Economic Feasibility of Mass Timber Manufacturing in Wisconsin: Assessing Feedstock, Cost Efficiency and Economic Impacts

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Abbreviations

CLT	Cross-Laminated Timber
DLT	Dowel-Laminated Timer
FIA	Forest Inventory and Analysis
FORCE	Feedstock Optimization and Resource Cost Evaluation
GIS	Geographic Information System
GLULAM	Glue-Laminated Timber
IBC	International Building Code
IMPLAN	Impact Analysis and Planning
MRIO	Multi-Regional Input-Output
NLT	Nail-Laminated Timber
SAM	Social Accounting Matrix
USFS	United States Forest Service
WDNR	Wisconsin Department of Natural Resources

Glossary

The following technical terms are used throughout this report:

Competition hotspot: A geographic area where multiple wood-processing facilities have overlapping areas of sourcing raw material leading to competition over the same resources.

Direct effects: The production changes or expenditures of an industry or a sector in the study area.

Employment: The number of jobs (full-time, part-time, and self-employed) created in the economy associated to any industry.

Growth-to-drain ratio: The ratio of the amount of wood fiber a given area can grow annually to the amount of wood fiver harvested annually. It is a measure to monitor forest sustainability.

Indirect effects: The production changes due to business-to-business purchases in the supply chain by an initial industry's demand of input purchases.

Induced effects: The changes in the household spending stemming from the labor income generated from direct and indirect effects.

Labor Income: The total value of all employment income (wages and benefits) which includes both employee compensation and proprietor income.

Multi-Regional Input-Output (MRIO): An economic impact analysis tool to assess how changes in the production of an industry in a study region influence production or final demand across other regions. It helps capture additional local effects generated through interregional commodity trade and commuting flows.

Output: The total economic activity or the total value of a business' production. Output is simply also viewed as revenues (sales).

Procurement zone: A geographically defined area within which wood processing facility sources its raw material (wood fiber).

Social Accounting Matrix (SAM) Multipliers: The ripple effects of changes in the regional economy due to changes in the industry activity. It is calculated by dividing the sum of direct, indirect, and induced effects by direct effects.

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

Value Added: The difference between the gross output of an industry or sector and cost of intermediate inputs or purchases from other firms in the production process. It encompasses the sum of labor income, other property income, and taxes on production and inputs.

Executive Summary

Wisconsin has great potential to lead the mass timber industry in the Midwest by leveraging its abundant forest resources, a well-established forest industry (already one of the state's leading manufacturing sectors), and a growing number of mass timber structures in the state. This study evaluated the feasibility of establishing a potential mass timber manufacturing facility in Wisconsin by assessing the feedstock procurement cost efficiency and the associated economic impacts.

A logistics optimization model was developed and used to analyze procurement zones, competition hotspots, feedstock availability, procurement costs and identify optimal location for a potential mass timber manufacturing facility. Input output (I-O) analysis was then performed to estimate the associated economic impacts in the local, state, and regional economy. We optimized (minimized) cost, distance, and time in moving products through the forest product supply chain (from forest to cities/towns), and identified optimal location based on two economic scenarios: (1) balancing logistics for demand and supply, and (2) accounting for supply only.

This study identified two optimal locations for mass timber manufacturing in Wisconsin – near Stevens Point (44°29'9.9312" N; 89°30'2.9448" E) in Portage County and near Gull Lake (46°0'0.6804" N; 91°47'23.2116" E) in Washburn County. The location near Stevens Point in Portage County emerged as the optimal location when considering both supply and demand, while the location near Gull Lake in Washburn County was the best candidate when focusing exclusively on supply. These selections were based on minimizing travel distance, time, and cost for transporting logs from forests to softwood mills, lumber from mills to potential mass timber facility, and finally the mass timber panels to consumers (cities).

Analysis of historical softwood sawtimber availability using Forest Inventory and Analysis (FIA) data revealed significant feedstock availability for the identified optimal locations within the procurement zones, based on the current market delivered log price for softwoods ($300/MBF). Washburn County has greater average annual softwood sawtimber availability than Portage County due to its proximity to forested areas. Among the Lake States, Wisconsin forests will primarily supply the feedstock, with small proportions from Michigan and Minnesota. Overall, forests under private ownership (over 60%) dominate the softwood sawtimber availability for a potential mass timber manufacturing facility.

