Market Enhancement for Small Diameter Timber in Florida

Final Project Report to Florida Department of Agriculture & Consumer Services-Division of Forestry, Tallahassee

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Executive Summary

This research project investigated opportunities for development of new markets or expansion of existing markets for small diameter timber in Florida. Specifically, the project included a review of the literature, an assessment of current and future timber inventories and harvest removals, and a market survey of timber buyers. The potential volume was determined for alternative markets for small diameter timber such as fuel wood, mulch, animal bedding and other specialty items. The findings of this investigation are summarized as follows.

A significant body of recent research, reviewed in this report, supports the viability of using small diameter timber for various products. A variety of public and private research and development efforts are underway for developing innovative uses for small diameter timber in roundwood products, engineered composite wood products, and biomass energy. A challenge remains to make this body of knowledge available in a usable and readily accessible format.

Demand for southern stumpage has declined considerably in the last decade as indicated by reductions in milling capacity, especially for pulp and paper, resulting from mill closures and consolidations, and increasing international competition. Consumption of pine pulpwood in the U.S. has declined for the past few years, due to substitution of hardwood furnish and recycled fiber for paper manufacturing. Prices for pine pulpwood stumpage in Florida have declined dramatically from a peak of around $50 dollars per cord in 1998 to around $20 currently. However, prices have been stable for the past two years. Harvesting of small diameter timber or thinning of overstocked stands in many areas is commercially unfeasible for conventional logging systems.

Acreage of pine plantations in the southern U.S. has increased dramatically over the past 50 years, however, current plantings have slowed to only about half the peak level in the 1980's. In the Northwest and Northeast Florida regions, 21 to 29 percent, respectively, of private pine inventory is in plantations in tree diameter classes (dbh) less than 9 inches.

Projections using the Timber Assessment Market Model (TAMM) and other associated forecasting models, indicates that pine plantation acreage in Florida will continue to increase, though at a slower rate, increasing by 35 percent from 1995 to 2020 or 1.2 percent per year, under the most likely scenario. Under the assumption of constant softwood removal levels in the southern U.S., overall pine inventories on private ownerships in Florida will increase 29 percent from 2000 to 2020, while inventories of small diameter timber (5.0 to 8.9 inches) are projected to increase 27 percent. Small diameter timber inventories are expected to increase significantly in the short term in the Northwest region, less so in the Northeast region.

A survey of Florida wood product manufacturers conducted as part this research indicated that small diameter pine timber is currently being utilized in large volumes for pulp, landscape mulch and animal bedding, with smaller uses for fence posts, barn poles, chip & saw, dimension lumber, engineered wood, and panels. No use was reported for fuel by survey respondents. Most respondents indicated that they expected to continue using small diameter timber at similar or increased levels for 5 years into the future (2009). Overall, the volume of small diameter timber used by the surveyed firms was expected to expand by nearly one million tons, or by 56 percent. The increase in expected usage is greatest for mulch, engineered wood and dimension lumber, with somewhat smaller increases expected for panels, fence posts, barn poles, and pulp, while the volume used for chip-and-saw is expected to decline. A large increase in usage in the Northwest Florida region is expected due to the opening of a new OSB plant.

Introduction

The State of Florida has over 29 thousand square miles in forests, representing nearly 50 percent of the state's land area. These forests are managed to produce a variety of wood and fiber products and to provide recreational opportunities and aesthetic values for both residents and millions of visitors. Tree species commercially utilized include southern pines, cypress, and a variety of hardwoods. The highly productive timberland in the northern part of Florida has the world's largest concentration of intensively managed plantations of southern pines. The forest products manufacturing sector produces lumber, poles/pilings, plywood, reconstituted wood products, pulp, paper and paperboard, preservative-treated wood products, and wood chemical products. The industry also produces electric power as a by-product by utilizing residual wood, bark and chemical extractives as biomass fuels to meet its energy needs and some surplus power is sold as well. In 1999, Florida had a total output of 650 million cubic feet (mcf) of industrial timber products and by-products, including 499 mcf of roundwood, of which 89 percent was softwood species (Bentley, Johnson and Ford, 2002). The pulp and paper sector has traditionally been the principal driver of the forest products industry in Florida. Pulpwood production was 261 mcf, which represented 52 percent of total roundwood produced in the state in 1999. The number of pulp mills in Florida has declined from 10 to 6 over the past 15 years, and roundwood consumption by these mills declined by 11 percent between 1997 and 1999, to 287 mcf of timber, including net imports of 26 mcf.

The total area of forest land In Florida, has decreased by about 15 percent over the past 40 years, due to rapid development and conversion to urban uses. Offsetting this trend has been the widespread establishment of timber plantations on former cropland. Much of this planting occurred under the Conservation Reserve Program (CRP) which provided a Federal cost sharing arrangement. In response to increasing prices for timber products, private landowners in the southern region are projected to continue expanding the area of pine plantations into the future, with area in Florida increasing from around 4.4 million acres in 1995 to about 7.0 million acres in 2040 (Prestemon and Abt).

There is increasing concern about the structure of the forest resource in Florida, and an overabundance of young plantations that need to be thinned in order to produce quality sawtimber. According to the USDA-Forest Service, Forest Inventory and Analysis (FIA) data, the area of softwood forests in sapling-seedling size class stands in Florida has increased from 2.8 to 3.1 million acres between 1982 and 1999, while the area of sawtimber stands has declined from 1.9 to 1.7 million acres (Conner and Hartsell, 2002). At the same time, pulpwood markets have been depressed due to global recession and reduced demand for paper products, competition from imported wood, and substitution of hardwood and recycled fiber instead of virgin softwood fiber sources for paper manufacturing. Prices for pine pulpwood have historically increased at or above overall economic growth rates, however recent average stumpage prices in Florida have declined from nearly $50 per cord in early 1998 to around $20 in the first quarter of 2005 (Timber Mart South). This situation has lead the forest products industry to seek new marketing opportunities for small diameter timber, to lessen dependence upon pulp and paper as the predominant market.

The state of Florida naturally has a very critical wildland fire risk situation, due to the pyrogenic nature of its upland ecosystems and the current situation of excess inventory of overstocked, small-diameter timber stands poses an increased risk of wildland fire. Development of markets for small-diameter timber will also help mitigate this fire risk.

Review of the Literature on Utilization of Small Diameter Timber

Utilization of small diameter timber has been the subject of numerous technical publications, research reports, conferences and symposia. Published information from these sources were reviewed to summarize the current state of technology and market potential for utilization of small diameter timber in Florida and the U.S. An annotated bibliography is provided in Appendix A. The findings are summarized here for structural product uses, energy uses, and harvesting/logistic issues for forest thinning.

There are many potential uses for small diameter and low-valued forest thinnings, however, economic feasibility depends upon location, manufacturing process, and market potential (LeVan-Green and Livingston, 2003). Market evaluation needs to consider product options, followed by a thorough market assessment and feasibility study to determine if and where those markets exist. Technological advances and new research into potential product options are helping to open the door for communities to develop rural enterprises that add value to small-diameter thinnings, create jobs, diversify forest-based rural communities, and reduce wildfire risk of overstocked timber stands. Evaluation of economic feasibility has begun in many local communities.

Structural Product Uses

A study by the USDA-Forest Products Laboratory examined the market potential for recreational buildings constructed from small diameter roundwood (SDR) on National and State forests and parks (Paun, Cantrell, and LeVan-Green, 2004). A survey of architects and building designers representing both Federal and State organizations was conducted to determine the current and potential market size of public recreational buildings and the extent to which SDR could be used as a building material. The results indicated that the number of recreational buildings on National and State forests, parks, and recreational areas could increase by over 10 percent to 51,500 buildings. Wood has been used in 57 percent of existing recreational buildings and its use could increase by 13 percent. Some 58 percent of the building professionals surveyed said they would consider using SDR in future recreational buildings. The market potential arising from SDR substitution, even for a near-substitute like lumber, is substantial. Cabins, pay stations, picnic shelters, concession stands, and information centers would be the best markets to target for SDR use. Roundwood is perceived as superior to all other building materials in terms of being an attractive and "green" material. The SDR market potential will grow to the extent that durability increases and maintenance and construction complexity decrease.

Structural application of small-diameter timber is currently limited by conventional construction standards (Wolfe, King, and Gjinolli, 2000). The round tapered shape of SDR is not compatible with conventional framing and cladding methods. To encourage more efficient use of small-diameter timber, the structural properties of Douglas-fir peeler cores and the efficacy of a “dowel-nut” connection for use in a roof framing system were studied. The results of this study provide a basis for deriving design properties for structural application in roof systems and the establishment of a database to support small-diameter timber design and construction standards.

The economic feasibility of using small-diameter material to manufacture various wood products, including oriented strandboard (OSB), stud lumber, random-length dimension lumber, machine-stress-rated random-length lumber, laminated veneer lumber (LVL), and market pulp, was examined by Spelter, Wang, and Ince. The analysis indicated that LVL promises the best ratio of revenue to wood input, followed by market pulp and OSB. Among the lumber alternatives, machine stress-rated lumber yields the greatest return. In terms of investment risk, the lower-cost lumber alternatives are favored over the capital-intensive OSB, market pulp, and LVL options.

Markets exist within certain areas that can utilize small diameter timber. Current markets require no investment in new processing facilities and are proven. They include the oriented strand board, pulp and sawmill markets. The problem with utilizing current markets is that they add little value to the SDT. Further processing could allow SDT into unseasoned wood markets which include green lumber, pallet material, rough fencing, firewood, mulch and other items that don't need to be kiln dried. These markets do add some value to SDT but are highly competitive. The most value-added dry-wood markets would require the largest investment for producing kiln dried products. This would include lumber that could be sold to the traditional secondary wood industry (Perkins, Smith and Jackson).

An extensive research program at the Forest Products Laboratory of the USDA Forest Service is focused on searching for economical and marketable uses for small-diameter material (USDA-FS). The projects include conserving timber through improving sawing technology and developing businesses for using small-diameter material. In typical North American logging or thinning operations, much low-value timber is felled and left on the ground, chipped, or burned because most mills are not equipped to handle it. Research is focused on processing small-diameter curved and cull timber into dimensional 2 by 4 studs and then converting that material into a value-added laminated I-beam, called LamLumber (Hunt and Winandy).

Wood posts are commonly used for many types of highway applications, and hold a substantial share of the market (Paun and Jackson). Square wood was used for guardrails and signs by more than 50 percent of surveyed highway department respondents. Given the relatively small circumference of signposts, this application may offer a sizeable SDT market opportunity. Also, roundwood was used by almost 40 percent of the respondents for fencing and landscaping posts, so the fencing post replacement market offers an opportunity for SDT. The type of posts used the past three years has changed little. This implies that newer post materials like plastic composites and poly-lumber may not compete directly against wood posts. Most roundwood posts used are within the 2 to 9 inch thickness range, and the majority of square wood posts used are 4 to 6 inches, indicating potential for increased SDT use. There appear to be very few concerns about possible negative characteristics of wood posts, such as preservative treatments.

World demand for engineered lumber products is driven by a shift to performance-based building codes, the changing nature of the softwood fiber supply, worldwide demand for affordable housing, and advances in resin technology and wood conversion systems (Schuler, Adair and Elias, 2001). Structural composite lumber, prefabricated wood I-joists and glulam products extend the forest resource by allowing higher product recoveries and using conversion technologies that facilitate broader use of underutilized species and sizes. They also enable higher stumpage prices as markets are created for a wider range of species, grades, and sizes of timber. Also, sustainable forestry objectives are enhanced as markets for small-diameter, low-grade fiber are developed throughout the world.

Considerable activity is dedicated to improving the economics of using what is termed "small diameter and underutilized" (SDU) material (Le Van-Green and Livingston, 2001). Several organizations have programs that are examining the current economics of existing technology, as well as new technologies. Some uses being investigated include dimension and nondimension softwood lumber, engineered wood products, glued-laminated timber, structural roundwood, wood composites, woodfiber/plastic composites, woodfiber products, pulp chips, compost, mulch, and energy. Numerous efforts are underway to address the current SDU situation. Some of these efforts involve social change, however, most rely on technology advancements, either through more effective forest operations, more efficient processing, or achieving higher value for some of the low-valued SDU material. In order to change the current situation, all efforts are essential.

The use of hardwoods in engineered wood products (EWP) is increasing (Bumgardner, Hansen, Schuler and Araman). Where EWP mills are available they can offer markets for small-diameter hardwoods and non-sawlog portions of the tree. Such opportunities can help make forest thinning operations more financially attractive. EWP derived from hardwoods in the East are becoming a major use for many species. Other promising research areas for utilization of small-diameter hardwoods include green dimension lumber and curve sawing of hardwood logs and lumber (Lin et al., 1995; Bratkovich et al., 2000). Research into "value-added" processing of small-diameter hardwoods also continues. There may be regional opportunities for specialty products such as rustic rail fencing, which accounts for about 20 manufacturers in West Virginia alone (West Va. Bureau of Commerce, 1997).

Cumbo, Smith and Becker (2004) conducted research to determine the lumber value that could be produced from smaller diameter timber, i.e. below 10 inches, and the market potential for these products. The lumber value analysis component of the study was conducted at a hardwood sawmill in southwest Virginia, in which 322 oak and hickory logs were randomly selected, graded, processed, stacked and air-dried prior to the market assessment. Hardwood consumers were identified within a 120-mile radius of the test mill and interviewed for the market assessment. Study results showed that the percentage of wider boards (6 in. to 8 in.) and higher grade boards (# 1 and 2) began to increase at a log diameter of approximately 8 inches. Lumber value increased substantially with increasing log diameter and the relationship appears to be linear. In addition, an overall higher increase in lumber value per thousand board feet was observed when sawing small-diameter hickory logs compared to small-diameter oak logs. While respondents to the market assessment noted a number of defects as problematic in their operations, voids and unsound areas tended to be important to most. Service attributes were important as well; specifically, short lead-times and availability of different species were important supplier attributes.

Biomass Energy Uses

Biomass energy production is a leading candidate for utilization of small diameter timber and forest thinnings. The USDA Rural Utility Service (RUS) has proposed supporting investments to convert forest thinnings to electric power at rural electric facilities. The Department of Energy's (DOE) Office of the Biomass Program, in the Office of Energy Efficiency and Renewable Energy, supports this approach by providing the technical and financial feasibility analysis for such ventures or enterprises.

Biomass-based electricity generation is a proven technology in the U.S., with about 11 GW of installed capacity it is the single largest source of non-hydro renewable electricity, including 7.5 GW of forest product industry and agricultural industry residues, about 3.0 GW of municipal solid waste-based generating capacity and 0.5 GW of other capacity such as landfill gas based production (Bain, Amos, Downing, Perlack, 2003). The electricity production from biomass is being used and is expected to continue to be used as base load power in the existing electrical distribution system.

A recent study by DOE examined the technical feasibility of a billion-ton annual supply of biomass in the U.S. (USDOE, 2005). It was concluded that there exists a sustainable supply of biomass sufficient to displace 30 percent or more of the country's present petroleum consumption. This would require approximately 1 billion dry tons of biomass feedstock per year from forestland and agricultural land, the two largest potential sources. Potential production exceeding 1.3 billion dry tons per year would represent more than a seven-fold increase from the amount of biomass currently consumed for bioenergy and biobased products. About 368 million dry tons could be sustainably produced on forestlands, and about 998 million dry tons could come from agricultural lands. The Energy Information Administration estimates there are 590 million tons (green basis) of biomass available in the United States yearly, with 20 million tons available today at prices of $1.25 per million Btu or less, enough to supply about 3 gigawatts of capacity (Haq, 2002). By comparison, the average price of coal to electric utilities in 2001 was $1.23 per million Btu.

The forest biomass inventory in the US is substantial, and significant amounts of wood residue are generated from processing, construction, demolition, and municipal solid waste (Skog and Rosen, 1997). Prospects for expanding the use of wood biomass for producing electrical power or ethanol will be enhanced by environmental needs and improvements in technology. Environmental needs include 1) reducing carbon emissions from fossil fuels and sequestering carbon; 2) removing wood from forests to improve forest health; 3) diverting urban waste streams from landfills; and 4) generating oxygenates for gasoline from ethanol. Improvements in technology include development of short-rotation intensive culture techniques for plantations and advances in electrical power and ethanol production processes. These efforts can help improve the comparative advantage of wood biomass feedstocks relative to fossil fuels. Key environmental concerns will constrain the supply of wood biomass from forests and plantations, particularly concerns for the effects of management for wood fuel on the diversity of plants and animals and on the depletion of soil and water resources.

In central Florida, numerous partners have combined to demonstrate the potential for growing short rotation woody crops (SRWC) as feedstocks for cofiring at utilities with up to 13,000 MW of capacity (Segrest, Rockwood, Stricker, and Alker). Cofiring up to 5 percent SRWCs is the most cost effective means of creating renewable energy while using existing power plant infrastructure. However, cofiring has not been adopted to the degree anticipated, due to problems in handling of biomass fuels, high costs for retrofitting, corrosion of boiler equipment, and large volumes of ash wastes generated (Hughes, 2000).

In a study conducted in the three counties of eastern Oregon, it was found that there is a significant amount of biomass not usable for wood products or other manufacturing industries available from forest resource management, agriculture and wood products manufacturing (Oregon Department of Energy, 2003). Biomass energy facilities could provide an economic use for this material. The feasibility of such a facility is enhanced if it is located close to the source of the biomass, and if it is sized appropriate to the volume of material available on a long-term basis. Biomass energy facilities could convert surplus biomass into electricity, industrial steam energy and fuel ethanol. A barrier to private sector investment in biomass energy facilities is the lack of specific information about the amount of feedstock available, the cost of feedstock delivered to the plant site and the best locations for proposed facilities relative to both feedstock supply and markets for energy products. There is critical need for this information in view of the high fire-risk in the forest and the need for economic stimulus in rural communities.

Forest Thinning and Small Diameter Timber Harvesting

Harvesting costs, logistics and availability of contractors are a major issue for utilization of small diameter timber. Dense stands of small-diameter timber present unique challenges for land managers. Trees in high-density stands often grow slowly and may be at risk to insects, diseases, and catastrophic fires (Camp, 2002). In 1996, the U.S. Congress recognized a need to address forest health issues and stimulate local resource-based economies. As part of this Congressional mandate, research was conducted on four harvest units, each thinned to a 20 foot spacing using different harvesting technologies. The stands were surveyed for damage prior to and following thinning to assess damage to the residual stand. The incidence of wounds to trees in different size and severity classes, and wound locations were compared. Each system performed better when judged by some criteria than by others. In general, cut-to-length processing caused less damage to the residual stand than whole-tree harvest, while skyline yarding was less damaging than forwarder yarding. Appropriate silvicultural prescriptions and harvesting technologies can reduce wounding to acceptable levels.

In another research study, the costs were compared for a thinning operation removing the stems as roundwood versus a flail chipper operation (Watson and Stokes, 1994). There was little difference in the cost of acceptable chips delivered to the digester between the two methods of thinning, but the flail chipper recovered an additional 4.2 tons of acceptable chips per acre which resulted in a higher economic return.

In another study of small diameter timber harvesting, sixteen stands were harvested at various intensities, with the proportion of basal area removed ranging from 0.27 to 1.00 (Kluender, Lortz, McCoy, Stokes and Klepac, 1998). Harvested sites were similar in slope and tree size. Harvest cost per hundred cubic feet of wood was inversely related to harvest intensity and tree size. Harvest intensity had the greatest influence on profitability in small-diameter timber. Because of the differences in average tree size removed by different harvesting prescriptions, some were more profitable than others. Profitability was greatest when removing large trees at high levels of harvesting intensity. In uneven-aged stands, single-tree selection was most profitable. Less profitable were selection in an even-aged stand, clear cutting, and shelterwood harvests, in that order. Selection at low removal intensities with small trees removed would be the least favored harvest method for the equipment observed. Harvesting profitability was near zero when removing trees averaging less than 8 inches diameter at breast height (DBH), so average tree size needs to be at least 8 inches DBH to break even.

In an analyses of simulated forest treatments for selected stand types in Sweden, both existing and non-existing forest fuel systems were tested (Bjorheden, Gullberg and Johansson, 2003). Simulated systems included a feller-chipper-forwarder and a two-machine system with a feller-bundler and a forwarder, and conventional thinning for pulpwood was included as a reference system. The average dbh of removed trees varied between 3.0 and 10.5 cm. The potential yield of biomass was high, at over 35 tonnes dry matter per hectare. Harvesting pulpwood exclusively takes only a small portion of the biomass potential. Forest fuel systems based on motorized manual work are the most competitive in the smallest diameter stands. The conventional pulpwood method showed the poorest result.

