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Research Report

North Central Minnesota Forestry Economic Impact Analysis 10-Year Projections

For

Minnesota Forest Resources Council

Bureau of Business and Economic Research

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Driven to Discover

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Table of Contents

Table of Figures

Table of Tables

North Central Minnesota Forestry Economic Impact Analysis
10-Year Projections

Project Description

In 2003, the Minnesota Forest Resources Council (MFRC) North Central Landscape Committee completed the first long-range forest landscape plan for 5.5 million acres in Aitkin, Becker, Beltrami, Cass, Clearwater, Crow Wing, Hubbard, Itasca, Mahnomen, and Polk counties. The first generation landscape plan was based in part on a 2001 North Central Minnesota Forestry Analysis prepared by the Bureau of Business and Economic Research (BBER), an entity of University of Minnesota Duluth's Labovitz School of Business and Economics. In 2016, the MFRC contacted the BBER to update this analysis. This updated analysis is intended to provide the basis for development of another generation of the Northeast Landscape Plan. The revised plan is being developed by MFRC staff with guidance provided by the North Central Landscape Committee.

This project will support the development of forest-based economic development goals through the MFRC's North Central Landscape Committee and offers a unique opportunity to increase coordination and collaboration in support of increased forest-based economic development.

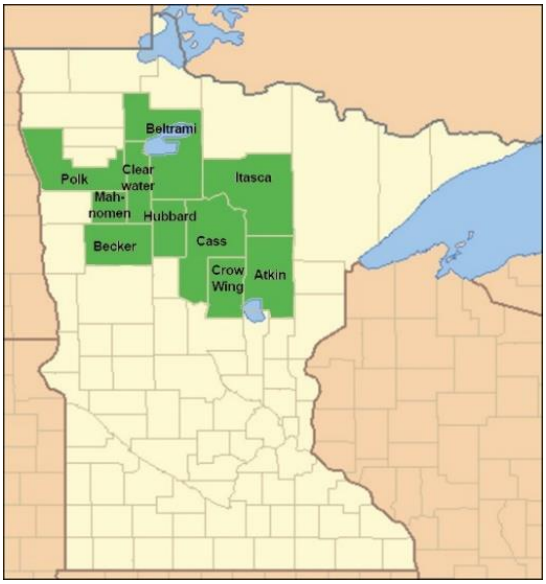
The research objectives of this study included the following:

- To compile data for the forest products industry in the North Central Region using statistics and reports from the U.S. Forest Service, Minnesota's Department of Natural Resources, forest industry representatives, and other sources.
- To analyze the data gathered and run statistical models for 10-year projections.
- In consultation with the organizations listed above, make 10-year projections with respect to forest-based industry value added, output, and employment for the counties that are within the North Central Region of Minnesota.

Study Area

The geographic scope for this economic impact analysis is proposed to be the North Central Forest Landscape counties of Aitkin, Becker, Beltrami, Cass, Clearwater, Crow Wing, Hubbard, Itasca, Mahnomen, and Polk in Minnesota. Technically, MFRC's North Central landscape region only includes the eastern half of Polk and the southern half of Beltrami counties, but both counties were included in their entirety to ensure alignment between data sources.

Figure 1. Counties of Minnesota's North Central Forestry Region



SOURCES: WIKIPEDIA, BBER

Input-Output Modeling

This study uses the IMPLAN Group's input-output modeling data and software (IMPLAN version 3.1). The IMPLAN database contains county, state, zip code, and federal economic statistics, which are specialized by region, not estimated from national averages. Using classic input-output analysis in combination with region-specific Social Accounting Matrices and Multiplier Models, IMPLAN provides a highly accurate and adaptable model for its users.

IMPLAN data files use the following federal government data sources:

- U.S. Bureau of Economic Analysis Benchmark Input-Output Accounts of the U.S.
- U.S. Bureau of Economic Analysis Output Estimates
- U.S. Bureau of Economic Analysis Regional Economic Information Systems (REIS) Program
- U.S. Bureau of Labor Statistics Covered Employment and Wages (CEW) Program
- U.S. Bureau of Labor Statistics Consumer Expenditure Survey
- U.S. Census Bureau County Business Patterns
- U.S. Census Bureau Decennial Census and Population Surveys
- U.S. Census Bureau Economic Censuses and Surveys
- U.S. Department of Agriculture Census

IMPLAN data files consist of the following components: employment, industry output, value added, institutional demands, national structural matrices, and inter-institutional transfers. Economic impacts are made up of direct, indirect, and induced impacts. The data used was the most recent IMPLAN data available, which is for the year 2015. All data are reported in 2017 dollars. More details on the assumptions and limitations of these models can be found in Appendix D, IMPLAN Assumptions.

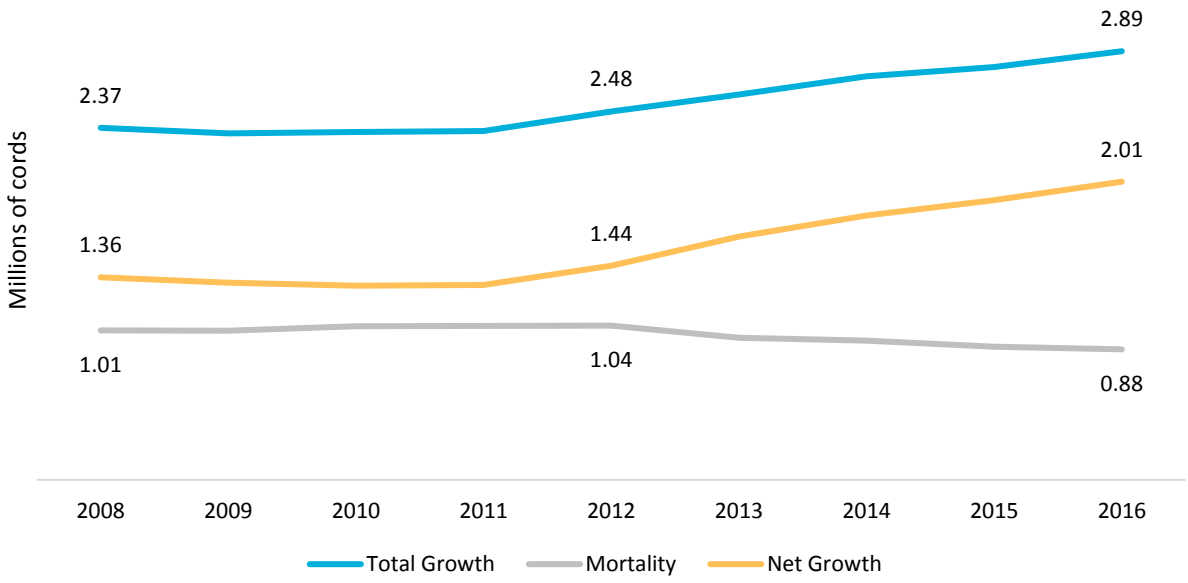
Inputs and Assumptions

The following section details some of the inputs required for modeling the economic contribution of the forestry industry, as well as the impacts of the four potential scenarios. These inputs include the current harvest levels (removals) of various timber species in the North Central region, as well as the current state of the industry in the area.

Data were collected from a variety of sources. Growth and removal estimates were gathered using the U.S. Forest Service Forest Inventory and Analysis (FIA) database. Industry production data was collected from IMPLAN. Scenario assumptions were developed in partnership with the North Central economic pathways committee. The research team worked under the assumption that the committee members provided good-faith estimates for all assumptions.

Harvest Levels

Figure 2. Growth and Mortality Rates of Growing-Stock Trees on Timberland, in Millions of Cords (North Central Region 2008-2016)



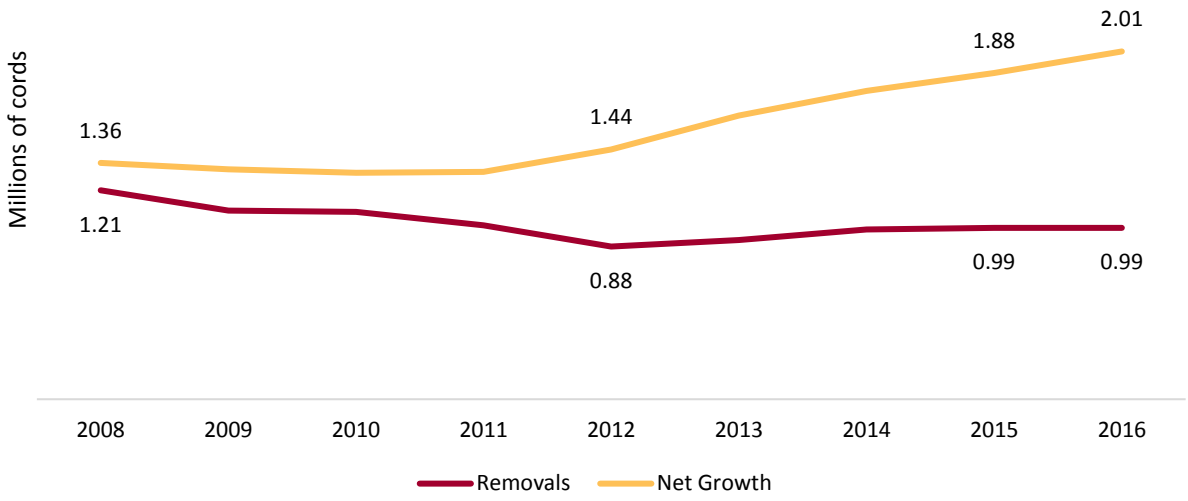
SOURCE: U.S. FOREST SERVICE, FOREST INVENTORY AND ANALYSIS (FIA)

Figure 2 highlights growth and mortality estimates of growing-stock trees on timberland from 2008 to 2016. The three measures shown in the figure are net annual growth (in yellow), average annual mortality (in gray) and gross annual growth (in blue).[1] In this figure, total growth is simply a measure of net growth plus mortality.[2] As can be seen from the figure, gross growth and net growth have followed mostly parallel paths during the nine-year period, remaining fairly flat between 2008 and 2011 and then rising gradually between 2012 and 2016. Average annual mortality, however, appears to have fallen between 2012 and 2016, with mortality levels at their lowest point (879,000 cords) in 2016.

[1] Formal definitions for these and other forestry terms can be found in Appendix C.

