioengineering 40: 753-759.

Forestry Commission (UK), Yield Models for Energy Coppice of Poplar and Willow, Empirical Models, Volume A, http://www.biomassenergycentre.org.uk.

Forestry Resources Task Force, Idaho Strategic Energy Alliance, 2009, Wood Bioenergy Homegrown Baseload Energy for Idaho, http://www.energy.idaho.gov/energyalliance/d/forest_packet.pdf.

Gallagher, T., B. Shaffer, and B. Rummer, 2006, An Economic Analysis of Hardwood Fiber Production on Dryland Irrigated Sites in the US Southeast, Biomass & Bioenergy 30: 794–802, http://www.srs.fs.usda.gov/pubs/ja/ja_rummer016.pdf.

Geary, T.F., G.F. Meskimen, and E.C. Franklin, 1983, Growing eucalyptus in Florida for industrial wood production, USDA Forest Service General Technical. Report. SE-23.

Geyer, W.A., 2006, Biomass Production in the Central Great Plains USA under Various Coppice Regimes, Biomass & Bioenergy 30: 778-783, http://www.gpsaf.unl.edu/GPPubs/Coppice%20article%20biomass%20bioenergy.pdf.

Gregg, D.J. and J.N. Saddler, 1996, Factors affecting cellulose hydrolysis and the potential of enzyme recycle to enhance the efficiency of an integrated wood to ethanol process, Biotechnology and Bioengineering 51: 375-383.

Heilman, P.E., D.V. Peabody, D.S. DeBell, and D.F. Strand, 1972, A test of close-spaced, short rotation culture of black cottonwood. Canadian Journal of Forest Research 2: 456-459.

Heilman, P.E. and D.V. Peabody, 1981, Effect of harvest cycle and spacing on productivity of black cottonwood in intensive culture, Canadian Journal of Forest Research 11: 118-123.

Heilman, P.E. and R.F. Stettler, 1985, Genetic variation and productivity of Populus trichocarpa and its hybrids. II. Biomass production in a 4-year plantation, Canadian Journal of Forest Research 15: 384–388.

Hill, J., E. Nelson, D. Tilman, S. Polasky, and D. Tiffany, 2006, Environmental, economic, and energetic costs and benefits of biodiesel and ethanol biofuels, Proceedings of the National Academy of Science U S A. 103:11206-10.

Himmel, M.E., S-Y Ding, D.K. Johnson, W.S. Adney, M.R. Nimlos, J.W Brady, and T.D. Foust, , 2007, Biomass Recalcitrance: Engineering Plants and Enzymes for Biofuels Production, Science 315: 804, http://www.uta.edu/biology/grover/classnotes/5101/ Himmel%20et%20al.pdf.

Hinchee, M., W. Rottmann, L. Mullinax, C. Zhang, S. Chang, M. Cunningham, L. Pearson, and N. Nehra, 2009, Short rotation woody crops for bioenergy and biofuels applications, In Vitro Cellular & Developmental Biology 45: 619–629, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2778772/.

Hoekman, S.K., 2009, Biofuels in the U.S. – Challenges and Opportunities. Renewable Energy 34:14–22, http://www.dri.edu/images/stories/editors/receditor /2009_hoekmank_busco.pdf.

Howell, F.M., J.R. Porter, P.B. Mason, and T.C. Blanchard, 2010, Spatial Contours of Potential Biomass Crop Production: An Examination of Variations by US Region, Journal of Rural Social Sciences, 25:1-32, http://www.ag.auburn.edu/auxiliary/srsa/pages/Articles/JRSS%202010%2025%202%201-32.pdf.

Hytönen, J. and L. Aro, 2010, Biomass production of birch on cut-away peatlands – energy wood with short rotation?, http://www.metla.fi/hanke/3479/doc/posteri.pdf.

Idaho Forest, Wildlife and Range Policy Analysis Group, 2000, Toward Sustainable Forest Management: Part II—The Role and Effects of Timber Harvesting in Idaho, http://www.cnrhome.uidaho.edu/documents/Report19ES.pdf?pid=69505&doc=1.

Indiana Department of Natural Resources, 2008, Woody Biomass Feedstock for the Bioenergy and Bioproducts Industries, http://www.in.gov/dnr/forestry/files/fo-WoodyBiomass_final.pdf.

Irland, L.C., P.E. Sendak, and R.H. Widmann, 2001, Hardwood pulpwood stumpage price trends in the northeast, http://www.fs.fed.us/ne/newtown_square/publications/technical_reports/pdfs/2001/gtrne286.pdf.

Isebrands, J.G., 2007, Best Management Practices Poplar Manual For Agroforestry Applications in Minnesota, http://www.extension.umn.edu /distribution/naturalresources/00095.html.

Kim, S. and B.E. Dale, 2005, Life cycle assessment of various cropping systems utilized for producing biofuels: bioethanol and biodiesel, Biomass & Bioenergy 29:426–39.

Labrecque, M., T.I. Teodorescu, and S. Daigle, 1997, Biomass productivity and wood energy of Salix species after 2 years growth in SRIC fertilized with wastewater sludge, Biomass and Bio-energy 12: 409-417.

Langholtz, M., D.R. Carter, D.L. Rockwood, J.R.R. Alavalapati, and A Green, 2005, Effect of dendroremediation incentives on the profitability of short-rotation woody cropping of Eucalyptus grandis, Forest Policy and Economics 7: 806-817.

Langholtz, M., D.R. Carter, and D.L. Rockwood. 2007, Assessing the Economic Feasibility of Short-Rotation Woody Crops in Florida, Florida Cooperative Extension Service Circular 1516, http://edis.ifas.ufl.edu/FR169.

Licht, L.A., and J.G. Isebrands, 2005, Linking phytoremediated pollutant removal to biomass economic opportunities, Biomass and Bio-energy 28: 203-218.

Manomet Center for Conservation Sciences, 2010, Biomass Sustainability and Carbon Policy Study, Commonwealth of Massachusetts; Department of Energy Resources, 182 pp, http://www.manomet.org/sites/manomet.org/files/Manomet_Biomass_Report_Full_LoRez.pdf.

Mantau, U., U. Saal, K. Prins, F. Steierer, M. Linder, H. Verkerk, J. Eggers, N. Leek, J. Oldenburger, A. Asikainen, and P. Anttila, 2010, Real Potential for Changes in Growth and Use of EU Forests, http://ec.europa.eu/energy/renewables/studies/doc/bioenergy/euwood_final_report.pdf.

McCracken, A.R. and L. Walsh, 2010, Developments in SRC Willow R&D in Northern Ireland, UK, http://www.esf.edu/ outreach/pd/2010 /srwc/documents /AMcCrackenDevelopSRC.pdf.

McKeand S.E. and B. Li, eds., 2005, Proceedings of the 28th Southern Forest Tree Improvement Conference, http://www.ces.ncsu.edu/nreos/forest/feop/Agenda2005/SFTIC/proceedings.pdf.

Mead, D.J., 2005, Forests for energy and the role of planted trees. Critical Reviews in Plant Sciences 24: 407–421; Mercker D., 2007, Short rotation woody crops for biofuels. University of Tennessee Agricultural Experiment Station, http://www.utextension.utk.edu/publications/spfiles/SP702-C.pdf.

Mercker, D., 2007, Short rotation woody crops for biofuels. University of Tennessee Agricultural Experiment Station, http://www.utextension.utk.edu/publications/spfiles/SP702-C.pdf.

Miller, R.O., and B.A. Bender, 2008, Growth and Yield of Poplar and Willow Hybrids in the Central Upper Peninsula of Michigan, http://www.cinram.umn.edu /srwc/docs/Powerpoints/R.Miller_Growth%20and%20Yield%20of%20Poplar%20and%20Willow%20Hybrids.pdf.

Mirck, J., J.G. Isebrands, T. Verwijst, and S. Ledin, 2005, Development of short-rotation willow coppice systems for environmental purposes in Sweden, Biomass & Bioenergy 28: 219-228.

Mitchell, C.P., 1984, An Experimental Study of Short Rotation Forestry for Energy, in Solar Energy R & D in the European Community, Reidel, 5: 88-95, http://books.google.com/books?id=lXBhn2RPIvEC&pg=PA89&lpg=PA89&dq=douglas+fir+for+energy+short+rotation&source=bl&ots=UpJ642T87s&sig=TCVL_e3JaTvgh8c7NAmm_t4Tts8&hl=en#.

Mola-Yudego, B. and P. Aronsson, 2008, Yield models for commercial willow biomass plantations in Sweden, Biomass & Bioenergy 32: 829–837.

Myneni, R.B., J. Dong, C.J. Tucker, R.K. Kaufmann, P.E. Kauppi, J. Liski, L.Zhou, V. Alexeyev, and M.K. Hughes, 2001, A Large Carbon Sink in the Woody Biomass of Northern Forests, Proceedings of the National Academy of Science 98: 14784-14789, http://www.pnas.org/content/98/26/14784.full.pdf.

O'Laughlin, J., 2010, Accounting for Greenhouse Gas Emissions from Wood Bioenergy: Response to the U.S. Environmental Protection Agency's Call for Information, http://www.cnrhome.uidaho.edu/documents/JayO"L_to-EPA_9-13-2010_PAG_31.pdf?pid=11P9711&doc=1.

Parikka, M., 2004, Global Biomass Fuel Resources. Biomass & Bioenergy 27: 613–620, http://faculty.washington.edu/stevehar/World%20woody%20biomass.pdf.

Perez-Verdin, G., D. Grebner, C. Sun, I. Munn, E. Schultz, and T. Matney, 2007, Woody Biomass Feedstock Supplies and Management for Bioenergy in Southwestern Mississippi, http://sofew.cfr.msstate.edu/papers/Perez-Verdin07.pdf.

Perlack, R.D., L.L. Wright, A.F. Turhollow, R.L. Graham, B.J. Stokes, and D. C. Erbach, US Dept of Energy and US Dept of Agriculture, 2005, http://www1.eere.energy.gov/biomass/pdfs/final_billionton_vision_report2.pdf.Rockwood D.L., D.R. Carter, M.H. Langholtz, and J.A. Stricker, 2006, Eucalyptus and Populus short rotation woody SEQ CHAPTER 1 crops for phosphate mined lands in Florida USA, Biomass & Bioenergy 30: 728–734.

Rockwood, D.L., and D.R. Dippon. 1989. Biological and economic potential of Eucalyptus grandis and slash pine as biomass energy crops. Biomass 20: 155–166.

Rockwood, D.L., N.N. Pathak, and P.C. Satapathy, 1993, Woody biomass production systems for Florida, Biomass & Bioenergy 5: 23–34.

Rockwood, D.L., G.F. Peter, M.H. Langholtz, B. Becker, A.Clark III, and J. Bryan, 2005, Genetically improved eucalypts for novel applications and sites in Florida. In: Proceedings of the 28th Southern Forest Tree Improvement Conference, 64–75. http://www.ces.ncsu.edu/nreos/forest/feop/Agenda2005/SFTIC/proceedings.pdf.

Rockwood, D.L. and G.F. Peter, 1998 (reviewed 2011), Eucalyptus and Corymbia Species for Pulpwood, Mulchwood, Energywood, Windbreaks, and/or Phytoremediation, Circular

1194 of the School of Forest Resources and Conservation, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida.

Rockwood, D.L., S.M. Pisano, and W.V. McConnell, 1996, Superior cottonwood and Eucalyptus clones for biomass production in wastewater bioremediation systems, Proceedings of Bio-energy ‗96, Seventh National Bio-energy Conference: 254–261.

Rockford, D.L., D.R. Carter, and J.A. Stricker, 2008, Commercial Tree Crops for Phosphate Mined Lands: Final report, Publication No. 03-141-225, Univ. of Florida.110 pp.

Rockwood D. L., and B. Tamang.2010.Description and performance of four Eucalyptus grandis cultivars released by IFAS/UF in 2009. Proceedings Florida State Horticultural Society 123:330-332.

Roebroeks, W, and P. Villa, 2011. On the earliest evidence for habitual use of fire in Europe, Proceedings of the National Academy of Sciences 108: 5209-5214, http://www.pnas.org/content/108/13/5209.

Rosenqvist, H., P. Aronsson, K. Hasselgren, and K. Perttu, 1997. Economics of using municipal wastewater irrigation of willow coppice crops, Biomass & Bioenergy 12: 1-8.

Rutledge, C.B., and G. C. Douglas, 1988, Culture of meristem tips and micropropagation of 12 commercial clones of poplar in vitro, Physiologia Plantarum 72: 367-373

Schmidt, D., 2006, Biomass Energy Opportunities from Hybrid Poplars In Minnesota, Woody Biomass Harvesting and Utilization Workshop, http://www.extension.umn.edu/agroforestry/biomass/schmidt.pdf.

Searchinger, T., R. Heimlich, R.A. Houghton, F. Dong, A. Elobeid, J. Fabiosa, S. Tokgoz, D. Hayes, and T-H. Yu, 2008, Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land-Use Change, http://www.abengoabioenergia.eu/corp/export/sites/abg_bioenergy/resources/pdf/acerca_de/informacion_tecnica/en/Sciencexpress_Croplands_for_Biofuels_Increase_Greenhouse_Gases.pdf.

Segrest, S.A. Rockwood, D.L. Stricker, J.A. Green, A.E.S. (1998). Energy crop yields for Eucalyptus and cottonwood, http://www.treepower.org/yields/main.html.

Shani, Z., M. Dekel, G Tsabary, R. Goren, and O. Shoseyov, 2004, Growth enhancement of transgenic poplar plants by over expression of Arbidopsis thaliana endo-1,4-β–glucanase, Molecular Breeding 14:¨321-330.

Stanton, B.J., 2007, Hybrid Poplar Feedstock Production: Economic Opportunity for Renewable Energy in North America, TAPPI International Conference on Renewable Energy, http://www.tappi.org/content/Events/07renew/07ren05.pdf.

Sticklen, M.B., 2008, Plant genetic engineering for biofuel production: towards affordable cellulosic ethanol Nature Reviews Genetics 9, 433-443.

Stricker J.A., D.L. Rockwood, S.A. Segrest, G.R. Alker, G.M. Prine.; and D.R. Carter, 2000, Short Rotation Woody Crops For Florida. University of Florida, http://www.treepower.org/papers/strickerny.doc.

Sullivan, J, 1994, Picea abies. In: Fire Effects Information System, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/.

Sun, Y. and J. Cheng, 2002, Hydrolysis of lignocellulosic materials for ethanol production: a review, Bioresource Technology 83: 1-11.

Talbert, C., and D. Marshall, 2005, Plantation Productivity in the Douglas-Fir Region Under Intensive Silvicultural Practices: Results from Research and Operations, Journal of Forestry 103: 65-70, http://courses.washington.edu/esrm427/Talbert_Marshall_Plantations.pdf.

U.S. Department of Agriculture, 2009, 2007 Census of Agriculture, http://www.agcensus.usda.gov/Publications/2007/Full_Report/usv1.pdf.

U.S. Department of Agriculture, Farm Service Agency, 2009, Program Fact Sheet: Noninsured Crop Disaster Assistance Program for 2009 and Subsequent Years, http://www.fsa.usda.gov/Internet/FSA_File/nap09.pdf, Accessed October, 2011.

U.S. Department of Agriculture, Forest Service, Forest Inventory and Analysis Program, http://www.fia.fs.fed.us/.

U.S. Department of Energy, 2006, Biomass Feedstock Composition and Property Database: All Sample Types, All Heat Properties, http://www1.eere.energy.gov/biomass/feedstock_databases.html.

U.S. Department of Energy, 2010, Biomass Energy Data Book: Edition 3, http://cta.ornl.gov/bedb/download.shtml or http://cta.ornl.gov/bedb/pdf/BEDB3_Full_Doc.pdf.

U.S. Department of Energy and U.S. Department of Agriculture, 2007, http://www1.eere.energy.gov/biomass/pdfs/2007ethanolreview.pdf.

U.S. Department of Energy and U.S. Department of Agriculture, 2011, http://www1.eere.energy.gov/biomass/integrated_bio-refineries.html.

U.S. Department of Interior, 2011, National Atlas of the United States: Forest Resources in the United States, http://nationalatlas.gov/articles/biology/a_forest.html.

U.S. Energy Administration, 2011, Total Energy: 1011 Monthly Energy Review: 1.2: Primary Energy Production by Source, http://www.eia.gov/totalenergy/data/monthly/pdf/mer.pdf.

U.S. Energy Information Administration, 2010, Renewable Energy Annual 2008, http://205.254.135.24/cneaf/solar.renewables/page/rea_data/rea.pdf.

Van deWalle, I., N. van Camp, L. van de Casteele, K. Verheyen, and R. Lemeu. 2007, Short-rotation forestry of birch, maple, poplar and willow in Flanders (Belgium) I—Biomass production after 4 years of tree growth, Biomass and Bio-energy 31: 267-275.

