

Forest Products Industries' Economic Contributions in Michigan, 2022

(Based on IMPLAN 2019 Pro Data)

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Executive Summary

Michigan has an estimated 20.1 million acres of forest land that cover 55 percent of its land base, with most of this forest land able to produce commercial timber. Almost 62 percent is privately owned, while state and local governments own roughly 23 percent and approximately 15 percent is in federal ownership (FIA, 2019). This report summarizes estimates of the economic contribution of forest products industries in Michigan using IMPLAN 2019 Pro data. These data pre-date and do not capture the impact of COVID-19 in forest products industries in Michigan.

Economic Progress Toward Five-year Goals

The governor-appointed Timber and Forest Products Advisory Council (TFPAC), formerly called the Timber Advisory Council (TAC) revised its five-year goals. Two of the goals were quantified and are listed in the table below. Significant progress has been made on the goals compared to 2012 values. Total output and number of direct jobs increased by 15 percent and 19 percent, respectively.

Goal	2012 Baseline	2017	2018	2019	2023 Target
Increase economic impacts to \$23 billion (total output)	\$17.5 billion	\$20.2 billion	\$20.3 billion	\$21.9 billion	\$23.0 billion
Increase forest products jobs industries employment to 46,000 by 2023 (direct jobs)	34,204 jobs	40,746 jobs	41,901 jobs	42,011 jobs	46,000 jobs

In 2019, Michigan's forest products industries provided direct employment to 42,011 people, leading to \$13.4 billion in direct output. In total contributions, these industries supported over 90,022 jobs, \$5.5 billion in labor income, \$8.3 billion in value-added, and about \$22 billion in total output.

Among the top sectors (excluding forest products sectors) impacted by forest products industries were real estate, truck transportation, employment services, restaurants, and wholesale. This group of sectors reflects spending by forest products companies, their suppliers, and individuals.

Leading Forest Products Industry Groups

Among the seven industry groups, the leading industries' rank in terms of direct jobs, value-added, and direct output varied by chosen measure: Wood furniture had the highest number of direct jobs (10,598), the highest value-added (\$0.9 billion), and the third highest direct output (\$2.3 billion).

Secondary paperboard and other paper products had the second highest number of direct jobs (9,176), the second highest value-added (\$0.9 billion), and the highest direct output (\$4.3 billion). Secondary solid wood products had the third highest employment (6,931), fourth highest value-added (\$0.5 billion), and fifth highest output (\$1.5 billion). Pulp, paper, and paperboard mills had the sixth highest number of direct jobs (3,426), the third highest value-added (\$0.6 billion), and the second highest direct output (\$2.6 million).

Leading Individual Forest Products Sectors

Among the 32 forest products sectors present in Michigan, the top four, by measure in order from highest to fourth highest of direct contributions, were: Employment- Paperboard container manufacturing (7,122 jobs), wood office furniture manufacturing (4,906 jobs), commercial logging (3,782 jobs) and sawmills (2,843 jobs) were the top four sectors and had a combined total of over 18,500 direct jobs. Labor income- Paperboard container manufacturing, wood office furniture manufacturing, paper mills, and commercial logging had the highest labor income, totaling \$1.3 billion. Value-added- Paperboard container manufacturing, wood office furniture manufacturing, paper mills, and sawmills had the highest value-added, totaling \$1.8 billion. Output- Paperboard container manufacturing, paper mills, wood office furniture, and paperboard mills were the top four sectors in output, totaling \$7.3 billion.

Michigan's Forest Products Industries Compared to Other Michigan Industries

The forest products industries provide more direct labor income, value-added, and output than commercial fishing, hunting, and trapping; mining and oil and gas production; and agricultural production industries (plant crop and animal). Overall, the forest products industries accounted for 6 percent of the nonfood manufacturing jobs in Michigan. Agricultural production provided the most employment. Over 5 percent of Michigan's 638,858 direct manufacturing jobs in 2019 were in the forest products industries (i.e., 1 in 18 manufacturing jobs).

Five-years Trends in Michigan's Forest Products Industries Economic Contribution

Since 2014, the direct jobs in forest products industries increased by 9.7%, direct output increased by 15.7%, value-added increased by almost 22%, labor income increased by 23.5%, and average wages per jobs increased by 12.5%. However, the direct jobs, direct output, and direct value-added in logging sector declined by 14% and 32.5%, and 32% respectively since 2014.

1 Introduction

Forests in Michigan are managed not only for timber production but also for wildlife habitat, water protection, biodiversity conservation, and forest-based ecosystem services (Michigan Forests 2014). About fifty-five percent (20.1 million acres) of land in Michigan is forested, and timberland accounts for 95 percent of this forest land (FIA 2019). Forest land is land at least 10 percent stocked by trees of any size, including land that formerly had such tree cover and that will be naturally or artificially regenerated. Forest land includes both land productive enough to produce harvestable timber (timberland), as well as less productive lands. Further, forest land includes lands that are administratively reserved from timber harvesting. Timberland is the largest component of forestland, totaling 19.1 million acres.

Most land is privately owned (62%), and the State of Michigan and USDA Forest Service are the major public owners (FIA 2019). Landowners pursue diverse goals. Private landowners have wide latitude in how they treat their lands. Some have a hands-off approach, while others pursue active management. There are several state and federal programs designed to encourage the active management of private forestlands. State forests and national forests are actively managed in many areas, while resource protection is emphasized in others. Active timber management provides the feedstock for Michigan's forest products industries.

Forests in Michigan have always supported local and state economies and generated employment and income (Leefers 2014, 2015). There is an increase in public interest, particularly in the post-recession period, and recent COVID-19 pandemic in knowing the economic contribution of forestry and forest products industries in Michigan. More specifically, the governor-appointed Timber and Forest Products Advisory Council revised its five-year goals. Two of the goals were to increase economic impacts to \$23 billion (total output) and to increase forest products direct employment to 46,000 by 2023. Significant progress has been made on the goals in 2017, compared to 2012 values. The total output and number of direct jobs increased by 15 percent and 19 percent, respectively in 2017 (Leefers, 2020). The impact of COVID-19 pandemic in forest products industries in Michigan for 2020 is not analyzed in this report because of data limitation. This report uses IMPLAN 2019 Pro Data. The 2018 and 2019 data reflect the economy before the pandemic occurred.