The economic impact analysis of operating a new mass timber manufacturing facility across two economic scenarios and four production scales (small, base, medium, and large) was performed using 2023 Impact Analysis for Planning (IMPLAN) data. The operation of a new mass timber facility is estimated to have substantial direct, indirect, and induced economic impacts at the county, state, and even at regional (Lake States) levels. At the state level, direct number of jobs is estimated to range from 28 (small-scale) to 180 (large-scale) and corresponding direct output of $35.3 million to $229.5 million for small-and large-scale respectively. Estimated total taxes generated at the state range from $3.07 million (small-scale) to $19.9 million (large-scale). Total output in Portage County ranges from $47.11 million (small-scale) to $306.29 million (large-scale), while in Washburn County, it ranges from $48.42 million to $314.76 million for small-and large-scale production, respectively.

Social Accounting Matrix (SAM) multipliers were similar across production scales but were higher in Washburn County, indicating stronger economic impacts in rural areas compared to areas closer to urban centers. In addition to economic output and job creation, facilities in rural areas can bring knowledge and technology transfer to the region – benefits not fully captured by IMPLAN.

Moreover, IMPLAN tracks commodity trade flow data, which consists of county-to-county dollar values of domestic trade in all IMPLAN commodities based on an origin-of production basis. In 2022, the total trade value for dimension lumber from Wisconsin to Michigan was $19.84 million, and $51.13 million to Minnesota. Conversely, Michigan exported $114.77 million worth of dimension lumber to Wisconsin. This indicates a strong interdependence of wood product flows and trade in the Lake States region.

Establishing a mass timber facility in Wisconsin could provide significant benefits to the Lake States region. Beyond supporting Wisconsin's local economy, such a facility would create employment opportunities, stimulate trade, and generate economic activity in neighboring states, including Michigan and Minnesota. The facility would contribute to labor income and overall economic value in the region through both direct operations and the ripple effects of related industries, enhancing regional development and fostering stronger economic linkages across the Lake States

In addition to economic benefits, operating a new mass timber manufacturing facility would bring new market opportunities, promote sustainable forest management, and support overall health of the forests and forest product industries. This is particularly important for revitalizing rural communities and supporting broader economic prosperity. With ample forest resources in Wisconsin and the Lakes States region, such a facility would support value-added production while also yielding competitive pricing, job creation across related industries, and stimulate rural economic development.

A combined analysis of identifying optimal mass timber facility locations based on economic optimization models and economic impacts analysis provides prospective industry stakeholders and policymakers valuable insights to evaluate feedstock logistics and enhance their merchantability of forest products and support informed decision making. Although this study identified two optimal locations based on two economic models and minimizing procurement transportation costs between supply and demand points, there may be other social-economic factors not captured in our model which might influence investment decisions. With sufficient timber resources and well-established primary supply chain infrastructure for mass timber industry, Wisconsin is well-positioned to support mass timber manufacturing facilities in any location in the state, depending on the specific socio-economic or related operational preferences of prospective investors.

1. Background

Building construction in the United States is undergoing transformation with the emerging class of wood products known as mass timber. Mass timber is a group of new building systems that uses engineered wood as the primary structural component, either alone or in combination with other materials such as light wood frame, steel, and concrete. Mass timber is gaining significant attention and interest because of its strength, dimensional stability, sustainability, and biophilic properties. Solid wood panels of varying dimensions are bonded together to form large, structural, load-bearing panels, which are used for floors, ceilings, walls, and beams, providing flexibility and strength but incurring only a fraction of carbon costs compared to traditional building materials like steel and concrete (Anderson et al., 2024).