Van Oosten, C., 2006, Hybrid Poplar Crop Manual for the Prairie Provinces, http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/apa11037.

Van Oosten, C., 2008, Purpose-Grown Woody Biomass Crops, http://www.poplar.ca/pdf/woodybiomrep.pdf.

Vermis, W. 2008, Genetic Improvement of Bio-energy Crops, Springer-Verlag, New York, pp. 397.

Volk, T.A., L.P. Abrahamson, C.A. Nowak, L.B. Smart, P.J. Tharakan, and E. H. White, E.H., 2006, The Development of Short-Rotation Willow in the Northeastern United States for Bioenergy and Bioproducts, Agroforestry and Phytoremediation, Biomass & Bioenergy 30: 715–727, http://www.sciencedirect.com science/article/pii/S0961953406000687.

Volk, T.A., M.A. Buford, B. Berguson, J. Caputo, J. Eaton, J.H. Perdue, T.G. Rials, D. Riemenschneider, B. Stanton, and J.A. Stanturf, 2010, Woody Feedstocks-Management and Regional Differences, http://www.swcs.org/documents /resources /Chapter_7__Volk__Woody_ Feedstocks_6D4F290C2D22F.pdf.

Volk, T.A., P. Woodbury, P. Castellano, R. Germain, and T. Buchholz, 2011, Woody Biomass Feedstock Supply Potential in New York State, http://www.uvm.edu /~cfcm/symposium/PDFs/Volk.pdf.

Wagner, J.E. and P.E. Sendak, 2005, The annual increase of Northeastern regional timber stumpage prices: 1961 to 2002. Forest Products Journal 55:36-45.

Walker, T., P. Cardellechio, A. Colnes, J. Gunn, B. Kittler, B. Perschel, C. Recchia, and D. Saah, 2010, Biomass Sustainability and Carbon Policy Study, http://www.manomet.org/sites/manomet.org/files/Manomet_Biomass_Report_Full_LoRez.pdf.

Weih, M., 2004, Intensive Short Rotation Forestry in Boreal Climates: Present and Future Perspectives, Canadian Journal of Forest Research 34: 1369–1378, http://research.eeescience.utoledo.edu /lees/papers_PDF/Weih_2004_CJFR.pdf.

Whitesell, C.D., D.S. DeBell, T.H. Schubert, R.F. Strand, and T.B. Crabb, 1992. Short-rotation management of Eucalyptus: guidelines for plantations in Hawaii. Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; http://www.fs.fed.us/psw/publications/documents/psw_gtr137/psw_gtr137.pdf.

Wilhelm, W.W., J.M.F. Johnson, D.L. Karlen, D.T. Lightle, 2007, Corn Stover to Sustain Soil Organic Carbon Further Constrains Biomass Supply, Agronomy. Journal 99:1665–1667, http://ddr.nal.usda.gov/bitstream/10113/14703/1/IND44011589.pdf.

Woudenberg, S.W., B.L. Conkling, B.M. O'Connell, E.B. LaPoint, J.A. Turner, and K.L. Waddell, 2010, The Forest Inventory and Analysis Database: Database Description and Users Manual Version 4.0 for Phase 2, http://www.fs.fed.us/rm/pubs/rmrs_gtr245.pdf.

Wright, L. 2006. Worldwide commercial development of bio-energy with a focus on energy crop-based projects, Biomass & Bioenergy 30: 706-714.

Wright, L., contract to the Oak Ridge National Laboratory, 2010, US Woody Crop Yield Summary - 2010, http://www.woodycrops.org /NR/rdonlyres/BF9B2067-FDB0-49B0-9543-8EEA03A415FD/2844 /USWoodyCropsYieldSummaryOct2010.pdf.

Zumrawi, A.A. and D.W. Hann, 1993, Diameter Growth Equations for Douglas-fir and Grand Fir in the Western Willamette Valley of Oregon, Research Contribution 4, Oregon State University, Forest Research Laboratory, http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/7618/RC4.pdf;jsessionid=4D7BC90BE6FE98BBDBA9E66899939603?sequence=1.

Appendix A.

DOE Biomass Program Biorefineries

ABENGOA BIO-ENERGY LLC.
Feedstock Stover, Switchgrass, Woody Biomass
Conversion Technology Biochemical
Primary Product ethanol
Bio-fuel Capacity 15,000,000
Scale Commercial
Location Hugoton, Kansas

ARCHER DANIELS MIDLAND, INC.
Feedstock Corn Stover
Conversion Technology Biochemical
Primary Product ethanol
Bio-fuel Capacity 25,800
Scale Pilot
Location Decatur, Illinois

ALGENOL BIO-FUELS, INC.
Feedstock Algae
Conversion Technology Biochemical
Primary Product ethanol
Bio-fuel Capacity 100,000
Scale Pilot
Location Freeport, Texas

AMYRIS BIOTECHNOLOGIES INC.
Feedstock Sweet Sorghum
Conversion Technology Biochemical
Primary Product renewable hydrocarbons
Bio-fuel Capacity 1,370
Scale Pilot
Location Emeryville, California

AMERICAN PROCESS, INC.
Feedstock Hardwood Derived Hydrolyzate
Conversion Technology Biochemical
Primary Product ethanol
Bio-fuel Capacity 894,000
Scale Pilot
Location Alpena, Michigan

MYRIANT
Feedstock Sorghum
Conversion Technology Biochemical
Primary Product bioproducts
Bio-fuel Capacity NA
Scale Demonstration
Location Lake Providence, Louisana

CLEAR FUELS TECHNOLOGY
Feedstock Woody waste and bagasse
Conversion Technology Thermochemical - Gasification
Primary Product renewable diesel, jet fuel
Bio-fuel Capacity 151,000
Scale Pilot
Location Commerce City, Colorado

ELEVANCE RENEWABLE SCIENCES
Feedstock Algae oil, Plant and Animal oils
Conversion Technology Chemical
Primary Product renwable jet fuel and diesel
Bio-fuel Capacity NA
Scale R&D
Location Bolington, Illinois

ENERKEM
Feedstock Municipal Sewage Waste, Forest Residues
Conversion Technology Thermochemical - Gasification
Primary Product ethanol
Bio-fuel Capacity 10,000,000
Scale Demonstration
Location Pontotoc, Mississippi

GAS TECHNOLOGY INSTITUTE
Feedstock Wood waste, corn stover, and algae
Conversion Technology Thermochemical - Pyrolysis
Primary Product renewable gasoline, diesel
Bio-fuel Capacity NA
Scale R&D
Location Des Plaines, Illinois

HALDOR TOPSOE, INC.
Feedstock Wood waste and non-merchantable wood
Conversion Technology Thermochemical - Gasification
Primary Product renewable hydrocarbons
Bio-fuel Capacity 345,000
Scale Pilot
Location Des Plaines, Illinois

ICM, INC.
Feedstock Corn Fiber, Switchgrass, Energy Sorghum
Conversion Technology Biochemical
Primary Product ethanol
Bio-fuel Capacity 245,000
Scale Pilot
Location St. Joseph, Missouri

INEOS NEW PLANET BIO-ENERGY JV
Feedstock Municipal Sewage Waste
Conversion Technology Hybrid
Primary Product ethanol
Bio-fuel Capacity 8,000,000
Scale Demonstration
Location Vero Beach, Florida

LOGOS TECHNOLOGIES
Feedstock Agricultural Residues, Energy Crops, Forest Resources
Detailed Feedstock Corn Stover, Switchgrass, Wood Chips
Conversion Technology Biochemical
Primary Product ethanol
Bio-fuel Capacity 50,000
Scale Pilot
Location Visalia, California

RENEWABLE ENERGY INSTITUTE INTERNATIONAL
Feedstock Rice hulls and forest residues
Conversion Technology Thermochemical - Gasification
Primary Product ethanol
Bio-fuel Capacity 625,000
Scale Pilot
Location Toledo, Ohio

SAPPHIRE ENERGY INC.
Feedstock Algae
Conversion Technology Algae
Primary Product algal lipids
Bio-fuel Capacity 1,000,000
Scale Demonstration
Location Columbus, New Mexico

SOLAZYME INC.
Feedstock Algae
Conversion Technology Algae
Primary Product algal lipids
Bio-fuel Capacity 300,000
Scale Pilot
Location Riverside, Pennsylvania

UOP LLC.
Detailed Forest Residues, Corn Stover, Bagasse, Switchgrass, Algae
Conversion Technology Thermochemical - Pyrolysis
Primary Product renewable diesel, gasoline, and jet fuel
Bio-fuel Capacity 60,000
Scale Pilot
Location Kapolei, Hawaii

ZEACHEM
Feedstock Hybrid Poplar, Stover and Cobs
Conversion Technology Hybrid
Primary Product ethanol
Bio-fuel Capacity 250,000
Scale Pilot
Location Boardman, Oregon

BLUEFIRE LLC
Feedstock Wood waste, Municipal Sewage Waste
Conversion Technology Biochemical
Primary Product ethanol
Bio-fuel Capacity 19,000,000
Scale Commercial
Location Fulton, Mississippi

PACIFIC BIOGASOL INC.
Feedstock Hybrid Poplar, Stover, Wheat Straw
Conversion Technology Biochemical
Primary Product ethanol
Bio-fuel Capacity 2,700,000
Scale Demonstration
Location Boardman, Oregon

LIGNOL
Feedstock Woody Biomass
Conversion Technology Biochemical
Primary Product ethanol
Bio-fuel Capacity 2,500,000
Scale Demonstration
Location Ferndale, Washington

NEW PAGE CORPORATION
Feedstock Mill Residues and un-Merchantable Wood
Conversion Technology Thermochemical - Gasification
Primary Product Renewable FT liquids
Bio-fuel Capacity 5,500,000
Scale Demonstration
Location Wisconsin Rapids, Wisconsin

VERENIUM LOUISIANA, LLC.
Feedstock sugarcane bagasse, energy cane and sorghum
Conversion Technology Biochemical
Primary Product ethanol
Bio-fuel Capacity 1,400,000
Scale Demonstration
Location Jennings, Louisiana

RANGE FUELS
Feedstock Woody biomass, forest residues, thinnings
Conversion Technology Thermochemical - Gasification
Primary Product ethanol and methanol
Bio-fuel Capacity 20,000,000
Scale Commercial
Location Soperton, Georgia

POET, LLC.
Feedstock Corn Cobs
Conversion Technology Biochemical
Primary Product ethanol
Bio-fuel Capacity 25,000,000
Scale Commercial
Location Emmetsburg, Iowa

FLAMBEAU RIVER BIO-FUELS, LLC.
Feedstock Mill Residues, Unmerchantable Forest Material, and Other Woody Biomass
Conversion Technology Thermochemical - Gasification
Primary Product renewable diesel, FT waxes
Bio-fuel Capacity 9,000,000
Scale Commercial
Location Park Falls, Wisconsin

MASCOMA
Feedstock Woody Biomass (aspen)
Conversion Technology Biochemical
Primary Product ethanol
Bio-fuel Capacity 20,000,000
Scale Commercial
Location Kinross, Michigan

RED SHIELD ACQUISITION
Feedstock Forest Resources
Conversion Technology Biochemical
Primary Product biobutanol
Bio-fuel Capacity 1,500,000
Scale Demonstration
Location Old Town, Maine

Appendix B.

Sample Government Data

Exhibit 1. NASS Data
Exhibit 2. FS FIA Data
Exhibit 3. Sample FS Species Groupings: Cottonwood/Poplar

Exhibit 1.

NASS Data

2007 Census Volume 1, Chapter 1 Table 38

Crop	Acres in Production		Harvested		Irrigated	
	Farms	Acres	Farms	Acres	Farms	Acres
Short-rotation woody crops - 2007	4,717	228,335	1,769	31,007	668	(D)
Short-rotation woody crops - 2002	6,285	288,686	1,940	31,920	(NA)	(NA)
2007 farms by acres in production						
1 to 9 acres	1,948	7,052	751	1,572	433	1,098
10 to 49 acres	1,926	43,191	696	7,310	178	2,484
50 to 99 acres	484	32,844	185	5,313	35	1,151
100 to 249 acres	270	38,571	90	5,409	12	468
250 to 499 acres	56	18,050	24	2,479	6	1,700
500 acres or more	33	88,627	23	8,924	4	(D)
500 to 749 acres	16	9,489	12	1,212	2	(D)
750 to 999 acres	2	(D)	1	(D)		
1,000 to 1,999 acres	5	7,486	2	(D)		
2,000 to 2,999 acres	5	12,185	4	2,870		
3,000 to 4,999 acres	2	(D)	1	(D)		
5,000 to 9,999 acres	1	(D)	1	(D)	1	(D)
10,000 acres or more	2	(D)	2	(D)	1	(D)
2002 farms by acres in production						
1 to 9 acres	2,892	9,193	910	1,928	(NA)	(NA)
10 to 49 acres	2,335	50,016	726	6,985	(NA)	(NA)
50 to 99 acres	570	38,393	139	4,562	(NA)	(NA)
100 to 249 acres	353	51,041	108	6,446	(NA)	(NA)
250 to 499 acres	92	31,320	33	2,836	(NA)	(NA)
500 acres or more	43	108,723	24	9,163	(NA)	(NA)
500 to 749 acres	19	12,158	10	(D)	(NA)	(NA)
750 to 999 acres	4	3,565	2	(D)	(NA)	(NA)
1,000 to 1,999 acres	10	12,186	4	(D)	(NA)	(NA)
2,000 to 2,999 acres	3	7,090	2	(D)	(NA)	(NA)
3,000 to 4,999 acres	4	15,662	3	785	(NA)	(NA)
5,000 to 9,999 acres					(NA)	(NA)
10,000 acres or more	3	58,062	3	(D)	(NA)	(NA)

2007 Census Volume 1, Chapter 1 Table 37

Geographic Area	2007					2002			
	Acres in Production			Acres Harvested		Acres in Production		Acres Harvested	
	Farms	Acres	Acres Irrigated	Farms	Acres	Farms	Acres	Farms	Acres
United States Total									
United States	4,717	228,335	(D)	1,769	31,007	6,285	288,686	1,940	31,920
States									
Alabama	13	99		2	(D)	145	1,635	38	428
Alaska	1	(D)				4	44	2	(D)
Arizona	14	213	48	7	11	21	710	12	(D)
Arkansas	62	1,749		29	511				
California	97	2,086	631	53	420	173	4,247	87	166
Colorado	119	2,768	962	72	435	88	1,931	41	190
Delaware						9	181	5	9
Florida						198	6,562	38	395
Georgia	71	2,813	364	39	658	170	2,206	49	304
Hawaii	59	(D)	29	25	50	16	(D)	5	(D)
Idaho	91	1,670	377	42	161	91	1,268	8	29
Illinois	117	2,152	523	53	595	148	4,796	67	1,550
Indiana	116	3,103	127	45	394				
Iowa	59	692	(D)	28	114	112	1,004	42	236
Kansas						26	(D)	11	23
Kentucky	83	1,222	45	46	301	54	1,260	37	304
Louisiana	203	16,329	65	46	3,356	183	20,350	35	1,495
Maryland	34	524	32	16	162	78	903	30	254
Michigan	311	7,934	431	127	1,234	422	10,966	147	1,482
Minnesota	225	(D)	116	83	672	274	10,060	86	762
Mississippi	527	44,638	231	128	4,866	387	33,892	89	4,421
Missouri	99	3,145	231	56	622				
Nebraska	28	152	31	14	19	25	262	14	44
Nevada	2	(D)	(D)	2	(D)	2	(D)		
New Mexico	13	49	27	4	6	15	121	8	46
New York	221	5,753	113	100	1,276	448	18,805	154	2,096
North Carolina	44	289	40	26	71	400	7,418	122	766
North Dakota	8	16	11						
Ohio	307	5,433	42	121	1,267	346	8,663	122	1,123
Oklahoma	52	877	61	31	420	59	1,783	19	181
Oregon	211	26,787	(D)	65	2,918	367	26,330	91	2,467
Pennsylvania	23	414	(D)	13	59	510	11,358	180	2,823
South Carolina	351	17,493	1,129	100	3,348	395	17,047	76	1,496
South Dakota	1	(D)		1	(D)	15	193	6	34
Tennessee	72	1,178	43	48	309	59	(D)	35	295
Texas	731	29,635	1,380	215	4,265	599	37,763	157	3,599
Utah	2	(D)	(D)	1	(D)	13	32	3	4
Virginia	176	(D)	81	55	708	242	6,133	56	512
Washington	153	12,638	(D)	71	1,714	148	22,463	62	3,535
West Virginia	15	188	(D)	1	(D)	32	112	4	5
Wisconsin	4	86		2	(D)	1	(D)	1	(D)
Wyoming	2	(D)	(D)	2	(D)	10	307	1	(D)

Exhibit 2.