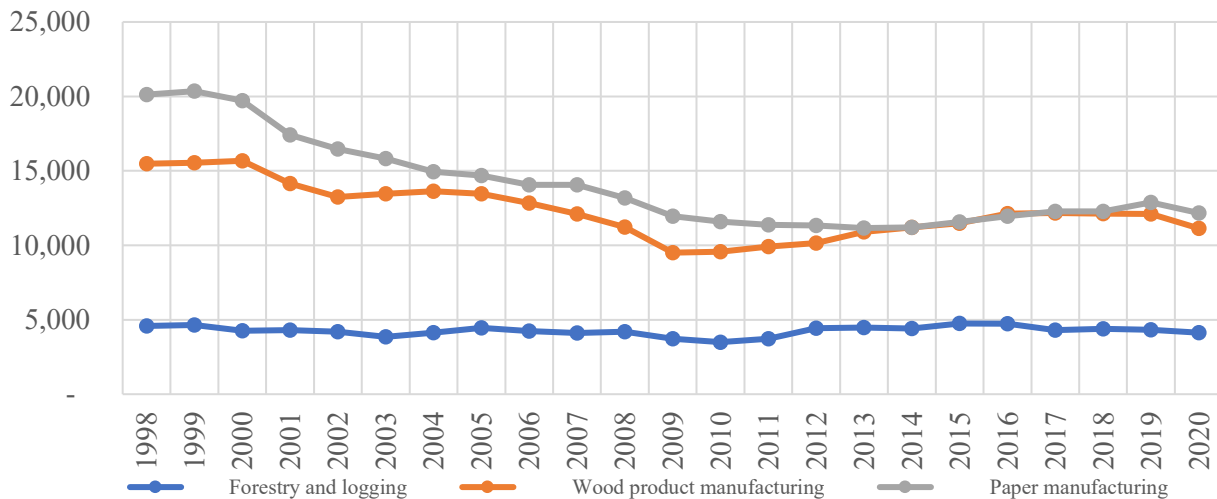


Figure 1 Total full-time and part-time employment in selected forest product industries (Data source: Bureau of Economic Analysis, 2022)

A trend analysis of the contribution of the forest products industry is necessary to portray the role this industry plays in Michigan. According to the recent Bureau of Economic Analysis (BEA) estimates, the forestry and logging industry employment has decreased by almost 10% since 1998 and 7% since 2005. However, forestry and logging industry jobs increased by 18% since 2010. Similarly, since 2010, wood product manufacturing and paper manufacturing employment have increased by 20.6% and 3.7% respectively (BEA 2018). The annual trend of these forest industries is shown in figure 1. Employment number in these selected forestry industries were decreasing before (pre-recession) or during the recession but are increasing in the post-recession period.

Understanding the importance of forest product industries and their economic contributions has become important to policy makers, public and private agencies, and academics as these industries impact jobs, income, and taxes. Many studies have been conducted on the economics of forestry, logging, and forest product industries across the United States. Most of these studies use Impact Analysis for Planning (IMPLAN) modeling software and data to estimate the economic contribution of forest product industries (e.g., Tilley and Munn 2007; Dahal et al. 2015, Khanal et al. 2017, Parajuli et al. 2017, Leefers 2018) and forest-based recreation activities (e.g., Poudel et al. 2016, 2017, 2018). IMPLAN is a mathematical model and calculates the estimated economic impact through algorithms that are deterministic rather than stochastic (Poudel et al. 2017, 2018).

Economic contribution analysis can play a role in the formulation of state and federal policies and regulations and related management activities pertaining to forestry, as these actions affect revenue, taxes, employment, and income. Hence, the periodic assessment of the economic contribution of forestry in Michigan is necessary to provide a consistent perspective and track the industry contributions over time. The objective of this paper is to estimate the economic contribution of forest products industries in Michigan in terms of employment (full- and part-time jobs), labor income, output, and value added by using 2018 and 2019 IMPLAN data.

2 Background

In light of increasing employment in the forestry and logging, wood product manufacturing, and paper manufacturing industries (figure 1), there is an increasing interest in how they contribute to Michigan's economy. The future of forests in Michigan depends in large part on the support and actions of policymakers and constituents. An essential element in garnering that support is documenting the magnitude of the contributions of forest products industries. Forests in Michigan are the basis for substantial economic activity, and thus, forest-based industries have long been recognized as a significant contributor to Michigan's economies (Leefers 2015, 2016).

Previous assessments by Leefers (2014, 2015, 2016) have shown that traditional forest products industries are relatively fluid, with the industry shifting over time. Forests in the U.S. have a diverse ownership pattern which has changed substantially over the last three decades. In 1981, there were about 66 million acres of timberland owned by industrial forest landowners that contributed 29% of the nation's timber supply (Smith and others 2004). In 2005, there was a 60% reduction of timberland owned by forest industry (Seneca Creek Associates 2005). As such, assessments of economic contributions quickly become dated. Several researchers across the U.S. have demonstrated the magnitude of contributions to the U.S. economy by forest products industries. As pointed out by Abt and others (2002), wood products jobs in the southern U.S. increased from 36.5% to 39.3% during 1987-1997. Furthermore, forest-based jobs increased by 13% from 1992 to 2001 in the southern U.S. (Aruna and others 1997, Tilley and Munn 2007). However, the Great Recession (2007-2009) severely impacted forest products industries in the U.S. Woodall and others (2011) reported that forestry-related sectors in the U.S. lost over 1.1 million jobs. In the northern U.S., wood products manufacturing, paper manufacturing, and furniture manufacturing lost 28% of jobs during this period (Woodall and others 2011). In the post-recession period, forest products industries in Michigan started to grow (Figure 1). In 2015, the total economic contribution of forest industries was \$21.2 billion and over 99,000 jobs were supported by this industry (Leefers 2018). In terms of forest-based recreation activities, 4.4 million people in Michigan spent \$6.1 billion on activities such as hunting, fishing and wildlife watching in 2011.

Leefers (2012) first documented the economic contribution of the forest products industry in Michigan using 2012 data. His report established the baseline conditions for studies that followed and, more importantly, illustrated the benefits of evaluating with a standard methodology so that comparisons between states were valid. Leefers (2014, 2015) followed suit in using 2014, 2015 data to demonstrate the overall forest-based industry contribution. Leefers (2018) replicated his previous studies using 2015 data to detail industry-level changes, and inter-sectoral changes that had occurred over the years between studies. These studies, in aggregate, have demonstrated the benefits of periodic evaluations of the economic contributions of forest-related activities. All of the above-referred studies have relied on an input-output analysis in whole or in part to estimate economic contributions. Input-output analysis is commonly used to document the economic contributions of the forest-products industries and forest-based recreation activities (Leefers 2012 2014 2015; Poudel and other 2016, 2017, 2018).

While this report does not analyze the impact of COVID-19 pandemic in forest products industries in Michigan, few studies in other part of the U.S. have used recent IMPLAN Version 6 data to

estimate the impact of COVID-19 pandemic in their states. In Wisconsin, forest products industry lost about 4.8% of direct jobs and 9.6% of direct industry output during 2018 and 2020-Q2 (Dahal, 2022)¹. In total, Wisconsin lost over 15,000 jobs tied to the forest products industry (Dahal, 2022). Similarly, forest products industries sustained close to a \$2 billion loss in total economic contribution in 2020 in North Carolina². The North Carolina forest products industries lost 6.7% of employment.

