Forest Products Industries' Economic Contributions: Michigan

May 2020

Prepared by

Public Sector Consultants
Lansing, Michigan
www.publicsectorconsultants.com

Prepared for

Michigan Department of Natural Resources
Forest Resources Division
Lansing, Michigan
www.michigan.gov/dnr

NORTHEAST-MIDWEST STATE FORESTERS ALLIANCE

PSC

PUBLIC SECTOR CONSULTANTS

DEPARTMENT OF NATURAL RESOURCES DNR MICHIGAN ™

FOREST SERVICE US DEPARTMENT OF AGRICULTURE

Foreword

The future health and sustainability of Michigan's forests is dependent on a vibrant forest products industry. Michigan's forests are renowned for their beauty and their complexity. From the northern mesic hardwood forests in the western Upper Peninsula to the urban forests in southeast Michigan, forests and trees are everywhere in the state. State, federal and commercial forest lands are common in the north while private woodlots and wildlife areas can be found across the southern counties. We rely on these forests to provide clean water, nutrient cycling, wildlife habitat, recreational settings, and timber. Hunting for morel mushrooms in the spring, camping in the summer, color touring in the fall, and cross-country skiing in the winter are a few of the many activities we enjoy in and near our forests.

Some publicly owned and some privately-owned forest are protected, and managers and owners promote the roles of natural processes. Some forests are simply neglected, and nature rules. Some forests are managed for other ecological, social and economic benefits that they provide including carbon sequestration and scenic beauty. The dynamics of these forests are affected by planned activities such as timber harvests and unplanned events such as exotic insect and disease infestations and wildfires. Extraction and utilization of wood plays an important role in shaping future forests. Some tree species, such as aspen and jack pine, require disturbances or clearings to grow. Without harvesting, shade-loving trees would eventually dominate sites because light needed by species like oaks and hickories would be lacking. Foresters play a key role in identifying types of management treatments needed to achieve desired outcomes. Many of the treatments yield wood that is processed by Michigan's forest products industries.

As highlighted in this report, forest products industries provide direct employment for over 40,000 people, and the industries, their suppliers, and their employees support over 91,000 jobs statewide. Many of these jobs are in northern Michigan, and they can be found throughout southern Michigan as well. The diversity of tree species leads to a diversity of wood-based products: maple syrup, wood mulch, musical instruments, log homes, electric power, lumber, veneer, plywood, particleboard, pallets, flooring, cabinets, furniture, and many more. These products are part of our heritage and part of our future. This report provides a clear snapshot of the industries; the industries have been growing in recent years along with the forests that support them. Citizens of Michigan can be proud of our forests and the role they play in our lives and in our economy.

Jeff Stampfly
Acting Chief & State Forester, Forest Resources Division
Michigan Department of Natural Resources

Suggested citation: Leefers, Larry, Jagdish Poudel, David Neumann, and Public Sector Consultants. 2020. *Forest Products Industries' Economic Contributions: Michigan*. Lansing: Public Sector Consultants.

Acknowledgements

This report was produced as part of a 20-state project supported by a U.S. Department of Agriculture Forest Service 2017 Landscape Scale Restoration Grant, administered by the Michigan Department of Natural Resources, Forest Resources Division on behalf of the Northeast-Midwest State Foresters Alliance Forest Markets & Utilization Committee. Dr. Larry Leefers, under contract with Public Sector Consultants, and Dr. Jagdish Poudel, Forest Economist with the MDNR Forest Resources Division contributed extensively to the Michigan report, and we thank them for their contributions.

Table of Contents

Executive Summary

This report assesses broad forest conditions and economic contributions of forest products industries in Michigan. It is one of 20 coordinated and comparable state reports in the northeastern and midwestern United States that provides an improved assessment of forests and the economies they support. Forest data come from the U.S. Forest Service's Forest Inventory and Analysis website, and economic data come from the 2017 Impact Analysis for Planning (IMPLAN), a commercially available economic input-output (IO) model.

Michigan boasts 20.3 million acres of forest land that cover 56 percent of its land base, with most of this forest land able to produce commercial timber. The majority, 62 percent, is privately owned, while state and local governments own roughly 23 percent and approximately 15 percent is in federal ownership.

Economic Progress Toward Five-year Goals

Recently, the governor-appointed Timber and Forest Products Advisory Council (TFPAC) 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.

Exhibit 1. TFPAC Five-year Goals

Goal	2012 Baseline	2017	2023 Target
Increase economic impacts to $23 billion (total output)	$17.5 billion	$20.2 billion	$23.0 billion
Increase forest products jobs industries employment to 46,000 by 2023 (direct jobs)	34,204 jobs	40,746 jobs	46,000 jobs

Forest Industries

This report presents seven forest products industries, which are based on 32 economic sectors in IMPLAN:

- Forestry
- Logging
- Primary solid wood products
- Secondary solid wood products
- Wood furniture
- Pulp, paper, and paperboard mills
- Secondary paperboard and other paper products

In 2017, Michigan's forest products industries provided direct employment to almost 41,000 people, leading to $12.2 billion in output. That same year, labor income was $2.7 billion and value-added was $3.5 billion. In total contributions, these industries supported over 91,000 jobs, $5.5 billion in labor income, $8.0 billion in value-added, and $20.2 billion in output.

Among the top sectors (excluding forest products sectors) impacted by forest products industries were wholesale and retail trade, real estate, restaurants, trucking, and hospitals. 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 (10,837), the highest value-added ($0.9 billion), and the third highest direct output ($2.2 billion).
- Secondary paperboard and other paper products had the second highest number of direct jobs (9,099), the second highest value-added ($0.8 billion), and the highest direct output ($4.0 billion).
- Secondary solid wood products had the third highest employment (7,048), fourth highest value-added ($0.5 billion), and fifth highest output ($1.4 billion).
- Pulp, paper, and paperboard mills had the sixth highest number of direct jobs (3,186), the third highest value-added ($0.6 billion), and the second highest direct output ($2.5 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, commercial logging, wood office furniture manufacturing, and sawmills 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 $1.2 billion.
- Value-added—Paperboard container manufacturing, wood office furniture manufacturing, paper mills, and commercial logging had the highest value-added, totaling $1.7 billion.
- Output—Paperboard container manufacturing, paper mills, wood office furniture, and sawmills were the top four sectors in output, totaling $6.8 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 636,000 direct manufacturing jobs in 2017 were in the forest products industries (i.e., 1 in 18 manufacturing jobs).