There are different types of mass timber products based on how the multiple solid wood layers are bonded together. In general, there are four main categories of mass timber: cross-laminated timber (CLT), glue laminated timber (Glulam), nail laminated timber (NLT), and dowel laminated timber (DLT). Among these, CLT—the most common derivative of mass timber—is a structural engineered wood panel in which multiple layers of dimension lumber are bonded orthogonally using adhesives. Glulam, on the other hand, consists of multiple layers of dimension lumber bonded parallel to each other, and is typically used for beams and columns. Layers of dimension lumbers are stacked on edge and fastened with nails and wooden dowels to create NLT and DLT, respectively. Additionally, mass plywood panels, which are a recent addition to the mass timber industry, are comprised of multiple layers of veneer engineered with either orthogonal or longitudinal orientation.

The development of mass timber dates back to the early 1990s in Europe, primarily in residential construction. However, it only began to gain traction in the United States in the early 2010s, finding its way into non-structural panels (Muszynski et al., 2017). In recent years, mass timber has garnered significant interest in the United States, with the number of mass timber manufacturing plants growing to 12 as of 2023, with only one facility in the Midwest (R. Anderson et al., 2024). With the rise of mass timber globally, it has been recognized for its great potential for use in mid-rise and high-rise buildings (Brandt et al., 2021; Muszynski et al., 2017). The number of mass timber projects in design or built has grown seven-fold, from 349 in 2018 to a total of 2,338 by December 2024 (WoodWorks, 2024). The approval of 2021 International Building Codes (IBC) was a monumental step, opening avenues for the use of mass timber as structural material in high-rise buildings up to 18 stories. The Ascent tower in Milwaukee, Wisconsin, which opened in 2022, stands at 25 stories high (284 feet) and comprises 19 stories of Type IV mass timber atop a six-story concrete podium, and is the tallest timber tower in the world (R. Anderson et al., 2024). This has accelerated the use of timber in high-rise buildings across the United States.

As home to the Ascent tower, Wisconsin has set a precedent for the growing momentum of mass timber in the Midwest. As of December 2024, the number of mass timber projects in Wisconsin that have been built or are under construction is 34, with an additional 13 in the design phase (WoodWorks, 2024). With over 40% of its land area covered by forests, Wisconsin's forest resources have demonstrated sustainability, as indicated by the growth-to-drain ratio of above 2.4 for softwoods and above 1.6 for hardwoods from 2007 to 2022 (Dahal, 2025). This presents an opportunity for the sustainable utilization of these resources to support the state's economy (Dahal, 2025). It also highlights the need for new market developments for forest landowners. About 70% of Wisconsin's forestland is owned by private landowners, followed by local and state ownership (21%) and federal or national forests (9%). Local government agencies, largely the 30 county forests own and manage an estimated 2.4 million acres of Wisconsin's forestland. Additionally, the forest product industry is one of the leading manufacturing sectors in the state, making a significant contribution to the local, state, and regional economy, with a total economic contribution of $42 billion, representing 4% of the state's gross domestic product (GDP) (Wisconsin DNR, 2025).

Wisconsin's forestland is predominantly hardwood forest type, with approximately 10% white/red/jackpine and 8% spruce and fir (Dahal, 2025). The Wisconsin Council on Forestry, in its September 13, 2022, meeting notes on "State of Mass Timber in WI" highlighted that the state's red pine and jack pine, spruce and fir have been approved for use in CLT panels (Wisconsin Council on Forestry, 2022). The meeting notes also emphasized that the higher cost of procuring CLT panels for mass timber projects is a major challenge, primarily due to the absence of mass timber manufacturing facilities in Wisconsin and neighboring states. Wisconsin remains optimistic about ongoing developments in testing hardwoods for CLT production and is actively interested in attracting mass timber manufacturing to the state using locally grown species.

Mass timber is not yet a commodity product, rather, its production depends on lumber, which is subject to market fluctuations driven by supply and demand (R. Anderson et al., 2024). The economic viability of forest products industries, especially primary industries such as sawmills, is largely influenced by the spatial structure of the forest products market. Their overall operation costs depend on their proximity to both feedstock sources and end markets, which directly impacts feedstock transportation and logistics costs (Aguilar & Vlosky, 2006; Stewart, 2004).