Tracking the economic contribution of forest products industries and forest-based recreation activities is critical for many reasons. First, quantifying the magnitude of these contributions is key to garnering support for forest resources and associated economic activity. Second, documenting changes among these activities over time is a useful method of measuring the economic health of these activities. Third, the economic data can be used to assess if changes in policy, legislation or tax law may be affecting forest-based economic activity. Finally, documenting shifts among specific types of forest-based economic activity in Michigan may indicate how responsive the various activities are concerning changes in local supply and demand. Hence, the proposed study will employ an input-output analysis to provide estimates for the forest products industries using 2018 and 2019 data using multi-industry approach.

3 Methods

The forest products industry influences the economy in three ways: direct (when industry responds to demand), indirect (initiated by the directly impacted sectors), and induced effects (household spending by employees in the directly and indirectly impacted industries). The total economic contribution is the value of production required to meet all the needs stemming from the initial activity – in this case, forest product-related purchases. Input-output modeling using IMPLAN is a conventional approach in documenting the economic contribution of forest products industries. However, these approaches change over time as new methods are developed and implemented. Recently, Henderson and others (2017) and Joshi and others (2017) highlighted similarities and differences in forest industry modeling in the southern U.S.

3.1 Method 1 vs Method 2

I-O models were constructed for Michigan using 2018 and 2019 IMPLAN state-level data. Models were constructed using a multi-industry approach. Major economic indicators such as employment (full-and part-time jobs), total income, total output and value-added (in millions of dollars) were estimated. To simplify reporting and facilitate comparisons between studies, economic contribution is computed for seven forest-based industry sectors, consistent with Leefers (2020): forestry; logging; primary solid wood products and wood-based power; secondary solid wood products; wood furniture; pulp, paper and paperboard; and secondary paperboard and other paper products.

¹ [Impact of COVID-19 On Wisconsin Forest Products Industry](#)

² [Economic Contribution of the Forest Sector in North Carolina, 2020 | NC State Extension Publications \(ncsu.edu\)](#)

In total, these sectors cover forest-specific manufacturing activities, including the conversion of trees into primary products and the manufacture of products used by other sectors and households. Primary industries (e.g., sawmills, reconstituted wood products [such as oriented strand board], and power plants) use wood directly from the forest, including roundwood, chips, or similar forms. Secondary industries (e.g., trusses and furniture) use one or more primary forest products (e.g., lumber and paperboard) in their manufacturing processes. Value is added as the timber is processed through primary and secondary manufacturers. Several sectors included wood and nonwood products (e.g., institutional furniture manufacturing). Therefore, output and other measures were reduced to better reflect the wood-only component in these sectors by using published government data or surveys (Gibson, Leefers, and Poudel 2020).

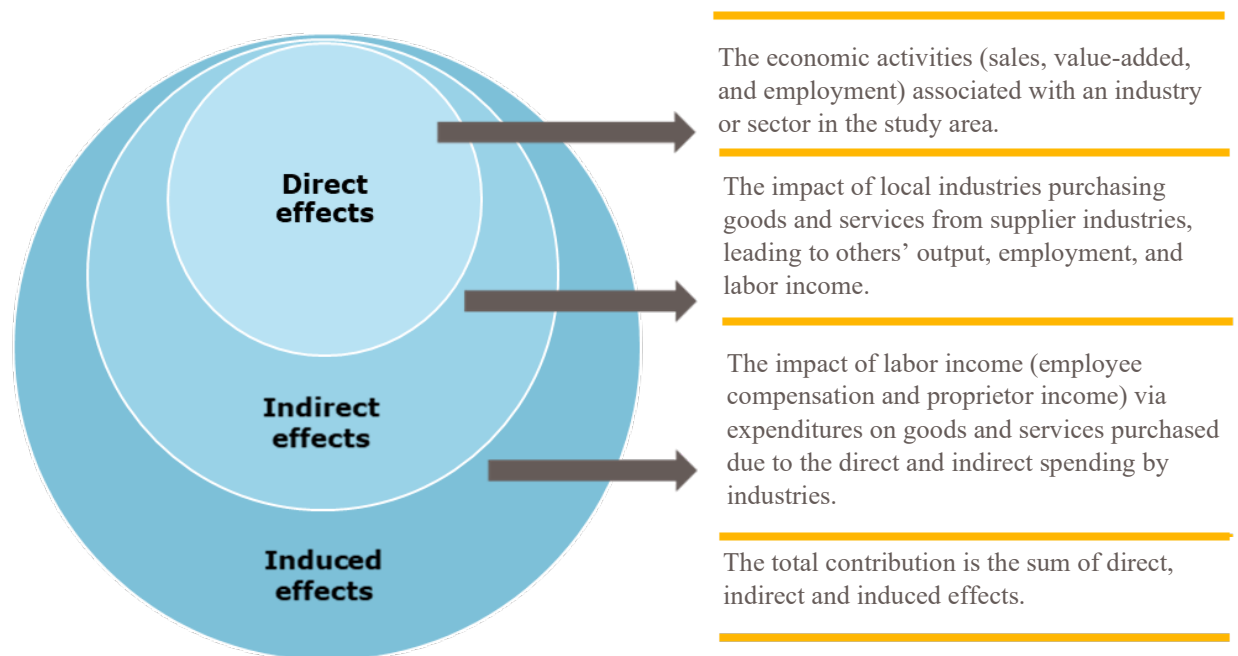


Figure 2 Concept of Total Economic Contribution Analysis

IO modeling using IMPLAN software and data is a conventional approach for documenting forest products industries' economic contributions. This analysis used the matrix inversion approach with external IMPLAN model adjustment as a primary method for estimating economic contributions of forest products industries in Michigan (Gibson, Leefers, and Poudel 2020). Major economic indicators generated by IMPLAN include employment (full- and part-time jobs), labor income, total output, and value-added.

4 Results

The economic contribution results section presents direct and total contributions for all forest products industries, direct and total contributions by forest product industry groups (e.g., logging,

furniture, etc.), the top forest products sectors, and the top non forest products sectors affected by the forest products industries. Finally, this section compares forest industries to other natural resources industries, and manufacturing industries within the state.

Contribution analysis provides a means to assess the role various industries play in a state’s economy. Michigan forest products industries’ total economic contribution in terms of output was \$21.9 billion, based on direct output of \$13.4 billion (Table 1). More than 42,000 direct jobs were associated with this level of economic activity, and the total number of jobs supported was 90,000. Direct labor income, which includes employee compensation and proprietor income, was \$2.8 billion, or \$67,502 per job. Total labor income, which includes income paid directly to industry employees and proprietors, their suppliers, and other industries they support, totaled \$5.5 billion.