FS FIA Data

Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Arkansas Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2005	2006	2007	2008	2009	2010	Grand Total
Ashe Juniper	16,821,135	13,093,236	13,033,327	11,982,692	12,994,215	18,461,998	86,386,603
Black Willow	152,289,039	174,677,635	162,401,461	149,601,344	167,501,021	150,805,426	957,275,926
Cottonwood and Poplar spp.	10,162,011						10,162,011
Eastern Cottonwood	107,378,464	113,066,312	113,802,601	125,728,116	116,940,406	120,345,195	697,261,094
Loblolly Pine	6,055,488,958	6,002,641,404	6,072,054,129	6,190,294,053	6,223,032,572	6,490,927,537	37,034,438,653
Shortleaf Pine	3,507,028,599	3,577,980,814	3,599,752,205	3,625,304,146	3,629,753,466	3,655,885,140	21,595,704,370
Swamp Cottonwood	28,300,352	329,729	323,578				28,953,659
Willow spp.	41,702,672	28,120,977	26,280,096	26,190,043			122,293,788
Yellow-Poplar	9,218,727	9,689,039	11,902,829	12,012,994	13,859,130	13,960,072	70,642,791
AR Total	10,599,904,320	10,597,788,867	10,686,368,094	10,820,774,620	10,877,607,755	11,163,888,466	64,746,332,122

Alabama Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2000	2001	2002	2003	2004	2005	2006
Black Willow		6,017,486	6,627,140	9,806,363	18,761,407	24,136,941	27,407,273
Cottonwood and Poplar spp.	11,204,588	13,651,083	14,020,031	14,239,953	14,352,522	14,239,953	14,310,312
Eastern Cottonwood	18,178,729	22,029,067	21,935,563	20,435,667	20,563,658	22,338,086	23,748,247
Loblolly Pine	9,013,127,136	8,972,916,741	9,091,300,771	9,393,784,016	9,844,383,867	10,235,859,484	10,509,353,595
Longleaf Pine	1,013,628,259	1,013,665,664	1,018,216,163	988,578,268	950,765,390	942,387,644	934,050,246
Pond Pine				8,027,362	8,073,102	8,131,015	8,154,413
Sand Pine	1,495,768	1,499,256	1,503,731	3,086,349	3,086,349	3,095,562	3,086,349
Shortleaf Pine	1,239,628,819	1,227,722,738	1,212,871,173	1,154,456,523	1,106,501,654	1,064,103,822	1,051,523,828
Slash Pine	914,969,092	902,862,139	917,306,547	918,280,897	912,372,736	890,678,655	890,381,635
Spruce Pine	246,833,422	250,714,174	236,836,558	225,823,305	196,865,883	180,993,562	189,288,737
Swamp Cottonwood	303,068	302,724	274,646	262,914	261,878	263,189	263,962
Virginia Pine	542,080,745	495,858,892	502,439,629	491,809,978	492,345,843	480,995,491	502,168,947
Willow spp.	39,292,040	38,100,374	34,095,396	34,555,868	20,926,164	11,066,711	8,820,761
Yellow Birch	111,447	111,116	111,447				
Yellow-Poplar	1,505,559,723	1,506,058,532	1,553,358,736	1,538,337,445	1,549,120,214	1,592,289,210	1,604,232,890
AL Total	14,995,456,735	14,920,515,020	15,089,297,103	15,292,389,031	15,611,136,166	15,958,982,874	16,239,669,576

Species	2007	2008	2009	2010	Grand Total
Black Willow	28,383,697	33,735,581	36,562,007	37,355,948	228,793,843
Cottonwood and Poplar spp.	14,198,512				110,216,954
Eastern Cottonwood	24,825,992	42,927,198	43,375,345	44,654,480	305,012,032
Loblolly Pine	10,688,251,644	10,941,217,291	11,185,531,068	11,631,008,159	111,506,733,772
Longleaf Pine	903,367,563	893,679,282	875,959,927	874,836,070	10,409,134,476
Pond Pine	8,154,413	8,119,366	8,195,738	8,207,435	65,062,844
Sand Pine	3,104,830	3,086,349	1,813,765	1,824,593	26,682,901
Shortleaf Pine	1,002,960,897	955,211,368	918,742,493	867,799,498	11,801,522,813
Slash Pine	860,033,528	848,747,759	820,442,735	822,492,665	9,698,568,388
Spruce Pine	167,746,359	158,951,174	163,174,150	156,519,779	2,173,747,103
Swamp Cottonwood	266,667	263,962	91,752	92,300	2,647,062
Virginia Pine	505,744,152	518,121,021	535,981,164	504,615,521	5,572,161,383
Willow spp.	6,201,741	2,939,122	1,725,787	1,482,829	199,206,793
Yellow Birch					334,010
Yellow-Poplar	1,633,562,242	1,677,894,197	1,723,657,085	1,741,630,034	17,625,700,308
AL Total	16,310,402,468	16,533,156,635	16,767,231,535	17,149,021,978	174,867,259,121

Connecticut Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2005	2006	2007	2008	2009	2010	Grand Total
Bigtooth Aspen	41,364,068	37,755,983	29,860,702	21,957,097	22,537,003	22,765,784	176,240,637
Eastern Cottonwood	6,719,704	7,519,658	5,619,117	7,329,712	5,439,350	5,595,617	38,223,158
Eastern White Pine	292,903,905	363,719,603	307,884,165	350,206,044	274,079,091	272,392,471	1,861,185,279
Pitch Pine		580,331	3,495,317	3,565,169	3,900,769	3,976,259	15,517,845
Quaking Aspen	10,808,104	7,531,782	7,866,747	8,090,736	6,929,110	7,513,310	48,739,789
Red Pine	3,552,151	9,183,526	5,855,873	6,297,953	7,223,003	6,606,060	38,718,566
Scotch Pine			921,209	948,362	878,233	2,248,141	4,995,945
Willow spp.		848,747	594,065	626,891	602,589	1,276,663	3,948,955
Yellow Birch	41,761,440	49,686,699	58,464,702	58,267,170	60,347,812	63,624,013	332,151,836
Yellow-Poplar	43,923,905	90,991,492	65,031,760	66,095,423	103,892,690	106,534,649	476,469,919
CT Total	456,346,782	594,236,558	503,920,892	542,318,296	506,038,058	512,637,906	3,115,498,492

Delaware Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2004	2005	2006	2007	2008	2009	2010	Grand Total
Bigtooth Aspen				1,704,290	1,436,242	1,523,236	1,564,300	6,228,068
Black Willow	2,459,839	2,504,908	1,520,638	1,607,191	1,541,050	950,813	787,348	11,371,787
Loblolly Pine	125,813,168	86,784,370	77,858,871	97,637,824	98,352,753	113,082,640	118,180,993	717,710,619
Virginia Pine	8,316,436	18,366,993	16,952,889	24,506,152	24,782,357	20,009,416	18,949,098	131,883,341
Yellow-Poplar	192,207,506	121,726,997	88,446,006	91,350,136	94,652,226	105,821,088	99,979,102	794,183,061
DE Total	384,698,407	275,327,600	236,843,761	264,970,582	264,409,477	284,072,547	281,087,740	1,991,410,114

Florida Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2004	2005	2006	2007	2008	2009	2010	Grand Total
Black Willow	3,214,629			2,641,251		2,493,010	2,690,115	11,039,005
Coastal Plain Willow	3,361,560			7,147,729		11,226,881	11,990,305	33,726,475
Eucalyptus spp.	348,906			333,780				682,686
Grand Eucalyptus	1,692,582			1,619,202		1,313,526	1,558,854	6,184,164
Loblolly Pine	1,544,191,034			1,417,384,322		1,433,006,507	1,404,695,835	5,799,277,698
Longleaf Pine	1,207,040,720			1,125,528,352		1,141,302,503	1,140,388,777	4,614,260,352
Pond Pine	122,058,842			143,969,289		145,290,421	141,595,310	552,913,862
Sand Pine	547,986,001			672,900,773		733,988,050	738,741,570	2,693,616,394
Shortleaf Pine	59,671,931			40,959,679		38,250,144	40,988,262	179,870,016
Slash Pine	5,201,282,124			5,178,450,375		5,431,293,882	5,547,667,869	21,358,694,250
Spruce Pine	43,395,354			56,801,351		49,012,494	53,892,255	203,101,454
Swamp Cottonwood	799,384			472,564		474,207	764,757	2,510,912
Willow spp.	964,663			585,579				1,550,242
Yellow-Poplar	109,185,156			94,395,583		96,496,298	88,013,445	388,090,482
FL Total	8,909,917,396			8,817,020,367		9,161,783,481	9,251,216,137	36,139,937,381

Georgia Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2000	2001	2002	2003	2004	2005	2006
Birch spp.	49,247,758	37,155,372	32,914,154	24,983,205			
Black Locust	21,453,454	21,847,197	20,266,860	19,627,815	20,628,823	20,712,692	20,079,838
Black Willow		674,642	5,249,520	14,919,550	23,100,485	30,137,256	33,027,166
Cottonwood and Poplar spp.	4,823,150	4,061,899	4,047,042	1,238,682	453,713	454,240	453,713
Eastern Cottonwood	662,088	1,483,202	1,525,753	6,713,771	7,877,376	8,259,333	7,420,247
Eastern White Pine	379,114,261	351,256,186	371,177,177	363,576,245	336,796,269	346,606,509	350,897,848
Loblolly Pine	9,115,552,859	9,154,529,681	9,462,448,884	9,529,721,715	10,091,107,770	10,520,353,407	10,806,202,192
Longleaf Pine	757,070,601	761,611,382	776,728,242	773,965,572	759,825,654	748,247,638	733,389,773
Pitch Pine	31,742,141	29,281,673	30,108,192	36,431,471	37,042,174	33,870,901	34,484,205
Pond Pine	138,765,760	133,197,354	121,753,312	117,809,286	105,418,285	109,559,302	108,340,975
Sand Pine	46,652,012	35,349,369	28,922,978	28,980,924	30,374,042	38,128,123	28,941,000
Shortleaf Pine	976,479,753	962,028,922	926,679,213	939,586,800	936,068,670	920,671,985	903,544,420
Slash Pine	4,109,829,972	4,170,898,499	4,182,816,894	4,200,010,313	4,219,666,919	4,326,922,228	4,375,262,011
Spruce Pine	55,955,167	56,407,802	69,616,524	61,548,068	55,703,537	56,065,197	58,728,162
Table Mountain Pine	9,162,221	9,509,009	9,549,235	9,734,892	9,601,354	9,621,395	6,482,027
Virginia Pine	602,625,390	629,466,549	630,598,820	603,588,458	605,547,731	587,918,302	561,651,172
Willow spp.	24,886,277	24,687,739	22,110,733	18,156,194	13,703,820	8,134,761	7,435,453
Yellow Birch	721,475	1,010,400	1,622,804	2,884,753	3,011,815	3,002,103	2,846,315
Yellow-Poplar	2,213,547,086	2,205,394,233	2,155,052,329	2,181,036,104	2,229,036,799	2,210,200,315	2,300,433,024
GA Total	18,781,686,671	18,835,333,886	19,090,057,022	19,177,580,040	19,724,215,107	20,216,702,205	20,579,149,007

Georgia Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet) (Continued)

Species	2007	2008	2009	2010	Grand Total
Birch spp.					144,300,489
Black Locust	20,270,945	20,477,572	19,117,967	18,689,727	223,172,890
Black Willow	38,439,353	49,120,748	58,118,753	58,739,840	311,527,313
Cottonwood and Poplar spp.	467,819				16,000,258
Eastern Cottonwood	7,462,130	6,885,791	6,395,762	7,045,709	61,731,162
Eastern White Pine	371,690,966	390,670,542	416,492,555	420,959,583	4,099,238,141
Loblolly Pine	11,257,676,691	11,571,503,164	11,811,503,339	12,020,096,655	115,340,696,357
Longleaf Pine	688,786,297	651,174,647	633,586,500	652,022,654	7,936,408,960
Pitch Pine	33,557,948	34,297,571	34,529,488	33,535,818	368,881,582
Pond Pine	109,250,906	113,390,940	122,930,030	116,790,369	1,297,206,519
Sand Pine	25,332,014	25,956,839	19,037,232	4,878,675	312,553,208
Shortleaf Pine	867,633,512	861,002,094	833,818,267	820,405,305	9,947,918,941
Slash Pine	4,305,190,043	4,434,819,377	4,440,998,003	4,436,762,236	47,203,176,495
Spruce Pine	68,128,950	72,093,870	71,184,165	72,724,388	698,155,830
Table Mountain Pine	833,645	1,039,405	1,046,904	1,048,727	67,628,814
Virginia Pine	552,033,037	541,404,497	557,377,337	565,692,373	6,437,903,666
Willow spp.	4,062,735	1,695,886			124,873,598
Yellow Birch	3,358,334	3,348,659	3,210,687	3,291,496	28,308,841
Yellow-Poplar	2,366,033,573	2,413,906,594	2,449,054,631	2,506,409,487	25,230,104,175
GA Total	20,978,526,749	21,452,673,254	21,746,954,239	22,010,371,687	222,593,249,867

Iowa Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2003	2004	2005	2006	2007	2008	2009	Grand Total
Bigtooth Aspen	16,255,015	16,175,166	14,976,263	15,069,680	9,080,747	7,454,537	6,027,914	85,039,322
Black Willow	51,703,573	41,912,892	50,928,776	50,840,550	51,585,927	55,113,617	46,889,432	348,974,767
Eastern Cottonwood	338,751,290	337,432,286	338,954,914	364,823,523	372,190,163	367,076,522	355,215,052	2,474,443,750
Eastern White Pine			236,457	251,388	261,453	241,391	278,430	1,269,119
Larch spp.	477,678	462,348	460,363	380,465				1,780,854
Peachleaf Willow	318,667	241,106	242,840	267,894	346,033	601,226	601,226	2,618,992
Ponderosa Pine	3,428,815	3,509,361	3,461,412	4,231,629	399,633	214,986	377,671	15,623,507
Quaking Aspen	2,790,727	3,534,230	3,714,974	4,236,345	4,361,763	4,765,110	4,998,779	28,401,928
Red Pine	884,627	845,612	848,865	1,246,220	1,634,295	965,716	1,398,745	7,824,080
Scotch Pine	50,808	50,445	149,771	231,245	213,416	164,164	222,369	1,082,218
White Willow	459,130	481,343	475,244	115,948				1,531,665
Willow spp.	406,116	390,479	239,098	207,955				1,243,648
IA Total	452,114,373	443,674,877	457,362,366	487,821,726	482,339,498	482,844,064	458,532,252	3,264,689,156

Illinois Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2003	2004	2005	2006	2007	2008	2009	Grand Total
Bigtooth Aspen	5,118,526	3,698,908	3,759,369	4,635,673	5,256,828	6,266,026	5,443,173	34,178,503
Black Willow	66,549,318	62,431,596	78,908,734	85,169,243	77,124,952	75,193,786	94,306,927	539,684,556
Cucumbertree	71,631	659,843	472,563	1,191,298	939,710	858,558	890,568	5,084,171
Eastern Cottonwood	312,246,384	316,787,150	327,610,987	347,165,579	350,654,857	339,127,866	350,286,515	2,343,879,338
Eastern White Pine	89,993,181	90,484,448	84,525,404	80,987,863	70,758,904	83,766,007	75,843,089	576,358,896
Loblolly Pine			2,401,272	1,979,497	4,272,467	3,903,503	3,954,509	16,511,248
Peachleaf Willow		58,326	45,612	52,524	48,138	42,084		246,684
Quaking Aspen	1,777,573	1,335,435	1,107,365	1,066,936	781,490	1,895,767	3,717,516	11,682,082
Red Pine	24,360,899	19,021,567	20,064,112	15,883,010	13,635,491	12,568,484	18,840,685	124,374,248
Scotch Pine	6,785,093	6,939,427	6,051,965	6,508,260	5,638,892	5,200,706	4,300,495	41,424,838
Shortleaf Pine	90,724,384	74,826,428	68,453,034	79,167,456	95,235,654	92,112,197	86,533,404	587,052,557
Swamp Cottonwood	635,637	457,659	423,645	519,359	245,800	274,173	711,144	3,267,417
Willow Oak			187,514	198,902	195,680	188,294	204,822	975,212
Yellow Birch	1,613,483	1,158,398	874,108					3,645,989
Yellow-Poplar	75,969,426	113,578,705	126,959,445	134,586,889	155,601,605	157,806,740	159,140,407	923,643,217
IL Total	735,148,026	775,362,635	800,384,462	843,214,929	865,921,064	864,348,457	893,787,431	5,778,167,004