Michigan's Forest Products Industries Compared to Those of Wisconsin and Minnesota

Forest products industries in the three Lakes States (Michigan, Wisconsin, and Minnesota) employed over 142,000 workers and accounted for almost $48.0 billion in direct output. Wisconsin's forest products economy was the largest in the region, followed by that of Michigan.

Glossary

The following technical terms are used throughout this report when discussing forestry and economic contributions.

Forestry Terms

Average annual harvest removals: The average annual merchantable volume of growing-stock trees that were live at the time of the previous inventory and were either cut and removed by direct human activity related to harvesting or died as a result of silvicultural or land-clearing activity by the time of the current inventory.

Average annual mortality: The average annual merchantable volume of growing-stock trees that were live at the time of the previous inventory and are dead in the current inventory.

Average annual net growth: The average annual change in merchantable volume of growing-stock trees, after deducting mortality volume, between inventories.

Forest land: Land that is 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 transition zones, such as areas between heavily forested and nonforested lands that have at least 10 percent canopy cover with live tally trees, or recently had at least 10 percent canopy cover by live tally trees based on the presence of stumps, snags or other evidence, and forest areas adjacent to urban and built-up lands, including pinyon-juniper and chaparral areas in the western U.S. and afforested areas. The minimum area for classification of forest land is one acre and 120 feet wide measured stem-to-stem from the outermost edge. Unimproved roads and trails, streams, and clearings in forest areas are classified as forest land if less than 120 feet wide.

Growing stock: Live trees of commercial species that meet minimum merchantability standards and only includes trees at least 5 inches in diameter at breast height. In general, these trees have at least one solid eight-foot section, are reasonably free of form defect on the merchantable bole, and at least 34 percent or more of the volume is merchantable. Excludes rough or rotten cull trees.

Timberland: A subset of forest land that produces or can produce crops of industrial wood and not withdrawn from timber utilization by statute or administrative regulation. (Note: Areas qualifying as timberland can produce at least 20 cubic feet per acre per year of industrial wood in natural stands. Currently inaccessible and inoperable areas are included.)

Economic Contribution Terms

Direct effects/contributions: 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.

Employment: The number of full- and part-time jobs associated with an industry.

Indirect effects/contributions: The impact of local industries purchasing goods and services from other industries, leading to others' outputs, employment, and labor income. This report uses "indirect effects" to refer to the combination of indirect and induced effects.

Induced effects/contributions: The impact of labor income (employee compensation and proprietor income) via goods and services purchased due to the direct and indirect spending by industries. For this report, induced effects are included with indirect effects and referred to as indirect effects.

Labor income: The dollar total of employee compensation and proprietor income; the latter is associated with self-employed individuals.

Output: The dollar measure of production within an area; it is also viewed as sales.

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, and more. 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").

Total effects/contributions: The sum of direct, indirect, and induced effects.

Value-added (also known as gross state product, or GSP): The sum of 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 region equals the total GSP.

Introduction

Forest products industries are an integral component of Michigan's economy. They provide jobs, raw materials, and finished goods that generate additional economic activity throughout the state, region, and nation. Previous studies of the industries' economic contributions have focused solely on Michigan—either documenting the industries' continuing recovery from the 2008–09 recession or examining the role the industries play in the statewide economy. This report compares the contributions of Michigan's forest products industries with those of adjacent states. It is one of 20 reports in the Northeast and Midwestern area of the United States that broadly assesses forests and their economic contributions. The interactions of these 20 states are covered in a regional report. In total, these documents provide a consistent reporting format, compiled using identical methods, across the northeastern and midwestern United States. Previous state-level reports in this area were not comparable because they used different methods and data.

To help quantify these relationships and consistently document the industries' contributions, the Forest Markets & Utilization Committee of the Northeast—Midwest State Foresters Alliance secured federal grant funds to conduct an analysis of 20 midwestern- and northeastern–area states as well as Nebraska. As part of this work, the same project team that completed the individual state reports—comprising members of the Michigan Department of Natural Resources, Public Sector Consultants, Michigan State University forestry economics professor emeritus Larry Leefers, and state forestry experts—published a 20-state report summarizing the economic contributions of forest products industries at a regional level. The U.S. Forest Service funded this work through a 2017 Landscape Scale Restoration grant.

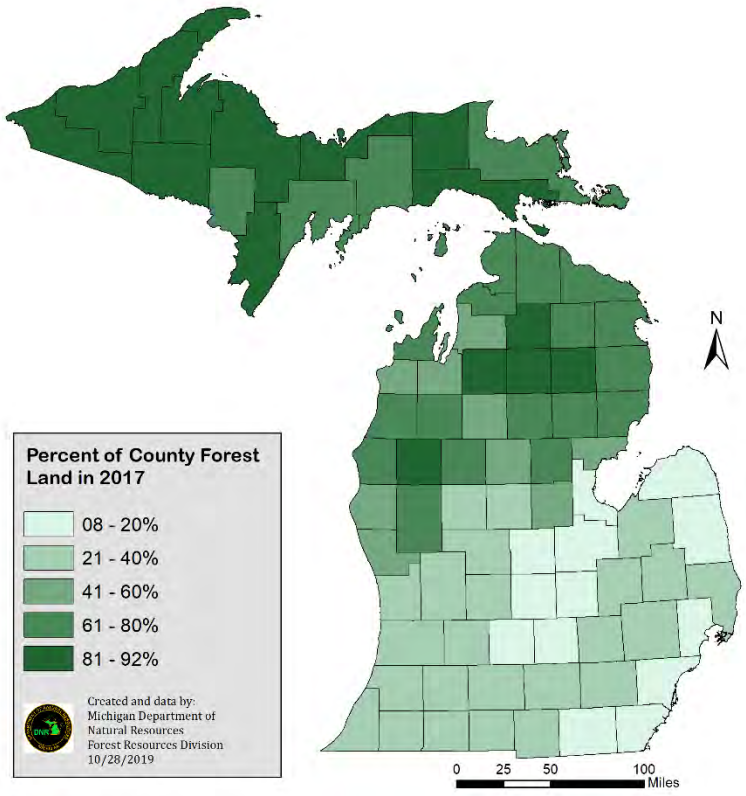
Much of the data used in this report were derived from the U.S. Forest Service Forest Inventory and Analysis database and from IMPLAN, a widely used economic modeling system. These data and related information are presented in four major sections: Forest Resources of Michigan, Forest Products Industries, Economic Contributions of Michigan's Forest Products Industries, and Summary. Due to rounding, some figures in the following tables may not sum to the exact total indicated. The appendices present the economic methods and detailed economic sector data used for this report.