Despite covering a large area of forestland in the southern United States, hardwoods continue to be grown primarily in natural, extensively managed stands. One reason has been that hardwood growth gains resulting from active management have been small in comparison with unmanaged stands. Recent studies indicate, however, that the productivity responses of very young (ages 1–15 years) natural even-aged hardwood stands to silvicultural treatments such as fertilization, herbicide release, or stocking control can yield large productivity increases, demonstrating the potential for faster timber growth of higher quality in shorter rotations (Siry, Robison, and Cubbage, 2004). In determining the extent to which these productivity increases may justify investment in various silvicultural treatments, the investigators developed hardwood management scenarios representing productivity increases of up to 33 percent. Timber revenues were estimated and rates of return compared across various management intensities. Results indicate that the assumed productivity increases would readily pay for treatments such as fertilization, herbaceous release, and stocking control while yielding rates of returns equal to or greater than those generated by untreated stands.

In summary, a significant body of recent research exists which supports the viability using small diameter timber for structural products, biomass energy, and timber stand improvement. The technology is available to address the issues of reducing forest fire hazard, improving rural economies, and reducing dependence on imported fossil fuels through improved utilization of small diameter timber resources. A challenge remains to make this body of knowledge available in a usable and readily accessible format, and developing government policies that will encourange and cultivate these industries.

Florida's Softwood Inventory Structure and Projections by Diameter Class

This section provides an overview of the current status of Florida's forests and softwood inventory structure, and develops forecasts of softwood inventories by product class. The discussion of the inventory situation in Florida is based on the latest Forest Inventory and Analysis (FIA) survey published for 1995 (Brown 1996). Unfortunately, updated FIA data for Florida are not ready for distribution by the Forest Service. The current (2005) forest inventory situation is expected to be significantly different in several key aspects, including total timberland acreage, acreage by management type (e.g., pine plantations), ownership patterns and pine growth rates, among others.

Land Use and Timber Removals

Of the 34.6 million acres of land in Florida, 16.2 million acres are classified as forest land, and 14.7 million acres are classified as non-reserved productive forest land, or timberland (Figure 1). Forest industry, timberland investment organizations, and non-industrial private forest landowners (NIPF) own the majority of timberland in Florida. Softwood harvests are also highest among private ownerships (Figure 2). Indeed, 88 percent of all softwood removals come from private ownerships, with the rest coming from national, state and other public forest lands. Although the amount of forest land in Florida moving into public ownership has risen considerably since 1995, it is unlikely that the proportion of softwood harvested has risen as much given the types of lands being acquired by state agencies and their ownership objectives.

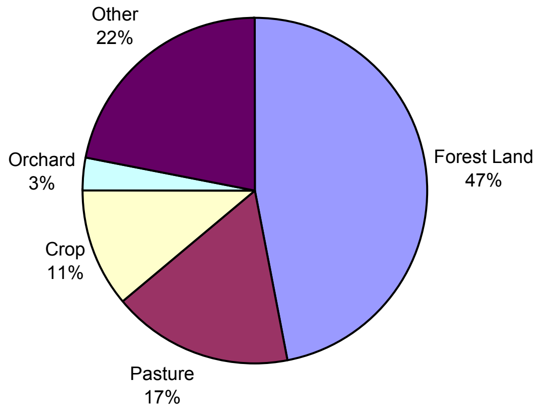

Figure 1. Land use in Florida, 1995.

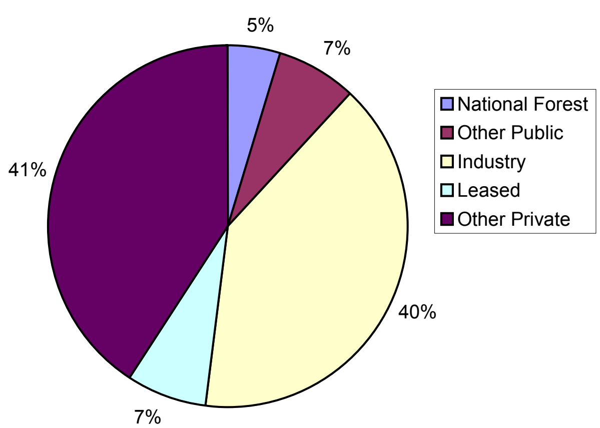

Figure 2. Proportion of average annual pine removals by ownership.

Of the 14.7 million acres of timberland in Florida in 1995, approximately 4.6 million acres (31 percent) were in pine plantations, the rest being in natural pine, oak-pine, upland and bottomland hardwood management types. The acreage in pine plantations in Florida has risen substantially over time (Figure 3). From 1962 to 1995, the average annual rate of increase in pine plantation acreage was 3.5 percent per year, and from 1977 to 1995 it was 2.2 percent per year. The rate of increase is thus decreasing which one would expect as land for potential conversion becomes scarcer.

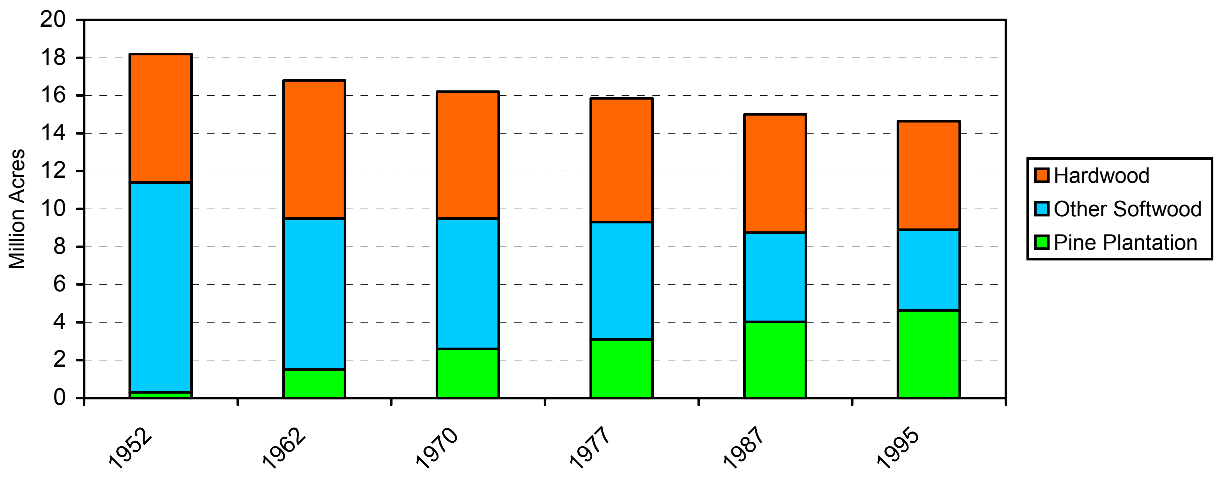

Figure 3. Acreage of timberland in Florida by broad management type.

The USDA Forest Service's Southern Forest Resource Assessment (SFRA) projects pine plantations in the southeastern U.S. to increase between 14 and 34 percent from 1995 to 2020, depending upon the scenario (Wear and Gries 2002). For the base case scenario, the projected increase in pine plantations in the southeastern US is 28 percent. For Florida, the SFRA projects a 35 percent increase in pine plantation acreage from 1995 to 2020, or 1.2 percent per year, under the base case scenario. This would be more or less in line with historical trends.

Softwood Forest Inventory

Florida's total growing stock inventory for softwoods and hardwoods has risen since 1952 (Figure 4), although the softwood growing stock inventory, including cypress, has been relatively stable since 1979. The USDA Forest Service FIA data defines four broad regions in Florida: northeast, northwest, central and south (Figure 5). Figure 6 shows the amount of pine inventory on private lands in Florida. It does not include pine inventory on public lands (e.g., National and State Forests, Water Management Districts), nor does it include cypress. The Northeast and Northwest regions contain, by far, the majority of pine growing stock inventory on private lands (88 percent of the state total). More than half of the total pine inventory located on private lands is in plantations in the northeast region (54 percent), while 40 percent is located in plantations in the northwest region. Most of the remaining inventory in is natural pine stands. The total amount of pine inventory on private lands in the central and southern regions of Florida are only 12 percent of the state total.

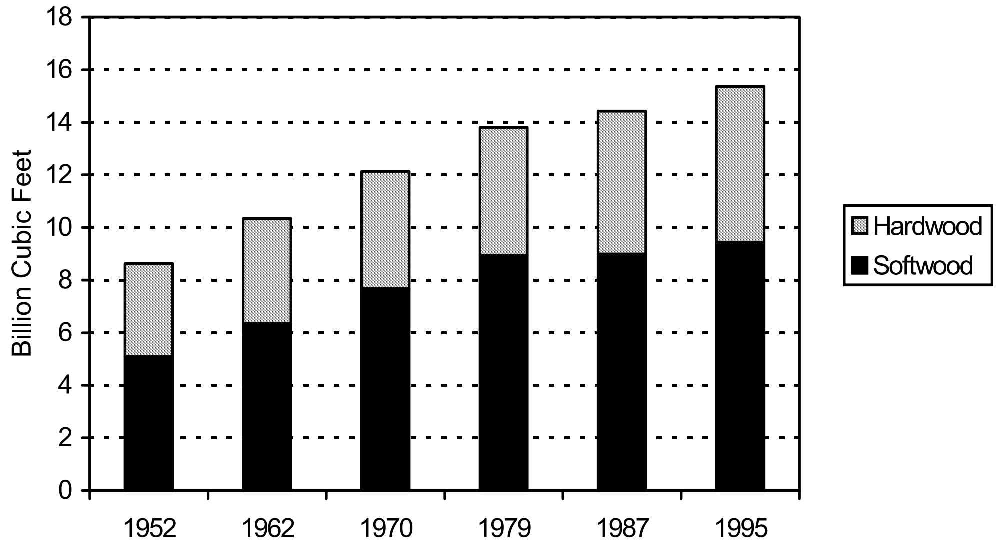

Figure 4. Total growing stock inventory in Florida, 1952-1995.

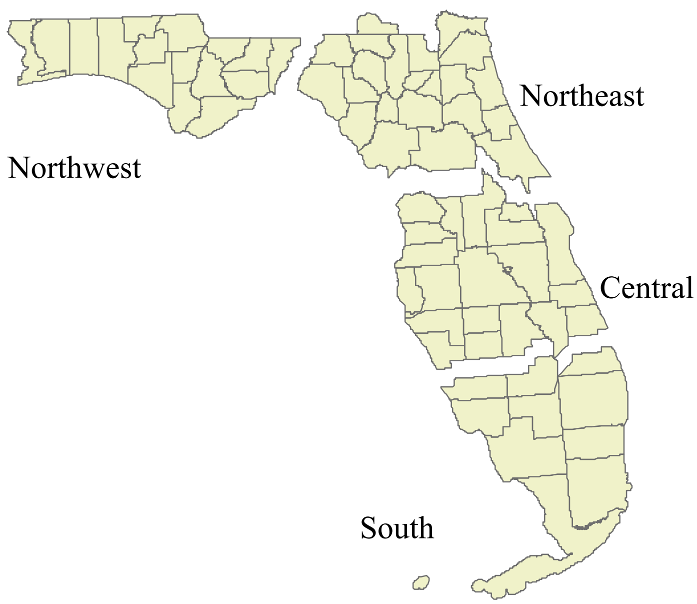

Figure 5. Forest inventory regions in Florida.

The distribution of pine inventory on private lands by diameter class is shown in Figures 7 and 8. Once again, the Northeast and Northwest regions contain most of this inventory. In both the northeast and northwest regions, 29 and 21 percent, respectively, of all private pine inventory is found on plantations in diameter classes less than 9 inches. In central and south Florida, more pine inventory is located in larger diameter classes and in natural stands. But again, these regions have only 12 percent of the state's pine inventory (Figure 6).

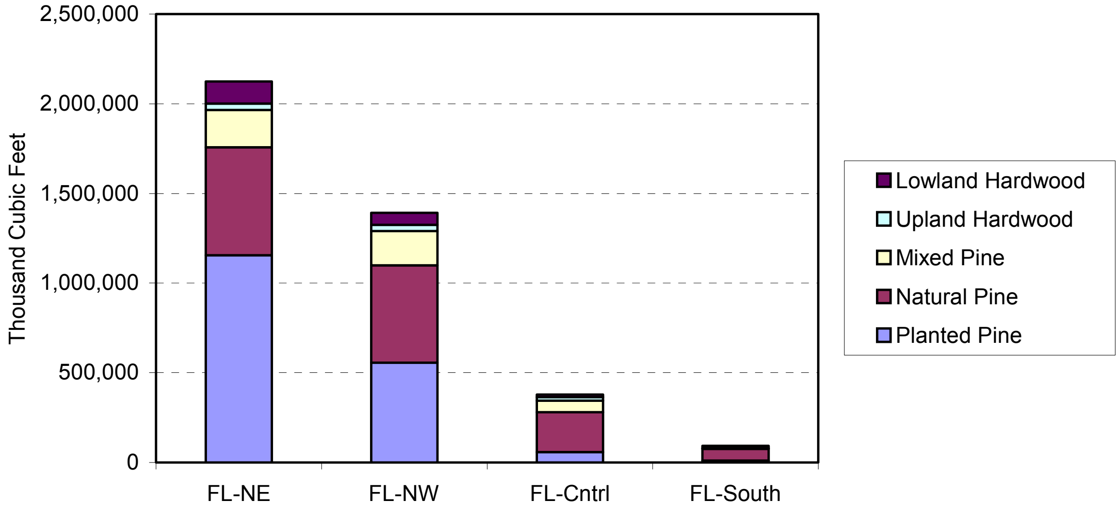

Figure 6. Pine inventory by management type and region on private lands in Florida.

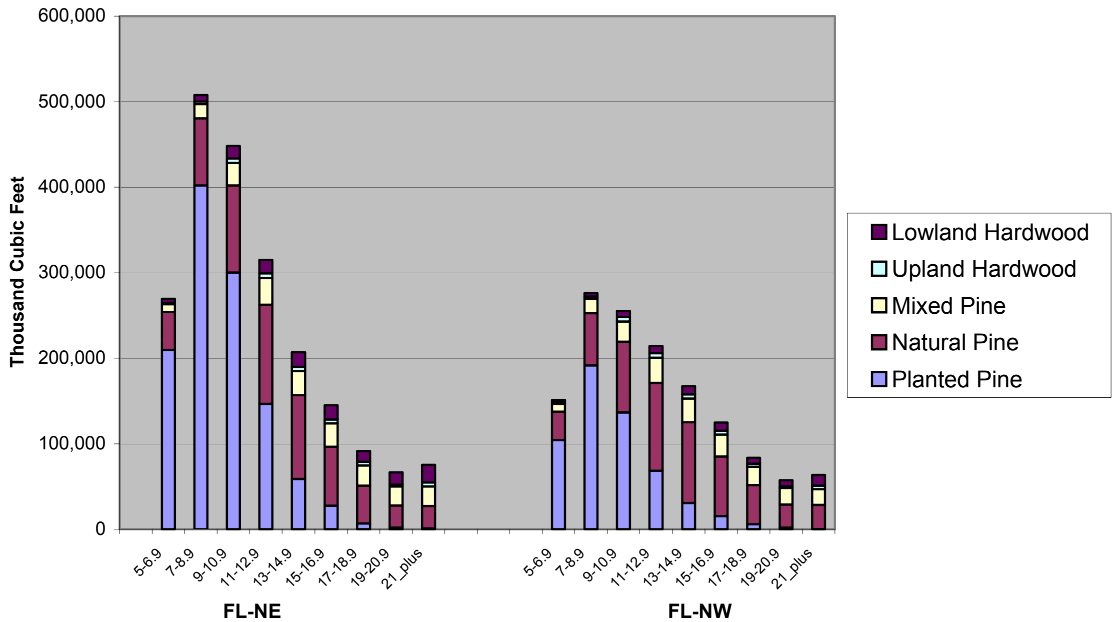

Figure 7. Pine inventory by diameter class on private lands in Northeast and Northwest Florida regions.

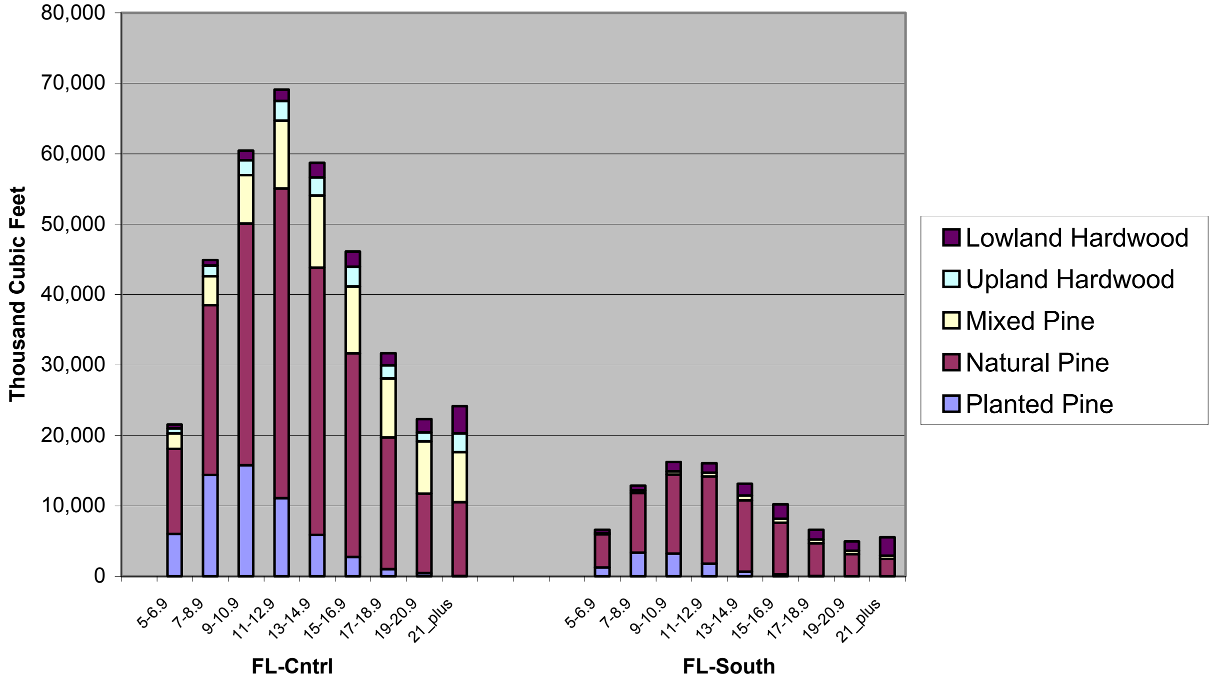

Figure 8. Pine inventory by diameter class on private lands in Central and Southern Florida regions.

Southern U.S. Production and Capacity Trends

U.S. demand for lumber, pulp and paper products affects stumpage prices and harvests in the Southern US and Florida. Assumptions regarding regional harvest levels play a major role in model forecasts of timber inventories in Florida. Historically, demand for pulpwood stumpage in the southern region has risen steadily primarily due to increasing population and GNP growth (Figure 9). However, recent trends indicate a significant softening of demand in the region.

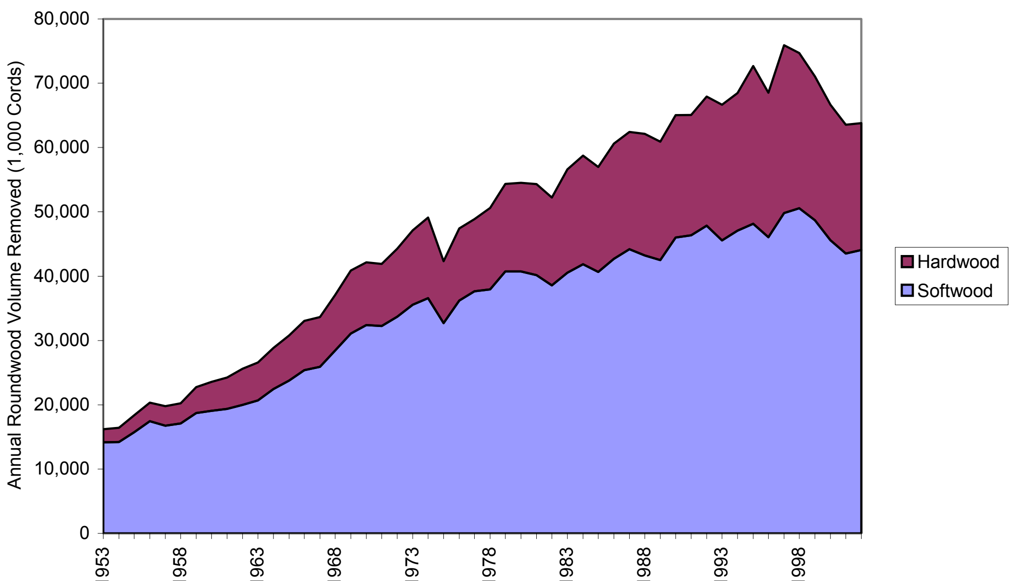

Figure 9. Pulpwood harvests in the southern US, 1953-2002.