Transportation distance, costs, and the spatial assessment of feedstock availability are critical factors in identifying optimal locations for forest product industries and ensuring a sustained supply chain (Adhikari et al., 2023; Anderson et al., 2011; Woo et al., 2020; Zhang et al., 2011). Minimizing transport distances not only reduces overall costs but also has significant environmental and sustainability benefits (Chen et al., 2019). Geographic Information System (GIS)-based analyses, using transportation network tools, have been widely used to identify locations and assess resource availability for various forest product industries (Ahmed et al., 2024; Adhikari et al., 2023; Aguilar & Vlosky, 2006; Xu et al. 2018, Khanal et al., 2024; Zhang et al., 2011). Optimization frameworks, combined with spatial tools such as GIS, offer means to evaluate feedstock logistics and identify cost-efficient options (Han et al., 2018).

The economic impact of a previously non-existent industry generates new revenues into the state, county, or region, as well as retaining revenues that would otherwise have been lost (Watson et al., 2007). The potential economic implications of the mass timber industry have become increasingly important in encouraging investments from the private sector and policymakers. Mass timber manufacturing is an emerging sector in the United States and has yet to be established as a mature industry. A few studies have performed economic impact analyses of potential mass timber manufacturing in Michigan and Minnesota, as well as a 12-story mass timber building in Oregon (Haynes et al., 2019; Khanal et al., 2024; Scouse et al., 2020).

This study aims to identify cost-efficient optimal location and feedstock availability for a potential mass timber manufacturing facility in Wisconsin and assess the economic impacts of operating the facility at the county, state, and regional levels.

Objectives

The objectives of this study are:

- Identify hotspots for softwood availability using a transportation logistics model.
- Identify potential locations for a new mass timber facility and estimate feedstock availability using the Feedstock Optimization and Resource Cost Evaluation (FORCE) model.
- Estimate the economic impacts to local, state, and regional economy with the operation of a new mass timber facility.

2. Methods

2.1 Data

Data on existing softwood processing sawmills in Wisconsin, including their geographical coordinates, production capacities, and species type, were provided by the Wisconsin Department of Natural Resources (WDNR). Detailed road transportation network data was obtained from ESRI (ESRI Data and Maps, 2017) to identify procurement zones based on travel distance, travel time, and permissible speed limits on road networks. The US Forest Service (USFS) Forest Inventory Analysis (FIA) plot data was retrieved from the FIA data mart (USDA, 2023) to estimate the growth, removals, and merchantable volume of softwood sawtimber. The 2023 Impact Analysis for Planning (IMPLAN) data from IMPLAN® Inc along with annual operation and maintenance costs of a mass timber manufacturing facility were retrieved for economic impact analysis.

2.2 Optimal location identification

To identify potential locations, we divided the state of Wisconsin into a tessellated grid of hexagonal polygons, each measuring 1,000 square kilometers (Figure 1). A total of 170 polygons were created, and a centroid at the center of each polygon was established. Since it is ideal for any manufacturing facility to be located close to major roads or highways, the centroid for each polygon was snapped to within three miles of the nearest roads and highways (Figure 1). This resulted in a total of 170 points as the potential locations for a mass timber manufacturing facility in Wisconsin. The "Network Analyst" tool in ArcGIS (ESRI, 2017) was used to calculate travel time and distance from forest plots to softwood mills, from