Forest Resources of Michigan

Michigan is rich in forest resources. It has had the greatest area of forest land since the 1930s, when statistics were first gathered (Paulson and Pugh 2016). Over 56 percent of the state is forested (Exhibit 3). 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.[1] Timberland is the largest component of forestland, totaling 19.3 million acres. Reserved forestland accounts for the other 1.0 million acres.

Exhibit 2. Percent of Forest Land by County, 2017



Most land is privately owned, and the State of Michigan and U.S. Forest Service are the major public owners (Exhibit 4). 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.

Trees are common throughout the state. They are in our forests, along our rivers, and in our yards. It is estimated that there are 14 billion trees in Michigan—1,400 trees for each person in the state. Michigan ranks fifth in the nation for amount of timberland, with more than 19.3 million acres (Pugh 2018).

[1] Forest land subcategories include timberland, which is forested land producing or capable of producing crops of industrial wood and not withdrawn from timber utilization by statute or administrative regulation, and reserved forestland, which is land that is withdrawn from timber utilization by statute or administrative regulation.

Exhibit 3. Michigan Land Area by Land Use Type, 2017 (U.S. Forest Service)

Land Use Type	Acres	Percentage
Forest land	20,340,255	56.1%
Nonforest land	15,930,293	43.9%
Total	**36,270,548**	**100.0%**

The majority of Michigan's forestland is privately owned (62 percent). 23 percent is owned by state and local governments, while the remainder is in federal ownership.

Exhibit 4. Forest Land by Ownership Group (2017)

Ownership Group	Acres	Percentage
National forest	3,078,498	15.1%
State and local governments	4,694,239	23.1%
Private	12,567,518	61.8%
Total	**20,340,255**	**100.0%**

Michigan's major forest types include northern hardwoods (maple/beech/birch), oak/hickory, aspen/birch, spruce/fir, and pine (Exhibit 5). Tree species with the greatest standing volume include sugar maple, red maple, northern white cedar, red pine, white pine, red oak, and aspen. Michigan is internationally known for its high-quality hard maple timber, which is prized for furniture manufacturing, flooring, and used in durable goods like baseball bats, butcher blocks, and work surfaces. Michigan's diverse timber species support a variety of forest products industries, including office and institutional furniture, pulp and paper manufacturing, paper and paperboard packaging, composite board (oriented strand board, particle board, and hardboard), structural lumber (studs), hardwood-grade lumber, and a variety of industrial lumber and wood packaging products.

Exhibit 5. Forest Land Area by Forest Type Group (2017)

Forest Type Group	Acres	Percentage
Maple/beech/birch	6,017,364	29.6%
Oak/hickory	3,335,291	16.4%
Aspen/birch	2,977,607	14.6%
Spruce/fir	2,568,272	12.6%
White/red/jack pine	2,180,508	10.7%
Other	3,261,213	16.0%
Total	**20,340,255**	**100.0%**

The estimated volume of standing timber suitable for forest products (i.e., the marketable volume of growing stock) was about 32.3 billion cubic feet, or about 409 million standard cords[2] (Exhibit 6). Average annual net growth exceeded annual harvest removals by a ratio of about 1.8 to 1. That is, for every cubic foot of harvesting that takes place, 1.8 cubic feet of timber grows after accounting for mortality. Average annual harvest removals in 2017 of growing stock were about 360.7 million cubic feet, or about 4.6 million cords—roughly 1 percent of standing volume.

Exhibit 6. Characteristics of Growing Stock in Michigan, 2017 (million cubic feet)

Measure	Total	National Forest	Other Federal	State and Local Government	Private
Net volume	32,343.2	5,403.1	533.1	6,604.6	19,802.5
Average annual net growth	638.6	86.5	3.5	130.9	417.6
Average annual harvest removals	360.7	20.9	-	73.2	266.6
Average annual mortality	378.7	48.1	8.4	74.8	247.5

Note: Net volume is merchantable volume, in cubic feet, of growing-stock trees for timber species (trees where diameter is measured at breast height) from a 1-foot stump to a minimum 4-inch top diameter, or to where the central stem breaks into limbs all of which are less than 4.0 inches in diameter. Volume loss due to rotten, missing, and form cull has been deducted. Growing stock is defined as live trees of commercial species that meet minimum merchantability standards and only includes trees at least 5 inches in diameter at breast height. Net growth is the average annual change (gross growth minus mortality) in merchantable volume, in cubic feet, of growing-stock trees on forestland. Harvest removals are the average annual merchantable volume, in cubic feet, of growing-stock trees at the time of removal from forest land. Annual mortality is the average annual merchantable volume, in cubic feet, of growing-stock trees at the time of mortality on forest land.

Forest Products Industries

Contribution analysis focuses on industries' role in an economy. The first step is often defining the region (e.g., a state). One of the next steps is to define exactly which economic sectors comprise the focus industries. To analyze the contributions of the forest industries, representatives from the U.S. Forest Service's northeastern and midwestern states and Nebraska selected 32 sectors by consensus for inclusion in the analysis. A description of the methods and data is presented in Appendix A. To concisely describe and communicate the economic contribution of the forest products industries, these 32 sectors were aggregated into seven broad groups (Appendix B):

- Forestry
- Logging
- Primary solid wood products

[2] A standard cord is a unit of measurement for pulpwood or sawlogs, generally equivalent to a stack of wood measuring four feet wide by four feet tall by eight feet long. A stacked cord of wood typically contains about 79 cubic feet of solid wood, excluding air space.

- Secondary solid wood products
- Wood furniture
- Pulp, paper, and paperboard mills
- Secondary paperboard and other paper products

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).

This report used IMPLAN to estimate economic contributions of the forest products industries. IMPLAN is a widely used input-output model that comprises economic data and software. IO models characterize financial linkages among and between sectors, households, and institutions. Within these models, various sectors have production functions that show the value of inputs used in production of outputs or commodities. Michigan's economy was represented by 510 sectors in 2017, the most recent year available for IMPLAN data at the time of the analysis. These sectors are based on the North American Industrial Classification System (NAICS).

IMPLAN models can be constructed for different geographic areas.