Indeed, demand for southern stumpage has declined considerably in the last decade as indicated by reductions in milling capacity (Figure 10). In particular, capacity in pulp and paper mills has resulted from mill closures and consolidations. Other reductions in pulp and paper capacity have resulted from shifting some existing capacity to production of higher valued-added products.

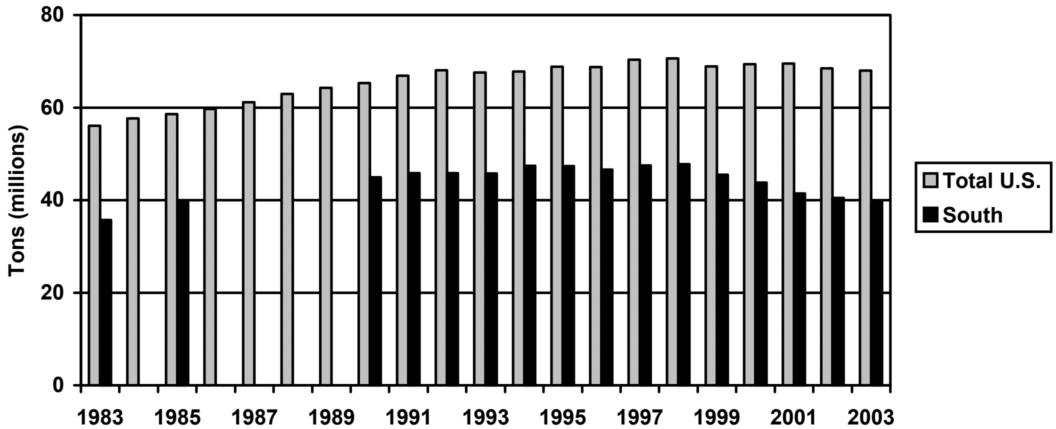

Figure 10. Pulp mill capacity in the U.S. and SouthernU.S., 1983-2003

From 1995 through 2003, southern pulp mill capacity declined by 16 percent while major competitors increased their capacity, particularly those in Sweden, Finland, Chile and Brazil (Figure 11). Pulp production in the U.S. declined 1.5 percent per year from 1995 to 2002, while Chile and Brazil increased pulp production 7.3 and 4.6 percent annually, respectively. The highest rates of increase have occurred however in Indonesia, which saw annual increases of 13.8 percent during the same period

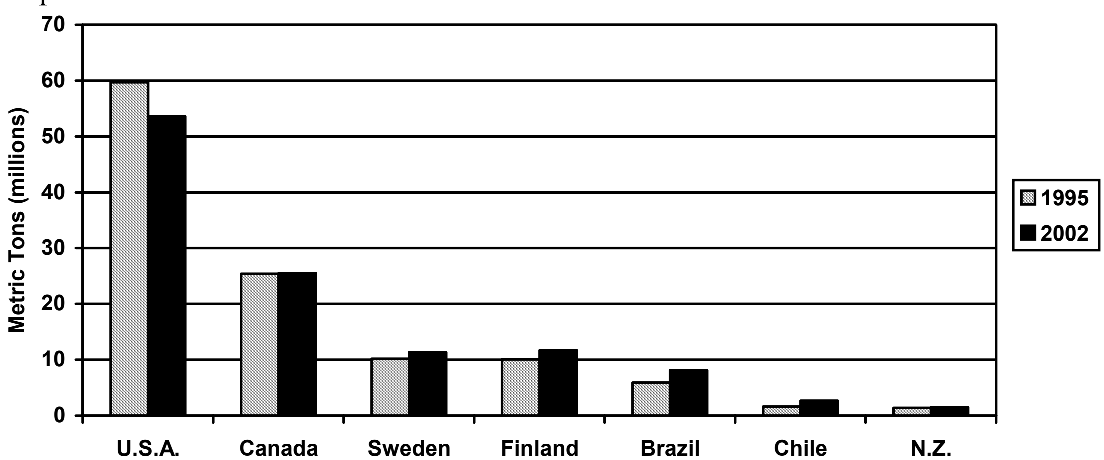

Figure 11. World pulp production, 1995 and 2002.

It is clear that pulp mill capacity and production are shifting overseas, and there has been significant reduction of activity in pulp and paper manufacturing in the southern U.S. Part of the explanation may be due to the technical age of existing mill facilities and the costs of improvements versus investment in new mills. Southern U.S. mills are at a comparative disadvantage to foreign mills in developing regions where costs are lower for labor, raw materials, and compliance with environmental regulations. Demand for stumpage used in the production of lumber and other higher valued products in comparison to pulpwood appears however to remain firm.

Shifting pulpwood demand in part explains recent downturns in pulpwood stumpage prices and investments in tree planting (Figure 12). The number of acres planted annually in the Southern

U.S. declined 30 percent between 1998 and 2004.

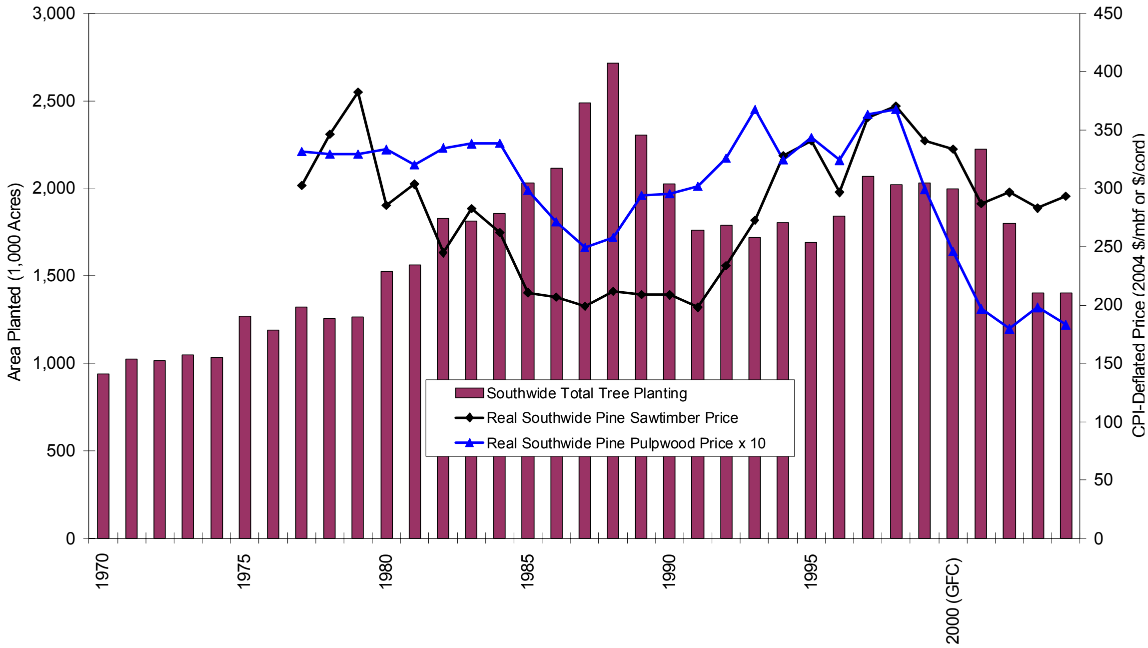

Figure 12. Tree planting and real timber prices in the Southern U.S., 1970-2004.

Forecasting Timber Inventory and Supply

For this analysis, softwood removals and inventory projections were made for private lands from 2000 to 2020. Public lands and cypress forests are not included in the final projections. Two models were used to provide inventory projections, the Timber Assessment Market Model (TAMM; Adams and Haynes 1996 and Haynes 2003) and the multi-product version of the Sub-Regional Timber Supply Model (MPSRTS; Abt et al. 2000). TAMM provides information on aggregate softwood removals for the Southcentral and Southeastern regions of the US, including 13 southern states from Texas to Virginia, but does not provide projections at the state level or at the product level. MPSRTS is used to allocate southeastern US softwood removals to one of 52 southern U.S. Forest Inventory and Analysis (FIA) regions, including the four regions in Florida (described above). MPSRTS also allocates aggregate softwood harvest levels to individual diameter classes in each sub-region.

TAMM is a spatial general equilibrium model of US timber markets that is designed to provide analytical capabilities to the Resources Planning Act of 1974. It has provided the most comprehensive information related to timber resource conditions nationwide. TAMM provides 50 year projections in an iterative (year by year) fashion. The model has the virtue of being fully integrated in the sense that stumpage markets for softwoods are connected to markets for final products, with the demand for final products driving stumpage demand. As a spatial model, it can also transfer excess demand for stumpage across various regions of the U.S., such that if stumpage prices rise in one supply region, demand can shift to other regions. TAMM is comprised of two major components, an economic model, and an inventory projection model. The inventory projection model is the Aggregate Timberland Assessment System (ATLAS). The economic module of TAMM determines softwood and hardwood harvests in each of nine supply regions in the U.S. for different ownerships, including forest industry, other private, and public. The two main regions in this analysis are the Southcentral (SC) and Southeast (SE) regions.

ATLAS allocates the aggregate harvest requirement across forest types, management intensities, and age classes in each region. The harvest volume is removed from current period inventory, then inventory is projected to the next period based upon internal yield tables for the different inventory classes. This process is continued in an iterative fashion until the end of the projection period is reached. The current version of TAMM makes projections from 1990 to 2040.

SRTS is a southern U.S. forest simulation model used to examine timber supply issues. Its primary use is the allocation of aggregate harvest requests to individual FIA survey units in the South. It also serves as an inventory projection model. Given an exogenous harvest request, SRTS will use current inventory information by survey unit to allocate current period harvest to each survey unit, and project the residual inventory one year forward based on historical growth rates. In the next year, a new exogenously determined harvest request is regionally allocated based on the new inventory information. The process continues for a predetermined number of years. Inventory is harvested and growth is calculated according to species, ownership, and age class in each sub-region. For each region, SRTS calculates a change in the market stumpage price, which is determined by the change in aggregate harvest and total inventory. The change in harvest is an exogenous input, while the change in inventory is provided by the growth and yield portion of SRTS for each sub-region. The regional price change is applied to each sub-region, along with its change in inventory to determine the change in sub-regional harvest.

The multi-product version of SRTS (MPSRTS) used in this analysis also allocates sub-regional harvests to either softwood (except cypress) or hardwood by diameter classes (products) based on a goal programming approach that ensures relative prices of products (e.g., pulpwood vs. chip-n-saw) stays stable over time. Thus, for instance, pulpwood demand would not be so large as to make pulpwood more valuable than sawtimber.

A limitation of this analysis is the use of 1995 inventory data for Florida. It was deemed important to make some assumptions based on historical trends of the increase in pine plantation acreage over the projection period. Our assumptions are in line with those provided in the SFRA study described above. It was assumed that pine plantation acreage on private lands would increase 2 percent per year to 2005 and a 1 percent per year thereafter to 2020. Given the decline in acreage available for conversion, the decrease in market activity, especially in pulpwood markets, and the decrease in reforestation intensity (described above), we consider a decline in the rate of increase in new plantations to be a reasonable assumption. However, growth per acre was also assumed to increase above early 1990’s levels due to advances in growing stocks and adoption of more intensive silvicultural practices.

The most recent TAMM softwood removal projections for the Southcentral and Southeast regions of the U.S. indicate only slightly increasing softwood removals (0.4 percent per year) from private ownerships (industrial and non-industrial) from 2000 to 2020. For this analysis therefore, we examined three softwood removal scenarios for the Southern U.S. to 2020: constant softwood removal levels, softwood removals increasing 1 percent per year, and softwood removals decreasing 1 percent per year (Figure 13).

Instead of projecting inventory by product class (i.e., pulpwood, chip-n-saw, sawtimber), we project diameter classes, since merchantability standards for product classes can differ depending upon the market situation, and the diameter class definitions in the MPSRTS model may not fit well with existing merchantability standards for some products. In the following sections, we will focus more on results occurring in the Northern regions of Florida.

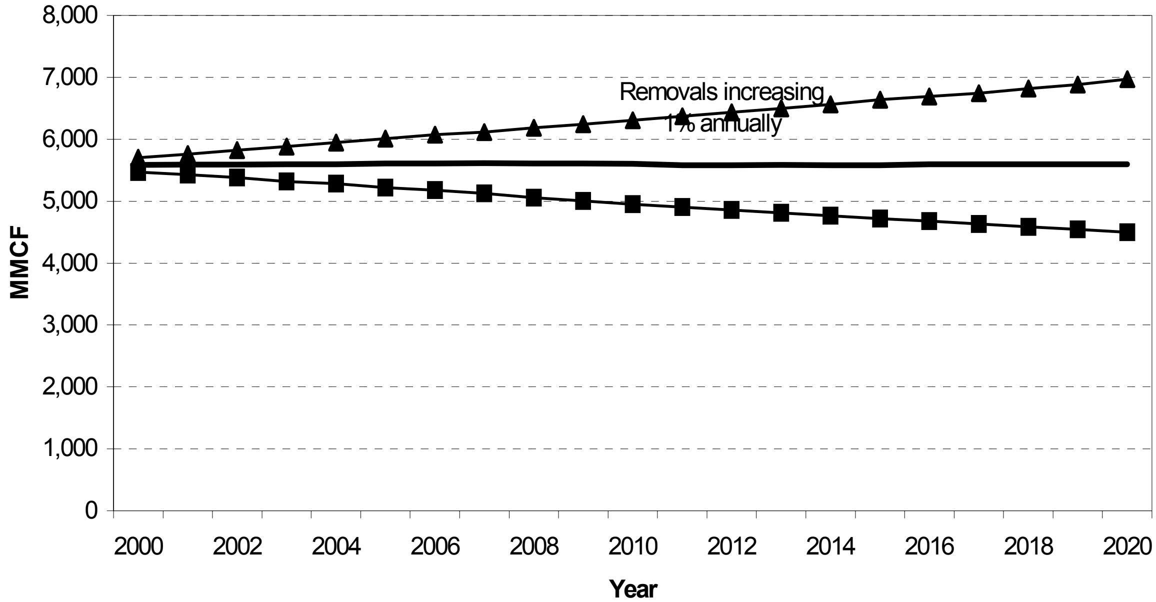

Figure 13. Softwood removals for three scenarios for the Southern U.S.: constant removals, removals increasing 1 percent annually, and removals decreasing 1 percent annually.

Forecast Results for Constant Harvest Removals

Under the assumption of constant softwood removal levels at the aggregate scale for the southern U.S., pine inventories on private ownerships in Florida will increase 29 percent from 2000 to 2020 (Figure 14). Most of the increase occurs in the Northwest region, where pine inventories will increase 47 percent from 1.4 billion to 2.1 billion cubic feet (cf) (Figure 16). Inventories in the Northeast region will increase 13 percent from 2.1 billion to 2.4 billion cf (Figure 15). Although in this scenario removals are assumed constant in the Southern U.S., removals in Florida increase over the projection period due to relative abundance of supply as compared to other FIA sub-regions.

To describe trends in volumes by tree diameter at breast height (DBH), classes are defined as small diameter (5.0-8.9 in. DBH) and large diameter (9.0+ in. DBH). State wide, inventory in the two smallest diameter classes (5.0 to 8.9 in.) are projected to increase 27 percent from 1.27 billion cf in 2000 to 1.61 billion cf in 2020. Inventory in the larger classes are projected to increase 29 percent from 2.75 billion cf in 2000 to 3.54 billion cf in 2020. Volumes in the small diameter classes comprise 36%, 37% and 34% of total volume in the Northeast region in years 2000, 2010, and 2020, and 31%, 39% and 33% for the same years in the Northwest region. Thus in the Northwest region, small diameter inventories are expected to increase significantly in the short term. Volumes in the larger diameter classes comprise 64 %, 63%, and 66% for the Northeast region and 69%, 61% and 67% for the Northwest region, also for 2000, 2010 and 2020.

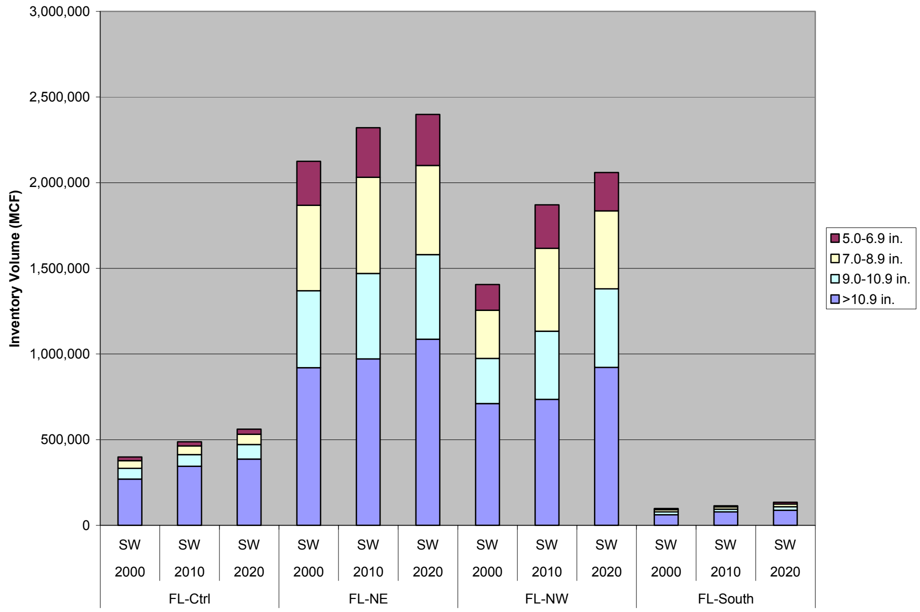

Figure 14. Projected pine inventory in Central, Northeast, Northwest, and South Florida by year and diameter class, assuming constant regional removals.

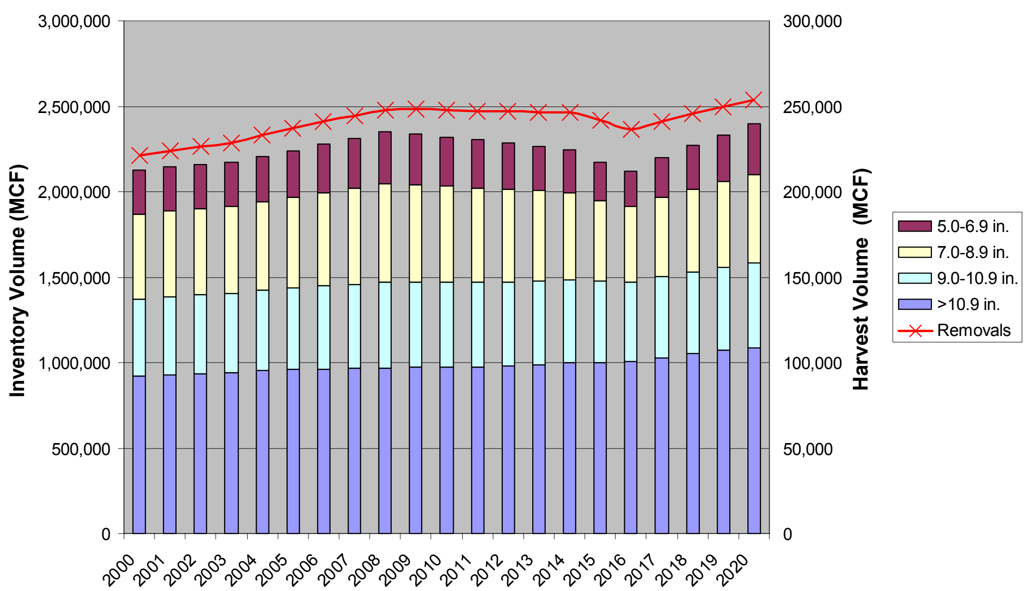

Figure 15. Projected inventory and removals for Northeast Florida, 2000-2020, assuming constant regional removals.