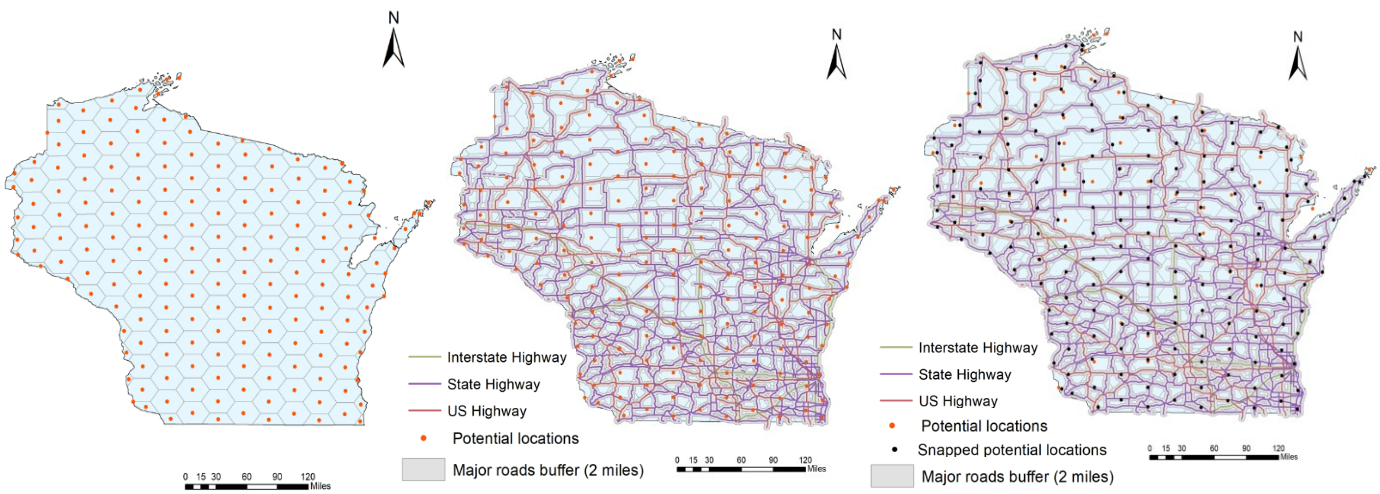

Figure 1. A tessellated grid of hexagonal polygons (each measuring 1,000 sq km) established as potential locations for prospective mass timber manufacturing facilities in Wisconsin.

softwood mills to potential mass timber locations, and from potential mass timber locations to cities, following the transportation logistics modeling approach developed by Pokharel et al. (2023).

We then used Python and Pulp solver, using the locations of forests, softwood mills, potential mass timber manufacturing locations, and cities, as well as the travel distances and times between these locations, to determine the optimal connections between each point. Mass timber is not a commodity product yet but largely depend on dimension lumber, which is a commodity and is produced by sawmills which operates on a commodity-driven marketplace, and assuming existing softwood mills with higher production capacity can expand their capacity to meet increased lumber demand for the mass timber industry, we selected 25 existing softwood mills in Wisconsin with capacities over 5,000 MBF for the optimization. We established a 100-mile aerial distance from the 25 softwood mills that were chosen because of the interdependence of wood product flows and trades as well as the structure of the timber market in the Lake States region. Additionally, we took into account the fact that the typical wood basket range for forest product milling facilities in Wisconsin is a radius between 50 and 100 miles. This resulted in a total of 17,750 forest plots across Michigan, Wisconsin, and Minnesota. Because mass timber structures offer innovative solutions to sustainable urban development; we also selected 86 out of the 87 major cities in Wisconsin selecting cities with population over 10,000.

2.2.1 Feedstock Optimization and Resource Cost Evaluation (FORCE) Model:

We developed an optimization model to minimize transportation cost, distance, and time, to utilize available logs to process into lumber for mass timber production. The objective function of our model is to minimize the travel (haul) cost, distance, and time with the resources routed as defined in Eq 1 between forests to softwood mills, softwood mills to potential locations for mass timber facilities, and from these facilities to cities.

$$min \sum_{i=1}^{m} \sum_{j=1}^{n} d_{ij} c_{ij} S_{ij} \quad \text{Eq. 1}$$

where d_{ij} is the distance, cost c_{ij} of moving feedstock (logs, lumber or mass timber panels) from point *i* (forest plot, sawmill or mass timber facility) to point *j* (sawmill, mass timber facility or cities), S_{ij} is the supply or amount of feedstock moving from point *i* to point *j*, *n* is the number of demand points (either softwood mills or potential locations for mass timber facility or cities) and *m* is the number of supply points (forest plots or softwood mills or potential locations for mass timber facility) used for optimal solution. We then modified Eq 1 as expressed in Eq 2 by adding a binary variable, r_{ij}, to ensure supply is routed only through the routes which we have identified as optimal routes. For the rest of the routes, no supply is routed. This ensures that the supply routed is split between multiple destinations to fulfill the demand via shortest routes.