Economic Contributions of Michigan's Forest Products Industries

This section of the report includes four major subsections: Economic Contributions Defined, Economic Contribution Results, Importance of the Forest Products Industries in Context, and Supplemental Economic Contribution Information.

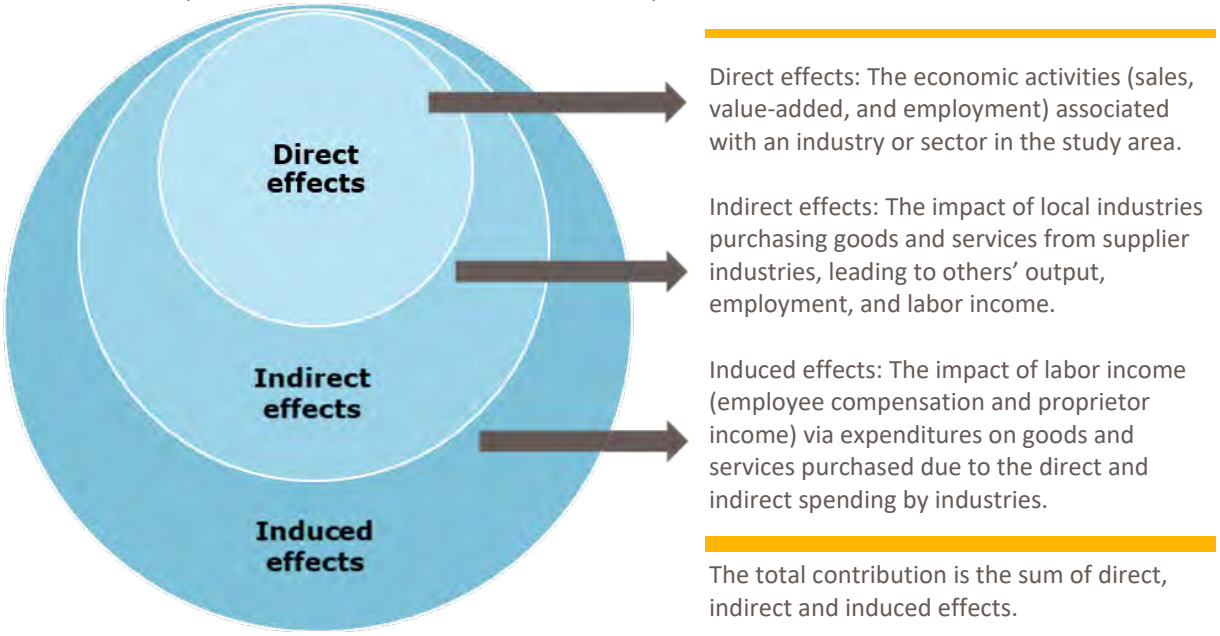
Forests and forest products industries are central for the transition to a greener and more sustainable economy. A green goods and services economy relies on the sustainable use of natural resources, and Michigan's forest products industries are tightly bound to forests and the goods and ecosystem services that they provide (e.g., wildlife habitat, watershed protection, carbon sequestration, etc.).

Economic Contributions Defined

Input-Output Analysis and IMPLAN

Forest products industries influence the economy in three ways: direct effects (when industries sell commodities in response to demand), indirect effects (as suppliers to directly impacted sectors), and induced effects (household spending by employees in directly and indirectly impacted sectors) (Exhibit 7). 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.

Exhibit 7. 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.

Interaction Between State and Regional Analyses

IMPLAN models are based on interactions across the economy. One important aspect of these interactions is whether commodities are sourced locally or imported. In smaller areas (e.g., counties), fewer commodities are sourced locally. As a result, leakages occur when purchases are made—that is, fewer dollars stay in the local economy.

Larger economies have fewer leakages and more commodities are sourced locally. For example, an examination of the logging industries (IMPLAN sector 16) in Michigan, Wisconsin, and Minnesota reveals that the direct employment for 2017 was 4,487, 5,207 and 2,495 jobs, respectively. Summing the individual state's total employment contributions (direct, indirect, and induced) yields 17,556 jobs. However, if the states are combined as one region, the total employment contribution increases to 17,803 jobs. This increase reflects less leakage and more local purchases.

The larger role is due to trade, but IMPLAN does not explicitly show trade with specific states, only overall imports and exports. The regional analysis highlights the larger role of forest products industries in the region's economy. Consequently, the state-level analyses underestimate the actual contributions from a regional perspective.

Economic Contribution Results

The contributions of Michigan's forests can increase with expanded emphasis on the use of wood-based products, adoption of modern wood energy technology, and clear linkages to ecosystem services. In 2013 and again in 2015, a Governor's Forest Products Summit was convened to explore ideas and options for growing the state's forest products industries. The Michigan Department of Natural Resources (MDNR) and the TFPAC developed five-year goals related to the industries, which were subsequently updated in 2019. Two related TFPAC objectives focus specifically on contribution analysis:

- Increase economic contributions of the forest products industries to $23 billion by 2023
- Increase forest products industries employment to 46,000 by 2023

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 nonforest products sectors affected by the forest products industries. Finally, this section compares forest industries in nearby states, other natural resources industries, and manufacturing industries within the state.

Direct and Total Contributions by Forest Products Industries

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 $20.2 billion, based on direct output of $12.2 billion (Exhibit 8). Approximately 41,000 direct jobs were associated with this level of economic activity, and the total number of jobs supported was 91,279. Direct labor income, which includes employee compensation and proprietor income, was $2.7 billion, or $65,650 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.

Exhibit 8. Statewide Economic Contribution of Forest Products Industries, 2017 Dollars

Effect	Employment	Labor Income (Thousands of Dollars)	Value-added* (Thousands of Dollars)	Output (Thousands of Dollars)
Direct	40,746	$2,674,986	$3,469,388	$12,182,247
Total	**91,176**	**$5,477,204**	**$7,987,222**	**$20,196,166**

* Value-added in IMPLAN is equivalent to GSP.

Each direct job in the forest products industries supported 1.24 additional jobs, and every $1 million in direct labor income supported an additional $1.05 million in indirect and induced labor income.

Most state economies are large relative to any particular industry or group of industries. The forest products industries are no exception. In 2017, Michigan's population was estimated at 9.9 million people, with total employment of 5.7 million. The gross state product was $517.8 billion from 510 economic sectors (of the possible 536 in the US). The GSP's largest component was labor income, which was $322.4 billion.