[2] According to the Forest Inventory Analysis (FIA) database, net annual growth is gross growth minus average annual mortality and minus the net volume of trees that became cull trees during the year. Cull trees are live trees that are unsuitable for the production of some roundwood products, now or prospectively. Cull trees can include those with decay (rotten cull) or poor form, limbiness, or splits (rough cull). Rough cull is suitable for pulpwood and other fiber products. Cull trees are not included in the gross annual growth estimate shown in Figure 2.

Figure 3. Net Growth and Removals of Growing-Stock Trees on Timberland, in Millions of Cords (North Central Region 2008-2016)



SOURCE: U.S. FOREST SERVICE, FOREST INVENTORY AND ANALYSIS (FIA)

Figure 3 highlights net growth and removal estimates of growing-stock trees on timberland from 2008 to 2016. As can be seen from the figure, growth just narrowly outpaced removals until about 2011, at which point the two measures began to diverge. In fact, in 2008, 1.21 million cords were removed annually, compared with 1.36 million cords of annual net growth of timber (an 88% harvest rate). In 2012, removals had fallen to 0.88 million cords for a 61% harvest rate. In the most recent year (2016), less than half of all net growth was harvested in the North Central region.

For the remainder of this analysis, all measures of removals and growth represent estimates from the year 2015 (1.88 million cords of net annual growth and 0.99 million cords in removals). 2015 was used as it aligns with the most recent IMPLAN dataset available. It is important to note that the results of the analysis and subsequent models are dependent on the estimates of net growth and removals as well as the industry production levels in that year. Another analysis performed using a different point in time may yield significantly different results.

Table 1. Average Annual Removals of Growing-Stock Trees, in Cords (North Central Region, 2015)

Species Category[3]	*National Forest*	*State*	*Private**	*County*	*Total*
Aspen	33,659	68,621	205,300	225,729	533,310
Red pine	33,559	20,284	40,930	9,852	104,625
Paper birch	893	13,106	16,897	36,501	67,397
Northern hardwoods	1,530	15,701	18,845	14,578	50,654
Oak	90	7,925	10,375	28,248	46,637
Balsam fir	1,221	3,736	10,448	19,472	34,877
Jack pine	-	6,187	25,021	1,302	32,510
Black spruce	-	22,458	-	9,466	31,924
Tamarack	-	13,416	-	13,922	27,338
Red maple	-	8,520	3,691	13,737	25,947
Lowland hardwoods	-	2,694	10,760	8,652	22,106
White spruce	176	2,295	6,250	1,429	10,151
Cedar	-	-	1,214	-	1,214
White pine	-	-	869	194	1,062
Other hardwoods	-	-	-	-	-
Total removals	**71,128**	**184,942**	**350,601**	**383,082**	**989,752**
Total volume	**11,386,488**	**11,185,195**	**36,015,341**	**13,696,855**	**72,283,878**

SOURCE: U.S. FOREST SERVICE, FOREST INVENTORY AND ANALYSIS (FIA)

*Private ownership includes individuals, corporations, Native American tribes, conservation organizations, clubs, and other private entities (United States Department of Agriculture 2008)

Table 1 shows removal estimates in much greater detail. Here, removals are broken out by species category and by ownership type. Aspen removals, at just over 533,000 cords in 2015, represent more than half (54%) of all the timber harvested in the North Central region, followed by red pine (11%), paper birch (7%), northern hardwoods (5%), and oak (5%). Nearly 40% of all removals happen on county lands. A similar, but slightly smaller share (35%) is harvested on private lands. Removals on state lands (19%) and national forest lands (7%) represent the remainder of the removals in the North Central region.

It is also interesting to compare average annual removals to the total volume of growing-stock trees managed for each ownership type. Counties harvest, by far, the greatest proportion of their available timber, roughly 3% of their 13.7 million available cords each year. The state harvests a smaller, but still significant, portion (1.7%) of their total volume of cords (11.2 million), followed by private owners (1%) and, finally, national forest lands (0.6%)

Industry Production

The economic contribution of the forest industry was estimated by using IMPLAN's most recent output and employment levels for the North Central region (2015). These data were the primary inputs for the baseline scenario and represent the current state of the forest industry in the study area.

[3] See Table 20, Appendix B for details on which MnDNR forest types and principal tree species are included in each species category.

Table 2. Employment and Output by IMPLAN Industry, North Central Region 2015

	Employment	*Labor Income, in Millions*	*Output, in Millions*
Paper mills	329	$33.1	$274.6
Reconstituted wood product manufacturing	291	$24.7	$143.2
Sawmills	250	$9.9	$66.8
Commercial logging	729	$32.1	$55.4
Wood container and pallet manufacturing	268	$8.9	$35.5
Wood preservation	69	$4.5	$35.1
Engineered wood member and truss manufacturing	155	$5.9	$31.6
Paper bag and coated and treated paper manufacturing	48	$4.3	$24.9
Wood kitchen cabinet and countertop manufacturing	201	$5.3	$22.3
Wood windows and doors and millwork manufacturing	83	$5.7	$19.9
All other miscellaneous wood product manufacturing	128	$4.1	$19.8
Prefabricated wood building manufacturing	73	$4.5	$15.1
Cut stock, resawing lumber, and planing	60	$2.8	$14.7
Other millwork, including flooring	52	$2.1	$10.6
Electric power transmission and distribution*	8	$0.9	$10.0
Truck transportation**	51	$2.9	$8.4
All other converted paper product manufacturing	20	$1.0	$6.6
Support activities for agriculture and forestry***	88	$3.3	$5.2
Nonupholstered wood household furniture manufacturing	42	$1.1	$4.5
Paperboard container manufacturing	2	$2.6	$3.1
Showcase, partition, shelving, and locker manufacturing	4	$0.1	$0.8
Forestry, forest products, and timber tract production	6	$0.2	$0.4
Electric power generation - biomass	-	$0.0	$0.0
Veneer and plywood manufacturing	-	$0.0	$0.0
Pulp mills	-	$0.0	$0.0
Paperboard mills	-	$0.0	$0.0
Stationery product manufacturing	-	$0.0	$0.0
Sanitary paper product manufacturing	-	$0.0	$0.0
Other basic organic chemical manufacturing	-	$0.0	$0.0
Wood office furniture manufacturing	-	$0.0	$0.0
Custom architectural woodwork and millwork	-	$0.0	$0.0
Total (Forestry Sector)	2,958	$159.8	$808.5
Total (All Sectors)	166,501	$6,614.3	$22,803.1
% Forestry	1.3%	2.4%	3.5%

SOURCE: IMPLAN

* 2% of electric power transmission and distribution from woody biomass, EIA 2017

** 2.8% of truck transportation applies to log and lumber hauling, EMSI 2017 and Reference USA 2017

*** 20% applies to forestry, EMSI 2017

More than 30 IMPLAN industries were included as part of the industry for this study. Table 2, on the previous page, details the employment and output for each industry as well as the total employment and output for the forestry sector in the North Central region and for the North Central economy as a whole.[4] Employment estimates are in terms of jobs, not in terms of full-time equivalent employees. Therefore, these jobs may be temporary, part-time, or short-term. Output, or revenue, is defined as the total value of all local production required to sustain activities. It includes company profits, spending on inputs, employee compensation, and taxes.

As shown in Table 2, paper mills contribute the largest amount to total output, followed by reconstituted wood product manufacturing, sawmills, and commercial logging. Interestingly, the commercial logging industry employs more than twice the number of workers as the other forestry industries but with lower output. This is likely the result of the seasonal nature of the industry.

In total, the forestry sector contributes nearly 3,000 full- and part-time jobs, $160 million in labor income, and more than $800 million in output to the economy of the North Central region. This equates to 1.3% of jobs in the study area, 2.4% of the labor income, and 3.5% of output.

Scenario Results

This section describes the direct, indirect, and induced economic contribution of the forestry sector along with four potential scenarios, each reflecting various changes to harvest and industry production. While each scenario represents potential changes over a ten-year period (2015-2025), all values were modeled using 2015 data, and all results are shown in current (2017) dollars. Results are measured in employment, output, and value added.

The scenarios are organized intentionally, with the first three scenarios (Baseline, I, and II) measuring the current or potential economic contribution of the forestry sector on the North Central region and the last two scenarios (III and IV) measuring the economic impact of a change in production for a specific industry or group of industries.

While the two terms, economic impact and economic contribution, are often used interchangeably, their meanings are actually quite different. A contribution analysis measures the support of an existing sector to the economy in a defined area, whereas an impact analysis is primarily used to determine impacts to the local economy by entry or exit of a firm or industry. Additionally, when performing a contribution analysis, certain changes must be made to the model to limit spending within related forestry industries. These limitations on inter-industry spending ensure that the sector being modeled is not being double-counted.

A brief description of each scenario along with the results of modeling are shown here. Detailed inputs and assumptions can be found in Appendix A.

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[4] Three industries, electric power transmission and distribution, truck transportation, and support activities for agriculture and forestry, were included in this specialized forestry sector, as they are central to the activities of the forest products sector. The numbers shown in Table 2 reflect only a portion of the employment and output for each of those three sectors. Electric power generation is not included, as most large electric companies (e.g. Minnesota Power, Great River Energy) classify as Electric Power Distribution, not generation.

Baseline Scenario

The baseline scenario reflects the current state of the forestry sector in the North Central region, based on harvest rates and industry inputs from 2015. As mentioned previously, this scenario represents the economic contribution of the forestry sector to the local economy. For this scenario, it is assumed that harvest levels and industry production will remain constant between 2015 and 2025 with no increase or decrease to any sector.

Table 3. Baseline Scenario Results, North Central Region, in Millions of Dollars

Impact Type	*Employment*	*Labor Income*	*Value Added*	*Output*
Direct Effect	2,958	$161.8	$233.1	$819.4
Indirect Effect	788	$32.8	$53.4	$118.1
Induced Effect	940	$30.1	$56.8	$104.2
Total Effect	4,685	$224.6	$343.4	$1,041.7

SOURCE: IMPLAN

Table 3 summarizes the total economic contribution from the forestry sector in the North Central region. These results use the 2015 IMPLAN employment and output levels as the original input for the model. The first column of Table 3, labeled employment, estimates the number of jobs that the forestry sector supports directly and indirectly. Employment estimates are in terms of jobs, not in terms of full-time equivalent employees. According to the results of this analysis, it is estimated that the forestry sector created almost 4,700 jobs in the North Central region in 2015.