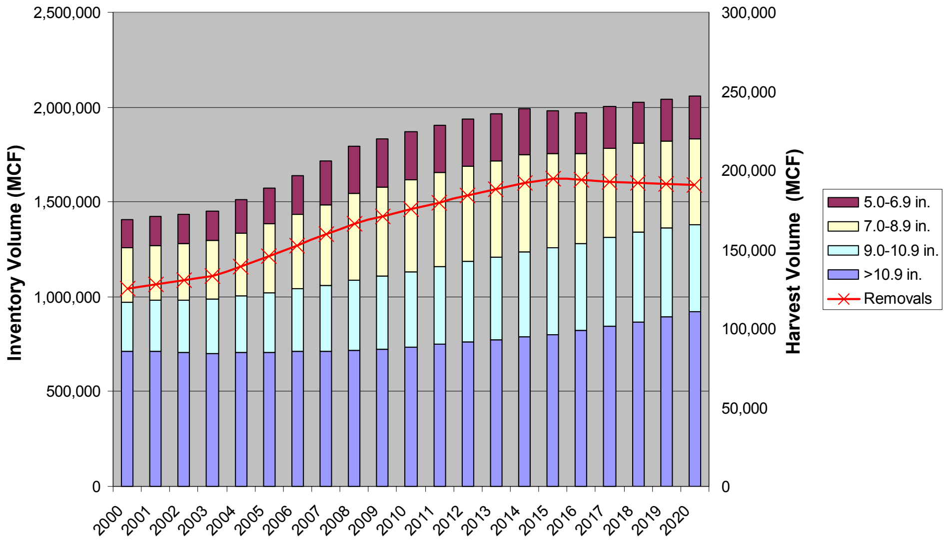

Figure 16. Projected inventory and removals for Northwest Florida, 2000-2020, assuming constant regional removals.

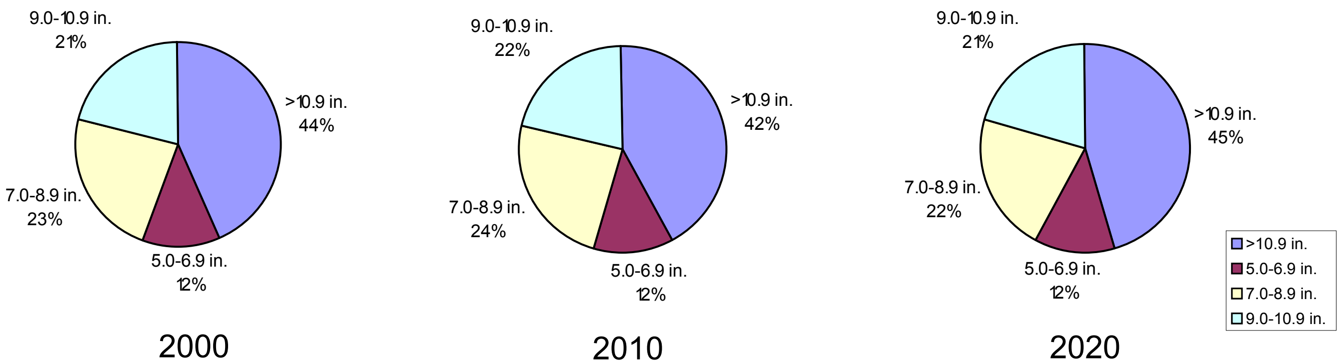

Figure 17. Pine inventory by diameter class, Northeast Florida, 2000-2020, assuming constant regional removals.

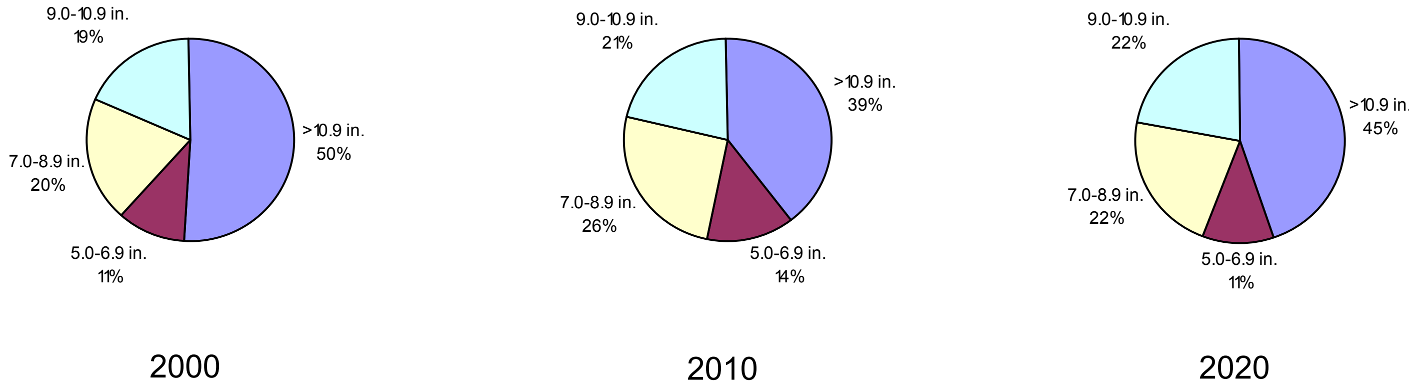

Figure 18. Pine inventory by diameter class, Northwest Florida, 2000-2020, assuming constant regional removals.

Table 1. Projections of Florida softwood inventory assuming constant regional removals to 2020 (thousand cubic feet).

		Region				
Year	DBH Class	FL-Ctrl	FL-NE	FL-NW	FL-South	Florida Total
2000	5.0-6.9 in.	21,673	256,398	149,842	7,074	434,987
	7.0-8.9 in.	45,034	498,456	282,256	13,488	839,234
	9.0-10.9 in.	61,751	450,012	263,485	16,694	791,942
	>10.9 in.	270,457	919,682	710,247	61,492	1,961,878
2000 Total		398,915	2,124,548	1,405,830	98,748	4,028,041
2010	5.0-6.9 in.	24,377	288,831	253,570	6,361	573,139
	7.0-8.9 in.	49,402	561,845	483,786	12,575	1,107,608
	9.0-10.9 in.	68,401	499,147	397,732	16,419	981,699
	>10.9 in.	345,070	971,253	735,501	78,433	2,130,257
2010 Total		487,250	2,321,076	1,870,589	113,788	4,792,703
2020	5.0-6.9 in.	29,497	297,668	225,136	9,434	561,735
	7.0-8.9 in.	59,573	520,768	454,691	16,971	1,052,003
	9.0-10.9 in.	84,690	493,654	458,463	20,256	1,057,063
	>10.9 in.	387,544	1,086,213	921,530	87,729	2,483,016
2020 Total		561,304	2,398,303	2,059,820	134,390	5,153,817

Results for Increasing Harvest Removals

Assuming softwood removal levels increase 1 percent annually at the aggregate scale for the southern US, pine inventories on private lands in Florida decrease 11 percent from 2000 to 2020 (Figure 19). Pine inventories in the Northwest region remain almost constant at 1.4 billion cf in 2000 and 2020 (Figure 21). Inventories in the Northeast region decrease 24 percent from 2.1 billion cf to 1.6 billion cf (Figure 20).

State wide, inventory in the two smallest DBH classes (5.0” to 8.9”) are projected to increase 1 percent from 1.27 billion cf in 2000 to 1.28 billion cf in 2020. Inventory in the larger classes are projected to decrease 16 percent from 2.8 billion cf in 2000 to 2.3 billion cf in 2020. Volumes in the small diameter classes comprise 36%, 37% and 41% of total volume in the Northeast region in years 2000, 2010, and 2020, respectively, and 31%, 40% and 37% for the same years in the Northwest region. Thus in both the Northeast and Northwest regions, small diameter inventories are expected to increase proportionally to total inventory. Volumes in the larger diameter classes comprise 64 %, 63%, and 59% for the Northeast region and 69%, 60% and 63% for the Northwest region, also for

2000, 2010 and 2020, respectively.

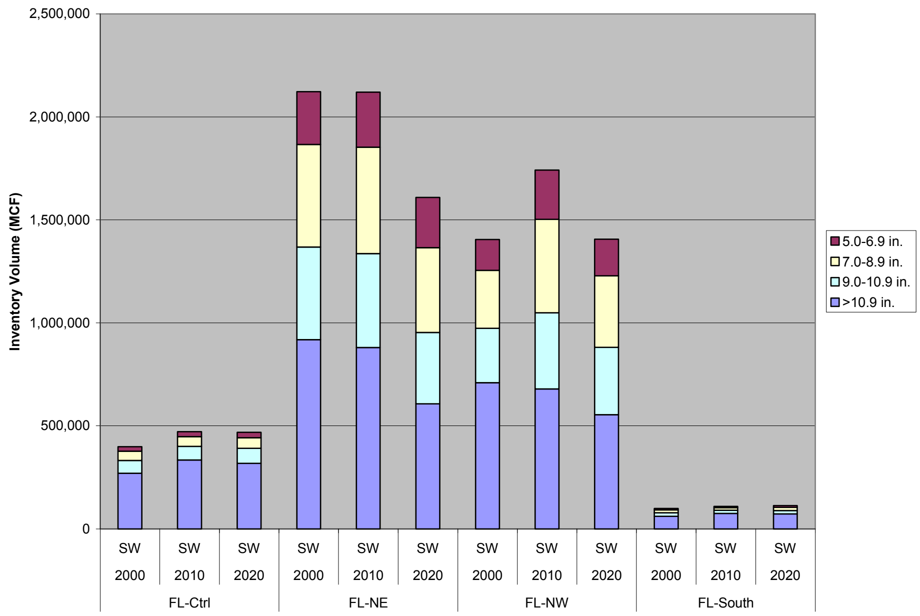

Figure 19. Projected pine inventory in Central, Northeast, Northwest, and South Florida, by year and diameter class, 2000-2020, assuming regional removals increase 1 percent annually.

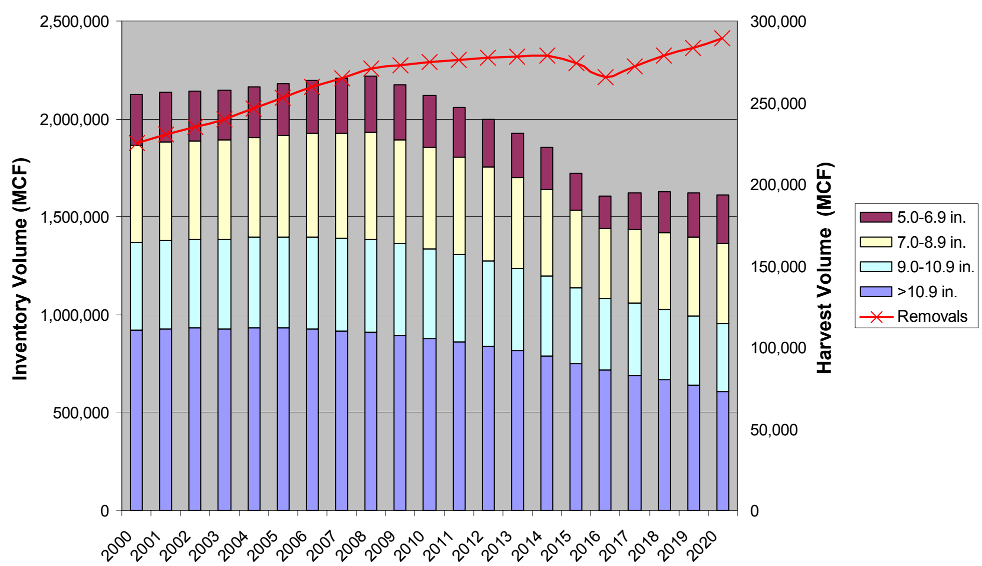

Figure 20. Projected inventory and removals for Northeast Florida, 2000-2020, assuming regional removals increase 1 percent annually.

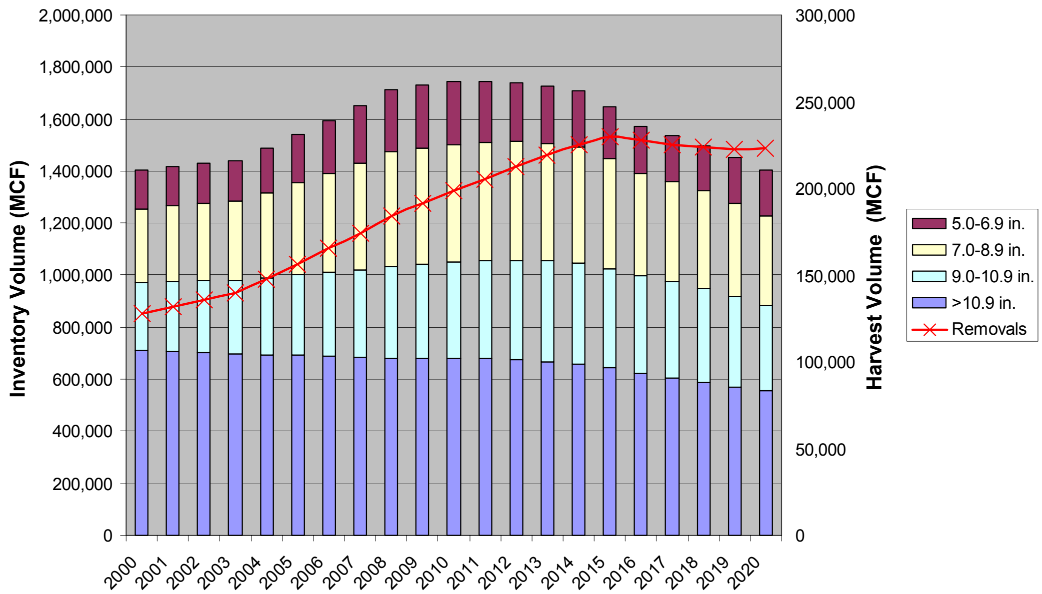

Figure 21. Projected inventory and removals for Northwest Florida, 2000-2020, assuming regional removals increase 1 percent annually.

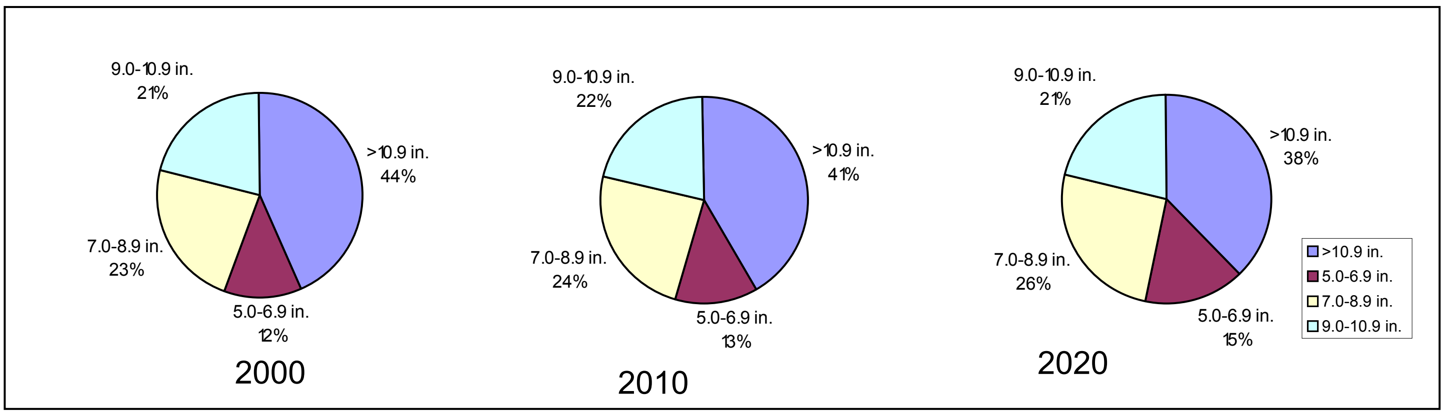

Figure 22. Pine inventory by diameter class, Northeast Florida, 2000-2020, assuming regional removals increase 1 percent annually.

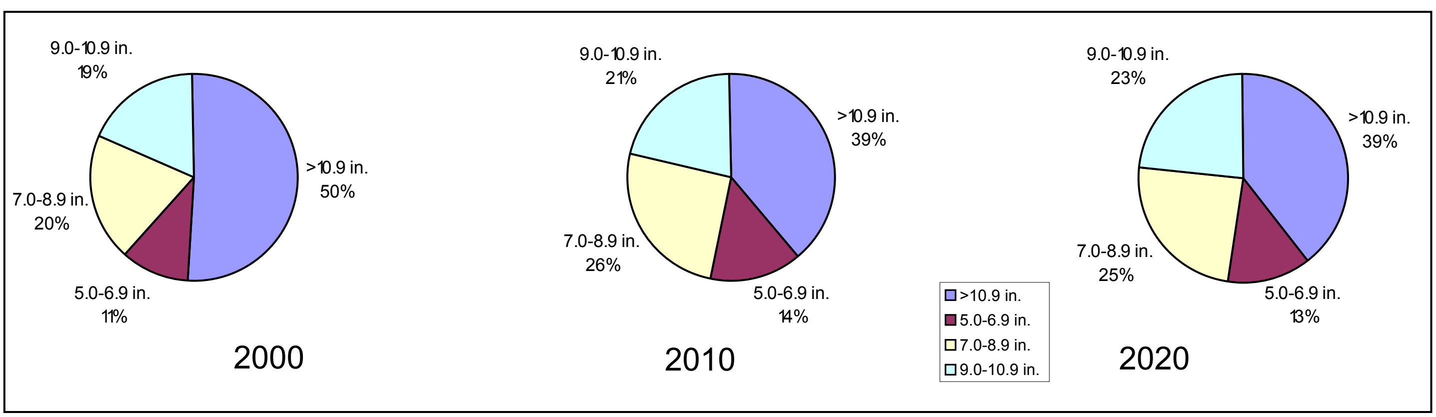

Figure 23. Pine inventory by diameter class, Northwest Florida, 2000-2020, assuming regional removals increase 1 percent annually.

Table 2. Projections of Florida Softwood Inventory Assuming Regional Removals Increase 1 Percent Annually to 2020 (thousand cubic feet).

		Region				
Year	DBH Class	FL-Ctrl	FL-NE	FL-NW	FL-South	Florida Total
2000	5.0-6.9 in.	21,658	255,925	149,620	7,070	434,273
	7.0-8.9 in.	45,007	497,808	281,952	13,483	838,250
	9.0-10.9 in.	61,720	449,543	263,231	16,689	791,183
	>10.9 in.	270,390	918,899	709,710	61,466	1,960,465
2000 Total		398,775	2,122,175	1,404,513	98,708	4,024,171
2010	5.0-6.9 in.	23,644	266,516	239,037	6,224	535,421
	7.0-8.9 in.	47,804	516,419	453,753	12,206	1,030,182
	9.0-10.9 in.	66,101	456,157	370,322	15,810	908,390
	>10.9 in.	334,332	880,174	678,650	75,149	1,968,305
2010 Total		471,881	2,119,266	1,741,762	109,389	4,442,298
2020	5.0-6.9 in.	26,410	244,221	177,678	8,670	456,979
	7.0-8.9 in.	52,147	411,969	346,938	15,261	826,315
	9.0-10.9 in.	73,040	345,537	326,612	17,575	762,764
	>10.9 in.	317,595	607,291	554,540	72,004	1,551,430
2020 Total		469,192	1,609,018	1,405,768	113,510	3,597,488

Results for Decreasing Harvest Removals

Assuming decreasing softwood removal levels 1 percent annually at the aggregate scale for the southern US, pine inventories on private lands in Florida will increase 61 percent from 2000 to 2020 (Figure 24). Pine inventories in the Northwest region increase 85 percent from1.4 billion cf in 2000 to 2.6 billion cf in 2020 (Figure 26). Inventories in the Northeast region increase 46 percent from 2.1 billion cf to 3.1 billion cf (Figure 25).

State-wide, inventory in the small diameter class (5.0” to 8.9”) are projected to increase 52 percent from 1.28 billion cf in 2000 to 1.94 billion cf in 2020. Inventory in the larger classes are projected to increase 65 percent from 2.76 billion cf in 2000 to 4.55 billion cf in 2020. Volumes in the small diameter classes comprise 36%, 36% and 32% of total volume in the Northeast region in years 2000, 2010, and 2020, respectively, and 31%, 39% and 32% for the same years in the Northwest region. Thus in the Northwest region, small diameter inventories are expected to increase significantly in the short term. Volumes in the larger diameter classes comprise 64 %, 64%, and 68% for the Northeast region and 69%, 61% and 68% for the Northwest region, also for 2000, 2010 and 2020, respectively.