Direct value-added for forest products industries was $3.5 billion; 0.7 percent of Michigan's total GSP. The percentage almost doubles to 1.5 percent when considering total value-added effects. These percentages hold for other economic measures (e.g., jobs) as well.

Direct and Total Contributions by Forest Product Industry Groups

As previously noted, the 32 IMPLAN forest products sectors were combined into seven industry groups (Appendix B). In Michigan, wood furniture was the largest of these groups in terms of direct employment, labor income, and value-added (Exhibit 9). Secondary paperboard and other paper products was 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. Estimates for all seven groups have increased in recent years (Poudel 2019).

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.

Exhibit 9. Direct Economic Contributions in Michigan, Industry Groups, 2017

Industry Group	Employment	Labor Income (Thousands of Dollars)	Value-added (Thousands of Dollars)	Output (Thousands of Dollars)
Forestry	1,321	$38,420	$44,745	$62,158
Logging	4,487	$159,122	$182,134	$280,775
Primary solid wood products	4,768	$321,264	$392,651	$1,689,171
Secondary solid wood products	7,048	$444,056	$490,191	$1,420,592
Wood furniture	10,837	$737,746	$919,632	$2,239,587
Pulp, paper, and paperboard mills	3,186	$334,981	$591,328	$2,493,853
Secondary paperboard and other paper products	9,099	$639,396	$848,708	$3,996,111
Total	**40,746**	**$2,674,985**	**$3,469,389**	**$12,182,247**

Exhibit 10. Total Economic Contributions in Michigan, Industry Groups, 2017

Industry Group*	Employment	Labor Income (Thousands of Dollars)	Value-added (Thousands of Dollars)	Output (Thousands of Dollars)
Forestry	1,006	$39,924	$45,601	$68,754
Logging	1,360	$50,753	$66,245	$106,630
Primary solid wood products	13,650	$762,121	$1,098,788	$2,792,150
Secondary solid wood products	14,888	$859,091	$1,145,163	$2,609,545
Wood furniture	22,207	$1,340,506	$1,888,220	$4,008,738
Pulp, paper, and paperboard mills	14,008	$946,096	$1,549,503	$4,202,047
Secondary paperboard and other paper products	24,058	$1,483,728	$2,193,724	$6,408,302
Total	**91,176**	**$5,477,204**	**$7,987,222**	**$20,196,166**

*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.

For the following sector-specific discussions, refer to Exhibit 9 for direct contribution details and Exhibit 10 for total contribution details. See Appendix C for detailed economic measures for industry groups and their component sectors.

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, forest protection, maple syrup production, and support activities for forestry. Timber tract operations include establishments primarily engaged in the operation of timber tracts for the purpose of selling standing timber. Maple syrup production was one of many activities in the "all other crop farming" sector. Support activities for forestry comprise establishments primarily engaged in performing particular support activities related to timber production, wood technology, forestry economics and marketing, and forest protection. These establishments may provide support activities for forestry, such as cruising timber, wildland firefighting, forest pest control, marking boundaries, and other forest management services.

Out of seven industry groups, forestry was the smallest in terms of direct contributions in 2017. Direct contributions were $62.2 million in output, 1,321 jobs, $38.4 million in labor income, and $44.7 million value-added. 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. For example, almost half (47 percent) of 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 Exhibit 10 underrepresent the industry's broader contributions—reporting total contributions for forestry is somewhat misleading because much of the forestry total contribution effects are hidden in the total contributions of other industries. The same holds true for logging below.

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 $280.8 million in output, 4,487 jobs, $159.1 million in labor income, and $182.1 million in value-added. 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, 79 percent of 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.

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. The direct contributions of the group were $1.7 billion in output, 4,768 jobs, $321.3 million in labor income, and $392.7 million in value-added. Total contributions for primary solid wood products, including direct, indirect and induced effects, were $2.7 billion in output, 13,351 jobs, $743.5 million in labor income, and $1.1 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.

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 $1.4 billion in output, 7,048 jobs, $444.1 million in labor income, and $490.2 million in value-added. Total contributions were $2.6 billion in output, 14,888 jobs, $859.1 million in labor income, and $1.1 billion in value-added.

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 $2.2 billion in output, 10,837 jobs, $737.7 million in labor income, and $919.6 million in value-added. Total contributions of wood furniture were $4.0 billion in output, 22,207 jobs, $1.3 billion in labor income, and $1.9 billion in value-added.

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, 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 $2.5 billion in output, 3,186 jobs, $335.0 million in labor income, and $591.3 million in value-added. Total contributions were $4.2 billion in output, 14,008 jobs, $946.1 million in labor income, and $1.5 billion in value-added.

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 2017 were $4.0 billion in output, 9,099 jobs, $639.4 million in labor income, and $848.7 million in value-added. Total contributions were $6.4 billion in output, 24,058 jobs, $1.5 billion in labor income, and $2.2 billion value-added.

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 (6,972 jobs), commercial logging (4,487 jobs), wood office furniture manufacturing (4,474 jobs), and sawmills (2,583 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 $1.2 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 $6.8 billion.

Top Nonforest Industries Impacted

Contribution analysis using IMPLAN relies on backward linkages from forest products industries sectors among themselves and to other sectors in Michigan. Including the 32 forest products industries present in Michigan, 194 sectors were impacted in 2017 (counting sectors with ten or more jobs supported). The top ten sectors (excluding forest products sectors) included wholesale and retail trade, real estate, restaurants, trucking, and hospitals (Exhibit 11). This set of sectors reflects indirect and induced spending by companies and individuals.

These data were at an aggregate level, so 1,742 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).

Exhibit 11. Direct Jobs Impacted by the Forest Products Industries Among Michigan's Top Ten Non-Forest Products Industries in 2017

Sector	Description	Jobs
395	Wholesale trade	3,749
440	Real estate	2,096
501	Full-service restaurants	1,934
502	Limited-service restaurants	1,914
411	Truck transportation	1,742
482	Hospitals	1,613
461	Management of companies and enterprises	1,601
468	Services to buildings	1,415
464	Employment services	1,395
405	Retail—general merchandise stores	951
Total	**NA**	**18,410**

Neighboring States

The Lake States area (Michigan, Wisconsin, and Minnesota) is an important region for forest products. Forest products industries employ over 142,000 workers across the region and account for almost $48 billion in direct output (Exhibits 12 and 13). Wisconsin had the largest forest products economy, with

67,793 direct jobs and sales more than $25 billion. Minnesota's industry was about half the size of Wisconsin's. Michigan falls between the two. The three largest industry groups, each with over 31,000 employees, were secondary paperboard and other paper products, secondary solid wood products, and wood furniture.