The second column, labor income, is an estimate of all employee compensation, including wages, benefits, and proprietor income. Assuming no change in production, it is estimated that the forestry sector will contribute roughly $225 million in employee wages and benefits in the North Central region by 2025. Column three, labeled value added, represents the contribution to the GDP made by an individual producer, industry, or sector. Assuming no change in current production levels, the forestry sector is estimated to have a total value added impact of just over $343 million in the North Central by 2025. The last column, output, is the value of all local production required to sustain activities. In total, the forestry sector is anticipated to contribute just over $1.0 billion in spending to the North Central region by 2025 through the combination of its direct, indirect, and induced effects.

Scenario I – Increase in Harvest Levels to Match Species Growth Rates

Scenario I reflects an increase in harvest levels of just over 20% between 2015 and 2025. The estimated increase in removals is the result of an alignment between net growth and removal rates; in cases where a species' net growth in 2015 exceeded removals, removal of the species was increased to match net growth rates. Conversely, if the current (2015) removal of the species exceeded net growth, removals were reduced to align with a more sustainable harvest level. [5]

The potential increase in harvest was then translated into a change in industry production. Using information

[5] For each industry, the sum of all new removals, in cords, was estimated using Industry/Species crosswalk shown in Appendix B. That total was then divided by the current (2015) level of removals. This percentage was used to increase industry output. See Appendix A, Scenario I for more details, including the formula used to determine potential removal amounts for each species.

gathered from industry representatives on which species are most commonly utilized by various industries, the research team estimated the potential increase in industry output that could result from the additional removals.[6] Industries that are central to the forestry sector, such as commercial logging, sawmills, and truck transportation, tended to see gains similar in magnitude to the increase in harvest (roughly 20%). Industries that currently make use of underutilized species, such as lowland hardwoods, have a greater opportunity to benefit from an increase in harvest from those species. Therefore, production levels in those industries were increased at a higher level. Conversely, industries that rely primarily on more widely utilized species, such as aspen, would likely have to cut back on production levels if aspen harvest rates were to decrease.

Table 4. Scenario I Results – Potential Increase in Economic Contribution from 20% Increase in Harvest Levels, in Millions of Dollars

Impact Type	*Employment*	*Labor Income*	*Value Added*	*Output*
Direct Effect	779	$31.3	$40.7	$146.6
Indirect Effect	166	$6.5	$10.5	$22.9
Induced Effect	182	$5.8	$11.0	$20.2
Total Effect	1,127	$43.6	$62.2	$189.7

SOURCE: IMPLAN

Table 5. Scenario I Results – Potential Total Contribution of North Central Forestry Sector (Baseline Plus 20% Increase in Harvest Levels), in Millions of Dollars

Impact Type	*Employment*	*Labor Income*	*Value Added*	*Output*
Direct Effect	3,737	$193.1	$273.9	$966.0
Indirect Effect	953	$39.3	$63.9	$141.0
Induced Effect	1,122	$35.9	$67.8	$124.5
Total Effect	5,812	$268.3	$405.6	$1,231.4

SOURCE: IMPLAN

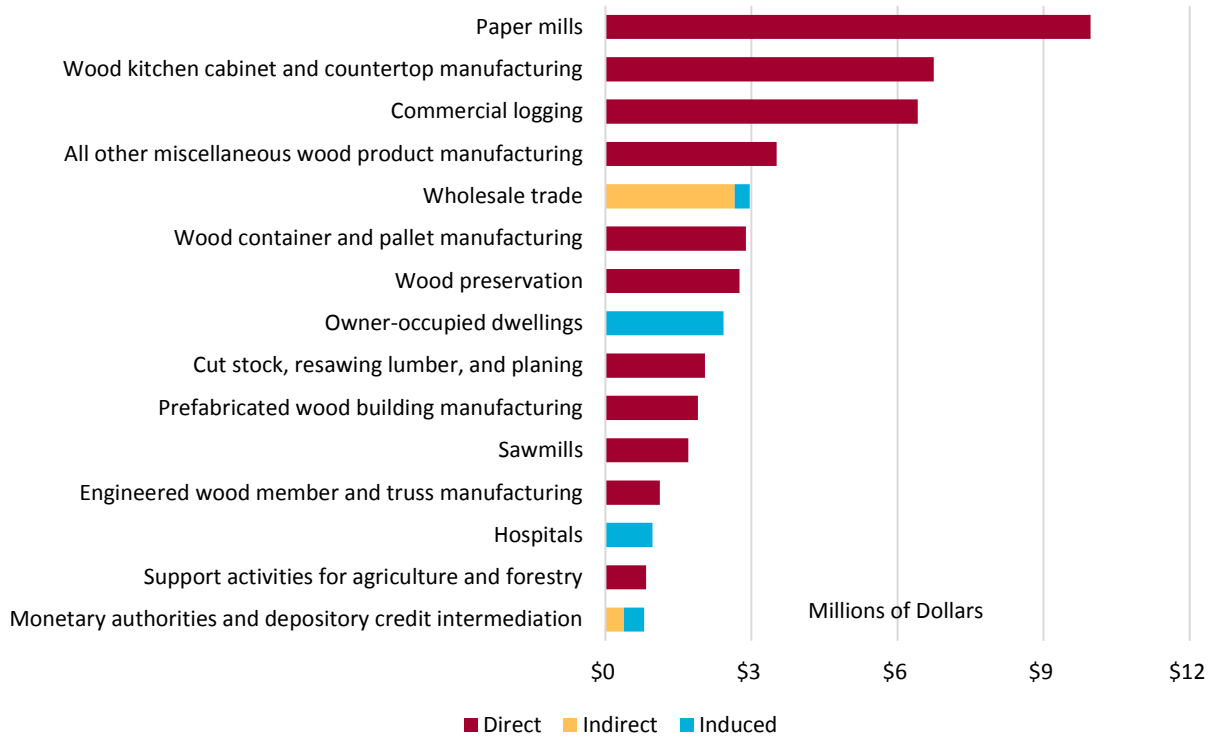
Tables 4 and 5 show the results of modeling for Scenario I. Table 4 results show the potential increase in economic contribution from the forestry sector if harvests rates were increased to better utilize available timber supply. Total effects are broken out by impact type: direct, indirect, and induced effect. The first row of the table, labeled direct effect, reflects jobs, labor income, value added, and output effects felt directly by the forestry sector. It is estimated that the forestry sector alone could see direct effects of nearly 800 jobs and almost $150 million in additional output by 2025 if the sector were able to increase harvest levels and utilize the additional timber by increasing industry production.

The indirect effect shows the measurement of increased spending between commercial, government, and service industries ($22.9 million in industry spending and 166 supported jobs) as a result of the direct effects. Induced effect measures the amount of increased spending by residential households ($20.2 million in household spending and 182 supported jobs) as a result of the direct effects. Total effect is the sum of direct, indirect, and induced effects.

[6] For each industry, the sum of all new removals, in cords, was estimated using the species to industry crosswalk shown in Appendix B. That total was then divided by the current (2015) level of removals. This percentage was then used to increase industry output. See Appendix A, Scenario I for more details.

Table 5 shows the total potential contribution for the forestry sector if the increased harvest levels were realized. This table simply shows the sum of the baseline results with the results from Table 4, equal to the increased employment and output. The results of this table indicate that, were the North Central region able to increase their forestry harvest levels and develop markets for underutilized species, the sector as a whole has the potential to contribute more than 5,800 jobs and over $1.2 billion in output to the region's economy.

Figure 4. Top 15 Industries Affected by Scenario I - Value Added, in Millions of Dollars



SOURCE: IMPLAN

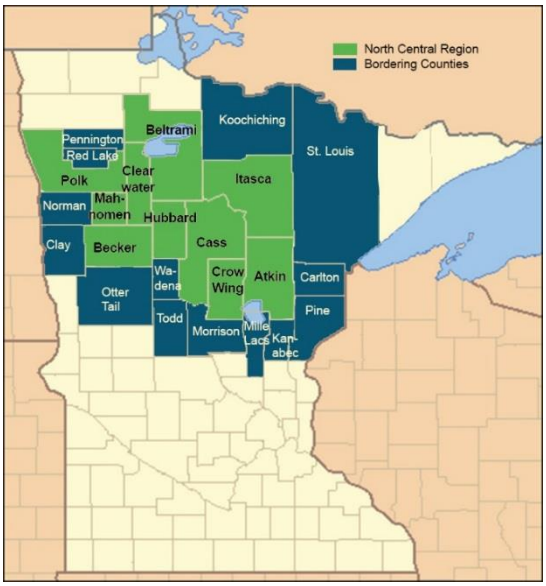
Figure 4 shows the fifteen industries most likely to be impacted by the increased harvest levels and industry production in Scenario I. Here, each industry's contribution in value added spending is shown in millions of dollars. Value added is a measure of the impacting industry's contribution to the local community; it includes wages, rents, interest, and profits. It can also be thought of as total revenue or output less spending on all initial costs.

Not surprisingly, the industries most likely to benefit are those directly contributing to the forestry sector already, including paper mills, wood kitchen cabinet and countertop manufacturing, and commercial logging. All of these industries would likely see large increases in their value added contribution as a result of increasing harvest rates and incorporating underutilized species in their production. In addition, a few supporting industries (wholesale trade, owner-occupied dwellings, hospitals, monetary authorities, and real estate) are likely to see large increases in value added spending as a result of their connections to the forestry sector.

Scenario II – Large Increase in Harvest from North Central and Neighboring Counties

Scenario II represents the most aggressive increase in production for the forest products sector in the North Central region. In this scenario, the sector is expected to increase output by roughly 45% between 2015 and 2025. This scenario uses the same method described in Scenario I, where harvest rates are increased within the North Central region to align with net growth for each species. In addition, Scenario II assumes additional increases in industry utilization as a result of importing timber from neighboring counties (see Figure 5).

Figure 5. North Central and Bordering Counties used in Scenario II



SOURCES: WIKIPEDIA, BBER

Using the same method described in Scenario I, the estimated increase in removals for Scenario II is the result of an alignment between net growth and removal rates; in cases where a species' net growth in 2015 exceeded removals, removal of the species was increased to match net growth rates. Conversely, if the current (2015) removal of the species exceeded net growth, removals were reduced to align with a more sustainable harvest level. This process was repeated for Scenario II, but for a wider geographic area to allow for larger increases in removals. It is assumed that all new available timber would be shipped into the North Central region to allow for the most significant growth in the forestry sector.