$$min \sum_{i=1}^{m} \sum_{j=1}^{n} d_{ij} c_{ij} S_{ij} r_{ij} \qquad \text{Eq. 2}$$

The constraints for this objective function are set as follows.

$$0 \leq S_i * r_{ij} \leq S_{max} * r_{ij} \quad \forall i \qquad \text{Eq. 3}$$

The supply routed from a specific point should be non-negative and should not exceed the capacity specified for that point.

$$0 \leq D_i \leq D_{max} \; \forall j \qquad \text{Eq. 4}$$

The demand received by a specific point should be non-negative and should not exceed the capacity specified for that point.

$$D_j = \sum_{j=1}^{n} S_{ij} \quad \forall j \qquad \text{Eq. 5}$$

The total demand supplied to all locations should equal the total supply that is provided by locations in set S

$$\sum_{i=1}^{m} \sum_{j=1}^{n} S_{ij} = \sum_{j=1}^{n} D_j \qquad \text{Eq. 6}$$

where, D_j denotes demand at the production facility. The total demand fulfilled at each location should equal the sum of supplies received by that location.

In this model, we first optimize/minimize haul cost of moving products through the supply chain. In addition to actual cost, the model can also work with travel time and haul distances as the surrogate of costs. We optimized all these parameters for this exercise to see if they produce different outcomes. In other words, we minimized the cost factor between forests and sawmills, then from sawmills to potential locations, from potential mass timber locations to cities considering the cumulative distances from the start point (forests) to end point (cities). In addition, optimization is done iteratively 15 times after identifying the optimal mass timber facility location to identify the forest plots supplying to sawmills. With each iteration, the model discards the forest that has been utilized before to satisfy the demand at the identified optimal location for 15 iterations.

2.2.2 Scenarios for identifying optimal location for mass timber manufacturing facility

We developed six scenarios based on different optimization metrics (cost- or distance- or time-based) and demand-supply weights for identifying potential locations using the above-described optimization model (Table 1). This report includes the results of Scenario 1 with cost-based optimization, while Scenarios 2 and 3 for distance and time-based optimization are in Appendix I.

Table 1. Scenarios for identifying optimal location for mass timber manufacturing facility in Wisconsin

SN	Sub-class	Scenario Name	Demand-Supply weights
1	*1a*	*Balanced Cost model*	*Equal weightage to demand and supply*
	1b	*Supply-Weighted Cost model*	*Only weightage to supply*
*2**	*2a*	*Balanced Distance model*	*Equal weightage to demand and supply*
	2b	*Supply-Weighted Distance model*	*Only weightage to supply*
*3**	*3a*	*Balanced Time model*	*Equal weightage to demand and supply*
	3b	*Supply-Weighted Time model*	*Only weightage to supply*

Note: Scenarios 2 and 3 are included in Appendix I.

The optimization model balancing demand and supply aims to optimize the allocation of resources efficiently considering supply-side constraints such as the availability of logs from timberlands and lumber from sawmills, as well as limited production capacity. On the demand side, factors such as proximity to markets (cities) and population size as a proxy for mass timber demand are considered. This model assumes mass timber industry as a matured industry in the United States with balanced supply and demand constraints. By accounting for demand and supply factors, the optimization model helps identify the most cost-efficient and market-balanced location for a potential mass timber manufacturing facility.

Given the current situation, where mass timber panels are transported across the country from the Pacific Northwest and Southeast as well as from Canada and Europe, we focused on siting a facility considering the supply-side of feedstock (logs and lumber). This approach helps ensure the identification of potential suppliers based on capacity and optimal location for a potential mass timber facility with a sustained and efficient supply of feedstock.

2.3 Procurement zone and competition hotspot identification

Identifying procurement zones and competition hotspots is crucial for planning efficient feedstock logistics and establishing economically viable forest product industries. We are optimizing travel distance, time, and costs for feedstock procurement across each point, as well as the overall supply chain from start to end points. Optimization frameworks are commonly used to evaluate decisions related to tactical, strategic, and operational aspects of forest product supply chains (Atashbar et al., 2018).