Indiana Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2003	2004	2005	2006	2007	2008	2009	Grand Total
Austrian Pine							69,664	69,664
Bigtooth Aspen	32,817,040	31,844,491	36,059,076	33,485,128	34,130,066	28,105,315	32,110,808	228,551,924
Black Willow	17,932,020	25,290,762	25,428,051	26,219,709	21,709,238	24,313,081	26,173,388	167,066,249
Eastern Cottonwood	237,391,874	246,237,418	250,017,758	269,068,830	258,700,671	276,883,686	263,118,459	1,801,418,696
Eastern White Pine	79,925,455	86,924,056	88,389,022	82,650,054	78,969,724	80,306,360	85,084,278	582,248,949
Quaking Aspen	4,190,869	3,824,137	2,348,004	2,088,759	4,558,030	4,633,750	4,383,859	26,027,408
Red Pine	29,801,547	28,428,983	28,406,649	28,542,492	30,599,283	35,405,829	31,773,069	212,957,852
Scotch Pine	4,085,624	4,280,770	2,783,541	2,255,566	3,470,453	4,003,507	4,382,025	25,261,486
Shortleaf Pine	39,606,533	36,168,074	35,961,820	37,057,107	36,880,793	33,405,652	35,854,495	254,934,474
Swamp Cottonwood	201,333	195,412	189,622	196,758	247,807	178,461	174,644	1,384,037
Virginia Pine	44,158,867	43,602,481	48,675,153	45,605,763	59,113,170	56,682,176	63,585,216	361,422,826
Weeping Willow			209,333	178,771	126,646	150,134	83,401	748,285
Willow spp.					337,750	3,940,605	2,756,097	7,034,452
Yellow Birch			57,028	45,652	40,300	24,227	28,877	196,084
Yellow-Poplar	944,981,817	984,799,980	1,023,639,198	1,035,688,223	1,126,093,326	1,091,996,674	1,080,383,285	7,287,582,503
IN Total	1,497,127,082	1,554,856,893	1,607,941,670	1,622,304,446	1,725,288,332	1,713,954,700	1,698,589,474	11,420,062,597

Kansas Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2003	2004	2005	2006	2007	2008	2009	Grand Total
Austrian Pine			55,157	55,302	55,266	55,426	55,320	276,471
Black Willow	49,654,049	44,554,202	35,836,480	35,202,477	30,300,715	33,243,951	33,020,331	261,812,205
Eastern Cottonwood	331,753,436	278,547,725	239,793,171	234,265,145	221,225,431	219,224,999	170,234,054	1,695,043,961
Eastern White Pine	2,703,171	2,038,646	1,623,713	2,213,481	2,115,434	2,483,722	2,605,760	15,783,927
Peachleaf Willow	4,449,705	8,471,804	6,962,420	9,265,813	9,004,819	7,809,892	2,940,616	48,905,069
Plains Cottonwood	16,163,217	48,916,227	113,560,505	98,587,415	116,823,711	175,843,511	174,367,965	744,262,551
Ponderosa Pine	10,449,824	7,675,546	6,172,453	5,462,182	4,907,769	6,123,113	6,513,681	47,304,568
Red Pine	4,822,228	3,636,771	2,896,566	3,948,663	3,773,755			19,077,983
Shortleaf Pine	2,861,875	2,158,335	1,719,041	2,343,435	2,239,631	448,034	470,048	12,240,399
White Willow	182,251	137,448	110,602					430,301
KS Total	447,673,744	423,964,121	432,943,009	411,930,376	410,149,028	464,856,056	410,002,194	3,001,518,528

Kentucky Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2004	2005	2006	2007	2008	2009	Grand Total
Bigtooth Aspen	533,224	523,382	617,488	1,990,240	1,988,551	2,542,017	8,194,902
Birch spp.	143,356						143,356
Black Willow	42,296,211	42,516,113	49,236,868	53,144,614	64,710,624	69,680,800	321,585,230
Cottonwood and Poplar spp.	113,448	112,975	113,924	112,502	112,502		565,351
Eastern Cottonwood	81,220,020	85,337,574	86,453,274	87,676,351	79,796,420	51,404,248	471,887,887
Eastern White Pine	91,974,217	87,886,080	91,558,359	109,116,509	123,970,252	127,850,704	632,356,121
Loblolly Pine	56,885,259	71,543,774	74,442,368	83,245,225	86,492,602	88,028,687	460,637,915
Pitch Pine	86,435,766	83,834,050	79,344,266	83,588,584	87,816,750	87,227,132	508,246,548
Shortleaf Pine	169,509,204	164,391,436	153,190,321	141,196,824	129,664,973	114,960,683	872,913,441
Swamp Cottonwood	2,079,093	2,041,994	2,051,581	2,162,869	2,165,458	2,162,869	12,663,864
Virginia Pine	456,468,247	432,244,887	436,833,899	427,437,504	419,399,734	402,882,799	2,575,267,070
Willow spp.	20,945,389	20,361,559	14,438,155	14,113,675	9,753,286		79,612,064
Yellow Birch	515,601	463,328	346,032	382,776	300,693	352,486	2,360,916
Yellow-Poplar	2,652,594,692	2,631,491,218	2,666,859,643	2,746,685,317	2,800,079,941	2,832,400,038	16,330,110,849
KY Total	3,900,961,656	3,874,186,152	3,912,416,536	4,004,066,251	4,056,146,373	4,029,678,779	23,777,455,747

Massachusetts Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2005	2006	2007	2008	2009	2010	Grand Total
Bigtooth Aspen	77,709,774	55,641,460	64,031,025	61,923,292	72,743,817	75,276,059	407,325,427
Black Willow	4,807,452	3,205,535	1,986,739	1,839,414	1,148,889	1,182,456	14,170,485
Eastern Cottonwood	7,970,442	7,306,581	5,630,508	3,609,019	4,342,365	4,373,705	33,232,620
Eastern White Pine	2,040,278,681	2,012,373,539	1,878,660,662	1,860,009,777	1,855,212,546	1,926,078,638	11,572,613,843
Pitch Pine	141,200,518	114,221,151	114,712,184	100,143,828	110,379,981	117,728,807	698,386,469
Quaking Aspen	58,932,455	52,407,349	50,335,200	48,621,489	47,934,812	48,031,814	306,263,119
Red Pine	6,576,307	7,640,061	5,704,638	5,587,962	6,157,017	6,475,353	38,141,338
Red Cedar/Juniper spp.	161,690	118,443	84,982			29,192	394,307
White Willow				195,016	176,993	176,993	549,002
Willow spp.	1,721,205	2,742,877	2,212,679	2,287,273	1,455,193	1,460,874	11,880,101
Yellow Birch	198,378,444	191,396,937	160,437,571	157,447,891	161,921,623	162,487,041	1,032,069,507
Yellow-Poplar	9,863,610	5,391,821	5,614,199	5,908,419	9,107,067	9,028,522	44,913,638
MA Total	2,553,825,983	2,477,678,152	2,310,773,503	2,270,886,390	2,292,466,771	2,361,057,976	14,266,688,775

Maryland Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2005	2006	2007	2008	2009	Grand Total
Bigtooth Aspen	3,232,997	2,022,053	2,745,407	7,627,903	6,674,281	22,302,641
Black Willow	6,634,377	6,266,872	3,747,502	2,487,533	2,728,878	21,865,162
Eastern Cottonwood				13,038,163	19,965,340	33,003,503
Eastern White Pine	26,642,789	27,925,912	44,607,609	35,533,134	32,951,383	167,660,827
Loblolly Pine	712,317,228	560,395,430	569,640,111	600,569,595	684,210,083	3,127,132,447
Pitch Pine	4,735,875	3,381,781	3,266,264	3,329,245	4,140,502	18,853,667
Quaking Aspen		611,766	367,244	308,553	1,050,886	2,338,449
Red Pine	26,252,018	16,817,136	47,631,444	38,333,068	25,861,743	154,895,409
Scotch Pine	802,531	319,542	508,625	3,169,286	2,156,438	6,956,422
Shortleaf Pine	5,335,223	1,971,659	3,561,070	4,338,586	4,455,847	19,662,385
Table Mountain Pine			1,814,566	3,469,134	2,141,038	7,424,738
Virginia Pine	148,302,942	139,352,872	137,681,254	138,865,812	148,129,606	712,332,486
Yellow Birch	1,217,757	1,025,752	7,671,816	7,750,240	5,129,905	22,795,470
Yellow-Poplar	1,561,314,282	1,339,814,668	1,222,097,179	1,207,500,892	1,247,024,223	6,577,751,244
MD Total	2,596,447,851	2,188,446,136	2,161,606,847	2,225,074,956	2,332,781,780	11,504,357,570

Maine Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2003	2004	2005	2006	2007	2008	2009	Grand Total
Balsam Poplar	113,690,198	116,880,721	108,826,434	109,946,439	112,327,888	106,078,445	107,091,023	774,841,148
Bigtooth Aspen	472,698,958	428,531,736	429,420,843	417,152,970	410,384,933	401,399,057	408,686,498	2,968,274,995
Black Willow	211,030	257,755	161,631	159,568	161,113			951,097
Eastern Cottonwood	3,583,167	2,067,957	1,367,989	1,250,814	1,219,715			9,489,642
Eastern White Pine	2,581,353,493	2,628,831,708	2,646,167,436	2,679,860,173	2,680,500,901	2,718,651,911	2,768,937,561	18,704,303,183
Larch spp.	3,315,213	6,901,676	4,087,340	5,652,261	5,579,187	6,397,739	10,675,450	42,608,866
Pitch Pine	23,166,664	22,379,342	20,553,016	22,610,627	18,448,436	14,882,755	15,191,815	137,232,655
Quaking Aspen	757,594,751	785,217,155	785,757,739	758,160,435	752,844,664	743,303,756	765,943,479	5,348,821,979
Red Pine	140,737,775	162,173,654	170,456,938	178,622,701	186,980,913	183,435,170	193,931,869	1,216,339,020
Scotch Pine	120,472	127,766	181,064	145,485	283,543	804,120	831,545	2,493,995
Swamp Cottonwood	122,808	122,857	116,948	115,291				477,904
Willow spp.	1,283,565	983,267	712,208	678,224	314,583	370,084	475,192	4,817,123
Yellow Birch	1,622,926,102	1,612,394,907	1,638,477,766	1,605,549,141	1,619,148,945	1,595,959,556	1,594,315,062	11,288,771,479
Yellow-Poplar				90,588	96,642	95,076	93,315	375,621
ME Total	5,727,490,717	5,775,497,037	5,814,420,395	5,788,494,128	5,804,304,767	5,787,972,305	5,884,538,316	40,582,717,665

Michigan Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2003	2004	2005	2006	2007
Austrian Pine	16,874,591	19,606,047	22,887,204	25,120,817	35,149,033
Balsam Poplar	229,261,700	228,589,834	224,083,731	220,420,454	223,368,104
Bebb Willow		107,353	240,798	293,247	524,653
Bigtooth Aspen	1,216,846,119	1,233,889,665	1,239,163,350	1,243,992,395	1,206,940,260
Black Willow	54,725,027	54,442,976	59,711,419	64,124,278	69,827,992
Cottonwood and Poplar spp.					
Douglas-Fir	10,712,963	8,628,954	8,021,873	11,829,726	14,192,635
Eastern Cottonwood	139,656,447	147,044,687	184,260,372	211,910,224	164,795,692
Eastern White Pine	1,325,172,635	1,291,170,661	1,296,973,535	1,310,300,351	1,390,576,065
Larch spp.	739,485	626,314	638,713	1,002,236	123,994
Loblolly Pine					536,011
Peachleaf Willow	2,429,581	1,945,201	1,835,144	1,948,860	1,257,919
Pitch Pine					
Quaking Aspen	1,639,445,527	1,632,285,000	1,607,369,265	1,595,497,594	1,600,101,535
Red Pine	2,042,002,481	1,985,305,447	1,951,834,823	1,962,992,913	2,055,776,630
Scotch Pine	160,586,443	155,914,516	152,502,037	158,181,957	172,300,470
Weeping Willow					
White Willow	1,965,697	1,580,980	1,852,489	1,334,805	
Willow spp.	791,449	656,419	764,485	496,408	2,918,514
Yellow Birch	674,109,430	664,070,422	659,855,685	647,524,950	648,312,733
Yellow-Poplar	45,937,084	56,595,956	39,789,717	49,576,805	72,993,240
MI Total	7,621,535,439	7,540,154,146	7,510,556,018	7,561,451,074	7,717,303,780

Michigan Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet) (Continued)

Species	2008	2009	2010	Grand Total
Austrian Pine	31,974,001	20,576,792	25,726,991	197,915,476
Balsam Poplar	216,289,359	213,109,313	212,901,261	1,768,023,756
Bebb Willow	487,796	408,030	458,364	2,520,241
Bigtooth Aspen	1,273,767,485	1,238,168,322	1,271,358,206	9,924,125,802
Black Willow	60,290,188	50,259,480	48,363,196	461,744,556
Cottonwood and Poplar spp.	185,000	231,326	283,564	699,890
Douglas-Fir	4,563,914	6,678,331	4,274,680	68,903,076
Eastern Cottonwood	191,964,326	203,813,074	259,547,168	1,502,991,990
Eastern White Pine	1,386,463,793	1,429,454,213	1,439,504,901	10,869,616,154
Larch spp.	107,862	87,019	109,389	3,435,012
Loblolly Pine	467,392	539,658	663,039	2,206,100
Peachleaf Willow	1,139,750	1,707,907	2,043,425	14,307,787
Pitch Pine	613,077	850,708	966,947	2,430,732
Quaking Aspen	1,648,225,068	1,670,838,292	1,657,857,705	13,051,619,986
Red Pine	2,084,346,706	2,211,012,260	2,174,248,807	16,467,520,067
Scotch Pine	142,913,592	146,049,966	155,808,097	1,244,257,078
Weeping Willow	546,163	611,338	755,234	1,912,735
White Willow				6,733,971
Willow spp.	4,075,603	4,220,535	5,164,968	19,088,381
Yellow Birch	644,885,701	662,135,048	636,881,057	5,237,775,026
Yellow-Poplar	66,419,544	62,116,792	37,302,679	430,731,817
MI Total	7,823,161,557	7,997,162,696	8,003,489,321	61,774,814,031

Minnesota Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2003	2004	2005	2006	2007
Austrian Pine	1,248,853	1,478,570	1,639,815	1,645,741	1,639,433
Balsam Poplar	472,924,014	446,234,455	425,470,916	399,517,637	379,662,114
Bebb Willow		662,430	653,017	653,085	753,642
Bigtooth Aspen	368,886,359	368,521,753	373,144,422	381,501,220	388,183,396
Black Locust	4,460,399	3,687,774	3,791,992	3,718,069	2,582,312
Black Willow	38,237,871	32,231,163	30,546,375	32,091,040	29,079,913
Cottonwood and Poplar spp.	493,108	619,707	623,808	670,032	1,410,953
Eastern Cottonwood	126,552,205	126,839,973	129,056,910	139,181,928	152,071,246
Eastern White Pine	450,273,576	473,090,642	482,250,521	504,327,198	519,381,528
Larch spp.	298,428	265,241	266,132	95,182	89,700
Lombardy Poplar					257,302
Peachleaf Willow	3,603,541	3,026,301	3,029,620	3,571,770	4,756,782
Quaking Aspen	3,737,773,313	3,688,880,248	3,661,645,308	3,583,043,924	3,476,481,729
Red Pine	837,149,665	868,291,590	910,738,933	925,400,893	969,459,632
Red Cedar/Juniper spp.		100,438	112,321	106,375	127,784
Scotch Pine	3,945,145	6,004,135	6,338,268	6,591,970	6,430,433
White Willow	186,422	212,775	173,622	124,858	124,750
Willow spp.	5,226,948	4,576,296	4,469,544	4,004,625	9,240,819
Yellow Birch	53,542,312	54,832,177	56,472,438	57,459,795	58,408,864
MN Total	6,104,802,159	6,079,555,668	6,090,423,962	6,043,705,342	6,000,142,332

Minnesota Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet) (Continued)

Species	2008	2009	2010	Grand Total
Austrian Pine	1,641,663	848,761	1,047,471	11,190,307
Balsam Poplar	359,875,253	358,583,157	350,415,972	3,192,683,518
Bebb Willow	669,789	108,567	107,841	3,608,371
Bigtooth Aspen	388,535,096	382,183,779	367,853,500	3,018,809,525
Black Locust	3,539,541	4,249,538	4,525,193	30,554,818
Black Willow	33,245,060	36,963,521	37,706,454	270,101,397
Cottonwood and Poplar spp.	1,320,618	8,141,217	12,479,264	25,758,707
Eastern Cottonwood	155,717,233	156,405,718	158,620,877	1,144,446,090
Eastern White Pine	557,461,302	537,040,231	549,207,110	4,073,032,108
Larch spp.				1,014,683
Lombardy Poplar	1,855,429	1,849,048	1,848,477	5,810,256
Peachleaf Willow	1,901,177	1,674,675	2,500,385	24,064,251
Quaking Aspen	3,464,011,432	3,461,929,029	3,462,912,579	28,536,677,562
Red Pine	1,022,938,947	1,078,488,664	1,118,209,971	7,730,678,295
Red Cedar/Juniper spp.	127,767			574,685
Scotch Pine	6,770,535	9,084,436	10,976,119	56,141,041
White Willow				822,427
Willow spp.	8,885,095	9,237,373	9,461,584	55,102,284
Yellow Birch	58,623,227	57,396,377	57,154,633	453,889,823
MN Total	6,067,119,164	6,104,184,091	6,145,027,430	48,634,960,148