Table 6. Scenario II Results – Potential Increase in Economic Contribution from Additional Local and Imported Timber, in Millions of Dollars

Impact Type	*Employment*	*Labor Income*	*Value Added*	*Output*
Direct Effect	1,895	$85.2	$114.9	$413.5
Indirect Effect	442	$17.7	$28.5	$62.4
Induced Effect	497	$15.9	$30.0	$55.1
Total Effect	2,834	$118.7	$173.4	$530.9

SOURCE: IMPLAN

Table 7. Scenario II Results –Potential Total Contribution of North Central Forestry Sector (Baseline Plus Additional Local and Imported Timber), in Millions of Dollars

Impact Type	*Employment*	*Labor Income*	*Value Added*	*Output*
Direct Effect	4,853	$246.9	$348.0	$1,232.9
Indirect Effect	1,230	$50.5	$82.0	$180.5
Induced Effect	1,436	$45.9	$86.8	$159.3
Total Effect	7,519	$343.4	$516.8	$1,572.6

SOURCE: IMPLAN

Results of modeling, shown in Tables 6 and 7, reflect the potential economic contribution of the forest products sector if production levels were increased by roughly 50% by 2025. These results are, by far, the

largest of the four scenarios and represents a loose example of "maximum capacity" for the forest products sector in the North Central region, based on available timber supply. If the forestry sector was increasing harvest levels in and around the North Central region, it is estimated that the sector, as a whole, could add roughly $410 million in revenue directly to forestry-related industries and another $118 million in revenue ($62.4 indirect and $55.1 million induced) to local businesses in supporting industries, such as wholesale trade, hospitals, nursing homes, bars, and restaurants. This increased revenue would equate to nearly 1,900 new jobs created directly in forestry-related industries and more than 900 in supporting industries.

Table 7 estimates the total contribution of the forestry sector assuming the significant increase in harvest levels and industry output described in Scenario II were to occur. Again, this table shows the sum of the 2015 economic contribution (Baseline) plus the added contribution from increased harvest and imported timber from the North Central region and surrounding counties (Table 6). If the forestry sector was operating at increased capacity and importing additional timber from surrounding counties, the sector would contribute more than $1.5 billion in additional output and more than 7,500 jobs to the economy of the North Central region.

Figure 6. Top 15 Industries Affected by Scenario II - Value Added, in Millions of Dollars

SOURCE: IMPLAN

Figure 6 shows the fifteen industries most likely to be impacted by the increased harvest levels and industry production in Scenario II. Again, each industry's contribution in value added spending is shown in millions of dollars.

It should not come as much of a surprise that the top three industries benefiting from Scenario II – paper mills, commercial logging, and all other miscellaneous wood product manufacturing – are some of the same ones shown in Scenario I. All of these industries are large employers in the North Central region. Therefore,

our analysis assumes they have the greatest opportunity to take advantage of increases in harvest levels.

One important point to note is that the current species mix used by a given company in the North Central region may not align exactly with the industry-to-species crosswalk used in this analysis (Appendix B, Table 21). For example, the species mix utilized by a paper mill will vary significantly depending on the type of paper being produced. Therefore, a paper mill that utilizes a very limited species mix (e.g. only aspen) will not benefit from increased harvest of underutilized species such as lowland hardwoods or oak, but another mill making a different kind of paper could see significant benefits. The same is true for the other wood manufacturing sectors shown in Figure 6.

Scenario III – Decrease in Harvest due to Decline in Demand for Wood/Paper Products

Scenario III estimates a 25% decline in production for the four major forest sector employers in the North Central region.[7] It is assumed that the decline in production would result from a drop in market demand for wood/paper products. The decrease in production for those four employers, a loss of over $130 million in output in four industries, is estimated to have an overall impact on the entire North Central forest products sector of roughly -16%.

Of course, the closure of one of the regional forest sector employers would likely have a negative impact on harvest rates as well. The model developed predicts that nearly all species would see a decline in removals of between -10% and -77%, depending on their current levels of harvest and net growth.[8]

As mentioned previously, the terms economic contribution and economic impact have very different meanings. Whereas a contribution analysis measures the support of an existing sector to the economy in a defined area, an impact analysis is primarily used to determine impacts to the local economy by entry or exit of a firm or industry. Scenarios III and IV are economic impact analyses, as they represent potential changes to industries within the forestry products sector, as opposed to the total contribution from the sector itself.

Table 8. Scenario III Results – Decline in Production among Major Forest Sector Employers, North Central Region, in Millions of Dollars

Impact Type	*Employment*	*Labor Income*	*Value Added*	*Output*
Direct Effect	-285	($19.4)	($33.2)	($132.0)
Indirect Effect	-256	($11.5)	($17.0)	($40.9)
Induced Effect	-153	($5.0)	($9.4)	($17.7)
Total Effect	-694	($35.9)	($59.6)	($190.6)

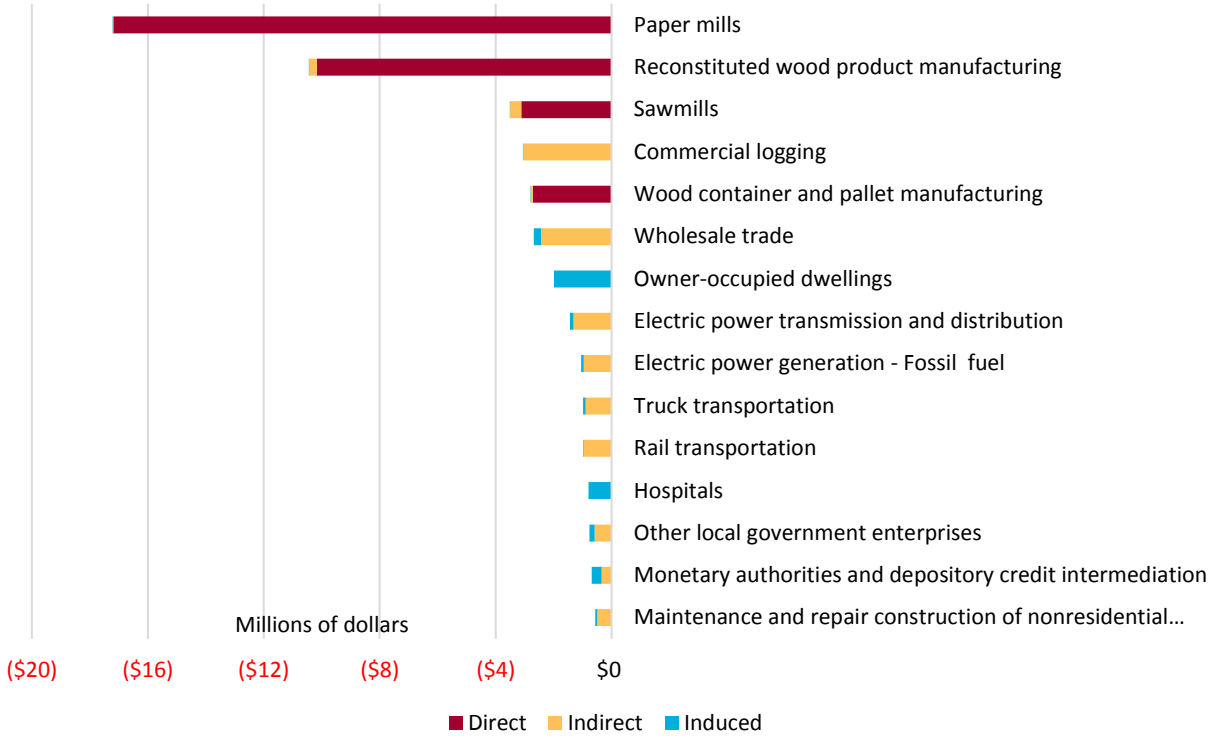
SOURCE: IMPLAN

Results shown in Table 8 reflect the potential reduction in employment, labor income, value added, and output resulting from the closure of one of the four wood consuming industries in the study area. Direct effects reflect the loss of jobs, labor income, and output felt directly by the local employers. While these numbers are purely hypothetical and do not refer to any particular company in the North Central region, they are representative of a combined decline in output of 25% for all four businesses, equating to a decrease of 285 employees, $19.4 million in labor income, and $132 in revenue. The indirect effect shows the

[7] UPM – Blandin Paper Mill (Grand Rapids), Norbord (Bemidji), Potlatch Corporation (Bemidji), and Savanna Pallets (McGregor)
[8] See Appendix A, Scenario III for more details on the assumptions used to develop projected removals

measurement of decreased spending between commercial, government, and service industries (-$40.9 million in industry spending and a loss of 256 jobs) as a result of the direct effects. Induced effect measures the decline in spending by residential households (-$17.7 million in household spending and a loss of 153 supported jobs) as a result of the direct effects. Total effects (-$190.6 million in output and a loss of 694 jobs) are the sum of the three.

Figure 7. Top 15 Industries Affected by Scenario III - Value Added, in Millions of Dollars



SOURCE: IMPLAN

Figure 7 shows the fifteen industries most likely to be impacted by the decreased demand for wood and paper products as outlined in Scenario III. Again, each industry's contribution in value added spending is shown in millions of dollars. Values are negative, so bars are shown in order of largest negative impact to smallest.[9]

One significant difference between the results shown here and the findings from the previous scenarios is that, because the results represent an economic impact analysis and not a contribution analysis, direct effects only apply to the industries of the four major employers: paper mills, reconstituted wood product manufacturing, sawmills, and wood container and pallet manufacturing. Other forestry-related industries are impacted but through indirect and induced effects. Therefore, commercial logging, wholesale trade, electric

[9] As noted previously, results represent a 25% decrease in output for the four major forestry industries in the North Central region: paper mills, reconstituted wood products manufacturing, sawmills, and wood container and pallet manufacturing. Economic impacts, including the distribution of indirect and induced effects, could vary significantly if one industry were more heavily impacted (i.e. by a plant closure).

power transmission and distribution, and truck transportation all see negative effects from the decline in demand, but the results are indirect.