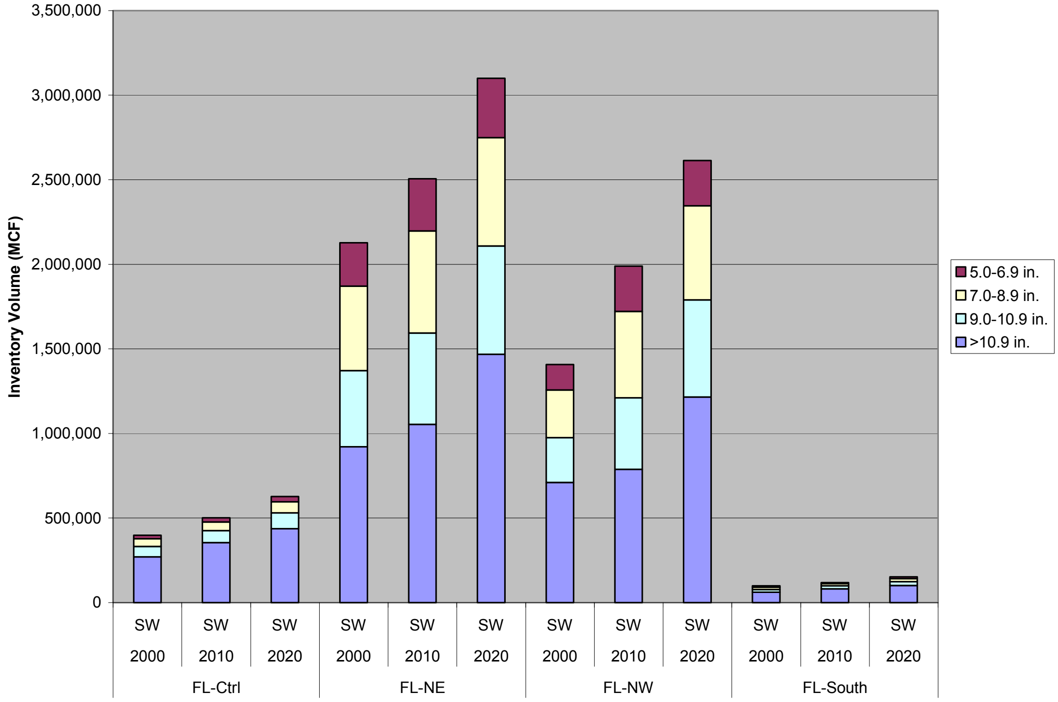

Figure 24. Projected pine inventory in Central, Northeast, Northwest, and South Florida by year and diameter class, 2000-2020, assuming regional removals decrease 1 percent annually.

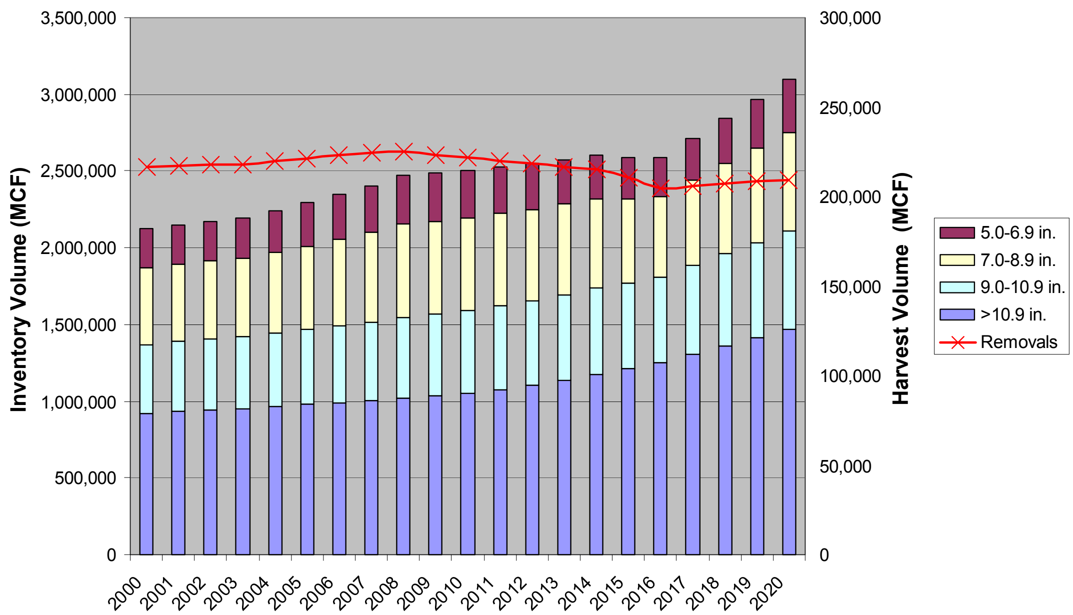

Figure 25. Projected inventory and removals for Northeast Florida, 2000-2020, assuming regional removals decrease 1 percent annually.

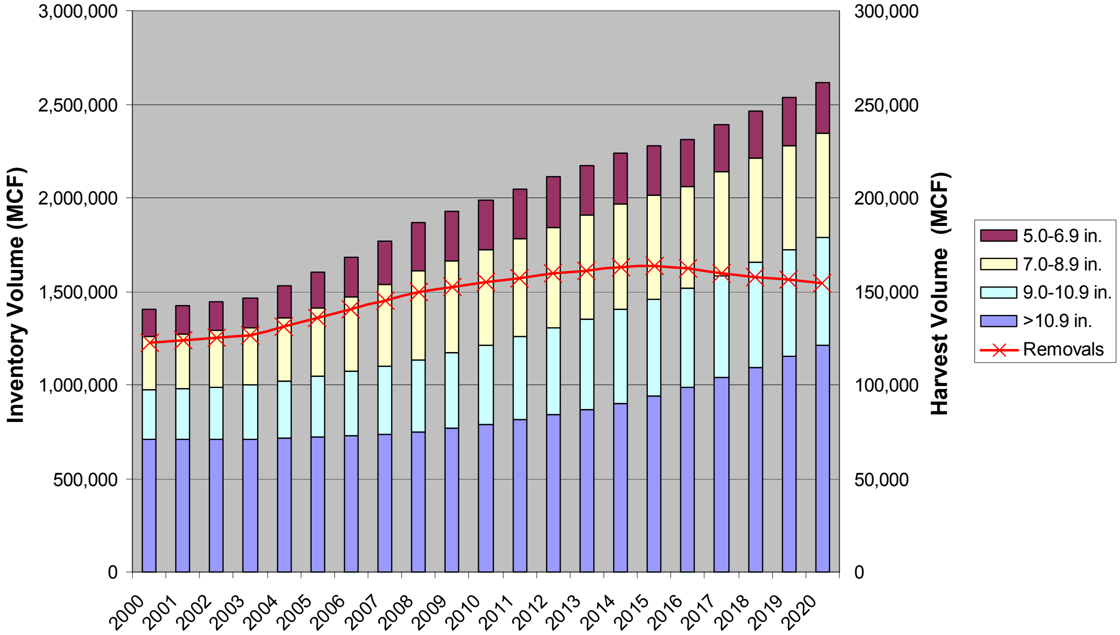

Figure 26. Projected inventory and removals for Northwest Florida, 2000-2020, assuming regional removals decrease 1 percent annually.

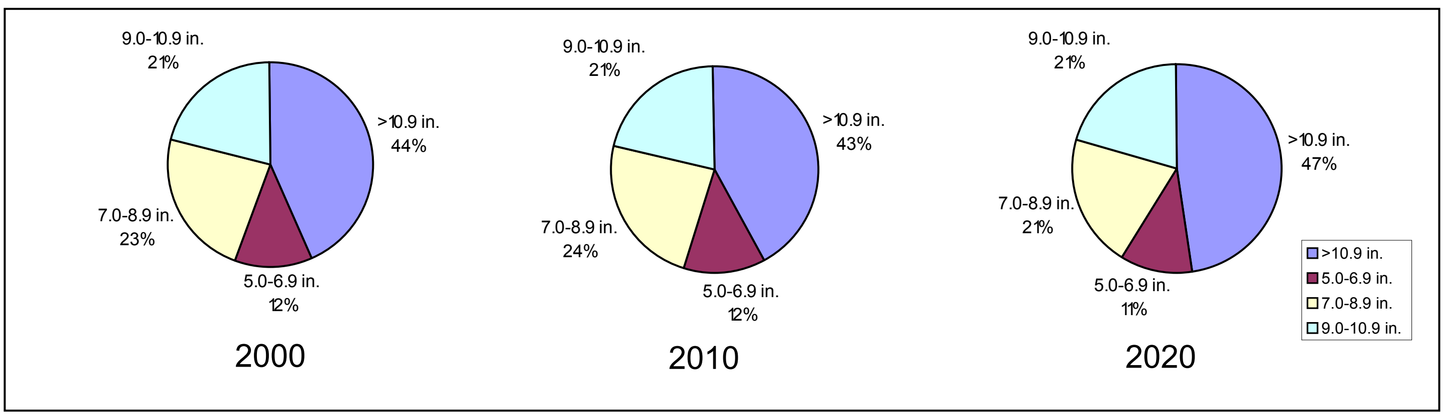

Figure 27. Pine inventory by diameter class, Northeast Florida, 2000 to 2020, assuming decreasing harvest removals by 1 percent annually.

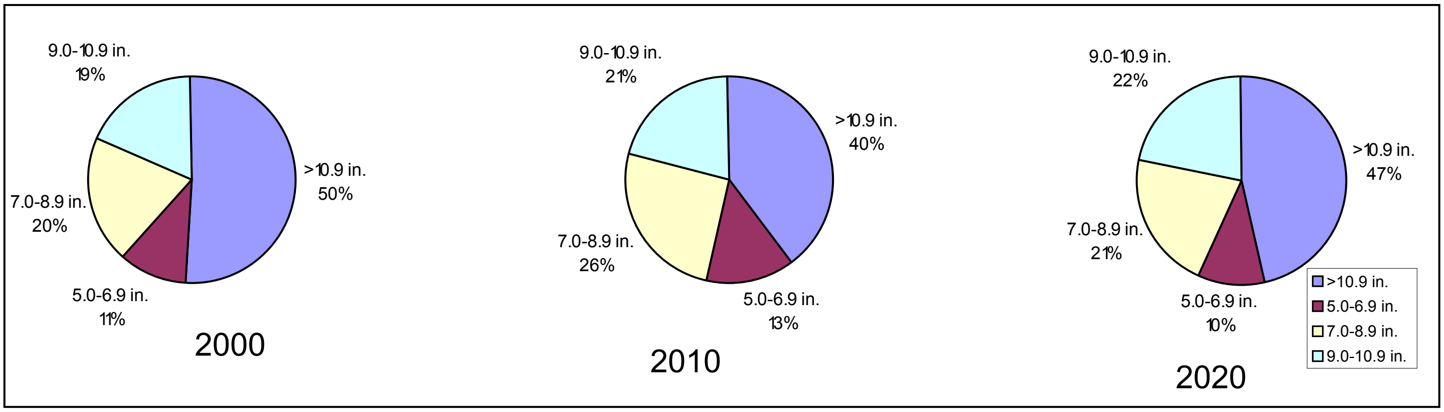

Figure 28. Pine inventory by diameter class, Northwest Florida, 2000 to 2020, assuming decreasing harvest removals by 1 percent annually.

Table 3. Projections of Florida Softwood Inventory Assuming Regional Removals Decrease 1 Percent Annually to 2020 (thousand cubic feet).

		Region				
Year	DBH Class	FL-Ctrl	FL-NE	FL-NW	FL-South	Florida Total
2000	5.0-6.9 in.	21,677	256,565	149,916	7,076	435,234
	7.0-8.9 in.	45,057	499,107	282,573	13,496	840,233
	9.0-10.9 in.	61,777	450,579	263,778	16,704	792,838
	>10.9 in.	270,549	920,610	710,888	61,522	1,963,569
2000 Total		399,060	2,126,861	1,407,155	98,798	4,031,874
2010	5.0-6.9 in.	25,060	309,022	266,559	6,513	607,154
	7.0-8.9 in.	50,903	603,766	510,744	12,893	1,178,306
	9.0-10.9 in.	70,548	538,698	422,482	16,991	1,048,719
	>10.9 in.	354,941	1,054,355	788,535	81,568	2,279,399
2010 Total		501,452	2,505,841	1,988,320	117,965	5,113,578
2020	5.0-6.9 in.	31,895	349,719	267,340	10,040	658,994
	7.0-8.9 in.	65,356	641,164	556,111	18,374	1,281,005
	9.0-10.9 in.	93,648	639,287	574,981	22,446	1,330,362
	>10.9 in.	436,455	1,468,382	1,214,963	101,208	3,221,008
2020 Total		627,354	3,098,552	2,613,395	152,068	6,491,369

Survey of Small Diameter Pine Timber Utilization by Forest Product Manufacturers in Florida

As part of this research, a survey of wood using industries in Florida was conducted to document the current and potential market for small diameter pine timber (SDPT). Surveys are an essential tool for market research, to help insure that a real need for the product exists.

Methods

A list of forest product manufacturing firms in Florida was obtained from the Florida Department of Agriculture and Consumer Services-Division of Forestry. This list included contact information and type(s) of products produced. A total of 126 firms that produce pulp, lumber, poles, posts, and various composites and engineered wood products, were selected for the survey. Manufacturers of certain products, such as plywood and engineered trusses, were excluded because they generally do not purchase small diameter roundwood timber. The selected firms were notified by mail regarding the purpose of the survey and to request their cooperation. A subcontractor with extensive experience in the forest products industry was retained to conduct telephone interviews with these firms (Mr. Ray Mason, Havana, FL). At least three attempts were made to contact each firm by telephone during April and May of 2005

Qualified respondents were asked a series of questions regarding use of SDPT. For purposes of this survey, small diameter timber was defined as 3 to 7 inches diameter at breast height (dbh). Seven inches diameter represents the lower size limit for Chip-and-Saw utilization. Information requested in the survey included:

- Total tonnage of SDPT used last year (2004)
- Total tonnage of SDPT expected to be used in five years (2009)
- Percentage of total current use of SDPT for the product classes of pulp, mulch or chips for landscaping, chips for panels, fence posts, fuelwood, engineered wood structures (e.g. beams, trusses), and miscellaneous others.
- Tonnage for expected future use of SDPT within each product class.
- Reasons for <u>not</u> using SDPT currently or in the future
- Recommendations for the forestry industry to increase demand for SDPT.

A copy of the questionnaire and informed consent statement are shown in Appendix B. This survey instrument was reviewed and approved by the University of Florida-Institutional Review Board (UFIRB) for compliance with ethical standards for human subjects research.

Results

The disposition of survey calls is summarized in Table 4. A total of 94 firms, or nearly 75 percent of targeted firms, responded to the survey and provided usable data, while the remainder of firms were either out of business (18%) or refused to participate or could not be reached (8%).

Current Usage of Small Diameter Pine Timber in 2004

Of the firms responding, 20 (21%) indicated that they currently used SDPT, and 74 (79%) did not (Table 5). The total volume of SDPT reported used in 2004 was slightly over 2 million tons, which represented an average of just over 100,000 tons per user.

Table 4. Disposition of survey telephone calls, April-May, 2005.

Disposition of Firms Surveyed	Number of Firms	Percent of Firms
Provided usable data	94	74.6
Out of business	22	17.5
Refused/Could not reach	10	7.9
Total	126	100.0

Table 5. Number, percent and volume of surveyed Florida firms using small diameter pine timber in 2004.

Current use of small diameter pine timber	Firms		Tonnage	
	Number	Percent	Mean	Total
Yes, use SDPT	20	21.3	100,639	2,012,775
No, do not use SDPT	74	78.7		0
Totals	94	100.0	N.A.	2,012,775

Current use of small diameter pine timber reported for various product classes is summarized in Table 6. Among the 20 firms reporting use of SDPT, the largest percentage used it for mulch (40%), followed by pulp (30%), fence posts (20%) and barn poles (20%). Smaller percentages of respondents reported using SDPT for chip & saw (10%), animal bedding (10%), dimension lumber (10%), engineered wood (5%), and panels (5%). None reported using SDPT for pallets or fuel. In terms of volume, pulp represented the largest volume use (1.57 million tons), followed by mulch (201,075 tons), and animal bedding (125,200 tons). Other smaller volume uses were for barn poles (30,880 tons), fence posts (25,420 tons) and chip-and-saw (22,800 tons). The largest average volume used per firm was for pulp (261,265 tons). Results reported in Table 6 were aggregated for all building products (reconstituted or engineered wood products, chip & saw, and dimension lumber), to avoid disclosure of information for products with small numbers of respondents.

Table 6. Usage of small diameter pine timber by surveyed Florida firms in 2004, by product class.

Uses	Firms Using SDPT			Volume (tons)	
	Number	Percent of All[a]	Percent of Users[b]	Mean	Total
Pulp	6	6.4	30.0	261,265	1,567,590
Mulch/Bedding	8	8.5	40.0	25,134	201,075
Building materials[c]	6	6.4	30.0	10,435	62,610
Fence posts	4	4.2	20.0	6,355	25,420
Pallets	0	0.0	0.0	0	0
Fuel	0	0.0	0.0	0	0
Barn poles	4	4.2	20.0	7,720	30,880
Totals	N.A.	N.A.	N.A.	N.A.	2,012,775

a. Percentage is based upon all 94 manufacturing firms found to be in business in May 2005.
b. Percentage is based only upon 20 firms currently using small diameter pine timber in 2004.
c. Includes reconstituted or engineered wood products, chip & saw, and dimension lumber.

Projected Usage of Small Diameter Pine Timber in 2009

Survey respondents were asked whether or not they planned to use SDPT in their operations in five years (2009). Of the 20 firms using SDPT in 2004, all planned to use it in 2009, and 16 of these firms indicated significantly greater usage was expected in 2009, with an average increase of 8.9 percent overall. The total tonnage expected to be used in 2009 exceeded 3.1 million tons, reflecting an increase of 56 percent over 2004, mainly due to expanded use by current users (Table 7). The average usage per respondent in 2009 is projected at 137,000 tons. However, it should be noted that there was considerable variation in firm sizes and in the projected usage of SDPT; a few smaller firms indicated that they could possibly double their usage of SDPT by 2009. Three of the 74 responding firms that did not use SDPT in 2004 indicated a likelihood of using it in 2009, which would bring the total number of users to 23.

An increase in the number of firms that expect to use SDPT in the future was reported for mulch, engineered wood and dimension lumber (Table 8). A large expansion in volume to nearly one million tons is expected for engineered wood, due to the opening of a new OSB plant. Other products with significant expansion in usage planned are panels, fence posts, and barn poles, while moderate expansion was reported for mulch and dimension lumber, and a small increase is expected for pulp. Volume used for chip-and-saw is expected to decline.

Table 7. Projected use of small diameter pine timber by surveyed Florida firms in 2009.

Projected Use of Small Diameter Pine Timber	Firms		Volume (Tons)	
	Number	Percent	Mean	Total
Yes, plan to use	23	24.5	136,676	3,143,550
No, do not plan to use	71	75.5		0
Totals	94	100.0	N.A.	3,143,550

Table 8. Predicted future usage of small diameter pine timber in 2009 by surveyed Florida firms, by product class.

Uses	Firms Using SDPT			Volume (Tons)	
	Number	Percent of All[a]	Percent of Users[b]	Mean	Total
Pulp	6	6.4	26.1	275,548	1,653,290
Mulch/Bedding	10	10.6	43.5	35,810	358,100
Building materials[c]	8	8.5	34.8	129,151	1,033,210
Fence posts	4	4.2	17.4	11,306	45,225
Pallets	0	0.0	0.0	0	0
Fuel	0	0.0	0.0	0	0
Barn poles	4	4.2	17.4	13,431	53,725
Totals	N.A.	N.A.	N.A.	N.A.	3,143,550

a. Percentage is based upon all 94 manufacturing firms found to be in business in May 2005.
b. Percentage is based upon 20 firms currently using small diameter pine timber in 2004.
c. Includes reconstituted or engineered wood products, panels, chip & saw, and dimension lumber.

Table 9. Change in volume of small diameter pine timber usage by surveyed Florida firms, 2004 to 2009, by product class.