Missouri Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2003	2004	2005	2006	2007
Black Willow	39,956,153	46,686,703	46,698,415	50,045,364	56,140,538
Eastern Cottonwood	154,194,006	145,758,737	148,369,201	182,069,163	182,770,842
Eastern White Pine	6,111,054	6,303,318	7,888,294	10,376,975	9,066,602
Peachleaf Willow	1,130,430	1,143,677	1,163,874	1,467,386	1,815,711
Scotch Pine	953,050	927,487	954,369	533,229	171,218
Shortleaf Pine	806,875,526	833,986,819	837,008,098	858,708,740	882,863,959
Swamp Cottonwood	31,573	31,573	36,625	43,763	81,058
Virginia Pine				318,353	290,327
Willow Oak	4,542,691	4,591,289	5,401,870	6,987,859	4,868,737
Yellow-Poplar	21,121,467	22,150,644	22,583,544	23,323,851	13,090,031
MO Total	1,308,569,791	1,347,597,075	1,349,532,384	1,408,969,570	1,428,577,003

Species	2008	2009	2010	Grand Total
Black Willow	51,161,131	78,084,603	88,043,319	456,816,226
Eastern Cottonwood	221,895,145	247,174,464	253,327,212	1,535,558,770
Eastern White Pine	9,991,691	9,471,056	10,507,143	69,716,133
Peachleaf Willow	653,558	573,846	478,948	8,427,430
Scotch Pine	5,101,109	2,677,533	2,770,703	14,088,698
Shortleaf Pine	900,639,952	922,957,571	928,086,060	6,971,126,725
Swamp Cottonwood				224,592
Virginia Pine	290,244	441,852	435,585	1,776,361
Willow Oak	4,202,414	6,459,723	6,762,491	43,817,074
Yellow-Poplar	17,507,379	16,140,612	18,029,798	153,947,326
MO Total	1,480,313,886	1,536,090,175	1,560,540,932	11,420,190,816

North Carolina Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2002	2003	2004	2005	2006	2007
Bigtooth Aspen				1,553,793	1,548,635	1,549,408
Birch spp.	0	0	0			
Black Locust	213,840,830	212,695,983	212,985,075	212,890,063	206,720,835	216,171,395
Black Willow		3,994,658	7,016,876	10,680,503	20,000,401	22,357,005
Coastal Plain Willow			209,280	204,471	202,616	205,431
Eastern Cottonwood	10,569,757	8,561,801	6,324,025	8,079,160	10,559,626	19,426,511
Eastern White Pine	931,895,884	954,665,079	971,159,830	1,002,933,023	997,686,762	1,031,919,384
Loblolly Pine	7,072,632,232	7,162,493,148	7,236,680,147	7,395,806,699	7,382,101,744	7,638,640,354
Longleaf Pine	426,202,812	432,804,894	415,497,918	443,874,962	455,276,230	460,539,546
Pitch Pine	135,181,542	135,170,293	136,864,420	137,821,229	116,747,049	103,416,317
Pond Pine	516,367,129	538,363,864	531,545,051	505,176,917	497,819,636	511,109,247
Red Cedar/Juniper spp.	0	0	0	0		
Shortleaf Pine	730,741,291	722,624,788	702,746,948	689,302,854	695,217,748	694,076,158
Slash Pine	88,280,300	73,982,331	69,172,823	99,663,968	90,325,774	112,687,787
Swamp Cottonwood	10,980,168	12,329,554	15,046,631	14,051,892	12,587,717	6,892,958
Table Mountain Pine	19,278,443	15,395,414	12,022,955	14,593,102	14,518,830	13,770,922
Virginia Pine	1,201,921,156	1,186,984,452	1,141,095,922	1,092,585,179	1,042,598,953	992,794,916
Willow Oak	266,341,652	255,225,583	244,703,293	239,731,198	246,460,898	245,133,991
Willow spp.	23,947,753	17,988,730	13,617,600	9,159,507	3,443,188	287,927
Yellow Birch	133,805,167	134,042,459	136,151,973	142,229,101	142,550,698	134,595,465
Yellow-Poplar	4,371,646,906	4,484,754,840	4,529,783,557	4,644,824,180	4,730,431,811	5,005,213,745
NC Total	16,340,081,173	16,540,290,145	16,576,212,517	16,845,680,691	16,857,456,989	17,404,014,764

North Carolina Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet) (Continued)

Species	2008	2009	2010	Grand Total
Bigtooth Aspen		1,513,385	1,510,502	7,675,723
Birch spp.				0
Black Locust		212,979,243	212,896,838	1,701,180,262
Black Willow		22,041,085	23,451,412	109,541,940
Coastal Plain Willow		204,471	204,471	1,230,740
Eastern Cottonwood		21,131,697	23,679,121	108,331,698
Eastern White Pine		1,038,747,908	1,069,276,464	7,998,284,334
Loblolly Pine		7,774,875,517	7,872,893,929	59,536,123,770
Longleaf Pine		468,031,552	481,154,651	3,583,382,565
Pitch Pine		104,933,626	106,079,681	976,214,157
Pond Pine		503,179,553	509,872,575	4,113,433,972
Red Cedar/Juniper spp.				0
Shortleaf Pine		694,984,512	667,760,314	5,597,454,613
Slash Pine		112,916,888	109,581,709	756,611,580
Swamp Cottonwood		7,257,861	4,528,712	83,675,493
Table Mountain Pine		13,691,706	13,513,842	116,785,214
Virginia Pine		1,017,247,272	992,935,934	8,668,163,784
Willow Oak		243,471,535	246,561,632	1,987,629,782
Willow spp.		288,000	287,900	69,020,605
Yellow Birch		146,768,693	138,933,907	1,109,077,463
Yellow-Poplar		5,063,815,480	5,101,330,245	37,931,800,764
NC Total		17,644,543,208	17,778,371,359	135,986,650,846

North Dakota Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2003	2004	2005	2006	2007
Balsam Poplar	10,764,359	8,927,366	11,858,392	8,539,972	7,367,143
Black Willow	281,503	212,585	168,935	3,622,872	4,340,302
Eastern Cottonwood	138,698,986	170,904,106	161,157,526	149,041,653	145,190,737
Peachleaf Willow	1,524,238	1,223,403	1,047,011	1,013,189	1,018,126
Plains Cottonwood					
Ponderosa Pine					3,395,343
Quaking Aspen	100,079,211	94,634,839	100,685,247	90,439,395	72,512,346
Rocky Mountain Juniper	30,032,945	33,016,709	32,344,406	33,635,140	42,170,318
White Willow	4,305,630	3,251,517	2,583,888		
Willow spp.		4,493,391	3,897,723	3,497,043	3,496,176
ND Total	285,686,872	316,663,916	313,743,128	289,789,264	279,490,491

Species	2008	2009	2010	Grand Total
Balsam Poplar	7,755,264	7,279,880	5,351,613	67,843,989
Black Willow	3,751,897	3,772,931	3,772,931	19,923,956
Eastern Cottonwood	110,524,501	62,604,561	40,710,344	978,832,414
Peachleaf Willow	1,262,144	1,295,092	1,254,216	9,637,419
Plains Cottonwood	49,357,314	89,316,295	127,130,255	265,803,864
Ponderosa Pine	3,383,593	3,397,895	3,397,393	13,574,224
Quaking Aspen	74,677,724	69,010,613	76,085,324	678,124,699
Rocky Mountain Juniper	37,456,112	38,700,684	41,238,751	288,595,065
White Willow				10,141,035
Willow spp.	3,509,130			18,893,463
ND Total	291,677,679	275,377,951	298,940,827	2,351,370,128

Nebraska Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2003	2004	2005	2006	2007
Austrian Pine					
Black Willow	32,424,139	26,362,918	27,841,099	38,845,592	32,286,173
Eastern Cottonwood	610,886,666	513,452,069	519,344,104	548,489,382	530,813,533
Eastern White Pine					
Norway Spruce	200,706	143,716	106,072	114,107	113,981
Peachleaf Willow	1,967,355	1,459,547	1,173,549	1,205,662	904,116
Plains Cottonwood	8,281,800	6,190,436	50,449,885	58,672,437	64,161,541
Ponderosa Pine	238,995,846	301,037,551	321,085,066	304,533,694	313,781,384
Rocky Mountain Juniper	18,635,092	20,052,563	19,224,700	22,975,716	27,371,103
Scotch Pine	967,829	798,239	641,989	381,839	
NE Total	921,473,793	876,329,234	945,422,590	980,667,213	974,731,341

Species	2008	2009	2010	Grand Total
Austrian Pine	1,722,513	1,677,509	1,690,122	5,090,144
Black Willow	29,513,154	36,488,766	30,981,019	254,742,860
Eastern Cottonwood	402,770,144	415,775,628	310,947,097	3,852,478,623
Eastern White Pine	192,380	187,353	188,762	568,495
Norway Spruce	117,720	114,060	114,114	1,024,476
Peachleaf Willow	312,065	550,259	554,396	8,126,949
Plains Cottonwood	122,623,939	208,358,017	309,102,350	827,840,405
Ponderosa Pine	290,128,605	326,671,976	318,513,513	2,414,747,635
Rocky Mountain Juniper	14,051,914	15,988,876	14,319,485	152,619,449
Scotch Pine	192,885	187,846	189,258	3,359,885
NE Total	869,305,169	1,011,857,867	992,428,029	7,572,215,236

New Hampshire Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2005	2006	2007	2008	2009	2010	Grand Total
Balsam Poplar	6,653,865	5,497,067	6,505,349	6,300,740	6,250,879	6,335,763	37,543,663
Bigtooth Aspen	86,030,632	68,499,637	69,473,840	76,061,616	72,371,869	67,514,763	439,952,357
Black Locust			215,889	215,193	236,698	236,698	904,478
Eastern Cottonwood	764,121	532,756	210,681	1,021,637	989,389	1,003,324	4,521,908
Eastern White Pine	2,172,357,811	2,100,468,530	2,033,184,829	2,077,810,089	2,112,625,925	2,136,149,389	12,632,596,573
Pitch Pine	36,213,156	25,865,574	21,499,376	23,006,760	23,220,252	24,879,049	154,684,167
Quaking Aspen	146,900,466	122,346,560	137,845,178	140,016,643	139,262,190	127,151,157	813,522,194
Red Pine	27,241,226	36,544,174	42,793,310	41,058,687	42,325,543	42,402,682	232,365,622
Scotch Pine	2,903,874	2,054,192	1,642,501				6,600,567
Willow spp.	298,323	371,963	228,078	522,186	551,900	577,020	2,549,470
Yellow Birch	602,327,626	606,081,222	609,597,528	617,422,396	613,797,775	612,837,827	3,662,064,374
NH Total	3,081,691,100	2,968,261,675	2,923,565,852	2,983,809,901	3,012,009,555	3,019,452,506	17,988,790,589

New York Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2005	2006	2007	2008	2009	Grand Total
Austrian Pine	1,568,052	1,151,001	847,234	876,138	303,309	4,745,734
Balsam Poplar	9,799,371	18,030,136	11,594,792	12,043,344	10,750,722	62,218,365
Bebb Willow					140,811	140,811
Bigtooth Aspen	357,486,521	361,300,380	384,142,040	380,337,762	357,067,760	1,840,334,463
Black Willow	263,730,858	226,150,766	204,262,351	220,401,652	205,658,796	1,120,204,423
Douglas-Fir	370,901	2,815,297	4,224,324	2,602,241	3,187,031	13,199,794
Eastern Cottonwood	84,405,475	128,763,091	143,574,578	159,786,385	168,151,590	684,681,119
Eastern White Pine	2,884,903,922	2,902,825,594	3,041,860,893	3,026,858,772	3,011,984,230	14,868,433,411
Larch spp.	47,418,802	55,511,052	67,687,641	70,176,196	74,263,818	315,057,509
Mountain-Ash spp.					375,898	375,898
Norway spruce	383,904,984	341,519,245	307,186,312	293,944,273	307,605,296	1,634,160,110
Pitch Pine	85,977,581	88,063,767	106,962,064	103,380,242	119,313,128	503,696,782
Quaking Aspen	857,028,318	828,807,098	812,257,107	839,970,196	796,400,232	4,134,462,951
Red Pine	497,054,368	511,347,549	496,902,416	462,779,405	496,966,979	2,465,050,717
Red Cedar/Juniper spp.	105,160	62,924	69,047	49,736	138,052	424,919
Scotch Pine	117,525,079	157,702,045	180,631,780	189,716,245	185,233,155	830,808,304
Table Mountain Pine		1,287,191	658,774	670,616	672,486	3,289,067
Virginia Pine		5,151,418	2,636,454	2,683,848	2,691,330	13,163,050
Weeping Willow					12,129,594	12,129,594
White Willow	12,565,488	11,095,903	9,042,794	8,686,365	12,022,937	53,413,487
Willow spp.	3,773,389	3,742,039	3,375,570	4,028,816	989,219	15,909,033
Yellow Birch	1,952,944,771	2,025,445,582	1,969,581,267	1,962,194,014	1,979,236,134	9,889,401,768
Yellow-Poplar	113,095,191	97,799,902	100,565,546	93,476,806	107,438,253	512,375,698
NY Total	7,774,646,642	7,856,103,602	7,968,020,613	7,953,344,550	7,984,031,914	39,536,147,321

Ohio Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2004	2005	2006	2007	2008	2009	Grand Total
Austrian Pine	5,537,849	6,186,858	3,948,928	4,193,111	7,793,654	9,784,882	37,445,282
Bigtooth Aspen	311,266,543	278,881,728	306,397,862	325,682,468	337,016,903	338,138,514	1,897,384,018
Black Willow	52,394,807	56,004,091	54,847,297	57,895,282	56,256,042	58,591,091	335,988,610
Eastern Cottonwood	178,284,389	133,789,197	169,069,816	176,204,770	158,384,910	165,586,140	981,319,222
Eastern White Pine	275,276,509	280,951,403	277,925,378	258,809,904	247,980,546	258,805,563	1,599,749,303
Loblolly Pine	282,561	4,291,076	3,795,647	5,079,753	5,221,634	6,360,407	25,031,078
Peachleaf Willow	64,271	44,408	53,367	44,675	29,022		235,743
Pitch Pine	48,608,913	38,833,703	31,723,157	32,620,359	24,163,499	25,206,759	201,156,390
Quaking Aspen	47,138,204	40,261,329	36,764,829	37,176,049	37,866,642	33,761,060	232,968,113
Red Pine	50,560,964	43,172,835	38,111,940	34,770,014	26,420,602	36,333,866	229,370,221
Red Cedar/Juniper spp.	1,229,211	904,670	1,032,416	907,867	907,866		4,982,030
Scotch Pine	14,534,260	21,686,619	27,177,926	26,449,315	25,232,592	26,548,796	141,629,508
Shortleaf Pine	2,880,740	1,791,976	1,430,282	401,379		311,734	6,816,111
Swamp Cottonwood	939,651	663,023	402,805	461,937			2,467,416
Virginia Pine	125,833,283	117,954,579	108,569,785	103,012,831	100,378,397	98,771,490	654,520,365
White Willow	61,870	50,507	36,439	36,343	36,506		221,665
Willow spp.	1,528,169	1,172,204	844,763	524,445			4,069,581
Yellow Birch	5,715,146	5,324,062	3,843,783	3,894,190	3,512,298	2,786,450	25,075,929
Yellow-Poplar	1,551,057,353	1,451,668,258	1,468,215,108	1,517,173,660	1,550,811,241	1,565,023,203	9,103,948,823
OH Total	2,974,479,363	2,768,542,301	2,786,600,285	2,840,182,372	2,838,409,974	2,876,707,414	17,084,921,709