Scenario IV – Increase in Biomass Utilization

Scenario IV reflects an increase in production in the forestry sector of roughly 14% between 2015 and 2025. In this scenario, the estimated increase in production is the result of an increase in the utilization of woody biomass. Based on information from Minnesota DNR representatives,[10] approximately 20% of the volume of timber harvested is in the form of tops and limbs, the feedstock used in the production of woody biomass. Using 2015 harvest levels, that would equate to roughly 200,000 cord equivalents (cde) of tops and limbs.[11] As of 2015, only about 30% of that volume (60,000 cde) is being used by the forestry industry.[12]

Scenario IV assumes full utilization of tops and limbs on the part of the forestry sector, particularly those industries that currently utilize woody biomass, either in the production of electricity, ethanol (organic chemical manufacturing), or reconstituted wood product manufacturing.[13]

Table 9. Scenario IV Results – Increase in Biomass Utilization, North Central Region, in Millions of Dollars

Impact Type	*Employment*	*Labor Income*	*Value Added*	*Output*
Direct Effect	109	$11.7	$31.0	$111.1
Indirect Effect	252	$10.4	$14.5	$32.4
Induced Effect	102	$3.3	$6.3	$11.8
Total Effect	464	$25.5	$51.8	$155.3

SOURCE: IMPLAN

Results shown in Table 9 reflect the potential increases in employment, labor income, value added, and output resulting from a significant increase in biomass production. Direct effects reflect additional jobs, labor income, value added, and output effects felt as a direct result of increased biomass usage. These direct effects are included in four forestry-related industries: reconstituted wood product manufacturing,[14] electric power transmission and distribution, electric power generation from biomass, and other basic organic chemical manufacturing. Assuming full utilization of woody biomass, these four industries combined could see more than 100 jobs and $111 million in revenue by 2025 as a result of the increased biomass utilization. The indirect effect shows the measurement of increased spending between commercial, government, and service industries ($32.4 million in industry spending and 252 supported jobs) as a result of the direct effects. Induced effect measures the amount of increased spending by residential households ($11.8 million in household spending and 102 supported jobs) as a result of the direct effects. Total effect is the sum of direct, indirect, and induced effects.

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[10] Phone conversation with Don Deckard, Minnesota DNR Forest Economist, 2/27/2017

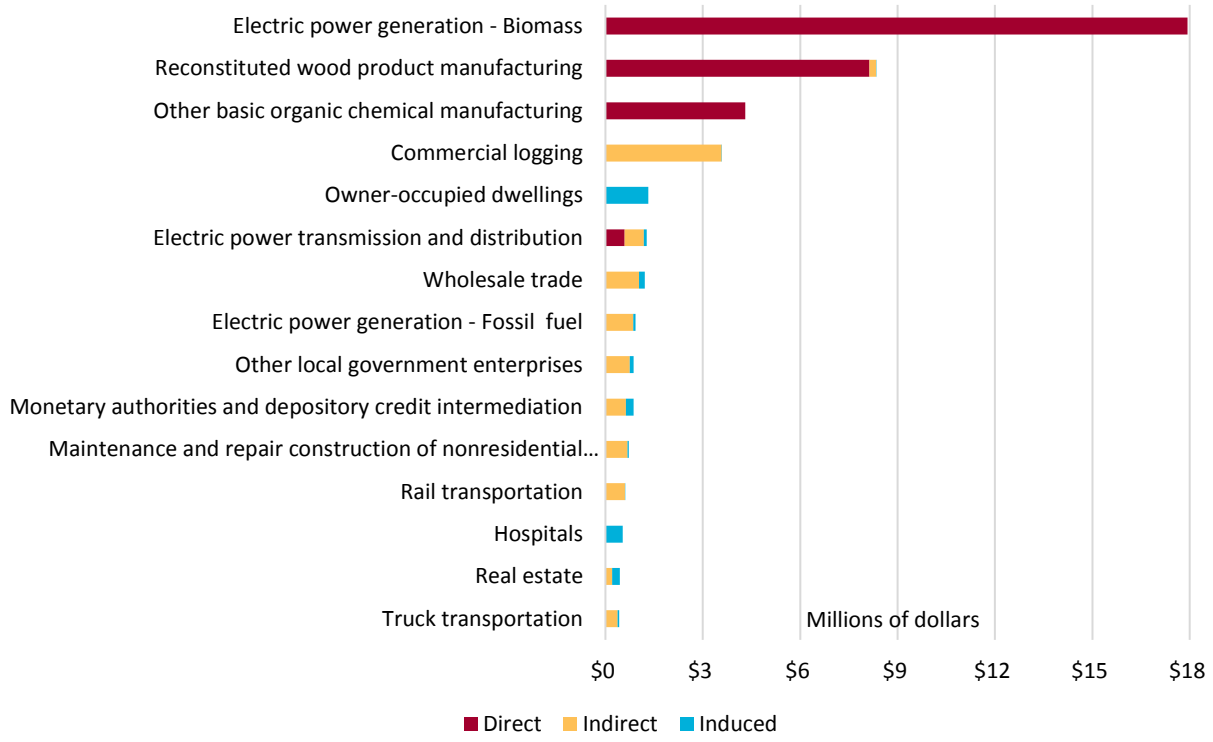
[11] After adjusting for the 1/3 leave requirement outlined in Minnesota's Best Management Practices

[12] See Appendix A, Scenario IV for more details on current biomass utilization

[13] See Appendix A, Scenario IV for more details on impacted industries and direct change in output

[14] The reconstituted wood product manufacturing sector was included to represent a hypothetical new manufacturing industry that could utilize large amounts of woody biomass in the North Central region, such as a torrefaction processing plant. Torrefaction, the thermal process to convert biomass into a coal-like material, is still an emerging technology, so impacts could vary depending on the actual size of a plant, the sector in which it were classified, and type of biomass used in production.

Figure 8. Scenario IV - Top 15 Impacted Industries



SOURCE: IMPLAN

Figure 8 shows the fifteen industries most likely to be impacted by the increase in biomass as outlined in Scenario IV. Again, each industry's contribution in value added spending is shown in millions of dollars.

The electric power generation from biomass, reconstituted wood product manufacturing, and other basic organic chemical manufacturing industries all see large direct effects from the increase in biomass utilization. Commercial logging, wholesale trade, and electric power generation from fossil fuels all see significant indirect effects. Owner-occupied dwellings, the IMPLAN sector used to represent mortgage payments and home repairs, sees significant induced effects from additional employee spending. Electric power transmission and distribution sees a combination of effects, as this industry is expected to incorporate biomass directly as part of its production and to provide support for the other biomass consumers indirectly.

Conclusions

This section provides a summary of the results of all four scenarios, as well as the output multiplier for each. Results are shown in 2017 dollars.

Table 10. Results for All Scenarios, North Central Region, in Millions of Dollars

Scenario	*Employment*	*Labor Income*	*Value Added*	*Output*	*Output Multiplier*
Baseline Scenario – Economic Contribution of Forest Products Sector on North Central MN	4,685	$224.6	$343.4	$1,041.7	1.27
Scenario I – Additional Contribution from Increased in Harvest Levels	1,127	$43.6	$62.2	$189.7	1.30
Scenario II – Additional Contribution from Increased Harvest and Timber Imports	2,834	$118.7	$173.4	$530.9	1.28
Scenario III – Economic Impacts from Decrease in Demand, Wood/Paper Products	-694	($35.9)	($59.6)	($190.6)	1.44
Scenario IV – Economic Impacts from Increase in Biomass Utilization	464	$25.5	$51.8	$155.3	1.40

SOURCE: IMPLAN

As shown in Table 10, the forestry sector contributed more than 4,600 jobs, nearly $225 million in wages, and more than $1.0 billion in spending to the economy of the North Central region in 2015. The sector had an output multiplier of 1.27, meaning that for every $1.00 spent in forestry, an additional $0.27 was created in the economy through indirect and induced effects.

The table also shows the potential added contribution from Scenario I, which assumes an increase in harvest levels throughout the North Central region as a result of better alignment between net growth and removals. If the sector was able to utilize the additional 200,000 cords resulting from increased harvest levels, the region could see an additional 1,127 jobs, almost $44 million in wages, and more than $189 million in new spending (over and above the contribution amounts estimated in the baseline scenario). The industries that would likely benefit the most from these changes would be those that currently use under-utilized species, such as lowland hardwoods, red pine pulpwood, and oak.

Scenario II represents the most aggressive increase in production for the forest products sector in the North Central region. In this scenario, the sector is expected to increase output by roughly 50% between 2015 and 2025 by increasing harvest rates within the region and by importing timber from neighboring counties. If the forestry sector was able to utilize the 500,000 cords resulting from increased harvest levels, the region could see more than 2,800 jobs, almost $120 million in wages, and just over $530 million in new spending (over and above the contribution amounts estimated in the baseline scenario). The industries that would likely benefit the most from these changes would be paper mills, commercial logging, and all other miscellaneous wood product manufacturing.

Finally, Scenarios III and IV show economic impacts of two potential changes to the forest products sector – a decrease in demand for wood and paper products in Scenario III and an increase in biomass utilization in Scenario IV. Both scenarios result in smaller impacts but larger output multipliers, as their effects ripple throughout a number of supporting industries, including commercial logging, wholesale trade, electric power generation from fossil fuels, and other related industries.

Appendix A. Detailed Inputs and Assumptions

This section highlights the inputs and assumptions required for modeling each scenario. In all cases, the actual inputs used for developing the IMPLAN models are shown in the tables entitled Projected Industry Production (North Central Region, 2015-2025). Harvest levels (and any additional inputs) are also provided to give context for the inputs used in modeling.

Baseline Scenario

Table 11. Baseline Scenario Harvest Levels, Current and Projected, North Central Region

Species Category	*Removals in Cords (2015)*	*Projected Change in Harvest (2015-2025)*	*Projected Removals in Cords (2025)*	*% Change in Removals (2015-2025)*
Aspen	533,310	-	533,310	0%
Red pine	104,625	-	104,625	0%
Paper birch	67,397	-	67,397	0%
Northern hardwoods	50,654	-	50,654	0%
Oak	46,637	-	46,637	0%
Balsam fir	34,877	-	34,877	0%
Jack pine	32,510	-	32,510	0%
Black spruce	31,924	-	31,924	0%
Tamarack	27,338	-	27,338	0%
Red maple	25,947	-	25,947	0%
Lowland hardwoods	22,106	-	22,106	0%
White spruce	10,151	-	10,151	0%
Cedar	1,214	-	1,214	0%
White pine	1,062	-	1,062	0%
Other hardwoods	-	-	-	0%
Total	989,752	-	989,752	0%

SOURCE: FIA

1. No change in harvest levels between 2015 and 2025 (See Table 11).
2. Impacts represent current level of spending and employment in forestry industries, 2025. See Table 2, page 10 for 2015 industry production levels.