Exhibit 12. Forest Products Industries Direct Employment in Michigan, Wisconsin, and Minnesota, 2017

Industry	Michigan	Wisconsin	Minnesota
Forestry	1,321	778	782
Logging	4,487	5,207	2,495
Primary solid wood products	4,768	4,564	1,489
Secondary solid wood products	7,048	14,911	11,288
Wood furniture	10,837	12,071	8,575
Pulp, paper, and paperboard mills	3,186	11,233	2,542
Secondary paperboard and other paper products	9,099	19,029	6,885
Sum of Direct Contributions	**40,746**	**67,793**	**34,055**

Exhibit 13. Forest Products Industries Direct Output in Michigan, Wisconsin, and Minnesota, 2017

Industry	Michigan (Thousands of Dollars)	Wisconsin (Thousands of Dollars)	Minnesota (Thousands of Dollars)
Forestry	$62,158	$33,960	$35,376
Logging	$280,775	$489,763	$140,983
Primary solid wood products	$1,689,173	$1,630,002	$720,227
Secondary solid wood products	$1,420,592	$3,041,763	$2,651,642
Wood furniture	$2,239,587	$2,174,899	$1,419,961
Pulp, paper, and paperboard mills	$2,493,853	$8,562,915	$2,185,705
Secondary paperboard and other paper products	$3,996,111	$9,349,409	$3,349,371
Sum of Direct Contributions	**$12,182,249**	**$25,282,710**	**$10,503,265**

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 $517.6 billion GSP (Exhibit 14). 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 2017. Agricultural production provided the largest amount of employment (full- and part-time), by far, of these industries.

Exhibit 14. Natural Resources and Agricultural Production Industries in Michigan, 2017

Industry	Employment	Labor Income (Thousands of Dollars)	Value-added (Thousands of Dollars)	Output (Thousands of Dollars)
Forest products	40,746	$2,674,987	$3,481,716	$12,182,249
Commercial fishing, hunting, and trapping	1,152	$7,325	$51,774	$52,329
Mining and oil and gas production	20,087	$827,114	$2,485,183	$4,133,628
Agricultural production (plant crop and animal)	87,073	$1,588,824	$2,949,105	$8,196,106
Total	**149,058**	**$5,098,250**	**$8,967,778**	**$24,564,312**

Labor income per job is highest in forest products ($65,650) and lowest in commercial fishing, hunting, and trapping ($6,360). For agricultural production, the average per job is $18,247; mining and oil and gas has the second highest average income at $41,177.

Most of the forest products industries are manufacturers, however, the forestry and logging groups and biomass power sector are not. There were over 636,000 manufacturing jobs in Michigan in 2017. Of these, almost 35,000 were in the forest products industries, 5.5 percent of the total. Of sixteen industries, forest products manufacturing was seventh in terms of employment behind transportation equipment, fabricated metal, machinery, food, plastics and rubber products, and miscellaneous manufacturing. It was eighth in terms of labor income, value-added, and output (Exhibit 15).

Exhibit 15. Manufacturing Industries in Michigan, 2017

Manufacturing Industries	Employment	Labor Income (Thousands of Dollars)	Value-added (Thousands of Dollars)	Output (Thousands of Dollars)
Transportation equipment	186,155	$17,690,648	$38,814,533	$153,932,873
Fabricated metal	82,723	$5,836,584	$8,051,803	$19,250,714
Machinery	74,545	$6,622,107	$8,420,730	$21,576,084
Food	45,805	$2,697,167	$5,167,118	$22,986,318
Plastics and rubber products	43,240	$3,126,439	$4,296,822	$13,691,410
Miscellaneous	39,827	$3,495,876	$4,689,509	$11,853,684
Forest products	34,787	$2,454,956	$3,193,070	$11,715,224
Chemical	28,487	$3,433,812	$7,296,659	$27,733,523
Primary metal	22,849	$2,103,337	$3,039,180	$11,536,417
Computer and electronic product	18,956	$332,257	$2,147,981	$6,442,924
Printing	17,049	$958,023	$1,325,307	$2,829,069
Electrical equipment	14,231	$1,654,386	$2,435,477	$6,970,692
Nonmetallic mineral product	11,393	$923,414	$1,605,831	$4,216,725
Beverage and tobacco product	8,285	$482,621	$1,119,076	$4,593,901
Textiles and apparel	6,373	$287,898	$439,891	$1,253,440
Petroleum and coal	1,622	$475,629	$1,098,343	$3,325,851
Total	**636,326**	**$52,575,151**	**$93,141,331**	**$323,908,849**

Supplemental Economic Contribution Information

The report by Gibson, Leefers, and Poudel provides a detailed discussion of which sectors were included and excluded from this analysis (2020). Most economic data used in this report were derived from IMPLAN, with two notable exceptions.

First, for most of the partial sectors (Appendix B), ratios of published government data were used to identify a portion of the industry that would be treated as forest products. In cases where only part of an IMPLAN sector was associated with forest products, analysts faced three options. The most conservative option was to include only sectors viewed as 100 percent in forest products, excluding sectors where only part produced forest products. At the other end of the spectrum, analysts could have focused on sectors producing any forest products at all, even if the forest products represented a small part of total output. Between these extremes, analysts could choose a third option—selecting the portion of a sector that produced forest products and include only that portion, mindful to include a means for assessing the magnitude of that portion. That is the approach used in this report.

Second, for sector 47, electric power generation–biomass, the IMPLAN employment figures appeared low based on prior knowledge of this sector. As a result, six facilities were surveyed to assess their 2017 employment. The updated direct employment figure (increased from 104 to 151) was used in IMPLAN analysis; other sector metrics were increased proportionally.

The MDNR has compiled a directory of forest products companies. They have identified over 800 logging and trucking firms, about 300 primary manufacturers, and more than 1,000 secondary manufacturers. This directory is potentially a source of additional information regarding the forest products industries.

Wood is used in many other products not covered by these 32 sectors highlighted in this report. For example, boats, blinds, musical instruments, burial caskets, organic chemicals, and pharmaceuticals may use wood directly or as an extract. However, the wood-only component of these product groups is difficult to quantify and not included in this report. Surveys could be designed and conducted to determine the forest products component of these sectors. In practice, the production functions, employment, output, and other metrics would need to be compiled and inserted into IMPLAN.