Table 1 Statewide Economic Contribution of Forest Products Industries in 2018 and 2019

Year	Effect	Employment	Labor Income (Thousands of Dollars)	Value-added* (Thousands of Dollars)	Output (Thousands of Dollars)
2019	Direct	42,011	2,835,807	3,860,006	13,429,583
	Total	90,022	5,567,745	8,338,161	21,940,876
2018	Direct	41,901	2,715,855	3,754,368	12,542,314
	Total	88,864	5,314,817	7,947,212	20,390,169

* Value-added in IMPLAN is equivalent to Gross State Products.

Each direct job in the forest products industries supported 1.14 additional jobs, and every \$1 million in direct labor income supported an additional \$1.96 million in indirect and induced labor income. The 32 IMPLAN forest products sectors were combined into seven industry groups. In Michigan, wood furniture was the largest of these groups in terms of direct employment, labor income, and value-added (Table 2). Secondary paperboard and other paper product were the second largest group in terms of direct employment, labor income, and value-added, and the largest group in terms of output. Forestry, which includes maple syrup production, timber tract operations, and forestry support activities, was the smallest group for all metrics. Two groups: pulp, paper and paperboard mills and secondary paperboard and other paper products- accounted for over half the output of forest products industries. Two-thirds of forest products industries’ employment was in the wood furniture, secondary paperboard and other paper products, and secondary solid wood products group.

Table 2 Direct Economic Contributions in Michigan, Industry Groups, 2018 and 2019

Years	Industry Group	Employment	Labor Income (Thousands of Dollars)	Value-added (Thousands of Dollars)	Output (Thousands of Dollars)
2019	Forestry	2,468	75,761	74,980	100,198
	Logging	3,782	162,701	146,344	271,501
	Primary solid wood products	5,630	360,242	585,604	2,138,561
	Secondary solid wood products	6,931	420,359	558,355	1,550,679
	Wood furniture	10,598	748,752	932,593	2,368,174
	Pulp, paper, and paperboard mills	3,426	368,461	635,289	2,662,376
	Secondary paperboard and other paper products	9,176	699,532	926,842	4,338,093
	Total	42,011	2,835,807	3,860,006	13,429,583
2018	Forestry	1,838	60,271	60,596	83,445
	Logging	4,521	160,208	167,228	318,704
	Primary solid wood products	5,107	314,641	514,950	1,753,362
	Secondary solid wood products	7,404	405,401	521,581	1,436,004
	Wood furniture	10,928	744,718	959,888	2,329,117
	Pulp, paper, and paperboard mills	3,275	351,491	631,920	2,568,038
	Secondary paperboard and other paper products	8,828	679,125	898,204	4,053,646
	Total	41,901	2,715,855	3,754,368	12,542,314

Table 3 Total Economic Contributions in Michigan, Industry Groups, 2018 and 2019

Year	Industry Group*	Employment	Labor Income (Thousands of Dollars)	Value-added (Thousands of Dollars)	Output (Thousands of Dollars)
2019	Forestry	1,739	53,947	64,940	100,324
	Logging	1,052	45,686	52,219	92,697
	Primary solid wood products	14,296	817,956	1,286,185	3,380,719
	Secondary solid wood products	13,872	803,593	1,167,652	2,726,657
	Wood furniture	22,008	1,369,633	1,942,127	4,323,927
	Pulp, paper, and paperboard mills	13,484	949,070	1,544,905	4,344,916
	Secondary paperboard and other paper products	23,570	1,525,578	2,277,386	6,967,961
	Total	90,023	5,565,464	8,335,414	21,937,204
2018	Forestry	1,952	71,362	84,232	128,995
	Logging	1,505	58,183	71,755	129,773
	Primary solid wood products	12,572	683,080	1,076,919	2,698,717
	Secondary solid wood products	14,229	770,692	1,100,011	2,547,424
	Wood furniture	22,425	1,360,996	1,941,731	4,199,305
	Pulp, paper, and paperboard mills	13,936	946,748	1,563,223	4,326,015
	Secondary paperboard and other paper products	22,249	1,423,756	2,109,340	6,359,940
	Total	88,868	5,314,817	7,947,212	20,390,169

*Forestry and Logging are reported in this table, but most of their contributions are as indirect inputs or intermediate inputs that are used in the production in the other five industry groups.

4.1 Forestry

The forestry group includes timber tract operations, establishments primarily engaged in the operation of timber tracts for the purpose of selling standing timber, maple syrup production, and support activities for forestry such as estimating timber; forest firefighting; forest pest control; treating burned forests from the air for reforestation or on an emergency basis; and consulting on wood attributes and reforestation related to timber production, wood technology, forestry economics and marketing, and forest protection.. Maple syrup production was one of many activities in the “all other crop farming” sector.

Out of seven industry groups, forestry was the smallest in terms of direct contributions in 2019. Direct contributions were \$100 million in output, 2,468 jobs, \$75.7 million in labor income, and almost \$75 million value-added. Direct jobs in forestry increased by almost 35% compared to year 2018. However, income per jobs declined by 6.3%. Total contributions are based, in part, on backward linkages

to suppliers. Total contributions for forestry can be lower than direct contributions (i.e., initial IMPLAN levels) because many of the contributions are inputs into other industries. This is particularly true when we analyze the forest products industries with the multi-industry backward linkages approach where most of the total jobs contribution are included as an input to other forestry sector. Many forestry jobs are counted as contributions in other industries, mostly logging and primary solid wood products (e.g., sawmills). Hence, the total contributions displayed in Table 3 underrepresent the industry's broader contributions. Reporting total contributions for forestry are somewhat misleading because much of forestry's total contribution effects are hidden in the total contributions of other industries. The same holds true for logging sector as discussed below.

However, when we assume forestry and logging industry as an individual single sectors and do not account for the backward linkages, we can estimate single sector economic impact of forestry and logging sectors. In such a case, the total impact will be larger than the direct impact.

4.2 Logging

The logging industry group contains establishments primarily engaged in one or more of the following: cutting timber, cutting and transporting timber, and producing wood chips in the field. Logging was the third smallest in terms of direct employment. The direct contributions of logging were \$271.5 million in output, 3,782 jobs, \$162.7 million in labor income, and \$146.3 million in value-added. Logging jobs declined by 16.3% in 2019 compared to 2018. However, income per job (wages) increased by 21.4% in 2019. Each logging job paid an average of \$43,000 per year in 2019. Most logging activity is an input into production in other industries, especially for manufacturing primary solid wood products (e.g., lumber), paper, and paperboard. In Michigan, most logging jobs are included in the total contributions of other industries. As with forestry, logging's total contributions are underrepresented due to their inclusion in other industries.