Uses	2004 Tonnage	Expected 2009 Tonnage	Percent Change from 2004 to 2009
Pulp	1,567,590	1,653,290	5.5
Mulch/Bedding	326,275	358,100	9.8
Building materials[a]	62,610	1,033,210	1550.2
Fence posts	25,420	45,225	77.9
Pallets	0	0	NA
Fuel	0	0	NA
Barn poles	30,880	53,725	74.0
Totals	2,012,775	3,143,550	56.2

a. Building materials includes reconstituted or engineered wood products, panels, chip & saw, and dimension lumber.

Reasons for Not Using Small Diameter Pine Timber

Insight into the current market situation was obtained by asking respondents to indicate the reason(s) that they did not use SDPT. This question was naturally posed only to those respondents that said they had not used SDPT during 2004. Only 11 of the 74 firms did not provide reasons for not using SDPT in 2004. The most frequent reason for not using SDPT, given by nearly 40 percent of responding non-users, was that they were not equipped to handle roundwood logs (Table 10). Most of these plants utilize lumber and/or poles in the manufacture of finished goods, although some indicated that they treat lumber or poles with preservatives. The next largest group of non-users of SDPT said they required larger diameter pine logs for the kinds of products they produce. For the most part, these firms produce dimension lumber, chip & saw and utility poles. The third largest group, comprised of nearly one-fifth of the non-using firms reported using species other than slash or long-leaf pine. They generally expressed a need for hardwoods, cypress or sand pine. Sand pine was preferred by several mulch manufacturers because its very light color and high porosity facilitates dyeing for landscape mulch. Five percent of the firms not using SDPT in 2004 said they no longer use wood products. Most of these were firms that had formerly used wood for fencing, but had substituted other materials for wood. Finally, three firms contacted had not used SDPT in 2004, but expressed a strong likelihood that they would be using it in 2009.

An overwhelming majority of the manufacturing plants that were not using SDPT in 2004 indicated that they would probably not use it in 2009. When asked why they would not be using SDPT in 2009, virtually all gave the same reasons given for not using it in 2004; i.e. they planned no changes in their manufacturing operations.

Table 10. Reasons for not using small diameter pine timber in 2004 reported by surveyd Florida firms.

Reason	Number Firms	Percent Firms
Do not buy/handle round wood; use lumber, poles obtained from others	29	39
Use only large diameter pine for poles, chip& saw, dimension lumber	25	34
Use only hardwood, cypress, cedar or sand pine	13	18
Uses no wood products	4	5
Temporarily not operating	3	4
Total	74	100

Literature and Information Sources Cited

Abt, R., Cubbage, F., and Pacheco, G., 2000. Southern Forest Resource Assessment Using the Subregional Timber Supply (SRTS) Model. *Forest Products Journal*. 50(4):25-33.

Adams, D., and R. Haynes. 1996. The 1993 Timber Assessment Market Model: Structure, projections, and policy simulations. *General Technical Report* PNW-GTR-368, 58 p. USDA Forest Service Pacific Northwest Research Station, Portland, OR.

Anonymous. Healthy Forest Legislation Passes Congress; Signed by President Bush. *Ecological Restoration*, Mar 2004, Vol. 22 Issue 1, p2, 2p. Available at http://weblinks2.epnet.com.

Antares Group. *Assessment of Power Production at Rural Utilities Using Forest Thinnings and Commercially Available Biomass Power Technologies.* Available at http://www.antaresgroupinc.com/doerusreport.htm

Bain, R.L., W.P. Amos, M. Downing, R.L. Perlack, 2003. *Biopower Technical Assessment: State of the Industry and Technology.* U.S. Department of Energy, National Renewable Energy Laboratory, Golden, Colorado, Report Number NREL/TP-510-33123, 03/31/2003. Available at http://www.nrel.gov/docs/fy03osti/33123.pdf.

Bain, Richard L. *Current and Potential Energy Products from Biomass*, US Department of Energy, National Renewable Energy Laboratory, Golden, Colorado, January 21, 2004. Powerpoint Presentation to Bioenergy and Wood Products Conference. Available at http://www.healthyforests.gov/initiative/biomass_conference/presentations/bain.pdf.

Bain, Richard L., and Ralph P. Overend. Biomass for Heat and Power. *Forest Products Journal,* Vol. 52, No. 2., Feb 2002. Available at http://www.fpl.fs.fed.us/tmu/pdf/fps_feb2002featurerichbain.pdf

Baumgartner, David M., Leonard R. Johnson, Edward J. DePuit. *Small Diameter Timber Symposium Proceedings, 2002*. Washington State University, Spokane, February 25 - 27, 2002. http://smalldiametertimber.wsu.edu/table_of_contents/index.html#economic

Bentley, J.W., T.G. Johnson and E. Ford. Florida's Timber Industry–An Assessment of Timber Product Output and Use, 1999. *Resource Bulletin* SRS-77, USDA/Forest Service, Southern Research Station, Asheville, NC, 2002.

Bjorheden R, Gullberg T, and Johansson J. Systems Analyses for Harvesting Small Trees for Forest Fuel in Urban Forestry, *Biomass and Bioenergy*, April 2003, vol. 24, no. 4, pp. 389-400(12). Available at http://www.sciencedirect.com/science.

Brown, M.J. 1996. Forest Statistics for Florida, 1995. *Resource Bulletin* SRS-6. Asheville, NC: US Department of Agriculture, Forest Service, Southern Research Station. 48 p.

Bumgardner, Matthew S., Bruce G. Hansen, Albert T. Schuler and Philip A. Araman. *Options for Small-Diameter Hardwood Utilization: Past and Present*, Proceedings of the Annual Meeting of the Southern Forest Economics Workers (SOFEW)-Hardwoods-An Underdeveloped Resource? Pp. 1-7. Available at http://www.srs4702.forprod.vt.edu/pubsubj/pdf/00t31.pdf.

Camp A.. Damage to Residual Trees by Four Mechanized Harvest Systems Operating in Small-Diameter, Mixed-Conifer Forests on Steep Slopes in Northeastern Washington: A Case Study., *Western Journal of Applied Forestry*, 1 January 2002, vol. 17, no. 1, pp. 14-22(9). Available at http://www.ingentaconnect.com/search.

Conner, R.C. and A.J. Hartsell. Forest Area and Conditions. Ch.16 in *Southern Forest Resource Assessment*, 2002, eds. D. Wear and J. Greis, USDA-Forest Service, Southern Research Station, Asheville, NC. *Technical Report* GTR SRS-53, pp. 357-401.

Cook J. and J. Beyea. Bioenergy in the United States: Progress and Possibilities. *Biomass and Bioenergy*, 1 June 2000, vol. 18, no. 6, pp. 441-455(15). Available at http://www.sciencedirect.com/science.

Cumbo, Dan W., Robert L. Smith, and Charles W. Becker III. Value Analysis of Lumber Produced from Small-diameter Timber. *Forest Products Journal,* Oct 2004, Vol. 54, Iss. 10; p. 29 (6 pages). Available at http://proquest.umi.com/pqdweb.

DiPardo, Joseph. *Outlook for Biomass Ethanol Production and Demand.* U.S. Dept of Energy, Energy Information Administration, July, 2000. Available at http://www.eia.doe.gov/oiaf/analysispaper/pdf/biomass.pdf.

Findley A.J., M.S. Carroll , and K.A. Blatner. Social Complexity and the Management of Small-Diameter Stands. *Journal of Forestry*, December 2001, vol. 99, no. 12, pp. 18-27(10), Available at http://www.ingentaconnect.com/content/saf/jof/2001/00000099/00000012/art00006.

Hansen, Bruce, Phil Araman, Cindi West, and Al Schuler. *Hardwood Timber Product Markets: A Focus on Small-diameter,* In, proceedings, Society of American Foresters 1999 National Convention, pp. 305-311. Available at http://www.srs4702.forprod.vt.edu/pubsubj/pdf/00t14.pdf.

Haq, Zia. *Biomass for Electricity Generation*. U.S. Dept of Energy, Energy Information Administration, July, 2002. Available at http://www.eia.doe.gov/oiaf/analysispaper/biomass/pdf/biomass.pdf

Haynes, R.W. (technical coordinator). 2003. An Analysis of the Timber Situation in the United States: 1952-2050. A Technical Document Supporting the 2000 USDA Forest Service RPA Assessment. *General Technical Report* PNW-GTR-560. US Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR. 254 p.

Hughes, Evan. 2000. Biomass cofiring: economics, policy and opportunities. *Biomass and Bioenergy* 19(6): 457-465.

Hunt, John F. and Jerrold E. Winandy. Lam I-Joists: A New Structural Building Product From Small-Diameter Fire-Prone Timber. United States Department of Agriculture, Forest Service, Forest Products Laboratory, *Research Note* FPL−RN−0291. Available at http://www.fpl.fs.fed.us/documnts/fplrn/fplrn291.pdf.

Kluender, R; D. Lortz, W. McCoy, B. Stokes, and J. Klepac. Removal Intensity and Tree Size Effects on Harvesting Cost and Profitability. *Forest Products Journal*. Jan 1998. v. 48 (1), 54-59. Available at http://proquest.umi.com/pqdweb.

LeVan-Green, Susan L., and Jean Livingston. Exploring the Uses For Small-Diameter Trees, *Forest Products Journal*, September 2001, Vol. 51, No. 9, pages 10-21. Available at http://www.fpl.fs.fed.us/documnts/pdf2001/levan01a.pdf.

LeVan-Green, Susan L., and Jean M. Livingston.Uses for Small-Diameter and Low-Value Forest Thinnings, *Ecological Restoration*, Vol. 21(1), March, 2003. Available at http://www.fpl.fs.fed.us/documnts/pdf2003/green03d.pdf.

Livingston, Jean. *Small Diameter Success Stories*, 2004. U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 33 p. Madison, WI: Available at http://www.fpl.fs.fed.us/tmu/pdf/sd_success_stories.pdf.

McNeil Technologies. *Biomass Resource Assessment and Utilization Options for Three Counties in Eastern Oregon*. Prepared for Oregon Department of Energy. Lakewood, CO, December, 2003. Available at http://www.energy.state.or.us/biomass/Assessment.htm.

Murat, Mirata, Helen Nilsson, and Jaakko Kuisma. Production Systems Aligned with Distributed Economies: Examples from Energy and Biomass Sectors, *Journal of Cleaner Production*, Volume 13, Issues 10-11 , August-September 2005, Pages 981-991. Available at http://www.sciencedirect.com/science.

Nechodom, Mark. *Economic and Policy Context of Woody Biomass Utilization for Electric Power*, Bioenergy and Wood Products Conference. Powerpoint Presentation. Available at http://www.healthyforests.gov/initiative/biomass_conference/presentations/nechodom.ppt

Paun, D, R. Cantrell, and S.L. LeVan-Green. Assessing the Market Potential of Roundwood Recreational Buildings. *Technical Report-Forest-Products Laboratory*, USDA Forest-Service. 2004. Available at http://www.fpl.fs.fed.us/documnts/fplgtr/fpl_gtr144.pdf.

Paun, Dorothy, and Gerry Jackson. Potential for Expanding Small-Diameter Timber Market: Assessing Use of Wood Posts in Highway Applications. US Department of Agriculture, Forest Service, Forest Products Laboratory, *General Technical Report*, FPL-GTR-120. Available at http://www.fpl.fs.fed.us/documnts/fplgtr/fplgtr120.pdf.

Perkins, Brian, Bob Smith, and Gerry Jackson. *Evaluating Markets for Small Diameter Timber: A Case Analysis in Northern Mississippi*. Center for Forest Products Marketing and Management, Department of Wood Science and Forest Products, Virginia Polytechnic Institute and State University. Available at http://www.woodscience.vt.edu/cfpmm/SDT%20Research%20Update%20032805.pdf.

Perlack R.D., M.E. Walsh, L.L. Wright and L.D. Ostlie. The Economic Potential of Whole-tree Feedstock Production, *Bioresource Technology*, March 1996, vol. 55, no. 3, pp. 223-229(7). Available at http://www.sciencedirect.com/science.

Prestemon, J.P. and R.C. Abt. Timber Products Supply and Demand. Ch. 13 in *Southern Forest Resource Assessment*, eds. D.N Wear and J.G. Greis. USDA/Forest Service, Southern Forest Research Station, Asheville, NC, Sept. 2002, pp. 299-325.

Scahill, John. *Biomass to Energy: Present Commercial Strategies and Future Options, Healthy Landscapes, Thriving Communities,* Bioenergy and Wood Products Conference, January 21, 2003. Available at http://www.healthyforests.gov/initiative/biomass_conference/presentations/scahill.ppt

Schuler A., C. Adair and E. Elias. Engineered Lumber Products: Taking Their Place in the Global Market, *Journal of Forestry*, 1 December 2001, vol. 99, no. 12, pp. 28-35(8). Available at http://www.ingentaconnect.com/content/saf/jof/2001/00000099/00000012/art00007.

Segrest, A., D. L. Rockwood, J. A. Stricker, and G. R. Alker. *Partnering to Cofire Woody Biomass in Central Florida*. The Common Purpose Institute, Gainesville, FL, and School of Forest Resources and Conservation, Box 110410, University of Florida. Cooperative Extension Service. Available at http://bioproducts-bioenergy.gov/pdfs/bcota/abstracts/4/z280.pdf.

Segrest, Steve. *Commercial Opportunities of Growing Energy Crop Trees on Mined Phosphate Land.*, The 18th Annual Regional Phosphate Conference, October 16 and 17, Lakeland, Florida. Available at http://www.fipr.state.fl.us/phosphate_conference_2003_abstracts_prelim.htm.

Siry, Jacek P, Daniel J. Robison and Frederick W. Cubbage. Economic Returns Model for Silvicultural Investments in Young Hardwood Stands. *Southern Journal of Applied Forestry*, Nov. 2004, vol. 28, no. 4, pp. 179-184(6). Available at http://www.ingentaconnect.com/content/saf/sjaf/2004/00000028/00000004/art00001

Skog, Kenneth E. and Howard N. Rosen.United States Wood Biomass for Energy and Chemicals: Possible Changes in Supply, End Uses, and Environmental Impacts*, Forest Products Journal* Vol. 47, No. 2, Feb 1997. Available at http://www.fpl.fs.fed.us/documnts/pdf1997/skog97a.pdf.

Spelter, Henry, Rong Wang, Peter Ince. Economic Feasibility of Products From Inland West Small-Diameter Timber. United States Department of Agriculture, Forest Service, Forest Products Laboratory, *General Technical Report* FPL-GTR-92. Available at http://www.fpl.fs.fed.us/documnts/fplgtr/fplgtr92.pdf.

Timber Mart South. Timber market newsletter (quarterly). Tom Harris, editor. Daniel B. Warnell School of Forest Resources, University of Georgia, Athens.

U.S. Department of Agriculture-Forest Service. *Forest Products Laboratory Research Program on Small-Diameter Materia.* Forest Products Laboratory, *General Technical Report* FPL-GTR-110 (Rev). Available at http://www.fpl.fs.fed.us/documnts/fplgtr/fplgtr110.pdf.

U.S. Department of Agriculture-Forest Service. *Opportunities for Using Thinnings from Forest*

Fuel-Reduction Activities Opportunities or Using Thinnings from Forest Fuel-Reduction Activities. Forest Products Laboratory, S&PF Technology Marketing Unit, Madison, WI. Available at http://www.fs.fed.us/fmsc/ftp/sdu/docs/TMUSmallwoodUses0304wo.pdf.

U.S. Department of Energy, Energy Information Administration. *Biomass: Wood, Renewable Energy Annual 1995*, Chapter 6. DOE/EIA-0603(95). Washington, DC, December 1995. Available at http://www.eia.doe.gov/cneaf/solar.renewables/page/wood/wood.pdf.

U.S. Department of Energy, *Roadmap for Agriculture Biomass Feedstock Supply in the United States*. Office of Energy Efficiency and Renewable Energy, Biomass Program. Available at http://devafdc.nrel.gov/pdfs/8245.pdf.

U.S. Department of Energy. *Biomass as Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-Ton Annual Supply*. Energy Efficiency and Renewable Energy, April 2005, Draft. Available at http://www.eere.energy.gov/biomass/publications.html#feed.

U.S. Department of Energy. *Review Report of the Regional Biomass Energy Program State Grant Projects* (2000), Regional Biomass Energy Program, 12/31/2004. Available at http://www.nrel.gov/docs/gen/fy05/37233.pdf.

U.S. Department of Energy, Energy Information Administration. *A View of the Forest Products Industry From a Wood Energy Perspective.* Available at http://www.eia.doe.gov/cneaf/solar.renewables/ataglance/wood/contents.htm

U.S. Department of Energy, Energy Information Administration. *Renewable Energy Trends, 2003.* Office of Coal, Nuclear, Electric and Alternate Fuels, July 2004. Available at http://www.eia.doe.gov/cneaf/solar.renewables/page/trends/trends.pdf.

Walsh, Marie E. Walsh, Robert L. Perlack, Anthony Turhollow, Daniel de la Torre Ugarte, Denny A. Becker, Robin L. Graham, Stephen E. Slinsky, and Daryll E. Ray. *Biomass Feedstock Availability in the United States: 1999 State Level Analysis*, Oak Ridge National Laboratory and US Dept. of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Centers. Available at http://bioenergy.ornl.gov/resourcedata/index.html.

Watson, Billy and B.Stokes. *Cost and Utilization of Above Ground Biomass in Thinning Systems*. Proceedings of the meeting on Advanced Technology in Forest Operations: Applied Technology in Action; 1994 July 24-29, Portland/Corvallis, OR. Oregon State University: 192-201. Available at http://www.srs.fs.usda.gov/pubs/ja/ja_watson008.pdf.

Wear, D.N. and J.G. Greis, editors. The Southern Forest Resource Assessment. *General Technical Report* SRS-53. US Department of Agriculture, Forest Service, Southern Research Station, Asheville, NC, 635 p.

Wolfe, Ron. Research Challenges for Structural Use of Small Diameter Round Timbers. *Forest Products Journal*, Vol. 50, No. 2, Feb 2000. Available at http://www.fpl.fs.fed.us/documnts/pdf2000/wolfe00a.pdf.

Wolfe, RW; King, JR; Gjinolli, A. *Dowel-Nut Connection in Douglas-Fir Peeler Cores.* USDA Forest Service, Forest Products Lab Report FPL-RP-586, Madison,WI, and Geiger Engineers, Bellingham, WA. Jul 2000. 24p., Available at http://www.fpl.fs.fed.us/documnts/fplrn/fplrn291.pdf.

Zerbe, J. I. Biofuels: Production and Potential. *Forum for Appl. Res. and Public Policy J.* 3(4):38-47, Winter, 1988. Available at http://www.fpl.fs.fed.us/documnts/pdf1988/zerbe88a.pdf.

Zerbe, John and Richard Bergman. *Primer on Wood Biomass for Energy.* USDA Forest Service, Forest Products Laboratory, State & Private Forestry Technology Marketing Unit, May 2004.Available at http://www.fpl.fs.fed.us/tmu/woodforenergy/primeronwoodbiomassforenergy.html

Appendix A-Annnotated Bibliography on Small Diameter Timber Utilization

Government Programs and Websites on Small Diameter Timber Utilization

From USDA Forest Services page on Small Diameter Utilization
http://www.fs.fed.us/fmsc/sdu/index.php
http://www.fs.fed.us/fmsc/sdu/products/index.php
http://www.fs.fed.us/fmsc/sdu/biomass/index.php

US Forest Service Program on Small-Diameter and Underutilized Forest Material, Forest Products Laboratory, State and Private Forestry Technology Marketing Unit, Madison, Wisconsin.
http://www.fpl.fs.fed.us/tmu/

Southeastern Regional Biomass Partnership:
http://www.serbep.org/

Biomass Energy Research Association:
http://www.bera1.org/
http://www.bera1.org/about.html
http://www.bera1.org/cyclopediaofEnergy.pdf

US Department of Energy, Energy Information Administration, Coal, Nuclear and Renewable Fuels Division, http://www.eia.doe.gov/fuelrenewable.html

Biomass Research and Development Initiative
http://www.bioproducts-bioenergy.gov/

General Articles and Government Technical Publications on Small Diameter Timber

Opportunities for Using Thinnings from Forest Fuel-Reduction Activities Opportunities or Using Thinnings from Forest Fuel-Reduction Activities. S&PF Technology Marketing Unit, USDA Forest Service, Forest Products Laboratory, Madison, WI
http://www.fs.fed.us/fmsc/ftp/sdu/docs/TMUSmallwoodUses0304wo.pdf
Slide Presentation: A good review of small diameter timber issues, with examples of ways to utilize forest/wood byproducts or thinnings to create high value (adding) products.