Summary

Over the last 20 years, individual states located in the midwestern and northeastern area of the United States have conducted statewide economic contributions studies of the forest products industries. However, these studies differed in approach, data used, and measures reported. Developing a consistent approach required funding that spanned multiple states. The Forest Markets & Utilization Committee of the Northeast—Midwest State Foresters Alliance secured grant funds through the Landscape Scale Restoration Program within the U.S. Forest Service, Eastern Region, State and Private Forestry to support investigation of the economic contributions of the forest products industry in the 20 northeastern and midwestern states and Nebraska. To that end, the MDNR Forest Resources Division (serving as the lead on the grant project) contracted with Public Sector Consultants to facilitate discussions among the project partner states and to reach consensus on an appropriate analysis methodology and report template for both the regional and state reports, in addition to conducting the analysis.

This report serves as a snapshot of economic contributions of the forest products industries in Michigan for 2017, as well as a baseline report for future analyses. State data were used in this report, but given IMPLAN's structure, substate and multistate analyses can be developed. However, future analyses may again require funding from the U.S. Forest Service or other institutions for assessments across multiple states. Methods used in developing this report are consistent across the region. There were 40,746 direct jobs in the forest products industries, and overall, 91,279 jobs were supported. Direct labor income was $2.7 billion with total labor income at $5.5 billion. Direct value-added was $3.5 billion, and the total contribution for value-added was $8.0 billion. Finally, direct output was $12.2 billion with a

total contribution of $20.2 billion in output. Similar report findings are available from other states in the region and are summarized in the regional report.

References

Gibson, Melissa, Larry Leefers, and Jagdish Poudel. 2020. Forest Products Industry Regional Economic Analysis: Methods. Lansing: Public Sector Consultants.

Henderson, James and Garen Evans. 2017. *Single and Multiple Industry Economic Contribution Analysis Using IMPLAN.* Starkville: Mississippi State University Forest and Wildlife Research Center. Accessed October 11, 2019. https://www.fwrc.msstate.edu/pubs/implan_2017.pdf

Leefers, Larry, Jagdish Poudel, David Neumann, and Public Sector Consultants. 2020. *Forest Products Industries' Economic Contributions in the Northeast and Midwest.* Lansing: Public Sector Consultants.

Parajuli, Rajan, James Henderson, Shaun Tanger, Omkar Joshi, and Ram Dahal. 2018. "Economic Contribution Analysis of the Forest-product Industry: A Comparison of the Two Methods for Multisector Contribution Analysis Using IMPLAN." *Journal of Forestry* 116(6): 513–519. https://doi.org/10.1093/jofore/fvy047

Paulson, Charles and Scott Pugh. 2016. "Forests of Michigan, 2016." *U.S. Department of Agriculture, Forest Service, Northern Research Station Resource Update*. Accessed October 17, 2019. https://www.fs.fed.us/nrs/pubs/ru/ru_fs113.pdf

Poudel, Jagdish. "Economic Contributions of Forest Products Industries in Michigan 2016." Unpublished manuscript, 2019. Microsoft Word file.

Pugh, Scott. 2018. "Forests of Michigan, 2017." *U.S. Department of Agriculture, Forest Service, Northern Research Station Resource Update.* Accessed October 29, 2019. https://doi.org/10.2737/FS-RU-153

United States Department of Agriculture Forest Service. 2019. "Forest Inventory EVALIDator." *United States Department of Agriculture Forest Service Forest Inventory and Analysis Program.* Accessed October 22, 2019. http://apps.fs.usda.gov/Evalidator/evalidator.jsp

Watson, Philip, Joshua Wilson, Dawn Thilmany, and Susan Winter. 2007. "Determining Economic Contributions and Impacts: What Is the Difference and Why Do We Care?" *The Journal of Regional Analysis & Policy* 37(2): 1–15. Accessed March 12, 2020. https://www.researchgate.net/publication/280717869_Determining_Economic_Contributions_and_Impacts_What_is_the_difference_and_why_do_we_care

Appendix A: Methods and Data

Input-Output Analysis: IMPLAN

Several key decisions related to methods were developed through a consensus process (Gibson, Leefers, and Poudel 2020). The project team, in consultation with the states, made consensus decisions regarding the modeling method for estimating economic contributions, the forest products sectors to include in analysis (either in total or in part), the IMPLAN year for reporting results, and the use of an analysis spreadsheet for consistent reporting.

The economic contributions of the region and each state's forest products industries relied on 2017 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 536 industry sectors for the 2017 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 increases, there can be overlap in the number of part-time jobs across sectors.

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.

Appendix B: Forest Products Industries Groupings and IMPLAN Sectors

Exhibit B1. Forestry Industry Grouping and IMPLAN Sectors

IMPLAN Sector	Sector Name
10	Maple syrup production*
15	Forestry, forest products, and timber tract production
19	Support activities for forestry*

Note: Sectors with an "*" indicate that only a portion of the sector is included in the forest products industries.

Exhibit B2. Logging Industry Grouping and IMPLAN Sector

IMPLAN Sector	Sector Name
16	Commercial logging

Exhibit B3. Primary Solid Wood Products Industry Grouping and IMPLAN Sectors

IMPLAN Sector	Sector Name
47	Electric power generation—biomass*
134	Sawmills
135	Wood preservation
136	Veneer and plywood manufacturing
138	Reconstituted wood product manufacturing

Note: Sectors with an "*" indicate that only a portion of the sector is included in the forest products industries.

Exhibit B4. Secondary Solid Wood Products Industry Grouping and IMPLAN Sectors

IMPLAN Sector	Sector Name
137	Engineered wood member and truss manufacturing
139	Wood windows and doors manufacturing
140	Cut stock, resawing lumber, and planing
141	Other millwork, including flooring
142	Wood container and pallet manufacturing
143	Manufactured home (mobile home) manufacturing
144	Prefabricated wood building manufacturing
145	All other miscellaneous wood product manufacturing

Exhibit B5. Wood Furniture Industry Grouping and IMPLAN Sectors

IMPLAN Sector	Sector Name
368	Wood kitchen cabinet and countertop manufacturing
369	Upholstered household furniture manufacturing
370	Nonupholstered wood household furniture manufacturing
372	Institutional wood furniture manufacturing*
373	Wood office furniture manufacturing
374	Custom architectural woodwork and millwork manufacturing
376	Showcase, partition, shelving, and locker manufacturing*

Note: Sectors with an "*" indicate that only a portion of the sector is included in the forest products industries.