4.3 Primary Solid Wood Products

The primary solid wood products industry group was the fourth largest group in terms of direct employment in Michigan. Primary solid wood products sectors include wood-based electric power generation, sawmills, wood preservation, veneer and plywood manufacturing, and reconstituted and wood product manufacturing industries. In 2019, the direct contributions of the group were \$2.1 billion in output, 5,630 jobs, \$360.2 million in labor income, and \$585.6 million in value-added. Total contributions for primary solid wood products, including direct, indirect and induced effects, were \$3.3 billion in output, 14,296 jobs, \$817.9 million in labor income, and \$1.2 billion in value-added. Many primary solid wood products (e.g., lumber and panels) are inputs in other industries; those inputs are counted in other industries' total contributions. The direct employment and output increased by 10% and 21% respectively, in 2019 compared to 2018.

4.4 Secondary Solid Wood Products

Secondary solid wood products was the third largest group in terms of direct employment in Michigan. This group contains engineered wood member and truss manufacturing; wood windows and doors manufacturing; cut stock, resawing lumber, and planing; other millwork, including flooring, wood

container, and pallet manufacturing; manufactured home (mobile home) manufacturing; prefabricated wood building manufacturing; and all other miscellaneous wood product manufacturing. Direct contributions of secondary solid wood products were \$1.5 billion in output, 6,931 jobs, \$420.3 million in labor income, and \$558.3 million in value-added. Total contributions were \$2.7 billion in output, 13,872 jobs, \$803.5 million in labor income, and \$1.1 billion in value-added.

4.5 Wood Furniture

Wood furniture was the largest group in terms of direct employment in Michigan. Wood furniture includes wood kitchen cabinet and countertop manufacturing; upholstered household furniture manufacturing; nonupholstered wood household furniture manufacturing; institutional wood furniture manufacturing; wood office furniture manufacturing; custom architectural woodwork and millwork manufacturing; and showcase, partition, shelving, and locker manufacturing. Direct contributions of wood furniture were \$2.3 billion in output, 10,598 jobs, \$748.7 million in labor income, and \$932.5 million in value-added. Total contributions of wood furniture were \$4.3 billion in output, 22,008 jobs, \$1.3 billion in labor income, and \$1.9 billion in value-added.

4.6 Pulp, Paper, and Paperboard Mills

The pulp, paper, and paperboard mills industry group was the second smallest in terms of direct employment in Michigan, but the second largest in terms of output. The group includes pulp mills, paper mills, and paperboard mills that make paper or pulp from raw wood and from purchased pulp. The pulp, paper, and paperboard mills group's direct contributions were \$2.6 billion in output, 3,426 jobs, \$368.0 million in labor income, and \$635.2 million in value-added. Total contributions were \$4.3 billion in output, 13,484 jobs, \$949 million in labor income, and \$1.5 billion in value-added.

4.7 Secondary Paperboard and Other Paper Products

The secondary paperboard and other paper products group was the second largest in terms of direct employment in Michigan. The group comprises paper and paperboard manufacturing, paper bag and coated and treated paper manufacturing, stationery product manufacturing, sanitary paper product manufacturing, and all other converted paper product manufacturing. Facilities in this group manufacture products from purchased pulp, paper, paperboard, or recycled materials. The direct contributions in 2019 were \$4.3 billion in output, 9,176 jobs, \$699.5 million in labor income, and \$926.8 million in value-added. Total contributions were \$6.9 billion in output, 23,570 jobs, \$1.5 billion in labor income, and \$2.2 billion value-added.

5 Discussion and Conclusions

Forestry and forest products industries have an important role in natural resources management as they provide a source of income and employment across a wide range of economic sectors where forest product industries operate. This report estimated the economic contribution of forest product industries in Michigan using 2019 IMPLAN Pro data and the multi-industry approach with internal model adjustment.

5.1 Top Forest Product Sectors

Among the 32 industry sectors that comprise the seven industry groups listed above; the leading sectors varied by the contribution measure examined. In terms of direct jobs, the four largest forest products sectors are paperboard and container manufacturing (7,122 jobs), wood office furniture manufacturing (4,906), commercial logging (3,782 jobs), and sawmills (2,843 jobs). These sectors reflect the diversity of manufacturing in the state.

The paperboard and container manufacturing sector comprises establishments primarily engaged in converting paperboard into containers without manufacturing paperboard. These establishments use corrugating, cutting, and shaping machinery to form paperboard into containers. Products made by these establishments include boxes, corrugated sheets, pads, pallets, paper dishes, fiber drums, and reels. In a consumer-driven economy with more and more shipping, this industry is well positioned for growth.

The commercial logging sector has establishments primarily engaged in one or more of the following: cutting timber, cutting and transporting timber, and producing wood chips in the field. Loggers are a critical component of the forest products industries. This sector has been expanding since the 2008–09 recession, but many people in the forest products industries are concerned that the aging logger population, insufficient recruitment and retention, and the high cost of entry into the business may limit other industries in the future.

The wood office furniture manufacturing sector covers establishments primarily engaged in manufacturing wood office furniture. The furniture may be made on a stock or custom basis and may be assembled or ready-to-assemble (i.e., knockdown). Michigan is home to three of the top five office and institutional furniture manufacturers in the nation: Steelcase, Herman Miller, and Haworth. The popularity of wood furniture continues, and the Michigan industry is growing. Large corporations and enterprises along with home-office demand are driving expansion of this market.

This sawmills sector comprises establishments primarily engaged in sawing dimension lumber, boards, beams, timbers, poles, ties, shingles, shakes, siding, and wood chips from logs or bolts. Sawmills may plane the rough lumber that they make with a planing machine to achieve smoothness and uniformity of size. Sawmills are distributed in all parts of the state; some specialize in selected species and products.

In terms of labor income, paperboard container manufacturing, wood office furniture manufacturing, paper mills, and commercial logging had the highest labor income, totaling \$1.3 billion. They also had the highest value-added, totaling \$1.7 billion. In terms of output, paperboard container manufacturing, paper mills, wood office furniture, and sawmills were the top four sectors, totaling \$6.6 billion.

5.2 Top Non- Forest Industries Impacted

Contribution analysis using IMPLAN relies on backward linkages from forest products industries sectors among themselves and to other sectors in Michigan. The top ten sectors (excluding forest products sectors) included other real estate, truck transportation, employment services, and full-service restaurants (Table 9). This set of sectors reflects indirect and induced spending by companies and individuals. These

data were at an aggregate level, so 2,111 jobs in truck transportation included log trucks, delivery trucks, and office jobs for some trucking companies, among others. Seven of these sectors were among the top ten sectors in the state of Michigan (real estate was number one, followed by hospitals and wholesale trade- each had over 200,000 jobs).