Scenario I – Increase in Harvest Levels to Match Species Growth Rates

Table 12. Scenario I Harvest Levels, Current and Projected, North Central Region

Species Category	*Removals in Cords (2015)*	*Projected Change in Harvest (2015-2025)*	*Projected Removals in Cords (2025)*	*% Change in Removals (2015-2025)*
Aspen	533,310	(35,348)	497,961	-6.6%
Red pine	104,625	52,040	156,665	49.7%
Paper birch	67,397	(37,429)	29,969	-55.5%
Northern hardwoods	50,654	48,967	99,621	96.7%
Oak	46,637	62,866	109,503	134.8%
Balsam fir	34,877	(5,749)	29,127	-16.5%
Jack pine	32,510	(24,894)	7,616	-76.6%
Black spruce	31,924	(10,762)	21,163	-33.7%
Tamarack	27,338	19,119	46,457	69.9%
Red maple	25,947	12,764	38,712	49.2%
Lowland hardwoods	22,106	88,704	110,810	401.3%
White spruce	10,151	10,733	20,884	105.7%
Cedar	1,214	-	1,214	0.0%
White pine	1,062	18,363	19,425	1,728.3%
Other hardwoods	-	2,771	2,771	-
Total	989,752	202,145	1,191,897	20.4%

SOURCE: FIA, MINNESOTA DEPARTMENT OF NATURAL RESOURCES (MNDNR)

1. Public agency maximum utilization rates estimated based on policy constraints as follows: county = 90%, state = 70%. Private utilization rate potential considers base = 40% with potential marginal gain = 20%, for a total utilization rate of 60%
2. If removal of a species is less than or equal to the potential utilization rate, then new available volume equals growth times utilization minus current removals, essentially bringing harvest removals up to the potential utilization rate.
3. If current removal of a species exceeds the ideal utilization but is still less than 95% of growth, then the new available volume equals 0, holding removals constant.
4. If current removals of a species exceeds 95% of growth, then the new available volume equals 95% of growth minus current removals, ensuring that removals do not exceed a healthy level of growth.
5. Removals on national forest lands were held constant, assuming no change from 2015 levels.
6. Potential harvest increases for white pine were limited to private lands only. Potential harvest increases for cedar were removed across all ownerships.
7. All modeling for Scenario I was performed using the contribution analysis method.

Table 13. Scenario I – Projected Industry Production (North Central Region, 2015-2025)

Description	*Output, in Millions (2015)*	*% Change in Output (2015-2025)*	*Direct Change in Output, in Millions (2025)*
Paper mills	$274.64	14.5%	$39.8
Wood kitchen cabinet and countertop manufacturing	$22.30	117.8%	$26.3
Wood preservation	$35.13	37.9%	$13.3
All other miscellaneous wood product manufacturing	$19.79	65.0%	$12.9
Commercial logging	$55.36	20.4%	$11.3
Wood container and pallet manufacturing	$35.53	26.6%	$9.4
Sawmills	$66.85	13.7%	$9.1
Cut stock, resawing lumber, and planing	$14.69	59.6%	$8.8
Engineered wood member and truss manufacturing	$31.55	16.2%	$5.1
Prefabricated wood building manufacturing	$15.09	32.9%	$5.0
Other millwork, including flooring	$10.62	19.2%	$1.3
Electric power transmission and distribution	$9.96	20.4%	$2.0
Nonupholstered wood household furniture manufacturing	$4.47	41.2%	$1.8
Truck transportation	$8.38	20.4%	$1.7
Support activities for agriculture and forestry	$5.18	20.4%	$1.1
Showcase, partition, shelving, and locker manufacturing	$0.77	13.4%	$0.1
Forestry, forest products, and timber tract production	$0.44	20.4%	$0.1
Paperboard container manufacturing	$3.14	-6.6%	-$0.2
All other converted paper product manufacturing	$6.58	-6.6%	-$0.4
Paper bag and coated and treated paper manufacturing	$24.89	-2.9%	-$0.7
Wood windows and doors and millwork manufacturing	$19.90	-6.2%	-$1.2
Reconstituted wood product manufacturing	$143.23	-1.7%	-$2.5
Total, Forestry Sector	**$808.49**	**17.8%**	**$144.1**

SOURCE: FIA, IMPLAN, NORTH CENTRAL ECONOMIC RESOURCES SUBCOMMITTEE

8. Table 13 shows the full list of industries and projected change in output used in modeling.
9. Overall increase of 17.8% in the forestry sector, as shown in Table 13, total forestry sector % change in output.
10. Direct change in output for individual forestry industries are calculated using the industry–species crosswalk shown in Table 21 (pages 32-33).
11. For each industry, the projected removals in cords (2025) was summed for all utilized species, then divided by the current removals in cords (2015) for those species. The result is a percentage change in harvest for the combination of species currently utilized by the industry.
12. The percentage change in harvest was then used to determine the appropriate increase or decrease in output for the industry (shown in Table 13 as % change in output).
13. Industries that are central to the forestry sector, such as commercial logging, sawmills, and truck transportation, tended to see gains similar in magnitude to the increase in harvest (roughly 20%). Industries that currently make use of underutilized species (such as lowland hardwoods) have a

greater opportunity to benefit from an increase in harvest from those species. Therefore, production levels in those industries were increased at a higher level. Conversely, industries that rely primarily on more widely utilized species, such as aspen, would likely have to cut back on production levels if aspen harvest rates were to decrease.

Scenario II – Large Increase Using Timber from Neighboring Counties

Table 14. Scenario II Harvest Levels, Current and Projected, North Central Region

Species Category	*Removals in Cords (2015)*	*Projected Change in Harvest (2015-2025)*	*Projected Removals in Cords (2025)*	*% Change in Removals (2015-2025)*
Aspen	533,310	(19,646)	513,663	-3.7%
Red pine	104,625	115,866	220,491	110.7%
Paper birch*	67,397	(37,429)	29,969	-55.5%
Northern hardwoods	50,654	64,461	115,115	127.3%
Oak	46,637	101,979	148,616	218.7%
Balsam fir*	34,877	(5,749)	29,127	-16.5%
Jack pine*	32,510	(24,894)	7,616	-76.6%
Black spruce	31,924	(3,578)	28,347	-11.2%
Tamarack	27,338	56,733	84,071	207.5%
Red maple	25,947	28,027	53,974	108.0%
Lowland hardwoods	22,106	136,214	158,319	616.2%
White spruce	10,151	31,560	41,711	310.9%
Cedar	1,214	-	1,214	0.0%
White pine	1,062	41,835	42,897	3,937.5%
Other hardwoods	-	4,702	4,702	-
Total	989,752	490,079	1,479,832	49.5%

SOURCE: FIA, MNDNR

*In certain cases, the projected change in harvest for Scenario I was larger than the value for Scenario II, indicating a higher potential capacity in the North Central region than the broader geographic area. In those instances, the value for Scenario I was used.

1. A larger geographic region was used to represent a higher capacity for harvest. For counties used, see Figure 5, page 15.
2. Public agency maximum utilization rates estimated based on policy constraints as follows: county = 90%, state = 70%. Private utilization rate potential considers base = 40% with potential marginal gain = 20%, for a total utilization rate of 60%
3. If removal of a species is less than or equal to the potential utilization rate, then new available volume equals growth times utilization minus current removals, essentially bringing harvest removals up to the potential utilization rate.
4. If current removal of a species exceeds the ideal utilization but is still less than 95% of growth, then the new available volume equals 0, holding removals constant.
5. If current removals of a species exceeds 95% of growth, then the new available volume equals 95% of growth minus current removals, ensuring that removals do not exceed a healthy level of growth.

6. Removals on national forest lands were held constant, assuming no change from 2015 levels.
7. Potential harvest increases for white pine were limited to private lands only. Potential harvest increases for cedar were removed across all ownerships.
8. In certain cases, the projected change in harvest for Scenario I was larger than the value for Scenario II, indicating a higher potential capacity in the North Central region than the broader geographic area. In those instances, the value for Scenario I was used. Those cases are marked with an asterisk in Table 14.
9. All modeling for Scenario II was performed using the contribution analysis method.

Table 15. Scenario II – Projected Industry Production (North Central Region, 2025)

Description	*Output, in Millions (2015)*	*% Change in Output (2015-2025)*	*Direct Change in Output, in Millions (2025)*
Paper mills	$274.6	37.7%	$103.6
All other miscellaneous wood product manufacturing	$19.8	195.5%	$38.7
Wood preservation	$35.1	108.1%	$38.0
Wood kitchen cabinet and countertop manufacturing	$22.3	161.6%	$36.0
Sawmills	$66.8	47.8%	$32.0
Cut stock, resawing lumber, and planing	$14.7	195.5%	$28.7
Reconstituted wood product manufacturing	$143.2	20.0%	$28.7
Commercial logging	$55.4	49.5%	$27.4
Prefabricated wood building manufacturing	$15.1	149.2%	$22.5
Wood container and pallet manufacturing	$35.5	47.1%	$16.7
Engineered wood member and truss manufacturing	$31.6	44.2%	$14.0
Nonupholstered wood household furniture manufacturing	$4.5	155.9%	$7.0
Electric power transmission and distribution	$10.0	49.5%	$4.9
Other millwork, including flooring	$10.6	46.4%	$4.9
Truck transportation	$8.4	49.5%	$4.1
Support activities for agriculture and forestry	$5.2	49.5%	$2.6
Showcase, partition, shelving, and locker manufacturing	$0.8	42.4%	$0.3
Forestry, forest products, and timber tract production	$0.4	49.5%	$0.2
Paperboard container manufacturing	$3.1	-3.7%	-$0.1
All other converted paper product manufacturing	$6.6	-3.7%	-$0.2
Wood windows and doors and millwork manufacturing	$19.9	-3.7%	-$0.7
Paper bag and coated and treated paper manufacturing	$24.9	-4.1%	-$1.0
Total, Forestry Sector	**$808.5**	**50.5%**	**$408.3**

SOURCE: IMPLAN, FIA

10. Table 15 provides the full list of industries and projected change in output used in modeling. Overall increase of 50.5% in the forestry sector.
11. Direct change in output for individual forestry industries are calculated using the industry–species crosswalk shown in Table 21 (pages 32-33).