Exhibit B6. Pulp, Paper, and Paperboard Mills Industry Grouping and IMPLAN Sectors

IMPLAN Sector	Sector Name
146	Pulp mills
147	Paper mills
148	Paperboard mills

Exhibit B7. Secondary Paperboard and Other Paper Products Industry Grouping and IMPLAN Sectors

IMPLAN Sector	Sector Name
149	Paperboard container manufacturing
150	Paper bag and coated and treated paper manufacturing
151	Stationery product manufacturing
152	Sanitary paper product manufacturing
153	All other converted paper product manufacturing

Appendix C. Detailed Economic Contribution Results

Direct Economic Contribution by IMPLAN Sector

Exhibit C1. Direct Economic Contributions, Forestry Detail, 2017

Sector	Employment	Labor Income (Thousands of Dollars)	Value-added (Thousands of Dollars)	Output (Thousands of Dollars)
Forestry, forest products, and timber tract production	477	$15,323	$20,243	$32,751
Support activities for forestry	606	$20,899	$21,451	$23,775
Maple syrup production	238	$2,198	$3,052	$5,632
Subtotal	**1,321**	**$38,420**	**$44,746**	**$62,158**

Exhibit C2. Direct Economic Contributions, Logging Detail, 2017

Sector	Employment	Labor Income (Thousands of Dollars)	Value-added (Thousands of Dollars)	Output (Thousands of Dollars)
Commercial logging	4,487	$159,122	$182,134	$280,775
Subtotal	**4,487**	**$159,122**	**$182,134**	**$280,775**

Exhibit C3. Direct Economic Contributions, Primary Solid Wood Products Detail, 2017

Sector	Employment	Labor Income (Thousands of Dollars)	Value-added (Thousands of Dollars)	Output (Thousands of Dollars)
Electric power generation—biomass	151	$22,488	$49,439	$124,090
Sawmills	2,583	$153,708	$164,179	$733,313
Wood preservation	186	$11,240	$14,868	$103,717
Veneer and plywood manufacturing	1,003	$59,667	$66,003	$275,210
Reconstituted wood product manufacturing	845	$74,161	$98,162	$452,840
Subtotal	**4,768**	**$321,264**	**$392,651**	**$1,689,170**

Exhibit C4. Direct Economic Contributions, Secondary Solid Wood Products Detail, 2017

Sector	Employment	Labor Income (Thousands of Dollars)	Value-added (Thousands of Dollars)	Output (Thousands of Dollars)
Engineered wood member and truss manufacturing	850	$53,746	$56,903	$193,521
Wood windows and doors manufacturing	774	$54,778	$60,648	$182,515
Cut stock, resawing lumber, and planing	697	$41,246	$50,219	$162,753
Other millwork, including flooring	1,253	$75,672	$86,576	$261,764
Wood container and pallet manufacturing	2,032	$118,844	$127,418	$334,557
Manufactured home (mobile home) manufacturing	120	$14,965	$17,965	$37,846
Prefabricated wood building manufacturing	412	$25,653	$26,974	$73,816
All other miscellaneous wood product manufacturing	910	$59,153	$63,487	$173,821
Subtotal	**7,048**	**$444,057**	**$490,190**	**$1,420,593**

Exhibit 16. Direct Economic Contributions, Wood Furniture Detail, 2017

Sector	Employment	Labor Income (Thousands of Dollars)	Value-added (Thousands of Dollars)	Output (Thousands of Dollars)
Wood kitchen cabinet and countertop manufacturing	1,559	$82,266	$89,558	$230,417
Upholstered household furniture manufacturing	223	$10,760	$12,061	$43,205
Nonupholstered wood household furniture manufacturing	792	$30,208	$36,425	$96,572
Institutional wood furniture manufacturing	1,791	$124,934	$140,801	$367,792
Wood office furniture manufacturing	4,474	$354,319	$485,223	$1,107,471
Custom architectural woodwork and millwork manufacturing	808	$52,556	$58,912	$135,750
Showcase, partition, shelving, and locker manufacturing	1,189	$82,703	$96,653	$258,380
Subtotal	**10,836**	**$737,746**	**$919,633**	**$2,239,587**

Exhibit 17. Direct Economic Contributions, Pulp, Paper, and Paperboard Mills Detail, 2017

Sector	Employment	Labor Income (Thousands of Dollars)	Value-added (Thousands of Dollars)	Output (Thousands of Dollars)
Pulp mills	58	$5,490	$7,659	$37,689
Paper mills	2,263	$247,852	$440,688	$1,763,529
Paperboard mills	864	$81,638	$142,981	$692,636
Subtotal	**3,185**	**$334,980**	**$591,328**	**$2,493,854**

Exhibit C7. Direct Economic Contributions, Secondary Paperboard and Other Paper Products Detail, 2017

Sector	Employment	Labor Income (Thousands of Dollars)	Value-added (Thousands of Dollars)	Output (Thousands of Dollars)
Paperboard container manufacturing	6,972	$479,081	$622,084	$3,146,581
Paper bag and coated and treated paper manufacturing	1,110	$95,440	$140,441	$507,553
Stationery product manufacturing	246	$12,986	$18,776	$85,579
Sanitary paper product manufacturing	56	$1,745	$4,203	$33,692
All other converted paper product manufacturing	715	$50,145	$63,204	$222,706
Subtotal	**9,099**	**$639,397**	**$848,708**	**$3,996,111**

Note: Value-added in IMPLAN is equivalent to gross state product.

U.S. Forest Service Nondiscrimination Statement

"In accordance with Federal law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, this institution is prohibited from discriminating on the basis of race, color, national origin, sex, age, disability, and reprisal or retaliation for prior civil rights activity. (Not all prohibited bases apply to all programs.)

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible State or local Agency that administers the program or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339. Additionally, program information is also available in languages other than English.

To file a complaint alleging discrimination, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at http://www.ascr.usda.gov/ complaint_filing_cust.html , or at any USDA office or write a letter addressed to USDA and provided in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by: (1) mail: U.S. Department of Agriculture, Office of the Assistant Secretary for Civil Rights, 1400 Independence Avenue, SW, Washington, D.C. 20250- 9410; (2) fax: (202) 690-7442; or (3) email: program.intake@usda.gov.

This institution is an equal opportunity provider."