Pennsylvania Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2004	2005	2006	2007	2008	2009	Grand Total
Austrian Pine	922,059	916,556	1,354,814	1,459,217	977,150	976,260	6,606,056
Balsam Poplar	5,777,232	5,781,531	3,993,250	7,345,845	5,495,281	408,836	28,801,975
Bigtooth Aspen	411,062,559	400,097,546	386,399,405	394,902,115	380,230,600	392,697,922	2,365,390,147
Black Willow	37,527,853	46,123,656	43,594,834	45,466,047	34,663,100	42,991,897	250,367,387
Douglas-Fir	3,421,479	3,438,683	6,509,049	5,896,063	5,058,071	3,174,099	27,497,444
Eastern Cottonwood	40,414,229	41,256,079	41,977,315	44,916,982	48,348,969	46,965,907	263,879,481
Eastern White Pine	784,205,923	805,380,607	867,082,012	872,166,675	930,497,458	948,708,686	5,208,041,361
Larch spp.	33,084,622	34,501,565	39,819,428	35,170,531	28,502,299	32,208,677	203,287,122
Loblolly pine	177,199	177,199					354,398
Peachleaf Willow	466,844	466,844	363,697	363,697	124,622	110,926	1,896,630
Pitch Pine	104,500,200	104,837,010	106,008,840	102,074,745	101,102,940	104,945,530	623,469,265
Quaking Aspen	207,417,716	223,711,569	235,807,999	236,899,928	235,448,958	238,857,652	1,378,143,822
Red Pine	156,029,377	148,617,071	145,803,109	138,133,158	134,098,244	132,864,628	855,545,587
Red Cedar/Juniper spp.	662,706	662,706	757,998		95,197	143,007	2,321,614
Scotch Pine	69,657,304	79,456,167	79,191,381	77,429,673	61,310,103	70,803,903	437,848,531
Shortleaf Pine	878,864	2,752,243	4,070,392	3,087,052	3,009,841	1,210,123	15,008,515
Table Mountain Pine	6,768,002	6,846,446	3,437,238	4,606,597	4,938,610	5,581,998	32,178,891
Virginia Pine	142,262,900	138,009,534	143,694,059	143,794,766	150,420,430	157,747,615	875,929,304
Willow spp.	7,507,652	6,997,035	3,306,772	11,131,724	7,848,785	8,574,410	45,366,378
Yellow Birch	328,153,544	328,577,061	328,286,745	319,100,627	318,219,180	314,157,753	1,936,494,910
Yellow-Poplar	1,426,252,111	1,456,823,569	1,531,875,928	1,527,866,813	1,598,018,231	1,674,713,975	9,215,550,627
PA Total	4,247,267,980	4,323,432,093	4,455,687,100	4,444,553,743	4,508,972,601	4,645,114,975	26,625,028,492

Rhode Island Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2005	2006	2007	2008	2009	2010	Grand Total
Balsam Poplar	218,857	139,446	85,271	138,966	142,167	143,584	868,291
Bigtooth Aspen	4,141,001	9,650,589	8,043,916	8,439,268	7,495,821	6,386,096	44,156,691
Eastern White Pine	101,034,929	132,595,872	134,827,756	143,816,293	135,800,364	130,935,275	779,010,489
Pitch Pine	30,920,532	26,326,069	21,845,554	20,668,549	18,891,837	18,802,475	137,455,016
Quaking Aspen		48,129	19,134	27,530	20,314	18,436	133,543
Scotch Pine					27,400	27,726	55,126
Willow spp.		27,404	17,486	17,156	17,368	318,815	398,229
Yellow Birch	12,651,553	9,172,531	8,786,640	10,690,540	8,448,719	12,091,446	61,841,429
Yellow-Poplar	1,925,765	1,259,582	909,857	1,276,389	1,138,604	3,162,120	9,672,317
RI Total	152,696,828	180,383,889	175,278,515	185,803,548	171,982,594	171,885,973	1,038,031,347

South Carolina Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2001	2002	2003	2004	2005	2006
Black Willow		189,261	3,767,360	5,945,868	17,514,467	21,096,062
Eastern Cottonwood	48,039,971	48,153,926	48,607,876	45,716,284	33,904,503	36,003,271
Eastern White Pine	66,683,022	72,070,515	75,783,319	77,727,629	75,717,355	76,560,379
Loblolly Pine	7,553,457,601	7,570,647,257	7,771,870,695	8,066,252,687	8,251,553,461	8,549,530,258
Longleaf Pine	491,647,436	506,949,772	498,474,931	514,085,523	518,604,255	529,960,634
Pitch Pine	4,329,942	4,289,569	4,291,029	9,378,139	8,914,924	8,967,624
Pond Pine	182,792,149	192,953,207	180,863,951	171,140,249	157,926,602	143,234,795
Shortleaf Pine	436,135,356	410,203,272	406,885,565	384,136,065	368,079,542	375,673,948
Slash Pine	227,279,454	195,702,779	184,654,890	188,427,440	194,660,452	196,499,189
Spruce Pine	14,330,246	14,431,502	14,443,442	10,538,840	6,290,462	6,712,032
Swamp Cottonwood	11,933,724	13,010,057	14,382,961	13,432,561	23,623,194	23,937,254
Virginia Pine	286,157,256	293,501,318	301,082,936	292,331,326	281,205,609	263,891,279
Weeping Willow					66,535	65,819
Willow Oak	340,800,429	357,029,461	358,415,599	380,009,750	366,287,314	368,530,994
Willow spp.	23,016,146	20,820,047	13,831,680	11,076,031	4,862,234	2,314,033
Yellow Birch	1,641,383	2,194,793	2,199,562	1,108,937	764,059	762,373
Yellow-Poplar	923,325,143	945,348,439	913,541,065	964,584,884	962,482,379	947,397,861
SC Total	10,659,352,127	10,695,340,189	10,840,114,299	11,184,767,015	11,322,116,213	11,597,611,714

South Carolina Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet) (Continued)

Species	2007	2008	2009	2010	Grand Total
Black Willow	25,238,552	26,016,108	25,966,991	24,738,552	150,473,221
Eastern Cottonwood	37,376,401	37,330,822	38,415,883	38,368,078	411,917,015
Eastern White Pine	79,122,939	80,089,448	81,856,232	83,225,654	768,836,492
Loblolly Pine	8,822,361,346	9,043,100,616	9,241,218,208	9,563,814,843	84,433,806,972
Longleaf Pine	540,713,674	550,153,010	563,188,549	570,501,934	5,284,279,718
Pitch Pine	8,967,624	8,196,270	9,824,300	9,903,697	77,063,118
Pond Pine	149,713,727	152,129,478	155,527,203	154,240,069	1,640,521,430
Shortleaf Pine	379,074,165	377,691,032	366,650,218	365,103,740	3,869,632,903
Slash Pine	204,940,339	204,152,433	188,110,925	186,202,250	1,970,630,151
Spruce Pine	9,684,023	9,752,992	10,284,163	13,891,715	110,359,417
Swamp Cottonwood	25,993,243	29,318,974	30,748,762	33,659,850	220,040,580
Virginia Pine	259,351,088	260,680,272	266,969,898	253,039,963	2,758,210,945
Weeping Willow	65,819	65,467	64,096	104,453	432,189
Willow Oak	387,516,573	384,572,735	388,915,904	392,456,149	3,724,534,908
Willow spp.					75,920,171
Yellow Birch	833,488	1,034,704	1,034,199	840,922	12,414,420
Yellow-Poplar	951,963,725	973,799,189	1,003,919,925	1,020,673,361	9,607,035,971
SC Total	11,924,746,426	12,179,692,769	12,415,277,663	12,755,130,007	115,574,148,422

South Dakota Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2003	2004	2005	2006	2007
Eastern Cottonwood	85,882,262	70,971,830	68,075,253	84,814,471	87,456,280
Plains Cottonwood					770,604
Ponderosa Pine	1,895,762,984	1,791,529,896	1,706,468,017	1,701,376,926	1,732,419,513
Quaking Aspen	22,142,481	28,554,110	25,569,966	23,671,776	21,404,019
Red Pine					
Rocky Mountain Juniper	6,087,059	6,345,760	16,195,979	17,057,925	25,681,573
White Willow			3,900,365	4,550,952	4,769,760
Willow spp.	1,232,177	1,012,373	780,365	908,349	48,706
SD Total	2,011,106,963	1,898,413,969	1,820,989,945	1,832,380,399	1,872,550,455

Species	2008	2009	2010	Grand Total
Eastern Cottonwood	70,604,538	69,125,295	52,729,527	589,659,456
Plains Cottonwood	21,137,743	17,770,976	46,308,497	85,987,820
Ponderosa Pine	1,737,044,415	1,727,121,906	1,738,965,028	14,030,688,685
Quaking Aspen	20,272,264	19,380,404	18,956,433	179,951,453
Red Pine			5,483,090	5,483,090
Rocky Mountain Juniper	33,606,563	34,675,299	25,602,630	165,252,788
White Willow	4,138,219	4,506,734	4,741,128	26,607,158
Willow spp.	39,105	47,479	47,479	4,116,033
SD Total	1,886,842,847	1,872,628,093	1,892,833,812	15,087,746,483

Tennessee Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2000	2001	2002	2003	2004	2005
Bigtooth Aspen	401,609	1,111,425	1,108,673	1,101,168	1,115,814	792,770
Birch spp.	782,142	245,827	245,998	244,756		
Black Willow		1,059,430	6,698,021	16,921,591	27,311,089	62,074,592
Cottonwood and Poplar spp.		1,751,534	2,127,523	2,106,575	2,128,836	2,124,505
Eastern Cottonwood	31,972,353	22,712,779	18,177,567	19,169,963	14,484,250	15,575,741
Eastern White Pine	483,571,412	479,554,220	484,812,237	501,250,834	483,631,567	458,395,283
Loblolly Pine	842,102,144	788,468,235	715,468,726	689,153,276	696,416,427	654,965,319
Pitch Pine	69,436,249	66,179,628	62,346,441	53,898,624	48,120,587	36,794,745
Shortleaf Pine	704,772,498	653,870,371	586,976,610	543,946,434	488,515,458	427,213,475
Swamp Cottonwood	0	0	0	0		
Table Mountain Pine	21,984,589	19,971,551	10,730,846	8,738,732	5,848,021	5,427,831
Virginia Pine	1,079,735,638	1,016,130,897	942,964,166	849,291,835	768,205,021	668,417,663
Willow spp.	80,323,517	76,803,033	75,108,442	68,866,123	55,469,667	16,522,244
Yellow Birch	86,389,431	83,101,613	88,958,186	90,543,379	85,484,354	107,477,307
Yellow-Poplar	2,531,041,279	2,597,604,372	2,687,429,087	2,755,000,709	2,859,691,334	2,891,333,308
TN Total	6,302,289,649	6,180,976,546	6,055,719,860	5,975,879,087	5,912,710,139	5,738,800,562

Species	2006	2007	2008	2009	2010	Grand Total
Bigtooth Aspen	954,773	948,429	948,429	952,396	958,810	10,394,296
Birch spp.						1,518,723
Black Willow	68,134,791	100,800,306	94,479,082	100,560,103	95,469,477	573,508,482
Cottonwood and Poplar spp.	367,057					10,606,030
Eastern Cottonwood	19,353,413	20,214,001	20,751,589	29,837,713	33,025,410	245,274,779
Eastern White Pine	453,623,067	454,209,544	467,464,688	472,946,791	515,315,556	5,254,775,199
Loblolly Pine	680,014,173	718,685,843	771,868,447	803,880,601	843,480,490	8,204,503,681
Pitch Pine	29,018,947	38,480,422	38,479,432	37,923,199	29,627,259	510,305,533
Shortleaf Pine	419,689,503	421,932,919	409,058,605	400,756,802	420,065,157	5,476,797,832
Swamp Cottonwood						0
Table Mountain Pine	4,152,972	5,904,059	5,896,858	6,096,794	6,631,794	101,384,047
Virginia Pine	616,184,007	623,599,478	632,386,112	629,959,390	618,746,301	8,445,620,508
Willow spp.	11,218,095					384,311,121
Yellow Birch	98,416,229	100,621,728	104,506,348	98,002,377	82,226,036	1,025,726,988
Yellow-Poplar	2,995,114,940	3,029,659,050	3,075,691,242	3,128,118,377	3,218,941,010	31,769,624,708
TN Total	5,773,993,211	5,880,843,845	5,991,195,902	6,075,555,814	6,234,412,502	66,122,377,117

Virginia Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2001	2002	2003	2004	2005
Bigtooth Aspen	15,989,687	14,083,276	14,467,618		18,695,502
Birch spp.	125,038	124,798	123,557		121,740
Black Willow		49,581	522,155		3,540,513
Eastern Cottonwood	2,377,552	2,415,014	2,370,138		3,775,430
Eastern White Pine	707,841,365	670,026,763	667,886,878		703,370,176
Loblolly Pine	3,653,146,394	3,704,186,016	3,801,929,213		3,979,047,559
Pitch Pine	211,644,442	202,970,529	208,937,434		193,935,864
Pond Pine	9,351,023	7,415,684	8,515,795		8,633,130
Shortleaf Pine	376,053,047	355,192,553	349,338,704		327,968,040
Southern Magnolia	0	0	0		0
Table Mountain Pine	82,274,307	84,454,391	81,786,447		76,802,126
Umbrella Magnolia					63,585
Virginia Pine	1,534,149,406	1,524,110,531	1,547,854,743		1,561,284,342
Weeping Willow					
White Willow					
Willow Oak	142,816,902	143,541,790	143,729,713		147,285,348
Willow spp.	3,456,782	3,374,236	2,399,802		2,553,833
Yellow Birch	28,088,873	28,343,410	27,288,881		29,815,859
Yellow-Poplar	4,581,275,164	4,598,170,614	4,653,901,255		4,802,949,134
VA Total	11,769,218,124	11,756,343,673	11,924,004,593		12,261,997,845

Virginia Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet) (Continued)

Species	2006	2007	2008	2009	2010	Grand Total
Bigtooth Aspen	18,845,716	26,165,984	26,036,410	25,602,892	25,113,750	185,000,835
Birch spp.						495,133
Black Willow	3,623,289	4,002,819	4,636,823	6,555,863	6,721,814	29,652,857
Eastern Cottonwood	3,645,083	1,809,465	1,809,465	1,882,956	1,795,730	21,880,833
Eastern White Pine	737,026,260	774,928,258	791,416,934	839,964,239	875,201,706	6,767,662,579
Loblolly Pine	3,992,124,600	4,261,296,526	4,271,643,619	4,448,902,906	4,595,310,628	36,707,587,461
Pitch Pine	193,468,058	209,112,357	212,609,505	204,930,493	214,545,807	1,852,154,489
Pond Pine	8,154,563	6,177,047	6,352,735	2,117,478	2,111,743	58,829,198
Shortleaf Pine	323,856,846	307,967,734	303,198,205	278,182,729	268,940,571	2,890,698,429
Southern Magnolia	0	50,380	50,257	50,135	50,257	201,029
Table Mountain Pine	83,169,900	84,889,502	87,031,455	91,376,746	93,134,540	764,919,414
Umbrella Magnolia	721,702	736,477	1,311,199	1,322,411	1,473,596	5,628,970
Virginia Pine	1,513,620,241	1,488,220,708	1,466,285,063	1,363,906,018	1,346,723,749	13,346,154,801
Weeping Willow				131,509	125,417	256,926
White Willow		623,614	623,614	1,732,873	2,108,040	5,088,141
Willow Oak	147,622,621	155,595,824	160,295,307	161,262,822	168,264,527	1,370,414,854
Willow spp.	1,901,308	1,037,387	1,036,595			15,759,943
Yellow Birch	37,802,249	36,316,274	34,726,413	36,230,126	33,933,783	292,545,868
Yellow-Poplar	4,957,608,115	5,045,692,647	5,132,036,669	5,364,026,319	5,473,080,437	44,608,740,354
VA Total	12,411,907,772	12,787,868,878	12,898,291,836	13,218,076,955	13,499,584,777	112,527,294,453

Texas Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2003	2004	2005	2006	2007
Ashe Juniper					3,076,773,959
Birch spp.	86,589	86,990	86,757		
Black Willow	34,960,198	40,638,189	39,655,477	44,248,662	92,932,168
Cottonwood and Poplar spp.	3,347,948	3,384,533	3,379,349	3,323,328	3,313,166
Douglas-Fir					
Eastern Cottonwood	47,417,343	48,055,901	50,878,561	54,606,204	126,279,584
Loblolly Pine	7,242,908,283	7,345,519,190	7,372,439,056	7,408,310,173	7,661,966,748
Longleaf Pine	103,050,230	96,436,339	95,070,837	87,453,168	85,526,100
Peachleaf Willow	498,732	432,198	468,729	36,839	36,814
Plains Cottonwood					142,425,161
Ponderosa Pine					
Rocky Mountain Juniper					5,012,564
Shortleaf Pine	1,465,199,161	1,469,062,180	1,494,398,052	1,433,452,801	1,384,086,883
Slash Pine	247,759,984	253,219,395	237,113,394	278,594,341	263,770,710
Virginia Pine	6,531,722	6,192,792	5,500,215	468,542	467,780
Weeping Willow					749,942
White Willow	1,190,608	1,198,572	1,190,608	749,511	762,129
Willow spp.	9,610,012	5,346,327	5,310,539	4,620,713	976,272
Pinchot Juniper					183,249,617
Redberry Juniper					327,131,241
Drooping Juniper					275,814
Alligator Juniper					21,139,490
Oneseed Juniper					10,982,343
Common or Two-Needle Pinyon					1,091,476
Mexican Pinyon Pine					24,306,701
Papershell Pinyon Pine					14,462,267
TX Total	9,668,976,951	9,787,070,241	9,838,255,594	9,863,867,175	14,172,449,437