12. For each industry, the projected removals in cords (2025) was summed for all utilized species in the broader geographic region then divided by the current removals in cords (2015) for those species in the North Central region. The result is a percentage change in harvest for the combination of species currently utilized by the industry.
13. The percentage change in harvest was then used to determine the appropriate increase or decrease in output for the industry in the North Central region (shown in Table 15 as % change in output).
14. Industries that are central to the forestry sector, such as commercial logging, sawmills, and truck transportation, tended to see gains similar in magnitude to the increase in harvest (roughly 50%). Industries that currently make use of underutilized species (such as lowland hardwoods) have a greater opportunity to benefit from an increase in harvest from those species. Therefore, production levels in those industries were increased at a higher level. Conversely, industries that rely primarily on more widely utilized species, such as aspen, would likely have to cut back on production levels if aspen harvest rates were to decrease.

Scenario III – Decrease in Harvest due to Decline in Demand for Wood/Paper Products

Table 16. Scenario III – Projected Industry Production (North Central Region, 2025)

Description	*Output, in Millions (2015)*	*% Change in Output (2015-2025)*	*Direct Change in Output, in Millions (2025)*
Paper mills	$274.6	-25.0%	($68.66)
Reconstituted wood product manufacturing	$143.2	-25.0%	($35.81)
Sawmills	$66.8	-25.0%	($16.71)
Wood container and pallet manufacturing	$35.5	-25.0%	($8.88)
All other forestry industries	$288.4	0%	$0
Total, Forestry Sector	**$808.5**	**-16.1%**	**($130.06)**

SOURCE: IMPLAN, MNDNR

1. This scenario represents a 25% decline in production for the four major forest sector employers in the North Central region.[15] It is assumed that the decline in production would result from a decline in market demand for wood/paper products and that negative impacts would affect the following species: aspen, red pine, paper birch, northern hardwoods, balsam fir, jack pine, black spruce, tamarack, red maple, and lowland hardwoods.
2. In total, the four businesses used roughly 790,000 cords in 2015. Therefore, a 25% decline in production for the four businesses would equate to approximately 197,000 cords.
3. Four industries shown in Table 16 all see declines in output of -25%, for an overall decline in output for the forestry sector of -16.1%.

[15] UPM – Blandin Paper Mill (Grand Rapids), Norbord (Bemidji), Potlatch Corporation (Bemidji), and Savanna Pallets (McGregor)

Table 17. Scenario III Harvest Levels, Current and Projected, North Central Region

Species Category	*Removals in Cords (2015)*	*Projected Change in Harvest (2015-2025)*	*Projected Removals in Cords (2025)*	*% Change in Removals (2015-2025)*
Aspen	533,310	(53,331)	479,979	-10.0%
Red pine	104,625	(10,462)	94,162	-10.0%
Paper birch	67,397	(37,405)	29,992	-55.5%
Northern hardwoods	50,654	(5,065)	45,589	-10.0%
Oak	46,637	(4,664)	41,973	-10.0%
Balsam fir	34,877	(5,755)	29,122	-16.5%
Jack pine	32,510	(24,902)	7,607	-76.6%
Black spruce	31,924	(10,758)	21,166	-33.7%
Tamarack	27,338	(2,734)	24,605	-10.0%
Red maple	25,947	(2,595)	23,353	-10.0%
Lowland hardwoods	22,106	(2,211)	19,895	-10.0%
White spruce	10,151	(1,015)	9,136	-10.0%
Cedar	1,214	(121)	1,093	-10.0%
White pine	1,062	(106)	956	-10.0%
Other hardwoods	-	-	-	0.0%
Total	989,752	(161,125)	828,627	-16.3%

SOURCE: FIA, MNDNR

4. To estimate the change in harvest levels as a result of the decline in output for the four firms, the affected species were negatively impacted as follows: in cases where Scenario I estimates were already less than -10%, the more negative value was used. In cases where Scenario I estimates were greater than -10%, a standard rate of -10% change in harvest was used. The value of 10% was selected so that the total decline in volume (161,125) was close to, but did not exceed, the 197,000 cord estimate cited above.
5. All modeling for Scenario III was performed using the impact analysis method.

Scenario IV – Increase in Biomass Utilization

1. The volume of biomass tops and limbs harvested and available is estimated at 20% of bolewood harvest (adjusted for one-third leave requirement).

Figure 9. Biomass Utilization in 2015, North Central Region

MFRC NC Landscape Region CY2015 Forest Biomass Utilization from Logging Operations

Energy Facility	Aitkin	Becker	Beltrami	Cass	Clearwater	Crow Wing	Hubbard	Itasca	Mahnomen	Polk	Total
#1	9,860		1,972	9,860				73,950			95,642
#3			16,255				16,255	6,502			39,013
#4	2,555										2,555
gt	12,415		18,227	9,860			16,255	80,452			137,210
cde	5,398		7,925	4,287			7,068	34,979			59,657

Table Notes
County volumes derived from DNR biomass surveys.
gt= green tons
cde= cord equivalents at 2.3 gt per cord
Compiled by: Don Deckard, Forest Economist
Date: 3-2-17

SOURCE: MNDNR

2. In 2015, North Central utilization was estimated at 59,657 cord equivalents (cde) from logging operations (or roughly 30% utilization rate of current harvest). See Figure 9.

Table 18. Scenario IV Harvest Levels, Current and Projected, North Central Region

Species Category	*Current Biomass Utilization, cde (2015)*	*Projected Change in Utilization (2015-2025)*	*Projected Biomass Utilization, cde* (2025)*	*% Change in Utilization (2015-2025)*
Aspen	32,145	74,517	106,662	232%
Red pine	6,306	14,619	20,925	232%
Paper birch	4,062	9,417	13,479	232%
Northern hardwoods	3,053	7,078	10,131	232%
Oak	2,811	6,516	9,327	232%
Balsam fir	2,102	4,873	6,975	232%
Jack pine	1,960	4,542	6,502	232%
Black spruce	1,924	4,461	6,385	232%
Tamarack	1,648	3,820	5,468	232%
Red maple	1,564	3,625	5,189	232%
Lowland hardwoods	1,332	3,089	4,421	232%
White spruce	612	1,418	2,030	232%
Cedar	73	170	243	232%
White pine	64	148	212	232%
Other hardwoods	-	-	-	
Total	59,657	138,293	197,950	232%

SOURCE: FIA, MNDNR

3. Current biomass utilization (in cde) for each species category was calculated by equally distributing the total amount utilized (59,657), based on each species' contribution to 2015 harvest levels.
4. The projected biomass utilization (2025) assumes full utilization of all harvested tops and limbs (20% of total harvest in 2015, or roughly 200,000 cde). Projected change in utilization was determined by calculating the difference between the potential volume available (20% of bolewood harvest) with the current utilization.

Table 19. Scenario IV – Projected Industry Production (North Central Region, 2025)

Description	*Output, in Millions (2015)*	*% Change in Output (2015-2025)*	*Direct Change in Output, in Millions (2025)*
Electric power generation - biomass	$0.0	--	$40.0
Other basic organic chemical manufacturing	$0.0	--	$40.0
Reconstituted wood product manufacturing	$143.2	20.00%	$28.6
Electric power transmission and distribution	$10.0	20.00%	$2.0
All other forestry industries	$655.3	0%	$0
Total, Forestry Sector	**$808.5**	**13.7%**	**$110.6**

SOURCE: MNDNR, IMPLAN

5. The appropriate levels of output for the four industries were determined by aiming for a percentage change in output (2015-2025) of approximately 14% for the forestry sector as a whole, roughly equal to the projected change in utilization of biomass (138,293 cords, as shown in Table 18) divided by the total volume of removals in cords in 2015 (989,752).
6. Of the four potential biomass-consuming industries, only two are currently present in the North Central region: reconstituted wood product manufacturing and electric power transmission and distribution. The remaining industries – electric power generation from biomass and other basic organic chemical manufacturing – did not exist in the North Central region in 2015.
7. The industries that did not exist in 2015 were impacted using a method called analysis by parts. Direct effects for those industries were determined by using IMPLAN's ratios of output, employment, labor income, and value added for those industries in the state of Minnesota.
8. According to forestry professionals in the North Central region, the reconstituted wood product manufacturing industry is not a current consumer of biomass but was included to represent a hypothetical new manufacturing industry in the North Central region, such as a torrefaction processing plant. Torrefaction, the thermal process to convert biomass into a coal-like material, is still an emerging technology, so actual inputs would vary depending on the size of a plant, the industry in which it were classified, and type of biomass used in production.
9. The two industries that were present in the North Central region in 2015 were impacted in proportion to their level of output in 2015. Both industries were modeled as seeing increases in production of 20% as a result of the increased biomass utilization.
10. All modeling for Scenario IV was performed using the impact analysis method.