Table 4 Top Ten Industries Impacted by Michigan’s Forest Products Industries—Number of Jobs, 2019

Sector	Description	Jobs
447	Other real estate	2,184
417	Truck transportation	2,111
472	Employment services	1,807
509	Full-service restaurants	1,732
396	Wholesale - Other durable goods merchant wholesalers	1,637
490	Hospitals	1,622
510	Limited-service restaurants	1,528
469	Management of companies and enterprises	1,124
476	Services to buildings	1,002
483	Offices of physicians	940
Total	NA	15,687

5.3 Importance of the Forest Products Industries in Context

To help contextualize the relative importance of the forest products industries, it is useful to compare the contribution of Michigan’s forest products industries with others. Natural resources and agricultural industries significantly contribute to the diversity of economic activities reflected in Michigan’s \$546.3 billion GSP. The forest products industries provide more direct labor income, value-added, and output than the commercial fishing, hunting, and trapping; mining and oil and gas production; and agricultural production industries. Michigan’s forest products industries comprised 0.7 percent of the GSP in 2019. Agricultural production provided the largest amount of employment (full- and part-time), by far, of these industries.

Table 5 Natural Resources and Agricultural Production Industries in Michigan, 2019

Industry	Employment	Labor Income (Thousands of Dollars)	Value-added (Thousands of Dollars)	Output (Thousands of Dollars)
Forest products	42,011	2,835,807	3,860,006	13,429,583
Commercial fishing, hunting, and trapping	895	8,911	61,550	74,152
Mining and oil and gas production	22,715	1,939,316	5,442,232	15,013,532
Agricultural production (Plant crop and animal)	79,344	1,665,706	3,070,308	7,884,009
Total	144,964	6,449,740	12,434,096	36,401,276

Labor income per job is second highest in forest products (\$65,502) and lowest in commercial fishing, hunting, and trapping (\$9,957). For agricultural production, the average per job is \$20,993; mining and oil and gas has the highest average income at \$85,376. Most of the forest products industries are manufacturers, however, the forestry and logging groups and biomass power sector are not. There were over 638,000 manufacturing jobs in Michigan in 2019. Of these, 35,621 were in the forest products industries, 5.6 percent of the total.

5.4 Annual Trends of Forest Products Industries Economic Contribution

5.4.1 Forest products industries direct jobs trend in Michigan

Direct jobs in forest products industries in Michigan varies by forest products sectors. Different forest products sectors observed changes. The substantial change was observed in industry group forestry which includes IMPLAN sector 15 (forestry, forest products, and timber tract production), IMPLAN sector 19 (support activities for forestry), and IMPLAN sector 10 (maple syrup production) as a partial sector. The number of direct jobs increased by 264% since 2014 in this industry group (Table 6). This is mainly because of the increased jobs in partial sectors: support activities for forestry and maple syrup production. These forest industry sectors are derived from the ratios from support activities for agriculture and forestry and all crop productions.

Table 6 Annual trends of direct jobs in forest products industries in Michigan

Industry Groups	2014	2015	2016	2017	2018	2019	% Change
Forestry	678	684	1,002	1,321	1,838	2,468	▲264.21%
Logging	4,402	4,491	4,145	4,487	4,521	3,782	▼14.09%
Primary Solid Wood Products Pulp, Paper, and Paperboard Mills	5,022	5,096	4,707	4,768	5,107	5,630	▲12.12%
Secondary Paperboard and Other Paper Products	3,288	3,086	3,096	3,186	3,275	3,426	▲4.21%
Secondary Solid Wood Products	8,084	8,472	8,778	9,099	8,828	9,176	▲13.51%
Wood Furniture	6,874	7,305	7,078	7,048	7,404	6,931	▲0.82%
Total	9,943	10,283	10,562	10,837	10,928	10,598	▲6.58%
	38,291	39,417	39,367	40,746	41,901	42,011	▲9.71%

5.4.2 Forest products industries direct output trend in Michigan

Direct output in logging sector declined by 32.5% since 2014. Almost all other industry group direct output saw some percentage increase. Direct output of Secondary Solid Wood Products and

Primary Solid Wood Products industries increased by almost 34% and 26% respectively since 2014. (Table 7)

Table 7 Annual trends of direct output in forest products industries in Michigan (in thousands of dollars)

Industry Groups	2014	2015	2016	2017	2018	2019	% Change
Forestry	45,199	46,623	55,713	62,158	83,445	100,198	▲121.68%
Logging	402,391	336,919	326,737	280,775	318,704	271,501	▼32.53%
Primary Solid Wood Products	1,693,615	1,663,017	1,488,963	1,689,173	1,753,362	2,138,561	▲26.27%
Pulp, Paper, and Paperboard Mills	2,603,351	2,547,166	2,525,727	2,493,853	2,568,038	2,662,376	▲2.27%
Secondary Paperboard and Other Paper Products	3,681,959	4,036,038	3,853,186	3,996,111	4,053,646	4,338,093	▲17.82%
Secondary Solid Wood Products	1,157,676	1,345,784	1,368,711	1,420,592	1,436,004	1,550,679	▲33.95%
Wood Furniture	2,017,070	2,039,722	2,154,251	2,239,587	2,329,117	2,368,174	▲17.41%
Total	11,601,261	12,015,268	11,773,287	12,182,249	12,542,314	13,429,583	▲15.76%

5.4.3 Forest products industries direct value-added in Michigan

The forest products industries direct value-added increased by almost 22% since 2014. Major increases were noted in forestry, primary solid wood products, and secondary solid wood products. Logging sector value-added declined by 32% since 2014 (Table 8)

Table 8 Annual trends of direct value-added in forest products industries in Michigan (in thousands of dollars)

Industry Groups	2014	2015	2016	2017	2018	2019	% Change
Forestry	25,571	27,588	31,785	44,745	60,596	74,980	▲193.22%
Logging	215,902	187,040	162,053	182,134	167,228	146,344	▼32.22%
Primary Solid Wood Products	372,506	357,916	325,234	404,979	514,950	585,604	▲57.21%
Pulp, Paper, and Paperboard Mills	542,272	567,931	648,626	591,328	631,920	635,289	▲17.15%
Secondary Paperboard and Other Paper Products	749,259	865,185	827,098	848,708	898,204	926,842	▲23.70%
Secondary Solid Wood Products	369,503	410,285	455,427	490,191	521,581	558,355	▲51.11%
Wood Furniture	890,117	825,490	888,502	919,632	959,888	932,593	▲4.77%
Total	3,165,129	3,241,433	3,338,725	3,481,716	3,754,368	3,860,006	▲21.95%

5.4.4 Forest products industries direct labor income in Michigan

The labor income in forest products industries increased by 23.4% since 2014. The largest percentage increases were noted in industry group-forestry followed by secondary solid wood products (Table 9)

Table 9 Annual trends of direct labor income in forest products industries in Michigan (in thousands of dollars)