Texas Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet) (Continued)

Species	2008	2009	2010	Grand Total
Ashe Juniper	3,015,117,231	3,093,519,867		9,185,411,057
Birch spp.				260,336
Black Willow	88,392,048	85,334,959	41,455,738	467,617,439
Cottonwood and Poplar spp.				16,748,324
Douglas-Fir	1,217,983	1,030,673		2,248,656
Eastern Cottonwood	125,780,143	118,817,863	34,454,043	606,289,642
Loblolly Pine	7,713,722,899	7,856,862,200	7,811,279,688	60,413,008,237
Longleaf Pine	70,872,595	64,915,169	65,233,908	668,558,346
Peachleaf Willow	36,757	36,870	371,309	1,918,248
Plains Cottonwood	115,309,951	96,813,651		354,548,763
Ponderosa Pine	183,264	155,081		338,345
Rocky Mountain Juniper	4,054,396	3,405,480		12,472,440
Shortleaf Pine	1,353,766,632	1,368,210,895	1,327,870,819	11,296,047,423
Slash Pine	241,928,831	245,409,462	208,598,101	1,976,394,218
Virginia Pine	246,190	246,528	124,420	19,778,189
Weeping Willow	603,582	505,829		1,859,353
White Willow	777,843	772,533	775,179	7,416,983
Willow spp.				25,863,863
Pinchot Juniper	225,588,197	249,896,766		658,734,580
Redberry Juniper	269,948,473	240,650,790		837,730,504
Drooping Juniper	201,751	170,724		648,289
Alligator Juniper	17,776,887	15,654,736		54,571,113
Oneseed Juniper	8,910,941	18,521,237		38,414,521
Common or Two-Needle Pinyon	2,799,686	2,546,899		6,438,061
Mexican Pinyon Pine	20,021,826	21,267,371		65,595,898
Papershell Pinyon Pine	12,552,905	19,699,268		46,714,440
TX Total	14,045,893,596	14,228,393,176	10,021,749,246	91,626,655,416

Vermont Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2005	2006	2007	2008	2009	2010	Grand Total
Balsam Poplar	7,560,602	6,543,246	11,676,921	12,035,333	12,844,149	13,056,037	63,716,288
Bigtooth Aspen	26,922,039	50,312,895	61,895,062	62,111,580	60,270,433	64,212,393	325,724,402
Black Willow		3,758,833	4,204,773	4,154,350	3,453,650		15,571,606
Eastern Cottonwood	1,850,614	6,879,314	11,694,681	11,123,349	13,248,643	13,799,945	58,596,546
Eastern White Pine	844,038,790	967,401,883	955,558,745	937,225,725	961,936,640	954,097,109	5,620,258,892
Larch spp.	2,116,806	1,312,580	916,535				4,345,921
Quaking Aspen	173,586,671	148,768,488	150,070,116	150,097,115	153,153,514	144,409,584	920,085,488
Red Pine	26,961,717	21,147,777	15,617,308	15,655,446	18,426,028	19,121,459	116,929,735
Scotch Pine	13,833,939	9,632,345	9,998,876	10,091,165	11,045,194	11,060,134	65,661,653
Willow spp.	40,519	22,030	123,404	154,816	242,995	235,084	818,848
Yellow Birch	703,750,157	656,818,945	728,382,090	726,844,148	750,417,911	747,658,800	4,313,872,051
VT Total	1,879,085,077	1,919,726,580	1,983,476,966	1,957,913,687	2,021,918,376	2,005,401,748	11,767,522,434

West Virginia Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2004	2005	2006	2007	2008	2009	Grand Total
Bigtooth Aspen	31,226,734	50,131,030	62,131,428	76,654,309	98,002,444	90,672,048	408,817,993
Black Willow		393,599	195,099	332,656	235,147	256,612	1,413,113
Cucumbertree	238,452,063	260,154,056	286,976,587	269,639,411	289,657,737	283,887,666	1,628,767,520
Eastern White Pine	405,960,200	371,691,436	348,417,812	339,193,023	361,251,709	362,613,333	2,189,127,513
Loblolly Pine	25,011,483	18,331,035	20,977,985	18,974,546	19,334,412	23,962,531	126,591,992
Pitch Pine	44,656,219	70,880,949	70,527,740	74,705,122	84,312,324	86,974,935	432,057,289
Quaking Aspen				5,284,559	4,518,568	3,426,071	13,229,198
Red Pine			1,234,158	1,823,920	3,168,271	3,772,340	9,998,689
Scotch Pine	4,135,475	3,934,300	2,833,126	2,386,621	1,966,870	1,199,197	16,455,589
Shortleaf Pine	34,031,495	20,096,887	15,473,042	10,411,721	9,695,685	7,636,554	97,345,384
Table Mountain Pine	30,724,948	37,406,697	59,592,034	37,384,859	31,157,802	32,931,527	229,197,867
Virginia Pine	468,986,448	353,433,255	299,721,181	356,017,192	336,468,370	352,187,656	2,166,814,102
Yellow Birch	310,210,062	308,889,638	271,527,715	268,991,526	289,672,462	292,752,018	1,742,043,421
Yellow-Poplar	3,786,465,740	3,829,447,741	3,999,757,533	3,843,666,656	3,895,704,092	3,930,390,164	23,285,431,926
WV Total	5,698,051,655	5,711,093,815	5,826,057,403	5,703,795,374	5,830,568,753	5,876,275,770	34,645,842,770

Wisconsin Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet)

Species	2003	2004	2005	2006	2007
Austrian Pine	68,415	56,187	56,822		
Balsam Poplar	46,823,700	43,885,591	42,400,947	38,714,589	33,943,325
Bebb Willow			67,780	89,934	192,756
Bigtooth Aspen	737,497,013	723,029,721	713,825,729	719,759,831	721,147,446
Black Willow	29,638,059	33,849,589	39,608,246	41,060,904	41,333,757
Douglas-Fir	131,175	110,474	111,823	103,507	106,179
Eastern Cottonwood	60,207,599	62,455,930	69,415,782	66,487,097	70,337,129
Eastern White Pine	1,281,475,107	1,306,956,291	1,325,195,646	1,355,602,658	1,388,909,345
Larch spp.	1,178,913	941,406	109,125	106,114	183,464
Norway Spruce	14,081,822	11,650,823	13,039,037	13,555,499	12,418,589
Peachleaf Willow	801,644	701,695	632,925	587,215	451,818
Quaking Aspen	1,865,795,942	1,831,450,056	1,805,738,497	1,791,131,405	1,776,607,289
Red Pine	1,394,114,905	1,401,564,197	1,431,709,935	1,472,174,963	1,485,835,022
Red Cedar/Juniper spp.		19,905	20,074	19,785	17,469
Scotch Pine	14,896,957	15,657,678	17,089,387	18,564,896	19,412,833
White Willow	1,522,061	1,211,988	1,217,943	1,266,664	1,876,021
Willow spp.	1,492,995	1,221,623	1,218,049	147,490	305,165
Yellow Birch	330,364,642	335,506,140	337,358,107	335,306,175	338,140,199
Silver Poplar		146,590	154,734	278,291	168,467
WI Total	5,796,943,385	5,793,914,956	5,822,305,997	5,879,710,335	5,915,117,063

Wisconsin Net Tree Volume on Forest Land By Species or Species Grouping (in Cubic Feet) (Continued)

Species	2008	2009	2010	Grand Total
Austrian Pine				181,424
Balsam Poplar	31,598,236	30,827,069	31,678,873	299,872,330
Bebb Willow	553,900	535,227	672,537	2,112,134
Bigtooth Aspen	719,505,705	693,620,965	682,283,724	5,710,670,134
Black Willow	40,543,073	41,057,966	39,924,834	307,016,428
Douglas-Fir	181,719	175,721	175,925	1,096,523
Eastern Cottonwood	84,823,499	90,269,721	79,223,177	583,219,934
Eastern White Pine	1,471,096,049	1,527,145,080	1,608,896,680	11,265,276,856
Larch spp.	127,192	123,583	123,726	2,893,523
Norway Spruce	14,395,963	15,635,439	16,730,097	111,507,269
Peachleaf Willow	330,481	413,585	354,564	4,273,927
Quaking Aspen	1,783,731,065	1,788,681,485	1,778,379,054	14,421,514,793
Red Pine	1,507,605,841	1,535,730,604	1,596,567,135	11,825,302,602
Red Cedar/Juniper spp.	24,240			101,473
Scotch Pine	19,511,549	19,862,697	22,182,814	147,178,811
White Willow				7,094,677
Willow spp.	327,756	368,312	4,127,970	9,209,360
Yellow Birch	348,654,776	353,377,748	346,182,677	2,724,890,464
Silver Poplar	151,493			899,575
WI Total	6,048,851,574	6,134,559,208	6,245,277,251	47,636,679,769

Exhibit 3.

Sample FS Species Groupings
Cottonwoods/Poplars

Group ID 37 Eastern Cottonwood and Poplar

Scientific Name	Common Name
Populus alba	silver poplar
P. angustifolia	narrowleaf cottonwood
P. balsamifera	balsam poplar
P. balsamifera ssp. trichocarpa	black cottonwood
P. deltoides	eastern cottonwood
P. deltoides ssp. monilifera	plains cottonwood
P. fremontii	Fremont cottonwood
P. grandidentata	bigtooth aspen
P. heterophylla	swamp cottonwood
P. nigra	Lombardy poplar
P. tremuloides	quaking aspen
Other miscellaneous *Populus* spp.	cottonwood and poplar

Group ID 44 Western Cottonwood and Poplar

Scientific Name	Common Name
P. angustifolia	narrowleaf cottonwood
P. balsamifera	balsam poplar
P. balsamifera ssp. trichocarpa	black cottonwood
P. deltoides	eastern cottonwood
P. deltoides ssp. monilifera	plains cottonwood
P. fremontii	Fremont cottonwood
P. nigra	Lombardy poplar
P. tremuloides	quaking aspen
Other miscellaneous *Populus* spp.	cottonwood and poplar

Appendix C

FSA Information Service Centers Contacted

Sue Ellen Sloca	1400 Independence Ave SW Rm 3617 Mailstop 0506 Washington, DC 20250	202-720-1598 (w)
John Underwood	Beacon Facility STOP 8368 9240 Troost Ave Kansas City, MO 64131	816-926-6992 (w) john.underwood@kcc.usda.gov
Vickie Lane	4121 Carmichael Rd Ste 600 Montgomery, AL 36106	334-279-3508 (w) vickie.lane@al.usda.gov
Donna Kramer	800 W Evergreen Ste 216 Palmer, AK 99645	907-761-7753 (w) donna.kramer@ak.usda.gov
Mark Grubbs	230 N 1st Ave Ste 506 Phoenix, AZ 85012	602-285-6320 (w) mark.grubbs@az.usda.gov
Anita Wilson	Federal Bldg 700 W Capitol Ave Rm #3416 Little Rock, AR 72201	501-301-3058 anita.wilson@ar.usda.gov
David Schaad	430 G Street #4161 Davis, CA 95616	530-792-6629 David.schaad@ca.usda.gov
Scott Miller	Denver Federal Ctr Bldg 56 Room 2760 Denver, CO 80225	720-544-2897 scott.miller@co.usda.gov
Doris Ostrowski	344 Merrow Rd Ste B Tolland, CT 06084	860-871-4090 doris.ostrowski@ct.usda.gov
Robin Talley	1221 College Park Dr Ste 201 Dover, DE 19904	302-678-4252 robin.talley@de.usda.gov

Tim Manning	4440 NW 25th Pl Ste 1 Gainesville, FL 32614	352-379-4511 tim.manning@fl.usda.gov
Neal Leonard	355 E Hancock Ave STOP 108 Athens, GA 30601	706-546-2207 Neal.leonard@ga.usda.gov
Steve Peterson	737 Bishop Ste 2340 Honolulu, HI 96813	808-441-2704 steve.peterson@hi.usda.gov
Jeremy Nalder	9173 W Barnes St Ste B Boise, ID 83709	208-378-5667 jeremy.nalder@id.usda.gov
Carl Burt	3500 Wabash Ave Springfield, IL 62711	217-241-6600 carl.burt@il.usda.gov
Rick Kelley	5981 Lakeside Blvd Indianapolis, IN 46278	317-290-3030 Rick.kelley@in.usda.gov
Dennis Olson	10500 Buena Vista Ct Des Moines, IA 50322	515-331-8420 Dennis.olson@ia.usda.gov
Dawna Ford	3600 Anderson Ave Manhattan, KS 66503	785-564-4743 Dawna.ford@ks.usda.gov
Marcinda Kester	771 Corporate Dr Ste 100 Lexington, KY 40503	859-224-7637 Marcinda.kester@usda.gov
DeWanna Pitman	3737 Government St Alexandria, LA 71302	318-473-7902 Dewanna.pitman@la.usda.gov
Scott Speck	967 Illinois Ave Bangor, ME 04401	207-990-9136 Scott.speck@me.usda.gov
Linda Slacum	339 Busch's Frontage Rd Ste 104 Annapolis, MD 21409	443-482-2764 linda.slacum@md.usda.gov

John Devine	445 West Street Amherst, MA 01002	413-253-4502 John.devine@ma.usda.gov
Julie Prine	3001 Coolidge Rd Ste 100 East Lansing, MI 48823	517-324-5111 julie.prine@mi.usda.gov
Lisa MacDonald	375 Jackson St Ste 400 St Paul, MN 55101	651-602-7707 lisa.macdonald@mn.usda.gov
Latrice Hill	6311 Ridgewood Rd Ste W100 Jackson, MS 39211	601-965-4300 #108 latrice.hill@ms.usada.gov
Amy Blattner	601 Bus Loop 70 W Parkade Ctr Ste 225 Colombia, MO 65203	573-876-0926 amy.blattner@mo.usda.gov
Dick Deschamps	PO Box 670 Bozeman, MT 59771	406-587-6875 Richard.deschamps@mt.usda.gov
Robin Wieland	1400 Independence Ave SW Mail Stop 0570 Washington, DC 20250	202-690-2814 robin.wieland@wdc.usda.gov
Mike Sander	7131 A Street Lincoln, NE 68510	402-437-5286 Mike.sander@ne.usda.gov
Daniel Rybicki	1755 E Plumb Ln Ste 202 Reno, NV 89502	775-784-5411 daniel.rybicki@nv.usda.gov
Linda Grames	James C. Cleveland Federal Bldg 53 Pleasant Street, Room 1601 Concord, NH 03301	603-224-7941 linda.grames@nh.usda.gov
Jerry Hlubik	Mastoris Professional Plaza 163 Rte 130 Bldg 2, Suite E Bordentown, NJ 08505	609-298-3446 #208 jerry.hlubik@nj.usda.gov

Brenda Archuleta	6200 Jefferson St NE Rm 211 Albuquerque, NM 87109	505-761-4921 brenda.archuleta@nm.usda.gov
Ginny Green	441 S Salina Street #536 Syracuse, NY 13202	315-477-6354 virginia.green@ny.usda.gov
Mike Eaves	4407 Bland Rd #175 Raleigh, NC 27609	919-875-4810 Mike.eaves@nc.usda.gov
Russell Bubach	1025 28th St SW Fargo, ND 58103	701-893-2204 Russell.bubach@nd.usda.gov
Cheryl Hinton	200 N High St Rm 540 Columbus, OH 43215	614-255-2454 cheryl.hinton@oh.usda.gov
Krey Heimer	100 USDA, Ste 102 Stillwater, OK 74074	405-742-1140 krey.reimer@ok.usda.gov
Kent Willet	7620 SW Mohawk Tualatin, OR 97062	503-692-1973 Kent.willet@or.usda.gov
Adam Lipton	One Credit Union Pl Ste 320 Harrisburg, PA 17110	717-237-2121 adam.lipton@pa.usda.gov
Wanda Perez	USDA, FSA 654 Plaza Building, Ste 829 654 Munoz Rivera San Juan, Puerto Rico 00918	787-294-1613 wanda.perez@pr.usda.gov
Alison Rose	60 Quaker Ln Ste 40 Warwick, RI 02886	401-828-8232 alison.rose@ri.usda.gov
Riley Odum	1927 Thurmond Mall Ste 100 Columbia, SC 29201	803-806-3851 riley.odum@sc.usda.gov
Thomas Kostel	200 4th St SW Rm 308 Huron, SD 57350	605-352-1170 tom.kostel@sd.usda.gov