Among different criteria, minimizing total cost is the most common criterion for optimization. Transportation cost is mostly accounted in the total cost function or independently as a single criterion in the optimization model (Atashbar et al., 2018). GIS-based road network optimization has been used to assess procurement areas and competition hotspots, identify optimal number and size of forest product industries, while optimizing transportation costs and selecting short-haul transport (Han et al., 2018; Pokharel & Latta, 2020; Stewart, 2004; Woo et al., 2020). It is also crucial to identify procurement zones to evaluate competition among different primary and secondary forest product industries for sustainable supply of resources at competitive prices (Yemshanov et al., 2014).

We used information on 2024 softwood stumpage prices from Wisconsin DNR and delivered log price for Pukall Lumber Company's Quinnesec Landing Price List effective October 11, 2024, (Pukall Lumber Co., 2024). We used prices for softwood species: red pine, white pine, spruce, Norway spruce, and white spruce in this study. We calculated haul time as a surrogate for transportation costs using delivered wood prices as shown in Eq 7 (Pokharel et al., 2023), and used locations of each softwood mills supplying lumber to potential mass timber facility and road network data to determine procurement zones of each softwood milling facilities following the approach developed by Pokharel & Latta (2020).

$$t = \left[0.5 * \frac{(p - p_h - p_s) * w}{r} * 60\right] - t_l \qquad \text{Eq 7}$$

where t is hauling time, p is the average mill delivered log price, p_h is the cost of harvesting wood products, p_s is the stumpage price, w is the weight limit of a truck trailer hauling wood products, r is the cost pf operating a truck per hour, and t_l is the loading and unloading time.

For this study, we used $p = \$300/MBF$ (obtained from Pukall Lumber Company's Quinnesec Landing Price List), p_h= 33.66% of delivered log price (Gibeault & Coutu, 2015), $p_s = \$122.20/MBF\ Scribner\ Decimal\ C\ log$ (stumpage price or public forestland obtained from Wisconsin DNR), $w = 4.5\ MBF$ and $r = \$85/hour$ (Khanal et al., 2024). Loading and shipping costs to the mills are included in the freight in Wisconsin (Gibeault & Coutu, 2015) so we did not use truck loading and unloading time for this study. The competition hotspots for all softwood mills were created using the Woodshed Mapping Tool for Lake States Wood Products Industry (Forest Economics and Resource Management (FERM) Lab, 2024).

2.4 Historic softwood sawtimber availability for mass timber

We used rFIA package (Stanke et al., 2020) in R software (RStudio Team, 2023) and overlaid FIA data from 2003 to 2022 within the procurement zones for the delivered log price ($300/MBF) and estimated the total softwood sawtimber availability for the softwood mills across all four scenarios.

2.5 Economic Impact Analysis

We used the Impact Analysis and Planning (IMPLAN, 2023) to assess the economic impacts of operating a new mass timber manufacturing facility in

Wisconsin at the county, state, and regional levels, which is a widely used input-output (I-O) modeling software tracking regional and annual economic data from federal agencies such as the US Department of Commerce, the US Census Bureau, the US Bureau of Labor Statistics, and others (Clouse, 2023). This economic analysis does not account for the construction of the manufacturing facility. The new mass timber manufacturing facility can impact the economy in three ways (Figure 2).