Industry Groups	2014	2015	2016	2017	2018	2019	% Change
Forestry	20,423	21,493	29,345	38,420	60,271	75,761	▲270.95%
Logging	160,876	170,021	149,057	159,122	160,208	162,701	▲1.13%
Primary Solid Wood Products	280,703	292,622	330,326	321,265	314,641	360,242	▲28.34%
Pulp, Paper, and Paperboard Mills	332,021	327,822	355,289	334,981	351,491	368,461	▲10.98%
Secondary Paperboard and Other Paper Products	554,907	615,081	621,727	639,396	679,125	699,532	▲26.06%
Secondary Solid Wood Products	320,486	374,950	489,648	444,056	405,401	420,359	▲31.16%
Wood Furniture	628,157	648,236	695,279	737,746	744,718	748,752	▲19.20%
Grand Total	2,297,572	2,450,226	2,670,671	2,674,987	2,715,855	2,835,807	▲23.43%

5.4.5 Forest products industries direct income per jobs in Michigan

The income per job varies by forest industry groups. In 2019, pulp, paper and paperboard mills employees made \$107 thousand per year on average. This is six percent increase since 2014. Overall, forest products industry jobs pay, on average, \$67.5 thousand per year.

Table 10 Annual trends of direct income per jobs in forest products industries in Michigan (in thousands of dollars)

Industry Groups	2014	2015	2016	2017	2018	2019	% Change
Forestry	30.14	31.41	29.28	29.09	32.80	30.70	▲1.85%
Logging	36.54	37.86	35.96	35.46	35.44	43.02	▲17.72%
Primary Solid Wood Products	55.89	57.43	70.18	67.38	61.61	63.98	▲14.47%
Pulp, Paper, and Paperboard Mills	100.99	106.21	114.77	105.15	107.32	107.55	▲6.50%
Secondary Paperboard and Other Paper Products	68.64	72.61	70.83	70.27	76.93	76.24	▲11.06%
Secondary Solid Wood Products	46.62	51.33	69.18	63.00	54.76	60.65	▲30.10%
Wood Furniture	63.17	63.04	65.83	68.08	68.15	70.65	▲11.84%
Grand Total	60.00	62.16	67.84	65.65	64.82	67.50	▲12.50%

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7 Appendix A: Methods and Data

7.1 Input-Output Analysis: IMPLAN

The economic contributions of the Michigan's forest products industries relied on 2018 and 2019 IMPLAN software and data. IMPLAN is a widely used economic IO model that focuses on interdependence among various producing and consuming sectors in the economy. IMPLAN has 517 industry sectors for the 2019 data set and is based on the NAICS. IMPLAN data are compiled and linked by the IMPLAN software (Version 3.1.1001.12); data come from various government agencies, including the U.S. Census Bureau, the U.S. Bureau of Labor Statistics, and the U.S. Bureau of Economic Analysis. Economic measures in IMPLAN include employment, labor income, value-added, output, and others. More detailed information on data sources is available at [the IMPLAN website](#).

Wassily Leontief developed IO modeling in the mid-20th century. Impact analysis examines the effects of changes in demand in a regional economy, while contribution analysis can evaluate the role of several related sectors in a region. IMPLAN provides the software and data to conduct such analyses. Each sector has a production function tracing the backward linkages (i.e., suppliers) to other sectors. Various sectors produce commodities (e.g., the logging sector produces logs). Leakages (e.g., foreign and domestic imports/exports) to and from other regions are also modeled. Social accounting flows among industries, households, government, and capital are included in IMPLAN.

The analysis process begins with creating an IMPLAN model. One or more geographic areas (e.g., counties or states) are selected as the region. Then, models are run through the creation of multipliers. This report uses Social Accounting Matrix (SAM) multipliers. Next, activities are selected to estimate either economic impacts or contributions. For example, analysts can estimate the impacts of expanding or contracting industries. In the case of contribution analysis, it is important to ensure that the level of production does not exceed the actual level of production in the region. Contribution analysis essentially counters the effects of the multipliers.

Contributions can be in terms of value-added, output, employment, and/or labor income. Value-added is commonly used to describe an industry's economic contributions and is a conservative measure of these contributions. Value-added is the difference between an industry's output, and the costs of intermediate inputs. When a sawmill sells a board, the value of the log and other inputs is not counted in value-added because they were counted when produced by loggers and others. Thus, only new additions to value (e.g., labor income) are included. Labor income is the major component of value-added and includes employee compensation and proprietor income. Value-added, summed across all sectors, is equal to GSP.

Another measure of economic contribution is industry output. For example, if a log is sold to a sawmill that sells boards, both sales are counted as part of the overall region's output, as they are important economic activities. Another measure, employment, includes both full- and part-time jobs. As the number of sectors in an analysis increase, there can be overlap in the number of part-time jobs across sectors.

7.2 *Methods*

IMPLAN estimates economic impacts (i.e., effects of economic changes) and contributions (i.e., effects of existing industries). Two methods for multisector economic contribution analysis are available (Parajuli et al. 2018), both requiring significant data manipulation.

The first method customizes the IMPLAN model by changing selected endogenous tables, whereas the second method adjusts input values based on matrix inversion prior to analysis. In method one, the changes are internal to IMPLAN and difficult to monitor from a quality control perspective.

Method two relies mostly on spreadsheet-based manipulation and is easier to monitor. When the contribution analysis is completed, direct effects from the IMPLAN sectors of interest equal the amounts shown in IMPLAN's "Industry Detail" table, and the total contributions (direct plus indirect plus induced) are estimated. Both methods prevent overreporting of total effects, which can occur if standard economic impact analysis is used when contribution analysis results are desired.

IMPLAN was designed for economic impact analysis. Multipliers ensure that the ripple effect manifests across the economy. A portion of those effects often involve self-purchases within the sector of interest. That is, if the output from the logging sector is \$1 million in a local economy, the economic impact of \$1 million in sales would be greater than that amount due to self-purchases. The contribution methods are designed to yield the \$1 million direct contribution and its associated effects. Put simply, the amount of sales (direct contribution) estimated cannot exceed the amount that actually exists. Methods one and two accomplish this.

The matrix inversion approach relies on developing detailed SAM output multipliers for each sector in the forest products industries. Hence, a 32x32 matrix is developed with the diagonal yielding a value close to 1.0 for the detailed multipliers relating each row-column sector to itself (e.g., logging to logging, sawmills to sawmills, etc.). The actual matrix can be developed in several ways. For example, the SAM matrix can be exported from IMPLAN and narrowed down to the appropriate row and columns for the forest products industries. Then, it can be used to develop detailed multipliers via matrix inversion. Alternatively, detailed multipliers can be exported and rearranged into a 32x32 matrix. The approach used in this report was to rely on a matrix developed by IMPLAN staff for the state. Then, the matrix was inverted and multiplied the initial IMPLAN output values for forest industries sectors to yield inputs for IMPLAN analysis.