Regan Soloman	801 Broadway, Room 579 US Courthouse Nashville, TN 37203	615-277-2615 regan.soloman@tn.usda.gov
David Sullivan	2405 Texas Ave S PO Box 2900 College Station, TX 77840	979-680-5154 david.sullivan@tx.usda.gov
Tom Miyagishima	125 S State St Rm 3202 Salt Lake City, UT 84138	801-524-4539 tom.miyagishima@ut.usda.gov
Kimberly Peck	356 Mountain View Dr Ste 104 Colchester, VT 05446	802-658-2803
Linda Cronin	Culpeper Bldg 1606 Santa Rosa Rd Ste 138 Richmond, VA 23229	804-287-1537 linda.cronin@va.usda.gov
Dwaine Schettler	316 W Boone Ave Ste 568 Spokane, WA 99201	509-323-3009 dwaine.schettler@wa.usda.gov
Kevin Hinkle	1550 Earl Core Rd Morgantown, WV 26505	304-284-4800 Kevin.hinkle@wv.usda.gov
Cally Ehle	8030 Excelsior Dr Ste 101 Madison, WI 53717	608-662-4422 cally.ehle@wi.usda.gov
Steve Swieter	951 Werner Ct Ste 130 Casper, WY 89601	307-261-5232 steve.swieter@wy.usda.gov

Appendix D

Pulpwood Producers and Processors

Name	Address	Phone Number
Alabama Wood Products, Inc.	1001 Avenue C Opelika, AL 36801-5847	(334) 745-6201
Ala-miss, Inc.	467 Street Peter Street State Line, MS 39362-9625	(601) 848-7811
Balfour Poles Company	8479 US Highway 19 Baconton, GA 31716-7510	(229) 787-0555
Balfour Timber Company	1101 W Clay Street Thomasville, GA 31792	(229) 228-1991
B & B Woodyard	3922 State Route 56 Tracy City, TN 37387	(931) 592-5556
Beasley Forest Products	712 Uvalda Highway Hazlehurst, GA 31539-4808	(912) 375-5174
Becker Forest Products, Inc.	W 6684 17th Street Necedah, WI 54646-7519	(608) 565-2454
B & M Pulpwood	11 Green Acre Road NE Rome, GA 30165-8954	(706) 232-5089
Bowater, Inc. Southern Division	12406 Armstrong Road Sequatchie, TN 37379-5926	(423) 332-2476
Bowen & Assocociates	13014 Espinheira Drive Cerritos, CA 90703-7328	(562) 860-5613
Branham Woodland Products, Inc.	606 W 1st Street Merrill, WI 54452-2230	(715) 722-0343
Braswell Wood Company, Inc.	1508 Peachburg Road Union Springs, AL 36089-6588	(334) 738-4899
B & S Timber Company, Inc.	22312 Poleyard Road Saucier, MS 39574	(228) 832-3121
Cade Wood, Inc.	258 Cade Woodyard Road Many, LA 71449	(318) 256-2192
Callahan Timber Company, Inc.	450038 State Road 200 Callahan, FL 32011	(904) 879-3702
Canal Holdings, LLC	1249 Highway 1 N Cassatt, SC 29032	(803) 432-8370
Carroll County Pulpwood & Timber Company, Inc.	385 Clem Lowell Rd Carrollton, GA 30116-6213	(770) 834-3311

Name	Address	Phone Number
Cellmark, Inc.	16390 Pacific Coast Highway # 200C Huntington Beach, CA 92649-1851	(562) 592-1200
	200 Tamal Plaza # 200 Corte Madera, CA 94925-1196	(415) 927-1700
	2800 Ponce DE Leon Boulevard # 1460, Coral Gables, FL 33134	(305) 461-2211
Cellmark Paper, Inc.	300 Atlantic Street # 500 Stamford, CT 06907	(203) 363-7800
Cellmark Pulp & Paper, Inc.	80 Washington Street # 1 Norwalk, CT 06850	(203) 299-5000
	200 Tamal Plaza # 200 Corte Madera, CA 94925	(415) 927-1700
	80 Washington Street Norwalk, CT 06850	(203) 299-5057
Cenla Timber, Inc.	3708 Old Marksville Highway Pineville, LA 71360	(318) 445-8637
Coastal Pulp & Paper, LLC	1980 Willamette Falls Drive West Linn, OR 97068	(503) 722-4457
Coastal Timber Company	3236 Highway 701 N Conway, SC 29526	(843) 365-2149
Connecticut Fibers, Inc.	410 Kingstown Road # 2 West Kingston, RI 02852	(401) 783-8800
CO-OP Pulpwood Company	385 W Houston Street Dadeville, AL 36853	(256) 825-6411
Crown Shavings	3544 County Road Chino, CA 91710	(909) 591-3808
Custom Mulch	9140 Warren H Abernathy Highway Spartanburg, SC 29301	(864) 804-6253
D & D Pulpwood, Inc.	1024 Noble Road Port Gibson, MS 39150	(601) 437-4012
Dearmon Timber Company	14314 Copeland Road Millry, AL 14314	(251) 846-2601
DE Berry Land & Timber	112 Leslie Street Troy, NC 27371	(910) 572-2698
Decatur, Inc.	954 Maple Lane # 100 Jacksonville, FL 33433	(904) 398-2110

Name	Address	Phone Number
Dobson Pu Lpwood, Inc.	4537 Highway 480 Campti, LA 71411	(318) 476-3348
Domtar Industries, Inc.	214 W Grand Avenue # 32 Wisconsin Rapids, WI 54495	(715) 712-1190
Donald Charles Timber Company	12809 Highway 84 W Roxie, MS 39661	(601) 322-7878
Dotson & Sons, Inc.	4975 Nettlesboro Road Lower Peach Tree, AL 35005	(334) 636-5600
E D Bessey & Son	80 Greenwood Street West Paris, ME 04289	(207) 674-2624
E & H Pulpwood, Inc.	10577 Alabama Highway 17 York, AL 36925	(205) 392-5391
Ekman & Company, Inc.	8750 NW 36th Street # 400 Doral, FL 33166	(305) 579-1200
Escambia Timber	1910 South Boulevard Brewton, AL 36426	(251) 867-5514
Eubanks, J Leonard	2915 Mayfield Lane Meigs, GA 31765	(229) 294-8324
Euc, Inc.	18021 Sky Park Circle # N Irvine, CA 92614	(949) 756-9901
Eufaula Pulpwood Company, Inc.	488 Montgomery Highway 82 W Eufaula, AL 36027	(334) 687-2784
Ewing Timber, LLC	6027 Quitman Highway Jonesboro, LA 71268	(318) 259-2204
Federated Fibers	1801 SW 68th Avenue Fort Lauderdale, FL 33317	(954) 691-0738
Fiber Resource Group	114 Lothrop Street Beverly, MA 01915	(978) 524-0550
Fiber Sources, Inc.	237 W 35th Street # 17 New York, NY 10001	(212) 867-3990
Flint River Wood	251 Riverview Drive Oglethorpe, GA 63137	(478) 472-7846
Forest Beasley Products, Inc.	712 Uvalda Highway Hazlehurst, GA 31539	(912) 375-5174
Forest Lowcountry Products, Inc.	1426 Hawkins Street Georgetown, SC 29440	(843) 546-1136
Frisco Pulpwood & Timber Company, Inc.	340 Pecan Street Uriah, AL 36480	(251) 862-2193

Name	Address	Phone Number
Future Fibres, Inc.	2000 NW 89th Place Doral, FL 33122	(305) 888-8520
George G. Tyler & Sons, Inc.	Middle Road Skowhegan, ME 04976	(207) 474-8163
Georgia Carolina, Inc.	516 N College Street Youngsville, NC 27596	(919) 556-4414
Georgia Resource Management	3000 Corporate Center Drive Morrow, GA 30260	(770) 968-4186
Glatfelter Pulp Wood Company	29809 Connelly Mill Road Delmar, MD 21875	(410) 742-3163
	2601 Princess Anne Street Fredericksburg, VA 22401	(540) 373-9431
Goodman Lumber Company, Inc.	5001 Grumby Road Wilsons, VA 23894	(804) 265-9030
Gowen Timber Company, Inc.	108 S Okefenokee Drive Folkston, GA 23894	(912) 496-2571
Hansson, Elof Pulp, Inc.	565 Taxter Road # 595 Elmsford, NY 10523-2327	(914) 345-8380
Horry County Development Corp.	2431 E Highway 501 Conway, SC 29526	(843) 347-4604
I E Moore Timber Company, Inc.	216 N Main Street Malvern, AR 72104	(870) 325-6666
Ingram Woodyards	2895 US Highway 1 N Vass, NC 28394	(910) 245-2177
International Paper Company	5533 County Road 82 NW Alexandria, MN 56308-8212	(320) 834-3350
International Paper Company Chester	9 Lancaster Highway Chester, SC 29706	(803) 581-5732
James A Moore Pulpwood	100 Newton Circle Griffin, GA 30223	(770) 229-1708
J F Rainer & Son Timberlands	107 1st Street S Reform, AL 35481	(205) 375-6393
J L Eubanks Timber Company, Inc.	132 E Railroad Street NE Pelham, GA 31779	(229) 294-4972
Jones Timber Corp.	136 Government Fleet Road Natchez, MS 39120-8105	(601) 445-9807
K C Wood Industries, Inc.	Highway 27 Monticello, MS 39654	(601) 587-7944

Name	Address	Phone Number
Korab International	500 Broadway Street # 340 Vancouver, WA 98663	(360) 693-0373
L A Penn And Sons, Inc.	304 Yandell Avenue Canton, MS 39046-3842	(601) 859-1861
L C Saunders Timber, Inc.	721 Juniper Cliff Road Brookneal, VA 24528	(434) 376-5132
Lewis Timber Company	1522 S Captain Gloster Drive Gloster, MS 01930	(601) 225-4892
Light Logging Company, Inc.	220 W 8th Street Hope, AR 71801	(870) 777-8997
Livingston Timber, Inc.	14521 Florida Boulevard Livingston, LA 70754	(225) 686-2134
Low Country Forest Products, Inc.	2413 Topsaw Road Georgetown, SC 29440-9381	(843) 546-1136
Magnolia Pulpwood Company	1920 Dawson Drive Haynesville, LA 71038	(318) 624-1155
Marubeni America Corporation	4321 W College Avenue # 380 Appleton, WI 54911	(920) 832-0465
Marubeni Pulp & Paper	3460 Torrance Boulevard # 170 Torrance, CA 90503	(310) 316-7737
Marubeni Pulp & Paper North America, Inc.	450 Lexington Avenue Front New York, NY 10017-3904	(212) 450-0190
Mastin's Enterprises, Inc.	11430 Post Oak Road Spotsylvania, VA 22551-5050	(540) 895-9081
Middle Georgia Timber, LLC	923 Oak Street Eatonton, GA 31024	(706) 485-6513
M & M Timber Enterprises, Inc.	16 N Rountree Street Metter, GA 30439	(912) 685-6415
M M Wright, Inc.	2415 Old Indian Road Brodnax, VA 23920	(434) 949-6181
Morgan Timber & Paving Company	8100 Washington Street SW Covington, GA 30014	(770) 786-3608
Morris Timber Company	457 Old Griffin Road Mcdonough, GA 30253-6710	(770) 957-1236
Mullins Pulpwood, Inc.	333 Lower Woodville Road Natchez, MS 39120-4439	(601) 442-3604

Name	Address	Phone Number
Omnisphere Corporation	15 Glen Street # 204 Glen Cove, NY 11542	(305) 388-4075
	1 Perimeter Park S # 123 Birmingham, AL 35243	(205) 969-1127
	8701 SW 137th Avenue # 205 Miami, FL 33183	(305) 388-4075
	505 N Riverfront Boulevard Dallas, TX 75207-4307	(214) 689-2422
Parham Pulpwood, Inc.	217 W 2nd Street Fordyce, AR 71742	(870) 352-2338
Peebles Timber, Inc.	190 Woodyard Lane Pitts, GA 31072	(229) 648-6621
P H Glatfelter Company	228 S Main Street Spring Grove, PA 17362	(717) 225-4711
Phillips Trucking	177 Avecor Drive Vonore, TN 37885	(423) 884-2394
Piedmont Woodyards, Inc.	121 Deep Creek Road Fayetteville, NC 28312	(910) 483-4507
	802 Woodland Avenue Sanford, NC 27330	(919) 776-3622
Porter Pulpwood & Logging Company	441 S Broad Street Extension Commerce, GA 30530	(706) 335-3998
Price & Pierce International, Inc.	12851 Banyan Creek Drive # 111 Fort Myers, FL 33919	(212) 301-0004
	11 Madison Avenue Floor 14l New York, NY 10010	(212) 301-0000
Pulpwood Producers, Inc.	138 Woodland Drive Simsboro, LA 71275	(318) 247-3958
Quality Hardwood, Inc.	2900 Attala Road 1010 Kosciusko, MS 39090	(662) 289-7098
Reid Timber, Inc.	731 N Central Avenue Winona, MS 38967	(662) 283-2635
Richton Tie & Timber Pulpwood	Deweese Road Philadelphia, MS 39350	(601) 656-4441
Robert B Wolter, Inc.	9 Wild Cherry Drive Little Compton, RI 02837	(401) 635-4067

Name	Address	Phone Number
Rollins Pulpwood & Timber Company	1911 US Highway 61 S Woodville, MS 39669	(601) 888-3000
R & R Sales	430 Oak Street Eastman, GA 31023	(478) 374-7168
Saco Wood, Inc.	867 N Memorial Drive Prattville, AL 36066	(334) 365-0694
Sam Whitfield Timber Company, Inc.	16202 W River Drive Kiln, MS 39556	(228) 255-1870
Sawyer-Stoll Timber Company	2113 1st Avenue N Escanaba, MI 49829	(906) 786-5025
Scott T Langley	5306 County Road 54 Camp Hill, AL 36850	(334) 864-9361
Scruggs Logging, Inc.	2665 Wards Fork Mill Road Cullen, VA 23934	(434) 542-5097
Sfk Pulp US, Inc.	580 Lincoln Park Boulevard # 344 Kettering, OH 45409	(937) 293-4660
Shaddix Pulpwood Company	166 County Road 512 Woodland, AL 36278	(256) 449-2332
Shaddix Pulpwood Trucking	24 Shaddix Road Lineville, AL 36266	(256) 396-2111
Shepherd Brothers Timber Company	6860 GA Highway 96 Irwinton, GA 31042	(478) 945-3137
Sheth, Ashish	430 Lewis Lane Pacifica, CA 94044	(650) 355-1383
Shoptaw & Sons Pulpwood, Inc.	3501 Genoa Road Texarkana, AR 71854	(870) 774-2766
Shull Timber Corp.	1501 Tollgate Road Concord, VA 24538	(434) 993-3343
Silvicraft, Inc.	295 Airport Road Monticello, AR 71656	(870) 367-8564
Southland Timber Company	N Highway 47 Fort White, FL 32038	(386) 497-1221
Stannard Pulpwood Sales, Inc.	1535 Route 9 Keeseville, NY 12944	(518) 834-7165
Steed & Hollis Pulpwood & Timber Company, Inc.	20 Monroe Street Brantley, AL 36009	(334) 527-8809
Steve Crawford Forest Products	861 Shadrack Street Waynesboro, GA 30830	(706) 554-5131

Name	Address	Phone Number
S & T Timber Company	112 Etheridge Road Auburn, GA 30011	(770) 962-3453
The Fiber Resource Group, Inc.	114 Lothrop Street Apartment 1 Beverly, MA 01915	(978) 524-0550
Thomaston Timber Company, Inc.	160 Water Street Camden, AL 36726	(334) 627-3850
Thompson Bros Pulpwood & Lumber Company, Inc.	Charboneau Road Ticonderoga, NY 12883	(518) 585-7020
Three Rivers Corp.	3004 Puryear Road Knightdale, NC 27545	(919) 266-6200
Tillman's Wood Yard	9081 Smith Station Road Edwards, MS 39066	(601) 852-4576
Tokyo Pulp & Paper International Company, Ltd.	400 Continental Boulevard Floor 6 El Segundo, CA 90245	(310) 426-2132
Treeland Products, Inc.	55 E 8th Avenue Bay Springs, MS 39422	(601) 764-2694
Valley Wood, Inc.	3119 University Avenue Columbus, GA 30101	(706) 565-9624
	5757 Alabama Highway SW Rome, GA 30161	(706) 234-1989
	107 E Lafayette Square La Fayette, GA 30728	(706) 639-9241
Van Dusen Forest Products	940 Ford Street Iron Mountain, MI 49801	(906) 774-3679
Watson Wood Company	1506 US Highway 59 S Linden, TX 75563	(903) 756-7381
Webb-Taylor Timber, Inc.	522 W Front Street Evergreen, AL 36401	(251) 578-1840
William Carey Meigs	1033 Highway 77 S Wadley, AL 36276	(256) 395-2358
W K Brown Timber Corp.	6717 Highway 25 N Hodges, SC 29653	(864) 374-3352
W S Richardson Pulpwood Buyers	301 E Cedar Street Warren, AR 71671	(870) 226-3661