Small Diameter Timber Symposium Proceedings, 2002. Baumgartner, David M., Leonard R. Johnson, Edward J. DePuit. Washington State University Spokane, Washington, February 25 - 27, 2002. http://smalldiametertimber.wsu.edu/table_of_contents/index.html#economic
Numerous papers in the following areas: Resource Situation, Role of Research and Small Diameter Timber, Ecological and Resource Considerations, Economic and Social Considerations, Silviculture, Low-Impact Harvesting Technologies, Transition in Processing Technologies, Product Development and Markets,

Uses for Small-Diameter and Low-Value Forest Thinnings, LeVan-Green, Susan L., and Jean M. Livingston. Ecological Restoration, Vol. 21, No. 1, (March) 2003.
http://www.fpl.fs.fed.us/documnts/pdf2003/green03d.pdf
There are many potential uses for small diameter and low-valued forest thinnings. The trick is

finding the right use within the economics of the location, manufacturing process, and potential market. The first step is market evaluation. One needs to consider several product options and then conduct a thorough market assessment and feasibility study to determine if and where those markets exist. After the marketing studies are completed and product options are narrowed, economic feasibility is examined. The evaluation process has begun in many local communities. Technological advances and new research into potential product options are helping to open the doors for communities to develop rural enterprises that add value to small-diameter thinnings. New jobs will be created, and the economic diversity of forest-based rural communities will be improved.

Forest Products Laboratory Research Program on Small-Diameter Material, United States Department of Agriculture, Forest Service, Forest Products Laboratory, General Technical Report, FPL-GTR-110 (Rev.) http://www.fpl.fs.fed.us/documnts/fplgtr/fplgtr110.pdf
An extensive research program at the Forest Products Laboratory of the USDA Forest Service is focused on searching for economical and marketable uses for small-diameter material. The projects described in this report range from conserving timber through improving sawing technology to developing businesses for using small-diameter material. Keywords: small-diameter timber, research, value-added, wood utilization, products

Small Diameter Timber for Fuel or Energy

A View of the Forest Products Industry From a Wood Energy Perspective. U.S. Dept of Energy, Energy Information Administration.
http://www.eia.doe.gov/cneaf/solar.renewables/at_a_glance/wood/contents.htm
This article describes the Forest Products Industry, estimates the approximate size and character of Industry subgroups that are important with respect to energy, identifies factors that most influence the energy profiles of these subgroups, and identifies and characterizes the most important manufacturing processes used by the subgroups in terms of their energy profiles, and how influencing factors are likely to change them. This article does not discuss electric utility use of biomass to generate power.

Assessment of Power Production at Rural Utilities Using Forest Thinnings and Commercially Available Biomass Power Technologies. http://www.antaresgroupinc.com/doerusreport.htm
The USDA Rural Utility Service (RUS) has proposed supporting investments to convert forest thinnings to electric power at rural electric facilities. The Department of Energy's (DOE) Office of the Biomass Program, in the Office of Energy Efficiency and Renewable Energy, agreed to support this approach by providing the technical and financial feasibility analysis. This study is a guide to biomass power technology, biomass supply and financial issues. It serves as a "pre-feasibility study" for a rural utility wishing to prepare an application to the RUS. It can also serve as primer for those interested in the current state of commercial biomass power.

Biofuels: Production and Potential. Zerbe, J. I., Forum for Appl. Res. and Public Policy J. 3(4):38-47. Winter, 1988. http://www.fpl.fs.fed.us/documnts/pdf1988/zerbe88a.pdf
To realize the potential of biomass, recent reductions in funds for research and technology transfer must be reversed. The costs for harvesting and transporting biomass must be reduced, conversion technologies must be advanced, our understanding of the potential environmental threats must be improved, and a better means for marketing biomass products must be established.

Biomass as Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-Ton Annual Supply, US Department of Energy, Energy Efficiency and Renewable Energy,

April 2005, Draft (PDF 9 MB). http://www.eere.energy.gov/biomass/publications.html#feed
This study explores whether the United States can produce a sustainable supply of biomass sufficient to displace 30% or more of the country's present petroleum consumption is evaluated. This goal was set by a joint advisory committee to the two departments as a vision for making a major contribution to energy needs. It would require approximately 1 billion dry tons of biomass feedstock per year. The short answer is yes. Looking at just forestland and agricultural land, the two largest potential biomass sources, this study found potential exceeding 1.3 billion dry tons per year, which is enough to produce biofuels to meet more than one-third of the current demand for transportation fuels. This annual potential is based on a more than seven-fold increase in production from the amount of biomass currently consumed for bioenergy and biobased products. About 368 million dry tons of sustainably removable biomass could be produced on forestlands, and about 998 million dry tons could come from agricultural lands.

Biomass Feedstock Availability in the United States: 1999 State Level Analysis, Walsh et al. Marie E. Walsh, Robert L. Perlack, Anthony Turhollow, Daniel de la Torre Ugarte, Denny A. Becker, Robin L. Graham, Stephen E. Slinsky, and Daryll E. Ray, Oak Ridge National Laboratory and US Dept. of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Centers. http://bioenergy.ornl.gov/resourcedata/index.html
This study provides estimates of potential biomass production in dry tons per year for each state at specific prices.

Biomass for Heat and Power. Bain, Richard L., and Ralph P. Overend, Forest Products Journal Vol. 52, No. 2., Feb 2002. http://www.fpl.fs.fed.us/tmu/pdf/fps_feb2002feature_richbain.pdf
A good overview and prospectus for Biomass produced energy in the U.S. is presented in this report. It discusses the major technologies involved and under development and where the most promising markets are for supply and utilization.

Biomass for Electricity Generation. Zia Haq, U.S. Dept of Energy, Energy Information Administration. July, 2002. http://www.eia.doe.gov/oiaf/analysispaper/biomass/pdf/biomass.pdf
http://www.epa.gov/cleanenergy/pdf/haq_apr20.pdf
The methodology of the National Energy Modeling System is discussed, and the underlying assumptions are explained. The Energy Information Administration estimates that there are 590 million wet tons of biomass available in the United States yearly; 20 million wet tons (enough to supply about 3 gigawatts of capacity) are available today at prices of $1.25 per million Btu or less. The average price of coal to electric utilities in 2001 was $1.23 per million Btu.

Biomass Resource Assessment and Utilization Options for Three Counties in Eastern Oregon. Prepared for: Oregon Department of Energy prepared by McNeil Technologies, Inc. Lakewood, CO December, 2003. Funded by: U.S. Department of Agriculture, National Fire Plan and Oregon Department of Energy. http://www.energy.state.or.us/biomass/Assessment.htm
The authors conclude that there is a significant amount of biomass not usable for wood products or other manufacturing industries available from forest resource management, agriculture and wood products manufacturing in the three counties of Oregon. Biomass energy facilities could provide an economic use for this material. The feasibility of such a facility is enhanced if it is located close to the source of the biomass, and if it is sized appropriate to the volume of material available on a long-term sustained basis. Biomass energy facilities could convert surplus biomass into electricity, industrial steam energy and fuel ethanol. A barrier to private sector investment in biomass energy facilities is the lack of specific information about the amount of feedstock available, the cost of feedstock delivered to the plant site and the best locations for proposed facilities relative to both

feedstock supply and markets for energy products. There is critical need for this information in view of both high fire-risk in the forest and the need for economic stimulus in rural communities.

Biomass to Energy: Present Commercial Strategies and Future Options, Healthy Landscapes, Thriving Communities: Bioenergy and Wood Products Conference January 21, 2003, John Scahill, National Bioenergy Center.
http://www.healthyforests.gov/initiative/biomassconference/presentations/scahill.ppt
Technical information of the use of biomass to generate heat and electricity is presented in this report.

Biomass: Wood, US Department of Energy, Energy Information Administration Renewable Energy Annual 1995, (Chapter 6) DOE/EIA-0603(95) Washington, DC, December 1995.
http://www.eia.doe.gov/cneaf/solar.renewables/page/wood/wood.pdf
A general review of sources and uses of wood biomass for energy production; current and future prospects of wood biomass energy production technology; economic benefits; and environmental issues related to the use of wood for energy is presented in this book chapter.

Biopower Technical Assessment: State of the Industry and Technology
Bain, R.L., W.P. Amos, M. Downing, R.L. Perlack. 03/31/2003, U.S. Department of Energy, National Renewable Energy Laboratory, Golden, Colorado, Report Number NREL/TP-510-33123.
http://www.nrel.gov/docs/fy03osti/33123.pdf
Biopower (biomass-to-electricity generation), a proven electricity generating option in the U.S. and with about 11 GW of installed capacity, is the single largest source of non-hydro renewable electricity. This 11 GW of capacity encompasses about 7.5 GW of forest product industry and agricultural industry residues, about 3.0 GW of municipal solid waste-based generating capacity and 0.5 GW of other capacity such as landfill gas based production. The electricity production from biomass is being used and is expected to continue to be used as base load power in the existing electrical distribution system.

Current and Potential Energy Products from Biomass, Bain, Richard L., US Department of Energy, National Renewable Energy Laboratory, Golden, Colorado, January 21, 2004. Powerpoint Presentation to Bioenergy and Wood Products Conference.
http://www.healthyforests.gov/initiative/biomass_conference/presentations/bain.pdf
Provides a national overview of bio-energy development and production with specific examples of successful enterprises and a comparison of several basic types of technology with their associated feedstock sources.

Economic and Policy Context of Woody Biomass Utilization for Electric Power, Nechodom, Mark, Bioenergy and Wood Products Conference. Powerpoint Presentation
http://www.healthyforests.gov/initiative/biomass_conference/presentations/nechodom.ppt
A good review of forest product industry in 2000 and of state programs to encourage or foster biomass use for energy production is in this presentation.

Outlook for Biomass Ethanol Production and Demand. DiPardo, Joseph. U.S. Dept of Energy, Energy Information Administration, July, 2000.
http://www.eia.doe.gov/oiaf/analysispaper/pdf/biomass.pdf
The technology used to produce ethanol from corn is mature and is not likely to experience significant cost reductions in the future. Producing ethanol from low-cost biomass will be important to making it competitive as a gasoline additive. If Department of Energy goals are met, the cost of

producing ethanol could be reduced by as much as 60 cents per gallon by 2015, using cellulosic conversion technology. This paper presents a midterm forecast for biomass ethanol production under three different technology cases for the period 2000 to 2020, based on projections developed with the Energy Information Administration's National Energy Modeling System. An overview of cellulose conversion technology and various feedstock options and a brief history of ethanol usage in the United States are also presented.

Primer on Wood Biomass for Energy, Zerbe, John and Richard Bergman, USDA Forest Service, Forest Products Laboratory, State & Private Forestry Technology Marketing Unit, May 2004 http://www.fpl.fs.fed.us/tmu/woodforenergy/primeronwoodbiomassforenergy.html.
Concepts of wood energy on a residential, commercial, and industrial scale in the United States are explained and described so individuals can develop a basic understanding and familiarity with bioenergy technology, and so that the Forest Service can help meet the demands of communities involved in the forest products industry. The terminology associated with this field is explained or described. Definitions specific to wood energy are given at the end of this report.

Renewable Energy Trends, 2003, U.S. Dept of Energy, Energy Information Administration, Office of Coal, Nuclear, Electric and Alternate Fuels, July 2004
http://www.eia.doe.gov/cneaf/solar.renewables/page/trends/trends.pdf.
This report provides an overview of renewable energy production and use with tables of historical data for 1999-2002, including revisions, and preliminary data for 2003. It includes data on renewable energy consumption starting in 1989 and going through 2003.

Review Report of the Regional Biomass Energy Program State Grant Projects (2000), Regional Biomass Energy Program, 12/31/2004. http://www.nrel.gov/docs/gen/fy05/37233.pdf.
The Regional Biomass Energy Program (RBEP) is a federally funded program with the specific goal to increase the production and use of bioenergy resources. The RBEP serves as a critical link in furthering bioenergy development. This Review Report of RBEP State Projects provides a brief narrative of some of the state initiatives being conducted within the five regional programs.

Roadmap for Agriculture Biomass Feedstock Supply in the United States, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Biomass Program.
http://devafdc.nrel.gov/pdfs/8245.pdf.
http://www.eere.energy.gov/biomass/publications.html#feed.
This report is more of an application of method of analysis and evaluation than a content source on the production, processing/storage and transportation of biomass feedstock as a feedstock for fuel or energy production.

U*nited States Wood Biomass for Energy and Chemicals: Possible Changes in Supply, End Uses, and Environmental Impacts,* Skog, Kenneth E., and Howard N. Rosen. Forest Products Journal Vol. 47, No. 2, Feb 1997. http://www.fpl.fs.fed.us/documnts/pdf1997/skog97a.pdf.
Forest biomass inventory is substantial in the US and significant amounts of wood residue are generated from processing, construction, demolition, and municipal solid waste. Prospects for expanding the use of wood biomass for producing electrical power or ethanol will be enhanced by environmental needs and improvements in technology. Environmental needs include 1) reducing carbon emissions from fossil fuels and sequestering carbon; 2) removing wood from forests to improve forest health; 3) diverting urban waste streams from landfills; and 4) generating oxygenates, possibly from ethanol, for gasoline. Technology needs include improvement of short-rotation intensive culture techniques for plantations and improvement of electrical power and ethanol

production processes. These efforts can help improve the comparative advantage of wood biomass feedstocks relative to fossil fuel feedstocks. Key environmental concerns will constrain the supply of wood biomass from forests and plantations; particularly concern for the effects of management for wood fuel on the diversity of plants and animals and on the depletion of soil and water resources.

Bioenergy in the United States: Progress and Possibilities, Cook J., Beyea J., Biomass and Bioenergy, 1 June 2000, vol. 18, no. 6, pp. 441-455(15). http://www.sciencedirect.com/science. Large-scale bioenergy development could indeed bring significant ecological benefits - or equally significant damage - depending on the specific paths taken. In particular, the land requirements for biomass production are potentially immense. Various entities in the United States have performed research; prepared cost-supply assessments, environmental impact assessments, life cycle analyses and externality impact assessments; and engaged in demonstration and development regarding biomass crops and other potential biomass energy feedstocks. These efforts have focused on various biomass wastes, forest management issues, and biomass crops, including both perennial herbaceous crops and fast-growing woody crops. Simultaneously, several regional and national groups of bioenergy stakeholders have issued consensus recommendations and guidelines for sustainable bioenergy development. It is a consistent conclusion from these efforts that displacing annual agricultural crops with native perennial biomass crops could - in addition to reducing fossil fuel use and ameliorating associated ecological problems - also help restore natural ecosystem functions in worked landscapes, and thereby preserve natural biodiversity. Conversely, if forests are managed and harvested more intensively - and/or if biomass crops displace more natural land cover such as forests and wetlands - it is likely that ecosystem functions would be impaired and biodiversity lost.

Commercial Opportunities of Growing Energy Crop Trees on Mined Phosphate Land.
Segrest, Steve - Director, Common Purpose Institute - Vice President Sterling Energy, The 18th Annual Regional Phosphate Conference, October 16 and 17, At the Lakeland Center - Lakeland, Florida. http://www.fipr.state.fl.us/phosphate_conference_2003_abstracts_prelim.htm.
This presentation is an overview of the synergies that we have found between Renewable Biomass Energy development and Phosphate Mine Land Reclamation, and the significant commercial opportunities that we believe are evolving. The agriculture and land reclamation background of this discussion will be our approximately 135 acre energy crop tree farm in Lakeland, Florida, sited on an old phosphate mine clay settling pond area. The tree farm consists of non-invasive eucalyptus and native cottonwood trees, and has been found to be an extremely productive in agro-forestry, with two-year-old trees achieving heights approaching 40 feet. The energy application of this project is through biomass co-firing in existing coal-fired power plants. Under this approach, a cost-effective renewable energy resource is created utilizing the power plant's existing infra-structure (e.g., boiler, turbine/generator) - thus eliminating the high capital costs of building a new stand alone power generation facility.

The Economic Potential of Whole-tree Feedstock Production, Perlack R.D.; Walsh M.E.; Wright L.L.; Ostlie L.D., Bioresource Technology, March 1996, vol. 55, no. 3, pp. 223-229(7) http://www.sciencedirect.com/science.
This economic evaluation of whole-tree feedstock production indicates that wood feedstocks have the potential to be grown, harvested and delivered at costs approximating $1.80 GJ-1 on good cropland. However, attaining this cost requires careful selection of the land base, careful matching of appropriate clones to sites, and using whole-tree direct load harvesting concepts. The direct load system significantly reduces harvest and handling costs by eliminating skidding and minimizing in-field handling, using high-speed continuous cutting principles and harvesting all year round for better equipment utilization and reduced biomass losses from handling and storage. Our estimate is

also based on regenerating new stands by replacing cut trees with improved clones rather than by coppice regrowth.

Partnering to Cofire Woody Biomass in Central Florida Segrest, A., D. L. Rockwood, J. A. Stricker, G. R. Alker, The Common Purpose Institute, Gainesville, FL, School of Forest Resources and Conservation, Box 110410, University of Florida. Cooperative Extension Service. http://bioproducts-bioenergy.gov/pdfs/bcota/abstracts/4/z280.pdf
In central Florida, numerous partners have combined to demonstrate the potential for growing short rotation woody crops (SRWC) for cofiring at utilities with up to 13,000 MW of capacity. Since 1997, the Common Purpose Institute has conducted cofiring studies and developed partnerships for SRWC planting and use. These partnerships build on more than two decades of SRWC research by the School of Forest Resources and Conservation at the University of Florida (UF) that has identified species and cultural options for commercial cropping. Cofiring up to 5% SRWCs is the most cost effective means of creating renewable energy while using existing power plant infrastructure.

Small Diameter Timber for Wood Products

Assessing the Market Potential of Roundwood Recreational Buildings. Paun, D; Cantrell, R; LeVan-Green, S L, Technical-Report-Forest-Products-Laboratory, USDA Forest-Service. 2004; http://www.fpl.fs.fed.us/documnts/fplgtr/fpl_gtr144.pdf.
The primary goal of this technical report was to estimate the market potential for recreational buildings constructed from SDR (Small diameter roundwood) on National and State forests and parks. A questionnaire designed to determine the current and potential market size of public recreational buildings and the extent to which architects and builders would consider using SDR as a recreational building material was distributed to architects and building designers representing both Federal and State organizations. The results indicate that (1) the number of recreational buildings on National and State forests, parks, and recreational areas could increase by 5,150 to 51,500 buildings; (2) wood has been used in 57% of existing recreational buildings and its use could increase by 13%; (3) 58% of the building professionals surveyed said they would consider using SDR in future recreational buildings; (4) the market potential arising from SDR substitution, even for a near-substitute like lumber, is substantial; (5) cabins, pay stations, picnic shelters, concession stands, and information centers would be the best markets to target for SDR use; (6) roundwood is perceived as superior to all other building materials in terms of being an attractive and "green" building material; and (7) SDR market potential will grow to the extent that durability increases and maintenance and construction complexity decrease.

Dowel-Nut Connection in Douglas-Fir Peeler Cores, Wolfe, RW; King, JR; Gjinolli, A, USDA Forest Service, Forest Products Lab., Madison, WI.; Geiger Engineers, Bellingham, WA. Jul 2000. 24p. Report: FPL-RP-586, http://www.fpl.fs.fed.us/documnts/fplrn/fplrn291.pdf.
Structural application of small-diameter timber is currently limited by conventional construction standards. The round tapered shape is not compatible with conventional framing and cladding methods. To encourage more efficient use of small-diameter timber, the structural properties of Douglas-fir peeler cores and the efficacy of a “dowel-nut” connection for use in a space frame roof system were studied. The results of this study provide a basis for deriving design properties for peeler core structural application in a space frame roof system and the foundation for establishing a database to support small-diameter timber design and construction standards.