Table 11 Aggregated Forest products industries and IMPLAN component sectors

IMPLAN Sector	SECTOR NAME
	Forestry
10	Maple syrup production
15	Forestry, forest products, and timber tract production
19	Support activities for forestry*
	Logging
16	Commercial logging
	Primary Solid Wood Products
45	Electric Power Generation - Biomass
132	Sawmills
133	Wood preservation
134	Veneer and plywood manufacturing
136	Reconstituted wood product manufacturing
	Secondary Solid Wood Products
135	Engineered wood member and truss manufacturing
137	Wood windows and doors manufacturing
138	Cut Stock, resawing lumber, and planing
139	Other millwork, including flooring
140	Wood Container and Pallet Manufacturing
141	Manufactured home (mobile home) manufacturing
142	Prefabricated wood building manufacturing
143	All other miscellaneous wood product manufacturing
	Wood Furniture
365	Wood kitchen cabinet and countertop manufacturing
366	Upholstered household furniture manufacturing
367	Nonupholstered wood household furniture manufacturing
369	Institutional wood furniture manufacturing*
370	Wood office furniture manufacturing
371	Custom architectural woodwork and millwork manufacturing
373	Showcase, partition, shelving, and locker manufacturing*
	Pulp, Paper and Paperboard
144	Pulp mills
145	Paper mills
146	Paperboard mills
	Paperboard and Other Paper Products
147	Paperboard container manufacturing
148	Paper bag and coated and treated paper manufacturing
149	Stationery product manufacturing
150	Sanitary paper product manufacturing
151	All other converted paper product manufacturing

Table 12 Direct contribution of forest products industries in Michigan

IMPLA N Sector	Description	Employment	Labor Income (Thousands \$)	Value Added¹ (Thousands \$)	Output (Thousands \$)
15	Forestry, forest products, and timber tract production	653	33,626	34,292	45,799
19	Support activities for forestry*	1,104	38,131	35,484	44,922
10	Maple syrup production*	710	4,004	5,204	9,477
	<i>Forestry Subtotal</i>	<i>2,468</i>	<i>75,761</i>	<i>74,980</i>	<i>100,198</i>
16	Commercial logging	3,782	162,701	146,344	271,501
	<i>Logging Subtotal</i>	<i>3,782</i>	<i>162,701</i>	<i>146,344</i>	<i>271,501</i>
45	Electric power generation - Wood*	140	26,059	70,335	174,950
132	Sawmills	2,843	160,596	223,298	870,760
133	Wood preservation	167	8,418	17,952	89,782
134	Veneer and plywood manufacturing	1,154	62,416	85,244	324,155
136	Reconstituted wood product manufacturing	1,326	102,752	188,775	678,913
	<i>Primary Solid Wood Products Subtotal</i>	<i>5,630</i>	<i>360,242</i>	<i>585,604</i>	<i>2,138,561</i>
135	Engineered wood member and truss manufacturing	943	56,874	75,754	234,683
137	Wood windows and door manufacturing	787	47,390	59,817	179,737
138	Cut stock, resawing lumber, and planing	732	37,655	59,209	179,939
139	Other millwork, including flooring	967	53,839	76,630	223,014
140	Wood container and pallet manufacturing	2,027	137,655	174,151	414,515
141	Manufactured home (mobile home) manufacturing	210	16,995	19,919	46,065
142	Prefabricated wood building manufacturing	484	28,190	35,873	102,112
143	All other miscellaneous wood product manufacturing	781	41,761	57,002	170,614
	<i>Secondary Solid Wood Products Subtotal</i>	<i>6,931</i>	<i>420,359</i>	<i>558,355</i>	<i>1,550,679</i>

365	Wood kitchen cabinet and countertop manufacturing	1,218	74,529	96,842	206,074
366	Upholstered household furniture manufacturing	144	7,400	8,076	26,221
367	Nonupholstered wood household furniture manufacturing	713	34,457	40,179	109,252
369	Institutional wood furniture manufacturing*	1,659	115,524	124,278	345,073
370	Wood office furniture manufacturing	4,906	381,520	500,338	1,259,126
371	Custom architectural woodwork and millwork	690	48,908	46,059	124,351
373	Showcase, partition, shelving, and locker manufacturing*	1,267	86,414	116,820	298,079
	<i>Wood Furniture Subtotal</i>	<i>10,598</i>	<i>748,752</i>	<i>932,593</i>	<i>2,368,174</i>
144	Pulp mills	74	7,194	9,875	49,555
145	Paper mills	2,188	247,012	425,498	1,624,172
146	Paperboard mills	1,164	114,255	199,916	988,648
	<i>Pulp, Paper, and Paperboard Mills Subtotal</i>	<i>3,426</i>	<i>368,461</i>	<i>635,289</i>	<i>2,662,376</i>
147	Paperboard container manufacturing	7,122	530,181	692,958	3,480,271
148	Paper bag and coated and treated paper manufacturing	1,032	93,382	136,802	503,165
149	Stationery product manufacturing	190	12,500	15,904	77,452
150	Sanitary paper product manufacturing	37	2,095	4,531	25,404
151	All other converted paper product manufacturing	795	61,373	76,646	251,802
	<i>Paperboard and Other Paper Products Subtotal</i>	<i>9,176</i>	<i>699,532</i>	<i>926,842</i>	<i>4,338,093</i>
	Total direct economic contribution	42,011	2,835,807	3,860,006	13,429,583

Table 13 Terms used to describe economic contributions

Term	Description
Output	The dollar measure of production within an area; it is also viewed as sales.
Employment	The number of full-time and part-time jobs associated with an industry.
Labor income	The dollar total of employee compensation and proprietor income; the latter is associated with self-employed individuals.
Indirect business taxes (IBT)	In general terms, IBT can currently be considered the combination of excise, sales and property taxes, as well as fees, fines, licenses and permits.
Value added	The sum labor income, other property income (e.g., rents and profits) and indirect business taxes (e.g., excise and sales taxes). It is the difference between an industry's total output and the cost of its intermediate inputs. The sum of value added for all economic sectors within the state equals the Gross State Product.
Direct effects	The economic activities (e.g., output, employment, labor income, and value added) associated with an industry or sector in the study area. These can describe the current economic sectors or changes to those sectors.
Indirect effects	The impact of local industries purchasing goods and services from other industries leading to others' outputs, employment and labor income.
Induced effects	The impact of labor income (employee compensation and proprietor income) via goods and services purchased due to the direct and indirect spending by industries.
Total effects	Sum of direct, indirect and induced effects.
Social Accounting Matrix (SAM) multipliers	These multipliers are derived by dividing the sum of direct, indirect and induced effects by the direct effects. The social accounts include payments made between households, households and government, etc. These are available for output, employment, labor income, and value added and are used to assess effects of changes in industry activity (i.e., "ripple effects").