Appendix B: Crosswalks

Table 20. Species Crosswalk

MNDNR Forest Types (a)	Principal Tree Species (a)	UMD/MFRC Report Category
01-Aspen	12-Trembling aspen	Aspen
	16-Largetooth aspen	
14-Balm of gilead	14-Balm of gilead/balsam poplar	
13-Birch	13-Paper birch	Paper birch
62-Balsam fir	62-Balsam fir	Balsam fir
61-White spruce	61-White spruce	White spruce
71-Black spruce, lowland	71-Black spruce	Black spruce
72-Tamarack	72-Tamarack	Tamarack
73-White cedar	73-White cedar	Cedar
09-Lowland hardwoods	01/39-Ash (black & green)	Lowland hardwoods
	02-Amer elm	
	03-Silver maple	
	06-Willow, 15-cottonwood	
20-Northern hardwoods	22-Sugar maple	Northern hardwoods
	23-Basswood	
	24-Yellow birch	
21-Red maple	21-Red maple	Red maple
30-Oak	Oak species	Oak
40-Central hardwoods	41-Bitternut hickory	Other hardwoods
	45-Box elder	
	25-Black walnut	
	26-Butternut	
	27-Black cherry	
51-White pine	51-White pine	White pine
52-Norway (red) pine	52-Red pine	Red pine
53-Jack pine	53-Jack pine	Jack pine

SOURCE: MNDNR

Table 21. Industries and Species Utilization

Industry	Species Utilization
Forestry, forest products, and timber tract production	Northern Hardwoods, Oak, Balsam Fir, White Spruce, Black Spruce, White Pine, Red Pine, Jack Pine, Paper Birch, Lowland Hardwoods, Other Hardwoods, Aspen, Tamarack, Red Maple
Commercial logging	Northern Hardwoods, Oak, Balsam Fir, White Spruce, Black Spruce, White Pine, Red Pine, Jack Pine, Paper Birch, Lowland Hardwoods, Other Hardwoods, Aspen, Tamarack, Red Maple
Support activities for agriculture and forestry	Northern Hardwoods, Oak, Balsam Fir, White Spruce, Black Spruce, White Pine, Red Pine, Jack Pine, Paper Birch, Lowland Hardwoods, Other Hardwoods, Aspen, Tamarack, Red Maple
Electric power generation – biomass*	Northern Hardwoods, Oak, Balsam Fir, White Spruce, Black Spruce, White Pine, Red Pine, Jack Pine, Paper Birch, Lowland Hardwoods, Other Hardwoods, Aspen, Tamarack, Red Maple
Electric power transmission and distribution	Northern Hardwoods, Oak, Balsam Fir, White Spruce, Black Spruce, White Pine, Red Pine, Jack Pine, Paper Birch, Lowland Hardwoods, Other Hardwoods, Aspen, Tamarack, Red Maple
Sawmills	Cedar, Northern Hardwoods, Oak, Balsam Fir, White Spruce, Black Spruce, White Pine, Red Pine, Jack Pine, Paper Birch, Lowland Hardwoods, Other Hardwoods
Wood preservation	White Pine, Red Pine, Jack Pine, White Spruce
Veneer and plywood manufacturing*	Northern Hardwoods, Oak, Paper Birch, Lowland Hardwoods, Other Hardwoods
Engineered wood member and truss manufacturing	Aspen, Northern Hardwoods, Oak, White Pine, Red Pine, Jack Pine, Other Hardwoods
Reconstituted wood product manufacturing	Aspen, Paper Birch, Red Pine, Jack Pine, Red Maple, Tamarack
Wood windows and doors and millwork manufacturing	Aspen, White Pine
Cut stock, resawing lumber, and planing	Northern Hardwoods, Oak, Paper Birch, Lowland Hardwoods, Other Hardwoods, Red Pine, Jack Pine,
Other millwork, including flooring	Paper Birch, Lowland Hardwoods, Oak, Red Maple, Aspen, Other Hardwoods, Northern Hardwoods
Wood container and pallet manufacturing	Northern Hardwoods, Oak, Lowland Hardwoods, Red Maple, Aspen Red Pine, Jack Pine, Tamarack,
Prefabricated wood building manufacturing	White Pine, Red Pine, Jack Pine
All other miscellaneous wood product manufacturing	Northern Hardwoods, Oak, White Pine, Red Pine, Jack Pine, Paper Birch, Lowland Hardwoods, Other Hardwoods
Pulp mills*	Aspen, Tamarack, Red Maple, Paper Birch, Lowland Hardwoods (ASH)
Paper mills	Balsam Fir, White Spruce, Black Spruce, Aspen, Tamarack, Red Maple, Paper Birch, Sugar Maple, Ash ,Red Pine, Jack Pine, White Pine
Paperboard mills*	Aspen

Paperboard container manufacturing	Aspen
Paper bag and coated and treated paper manufacturing	Aspen, Tamarack
Stationery product manufacturing*	
Sanitary paper product manufacturing*	
All other converted paper product manufacturing	Aspen
Other basic organic chemical manufacturing	Northern Hardwoods, Oak, Lowland Hardwoods, Other Hardwoods, Tamarack
Wood kitchen cabinet and countertop manufacturing	Northern Hardwoods, Oak, Other Hardwoods
Nonupholstered wood household furniture manufacturing	Red Maple, Paper Birch, Oak, White Pine, Red Pine, Jack Pine, Northern Hardwoods, Other Hardwoods
Wood office furniture manufacturing*	Oak, Lowland Hardwoods, Red Maple, Northern Hardwoods, Other Hardwoods
Custom architectural woodwork and millwork*	White Pine, Red Pine , Aspen, Oak, Hardwoods, Other Hardwoods, Lowland Hardwoods
Showcase, partition, shelving, and locker manufacturing	Aspen, White Pine, Red Pine, Jack Pine, White Spruce, Black Spruce, Lowland Hardwoods (ASH)
Truck transportation	Northern Hardwoods, Oak, Balsam Fir, White Spruce, Black Spruce, White Pine, Red Pine, Jack Pine, Paper Birch, Lowland Hardwoods, Other Hardwoods, Aspen, Tamarack, Red Maple

*Industry did not exist in study area in 2015

SOURCE: NORTH CENTRAL ECONOMIC RESOURCES SUBCOMMITTEE

Appendix C: Definitions Used in this Report

Analysis by parts: The process of splitting or parsing an impact analysis issue into smaller and more specific parts. This technique allows the user to specify the amount of commodity inputs, the proportion of local labor income, and the proportion of local purchases.

Average annual mortality of growing stock: The average cubic foot volume of sound wood in growing-stock trees that died in one year.

Average annual removals from growing stock: The average net growing-stock volume in growing-stock trees removed annually for roundwood forest products, in addition to the volume of logging residues and the volume of other removals.

Backward linkages: The interconnection of an industry to other industries from which it purchases its inputs in order to produce its output. It is measured as the proportion of intermediate consumption to the total output of the sector (direct backward linkage) or to the total output multiplier (total backward linkage). An industry has significant backward linkages when its production of output requires substantial intermediate inputs from many other industries.[16]

Bolewood: Section of the bole (trunk of the tree) that is utilizable for a commercial product and is cut square at both ends to be made ready for delivery for processing.

County and municipal: An ownership class of public lands owned by counties or local public agencies, or lands leased by these governmental units for more than 50 years.

Direct effect: Initial new spending in the study area resulting from the project.

Economic contribution: The gross changes in a region's existing economy that can be attributed to a given industry, event, or policy.

Economic impact: The net changes in new economic activity associated with an industry, event, or policy in an existing regional economy.

Employment: Estimates (from U.S. Department of Commerce secondary data) are in terms of jobs, not in terms of full-time equivalent employees. Therefore, these jobs may be temporary, part-time, or short-term.

Federal land: An ownership class of public lands owned by the U.S. Government.

Gross output: The value of local production required to sustain activities.

Growing-stock tree: All live trees 5.0 inches (12.7) cm) DBH or larger that meet (now or prospectively) regional merchantability requirements in terms of saw-log length, grade, and cull deductions. Excludes rough and rotten cull trees.

Indirect effect: The additional inter-industry spending from the direct impact.

Induced effect: The impact of additional household expenditures resulting from the direct and indirect impact.

Labor income: All forms of employment income, including employee compensation (wages and benefits) and proprietor income.

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[16] IMPLAN, 2015

Leakages: Any payments made to imports or value added sectors that do not in turn re-spend the dollars within the region.

Multipliers: Total production requirements within the Study Area for every unit of production sold to Final Demand. Total production will vary depending on whether Induced Effects are included and the method of inclusion. Multipliers may be constructed for output, employment, and every component of Value Added.

National forest: An ownership class of Federal lands, designated by Executive order or statute as National Forests or purchase units, and other lands under the administration of the Forest Service including experimental areas.

Net annual growth: The average annual net increase in the volume of trees during the period between inventories. Components include the increment in net volume of trees at the beginning of the specific year surviving to its end, plus the net volume of trees reaching the minimum size class during the year, minus the volume of trees that died during the year, and minus the net volume of trees that became cull trees during the year.

Net volume in cubic feet: The gross volume in cubic feet less deductions for rot, roughness, and poor form. Volume is computed for the central stem from a 1-foot stump to a minimum 4.0-inch top diameter outside bark, or to the point where the central stem breaks into limbs.

State land: An ownership class of public lands owned by States or lands leased by States for more than 50 years.

Timberland: Forest land that is producing or is capable of producing crops of industrial wood and not withdrawn from timber utilization by statute or administrative regulation. (Note: Areas qualifying as timberland are capable of producing in excess of 20 cubic feet per acre per year of industrial wood in natural stands. Currently inaccessible and inoperable areas are included.)

Value added: A measure of the impacting industry's contribution to the local community; it includes wages, rents, interest, and profits.

Appendix D: IMPLAN Assumptions

The following are suggested assumptions for accepting the impact model:[17]

Backward-linkages: IMPLAN is a backward-linkage model, meaning that it measures the increased demand on industries that produce intermediate inputs as a result of increases in production. However, if an industry increases production, there will also be an increased supply of output for other industries to use in their production. Models that measure this type of relationship are called forward-linkage models. To highlight this concept, consider the example of a new sawmill beginning its operations in a state. The increased production as a result of the sawmill's operations will increase the demand for lumber, creating an increase in activity in the logging industry, as well as other supporting industries such as electric transmission and distribution. IMPLAN's results will include those impacts, but will exclude effects on any wood product manufacturers located nearby that might be impacted by the newly available supply of lumber.

Employment: IMPLAN input-output is a production-based model, and employment numbers (from U.S. Department of Commerce secondary data) treat both full- and part-time individuals as being employed.

Fixed production patterns: Input-output (I-O) models assume inputs are used in fixed proportion, without any substitution of inputs, across a wide range of production levels. This assumption assumes that an industry must double its inputs (including both purchases and employment) to double its output. In many instances, an industry will increase output by offering overtime, improving productivity, or improvements in technology.

Fixed prices and no supply constraints: IMPLAN is a fixed-price model. This means that the modeling software assumes no price adjustment in response to supply constraints or other factors. In other words, the model assumes that firms can increase their production as needed and are not limited by availability of labor or inputs and that firms in the local economy are not operating at full capacity.

Industry homogeneity: I-O models typically assume that all firms within an industry have similar production processes. Any industries that fall outside the typical spending pattern for an industry should be adjusted using IMPLAN's Analysis-by-Parts technique.

Leakages: A small area can have a high level of leakage. Leakages are any payments made to imports or value added sectors, which do not in turn re-spend the dollars within the region. What's more, a study area that is actually part of a larger functional economic region will likely miss some important linkages. For example, workers who live and spend outside the study area may actually hold local jobs.

[17] Bureau of Economic Analysis https://www.bea.gov/papers/pdf/WP_IOMIA_RIMSII_020612.pdf