Economic Feasibility of Products From Inland West Small-Diameter Timber, Spelter, Henry., Rong

Wang, Peter Ince., United States Department of Agriculture, Forest Service, Forest Products Laboratory, General Technical Report FPL-GTR-92.
http://www.fpl.fs.fed.us/documnts/fplgtr/fplgtr92.pdf.
Abstract: The economic feasibility of using small-diameter material from Rocky Mountain forests to manufacture various wood products (including: oriented strandboard (OSB), stud lumber, random-length dimension lumber, machine-stress-rated random-length lumber, laminated veneer lumber (LVL), and market pulp was examined. The analysis indicated that LVL promises the best ratio of revenue to wood input, followed by market pulp and OSB. Among the lumber alternatives, machine stress- rated lumber yields the greatest return. In terms of investment risk, the lower-cost lumber alternatives are favored over the capital-intensive OSB, market pulp, and LVL options. The manufacture of OSB would require the most fiber, almost four times the amount required for market pulp. Keywords: Oriented strandboard, particleboard, medium density fiberboard, LVL

Evaluating Markets for Small Diameter Timber: A Case Analysis in Northern Mississippi. Perkins, Brian, Bob Smith, & Gerry Jackson, Center for Forest Products Marketing and Management, Department of Wood Science and Forest Products, Virginia Polytechnic Institute and State University.
http://www.woodscience.vt.edu/cfpmm/SDT%20Research%20Update%20032805.pdf
Markets exist within northern Mississippi that can utilize SDT. The current markets require no investment in a new processing facility and are proven. They include the oriented strand board, pulp and sawmill markets. The problem with utilizing current markets is that they add little value to the SDT. Further processing could allow SDT into unseasoned wood markets which include green lumber, pallet material, rough fencing, firewood, mulch and other items that don't need to be kiln dried. These markets do add some value to SDT but are highly competitive. The most value-added dry markets would require the largest investment and kiln dried products. This would include lumber that could be sold to the traditional secondary wood industry.

Lam I-Joists: A New Structural Building Product From Small-Diameter Fire-Prone Timber, Hunt, John F., and Jerrold E. Winandy, United States Department of Agriculture, Forest Service, Forest Products Laboratory, Research Note FPL−RN−0291.
http://www.fpl.fs.fed.us/documnts/fplrn/fplrn291.pdf.
In typical North American logging or thinning operations, much of this low-value timber is felled and left on the ground, chipped, or burned because most mills are not equipped to handle it. In the study reported here, research was focused on processing small-diameter curved and cull timber into dimensional 2 by 4 studs and then converting that material into a value-added laminated I-beam, called LamLumber. This paper describes research to date on processing needs and basic research being conducted on small-diameter timber.

Potential for Expanding Small-Diameter Timber Market: Assessing Use of Wood Posts in Highway Applications. Paun, Dorothy, and Gerry Jackson, US Department of Agriculture, *Forest Service, Forest Products Laboratory, General Technical Report*, FPL-GTR-120.
http://www.fpl.fs.fed.us/documnts/fplgtr/fplgtr120.pdf.
Wood and steel were the most commonly used posts in all types of highway applications, and wood posts hold a substantial share of the market. Square wood was used by more than 50% of the respondents for guardrails and signs. Given the relative small circumference of signposts, this application may offer sizeable SDT market opportunity. Roundwood was used by almost 40% of the respondents for fencing and landscaping posts, so the fencing post replacement market offers an opportunity for SDT. The type of posts used the past three years has changed little. This implies that newer post materials like plastic composites and poly-lumber may not compete directly against

wood posts. There appear to be very few concerns about possible negative characteristics of wood posts, such as preservative treatments. Most roundwood posts used are within the 2- to 9-in. range, which clearly shows potential for increased SDT use. The majority of square wood posts used are within four sizes that can be supplied by SDT: 4 by 4, 4 by 6, 6 by 6, and 6 by 8 inches. This article has an extensive and general bibliography.

Research Challenges for Structural Use of Small Diameter Round Timbers, Wolfe, Ron, Forest Products Journal, Vol. 50, No. 2, Feb 2000.
http://www.fpl.fs.fed.us/documnts/pdf2000/wolfe00a.pdf
Overstocked forests are subject to attack by insects and disease and, as a result of the heavy fuel load, risk total destruction by fire. Prescribed burning is tool for suppressing the growth of brush and tree seedlings, but it is often restricted for environmental reasons. Overstocked forests must be thinned to reduce the fuel load before prescribed burning can be used. One way to help recover the cost of mechanical thinning is to promote value-added structural uses of the small-diameter round timber. Value-added uses of this material can provide immediate revenues and promote rural economic development. This paper is an overview of the options for round timber structural applications and contains recommendations for research needed to promote acceptance of engineered applications.

Small Diameter Success Stories, Livingston, Jean. 2004. U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 33 p. Madison, WI.
http://www.fpl.fs.fed.us/tmu/pdf/sd_success_stories.pdf.
From information gathered in onsite interviews, this report describes how several businesses and community organizations are contributing to the health of the forest and their community by successfully making use of small-diameter and underutilized material.

Engineered Lumber Products: Taking Their Place in the Global Market, Schuler A.; Adair C.; Elias E., Journal of Forestry, 1 December 2001, vol. 99, no. 12, pp. 28-35(8)
http://www.ingentaconnect.com/content/saf/jof/2001/00000099/00000012/art00007
World demand for engineered lumber products is driven by a shift to performance-based building codes; the changing nature of the softwood fiber supply; worldwide demand for affordable housing; and advances in resin technology and wood conversion systems. From structural composite lumber to prefabricated wood I-joists and glulam, these products extend the forest resource by allowing higher product recoveries and using conversion technology that facilitates broader use of underutilized species and sizes. They also enable higher stumpage prices as markets are created for a wider range of species, grades, and sizes of timber. And sustainable forestry objectives are enhanced as markets for small-diameter, low-grade fiber are developed throughout the world.

Exploring the Uses For Small-Diameter Trees, LeVan-Green, Susan L., and Jean Livingston, Forest Products Journal, September 2001, Vol. 51, No. 9, pages 10-21.
http://www.fpl.fs.fed.us/documnts/pdf2001/levan01a.pdf
Considerable activity is dedicated to improving the economics of using small diameter and underutilized (SDU) material. Several organizations have programs that are examining the current economics using existing technology, as well as new technologies that can improve the economics. Some uses being investigated include: Dimension and nondimension softwood lumber, engineered wood products, glued-laminated timber, structural roundwood, wood composites, woodfiber/plastic composites, woodfiber products, pulp chips, compost, mulch, and energy. Numerous efforts are underway to address the current SDU situation in the forest. Some of these efforts involve social change. However, most rely on technology advancements, either through more effective forest

operations, more efficient processing, or achieving higher value for some of the low-valued SDU material. In order to change the current situation, all efforts are essential.

Hardwood Timber Product Markets: A Focus on Small-diameter, Hansen, Bruce, Phil Araman, Cindi West, and Al Schuler. In, proceedings, Society of American Foresters 1999 National Convention. 305-311. http://www.srs4702.forprod.vt.edu/pubsubj/pdf/00t14.pdf
Major solid wood and fiber markets are discussed in this article. Discusses studies of "brown" maple acceptance including consumer preferences and knowledge. In conclusion, we view rubberwood attributes and its use in the manufacture of numerous wood products.

Options for Small-Diameter Hardwood Utilization: Past and Present, Bumgardner, Matthew S., Bruce G. Hansen, Albert T. Schuler and Philip A. Araman, Proceedings, Annual Meeting of the Southern Forest Economics Workers (SOFEW)-Hardwoods-An Underdeveloped Resource? . 1-7. http://www.srs4702.forprod.vt.edu/pubsubj/pdf/00t31.pdf
The use of hardwoods in engineered wood products (EWP) is increasing. Where EWP mills are available they can offer markets for small-diameter. hardwoods and non-sawlog portions of sawlog trees. Such opportunities can help make intermediate silvicultural treatments more financially attractive. EWP derived from hardwoods in the East are becoming a major use for many species. Other promising research areas for utilization of small-diameter hardwoods include green dimension (Lin et al. 1995; Bratkovich et al. 2000) and curve sawing of hardwood logs and lumber. Research into "value-added" processing of small-diameter hardwoods similar to System 6 also continues. Also, there may be regional opportunities for specialty products such as rustic rail fencing, which accounts for about 20 manufacturers in West Virginia alone (West Virginia Bur. of Commer. 1997)..

Production Systems Aligned with Distributed Economies: Examples from Energy and Biomass Sectors, Murat Mirata, Helen Nilsson, and Jaakko Kuisma. Journal of Cleaner Production, Volume 13, Issues 10-11 , August-September 2005, Pages 981-991. Available at http://www.sciencedirect.com/science.
This paper reviewed and discussed selected production systems and some of their attributes that contribute to their desirability as elements of distributed economies. It also highlighted some of the factors that affect their development and sustained operation. A common feature of such systems is that they have a focus on using local resources for the generation of value added products. This flexibility allows these systems to take advantage of a diverse range of inputs and their viability is enhanced by collaborative linkages with a diverse range of other activities. More importantly, they provide environmental, social, and economic benefits that are shared by a wide group of local parties. Therefore, these production systems provide useful building blocks for robust economic systems that are closer to local people and provide a higher quality of life – two of the main objectives of distributed economies.

Value Analysis of Lumber Produced from Small-diameter Timber, Dan W Cumbo, Smith, Robert L., Charles W Becker III. Forest Products Journal. Madison: Oct 2004. Vol. 54, Iss. 10; p. 29 (6 pages) http://proquest.umi.com/pqdweb.
The goal of this research was to determine the lumber value that could be produced from smaller diameter timber (below 10 in.). Market potential for the products produced (hardwood lumber and cants) was assessed as well. The lumber value analysis component of the study was conducted at a hardwood sawmill in southwest Virginia. For the mill study, 322 oak and hickory logs were randomly selected. After grading, all logs were processed through the sawmill, graded, "stacked and stickered," and placed on the air-dry yard prior to the market assessment. Hardwood consumers were identified within a 120-mile radius of the test mill and interviewed for the market assessment. Study

results revealed that the percentage of wider boards (6 in. to 8 in.) and higher grade boards (grades 1 and 2) began to increase at a log diameter of approximately 8 inches. Lumber value increased substantially with increasing log diameter and the relationship appears to be linear. In addition, an overall higher increase in lumber value per thousand board feet was observed when sawing small-diameter hickory logs compared to small-diameter oak logs. While respondents to the market assessment noted a number of defects as problematic in their operations, voids and unsound areas tended to be important to most. Service attributes were important as well. Specifically, most noted short lead-times and availability/diversity of species offered as important supplier attributes.

Management and Harvesting of Small Diameter Timber

Cost and Utilization of Above Ground Biomass in Thinning Systems. Watson, Billy; Stokes, Bryce, 1994, Proceedings of the meeting on Advanced Technology in Forest Operations: Applied Technology in Action; 1994 July 24-29; Portland/Corvallis, OR. Oregon State University: 192-201. http://www.srs.fs.usda.gov/pubs/ja/ja_watson008.pdf.
The costs and utilization were compared for a thinning operation removing the stems as roundwood with a flail chipper operation. The flail chipper operation recovered an additional 4.2 tons of acceptable chips per acre which resulted in a higher return to the site. There was little difference in the cost of acceptable chips delivered to the digester between the two methods of thinning.

Damage to Residual Trees by Four Mechanized Harvest Systems Operating in Small-Diameter, Mixed-Conifer Forests on Steep Slopes in Northeastern Washington: A Case Study., Camp A., Western Journal of Applied Forestry, 1 January 2002, vol. 17, no. 1, pp. 14-22(9)
http://www.ingentaconnect.com/search/
Dense stands of small-diameter timber present unique challenges for land managers. In the inland West, trees in high-density stands often grow slowly and may be at risk to insects, diseases, and catastrophic fires. In 1996, the U.S. Congress recognized a need to address forest health issues and stimulate local resource-based economies in northeastern Washington. As part of this Congressionally mandated research effort, four harvest units, each thinned to a 20 ft spacing using different harvesting technologies, were surveyed for damage prior to and following commercial thinning. Comparisons were made among the systems tested to assess damage to the residual stand. Overall incidence of wounds, wounds in different size and severity classes, and wound locations were compared. Each system performed better when judged by some criteria than by others. In general, cut-to-length processing caused less damage to the residual stand than whole-tree harvest; skyline yarding was less damaging than forwarder yarding. Appropriate silvicultural prescriptions and harvesting technologies can reduce wounding to acceptable levels.

Economic Returns Model for Silvicultural Investments in Young Hardwood Stands, . Siry, Jacek P; Daniel J. Robison; Frederick W. Cubbage, Southern Journal of Applied Forestry, November 2004, vol. 28, no. 4, pp. 179-184(6)
http://www.ingentaconnect.com/content/saf/sjaf/2004/00000028/00000004/art00001
Despite covering the majority of forestland in the southern United States, hardwoods continue to be grown primarily in natural, extensively managed stands. One reason has been that hardwood growth increases resulting from active management have been small in comparison with unmanaged stands. Recent studies indicate, however, that the productivity responses of very young (ages 1–15 years) natural even-aged hardwood stands to silvicultural treatments such as fertilization, herbicide release, or stocking control can yield large productivity increases, demonstrating the potential for faster timber growth of higher quality in shorter rotations. In determining the extent to which these productivity increases may justify investment in various silvicultural treatments, we have developed

hardwood management scenarios representing productivity increases of up to 33%. Timber revenues have been estimated and rates of return compared across various management intensities. Results indicate that the assumed productivity increases would readily pay for treatments such as fertilization, herbaceous release, and stocking control while yielding rates of returns equal to or greater than those generated by untreated stands.

Healthy Forest Legislation Passes Congress; Signed by President Bush. Ecological Restoration; Mar 2004, Vol. 22 Issue 1, p2, 2p. http://weblinks2.epnet.com
Reports on the Healthy Forests Restoration Act of 2003 introduced into the United States House of Representatives and passed by the Congress. Hazardous fuels reduction programs to be conducted on Forest Service and Bureau of Land Management lands; Development and use of forest biomass for energy and commercial products; Mention of the area of land affected by the act.

Removal Intensity and Tree Size Effects on Harvesting Cost and Profitability. Kluender, R; Lortz, D; McCoy, W; Stokes, B; Klepac, J., Forest products journal. Jan 1998. v. 48 (1), 54-59. http://proquest.umi.com/pqdweb.
Sixteen stands were harvested at intensities (proportion of basal area removed) ranging from 0.27 to 1.00. Harvested sites were similar in slope and tree size. Harvest cost per hundred cubic feet of wood (CCF) was inversely related to harvest intensity and tree size. Harvesting profitability per CCF was near zero when removing trees averaging less than 8 inches diameter at breast height (DBH). Harvest intensity had the greatest influence on profitability in small-diameter timber. Harvest profitability was greatest when removing large trees at high levels of harvesting intensity. Because of the differences in average tree size removed by different harvesting prescriptions, some prescriptions were more profitable than others. Single-tree selection in an uneven-aged stand was most profitable. Less profitable were selection in an even-aged stand, clear cutting, and shelterwood harvests, in that order. Selection at low removal intensities with small trees removed would always be the least favored harvest method with the equipment spreads we observed. Average removed tree size needed to be at least 8 inches DBH to break even.

Social Complexity and the Management of Small-Diameter Stands, Findley A.J.; Carroll M.S.; Blatner K.A., Journal of Forestry, December 2001, vol. 99, no. 12, pp. 18-27(10), http://www.ingentaconnect.com/content/saf/jof/2001/00000099/00000012/art00006
The disposition of small-diameter forest stands is linked to forest health, ecological restoration, and timber harvest–highly contentious issues without public or technical consensus. We present results of a qualitative social assessment focusing on small-diameter stand management on the Colville National Forest in northeastern Washington to illustrate social complexity embedded in the decisions that confront forest managers. The discussion is broadened to suggest that the social complexity inherent in small-diameter stand management is an issue that must be confronted throughout the West (and to some extent the entire country), as increasing emphasis is placed on forest restoration on public lands.

Systems Analyses for Harvesting Small Trees for Forest Fuel in Urban Forestry, Bjorheden R.; Gullberg T.; Johansson J. Biomass and Bioenergy, April 2003, vol. 24, no. 4, pp. 389-400(12). http://www.sciencedirect.com/science.
Analyses are performed as simulated treatments in selected stand types. Both existing and non-existing forest fuel systems are tested. Conventional cleaning and conventional thinning for pulpwood are included as reference systems. The average dbh of removed trees varied between 3.0 and 10.5cm.The potential yield of biomass in the studied stand types is high-under Swedish conditions at over 35 tonnes dry substance per ha. Harvesting pulpwood exclusively takes only a

small portion of the biomass potential. Forest fuel systems based on motor-manual work are the most competitive in the smallest diameter stands. Simulated systems include a feller-chipper-forwarder and a two-machine system with a feller-bundler and a forwarder. The conventional pulpwood method shows the poorest result.

Appendix B--Survey of Small Diameter Timber Use by Florida Forest Product Manufacturers

Interviewer Script
"Hello, I'm Ray Mason, a forestry consultant, and I'm calling for the Florida Agricultural Market Research Center at the University of Florida. Last year, we conducted a survey of virtually every firm in the Florida forestry industry. If you responded, we appreciate the information that you provided. As a follow-up to that survey, the Florida Division of Forestry has asked us to identify ways to expand market demand for small diameter (3″ - 7″) pine. It is hoped that greater utilization for innovative products will result in improved economic returns to landowners and possibly manufacturing firms such as yours. We are interested in you opinions even if you don't currently use small diameter pine and don't anticipate using any in the foreseeable future. Information collected for this survey is confidential. Your participation is voluntary. You do not have to answer any questions that you do not wish to, and you may terminate the survey interview at any time. The survey should take about 10 minutes or less. Do you agree to proceed with the interview?"

[If respondent consents to survey, proceed with interview; if not, thank and terminate interview].

[Note to Interviewer: Enter names and other information on record form prior to interview]

Please give us your **best estimates** of the following:

1. How many <u>total</u> tons of small diameter (3″ - 7″) pine did you use in 2004? [If amount greater than zero, enter amount on form and skip to Q7]

2. [If response to Q1 is "none" or "zero" ask] What are the main reasons you didn't use any small diameter pine? [Probe]

Current Non-Users Of Small Diameter Pine

3. How many tons of small diameter pine, if any, do you expect to use in five years? [Enter amount on "Total" line in table, then ask Q5.

4. [If answer is "none", ask] why not?

5. How many tons of these will be used for [each product in Table 1]? [Enter tons for each use in Col. 4.]

6. What could the forestry industry do to increase demand for small diameter pine? [Enter responses in right column]

Current Users Of Small Diameter Pine

7. What products did you manufacture from these small diameter pines? [Check uses in Table, Col. 2]

8. What percentage of the small diameter pines used in 2004 were used for [each type of use checked; Enter percentages and make sure percentages sum to 100].

9. How many tons of small diameter pines do you expect to use in five years for [each major use category listed in table]?

10. What could the forestry industry do to increase the overall demand for small diameter pines?

[When interview completed]. Thank you very much for your help. Would you like a copy of our final report on the results of this survey? [If yes, verify mailing address].

Survey Response Form

Firm Name: ________________________________
Telephone No.: ________________________________
Person Interviewed: ________________________________
Title: ________________________________
Mailing Address: ________________________________
Date of Interview: __________________

(Users)
Total tons of small diameter pine used in 2004 _____________ tons

(Users and Nonusers)
Tons of small diameter pine expected to use in five years: _____________ tons

(Nonusers) Main reasons didn't use any small diameter pine

____
____
____
____

(Nonusers) Reasons not expecting to use any small diameter pine in the future (5 years)

____
____

(Users and Nonusers) Recommendations to increase overall demand for small diameter pine

____
____
____
____

Send copy of final report on the results of this survey
____ Yes ____ No

Uses of Small Diameter Pine	Check Current Uses, 2004 (Q7)	Percent of Current Uses (Q8)	Expected Volume Used in 5 Years (Tons) (Q5, Q9)	Notes and specific recommendations for increasing demand for small diameter pine (Q6, Q10)
Pulp	_____	________%	________	____________________ ____________________
Mulch or chips for landscaping	_____	________%	________	____________________ ____________________
Chips for panels	_____	________%	________	____________________ ____________________
Fence Posts	_____	________%	________	____________________ ____________________
Pallet Material	_____	________%	________	____________________ ____________________
Fuelwood	_____	________%	________	____________________ ____________________
Engineered Wood Structures (e.g beams, trusses)	_____	________%	________	____________________ ____________________
Other (specify) ________________	_____	________%	________	____________________ ____________________
Other (specify) ________________	_____	________%	________	____________________ ____________________
Other (specify) ________________	_____	________%	________	____________________ ____________________
Totals	N.A.	**100** %	________	____________________ ____________________