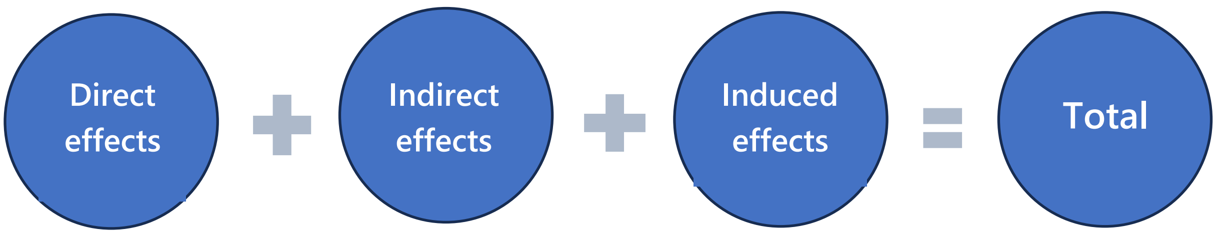

Figure 2. Effects of economic impact analysis using Input-Output model

Direct effects include immediate effects in the economy by the new mass timber manufacturing facility. Indirect effects result from the business-to-business purchases by the mass timber facility to produce outputs. Induced effects stem from the changes in household spending caused by the labor income from direct and indirect effects.

The Social Accounting Matrix (SAM) is an accounting framework which shows how industries are connected (interdependence) in the economy. SAM multipliers measure the value of all production and consumption linkage effects, calculated by dividing the sum of direct, indirect, and induced effects by direct effects, and represent the ripple effects of changes in the regional economy due to changes in industry activity. Larger the multiplier, greater is the economic impact. The multipliers reported in this study are the SAM multipliers.

We estimated the economic impacts of operating potential mass timber manufacturing using 2023 IMPLAN data reported in 2023 US dollars, which is the most recent available data to date. To date, IMPLAN does not have a separate industry sector for mass timber, thus we (Dahal et al., 2020; Khanal et al., 2024) used Industry Sector 127 Engineered Wood Member and Truss Manufacturing as a proxy industry for the mass timber industry. However, using this sector solely will overestimate the economic impact, therefore we imported its industry spending pattern but modified the production function coefficients to create a customized spending pattern for the mass timber facility.

For our analysis, we used direct output based on 25 mass timber building projects in Wisconsin that have been built or in the design phase using CLT from 2004 to 2024, as reported by WoodWorks Mapping Mass Timber tool (WoodWorks, 2024). We converted the total square footage of all 25 mass timber building projects into volume (cubic meters) using a mass timber usage factor of 0.625 per square foot of building area (R. Anderson et al., 2024). The total volume of CLT used in the 25 projects was estimated to be 1.22 million cubic feet (34.49 thousand cubic meters). The per-unit price of CLT for a mass timber building with walls/roof, glulam beams, and wood-frame structure is taken as $50 per square feet ($1,765.73 per cubic meters) for CLT (Mallo & Espinoza, 2016). We then multiplied the total volume of CLT by the per unit price to estimate the direct output. Timberlab, a subsidiary of Swinerton plans to construct and operate a new CLT manufacturing facility in Oregon, anticipating an annual output of 100,000 cubic meters of finished CLT products and creating 100 manufacturing jobs at the facility (Timberlab, 2024). Based on this information, we estimated base (current) production scale of 34.49 thousand cubic meters of CLT requiring 48 manufacturing jobs for the potential mass timber manufacturing facility in this study.

We customized the spending pattern of Industry Sector 127 Engineered wood member and truss manufacturing and tailored it to align with the new mass timber manufacturing facility based on past studies assessing the economic feasibility of mass timber manufacturing in Oregon and Southwest Washington (Oregon BEST, 2017), Minnesota (Haynes et al., 2019), and Michigan (Khanal et al., 2024). We identified 12 industry sectors that would comprise the annual expenditures for a mass timber manufacturing facility (Table 2). Of the 12 industry sectors, Dimension lumber and boards holds the largest cost share (50%) of the total production cost (R. Anderson et al., 2020). Other manufacturing costs comprise the remaining 50% of the costs such as adhesives, energy, machinery and equipment, truck transportation, and overhead.

Table 2. Customized industry spending pattern for a new mass timber manufacturing facility

2023 IMPLAN sector	2023 IMPLAN sector commodity code	%	Source
Electric power transmission and distribution	3042	3.50	(Anderson et al., 2020)
Fabric coating mills	3111	3.70	(Oregon BEST, 2017)
Dimension Lumber and boards	3124	50.00	(Anderson et al., 2020)
Plastics material and resin manufacturing	3156	8.90	(Oregon BEST, 2017)
Paint and coating manufacturing	3167	0.90	(Oregon BEST, 2017)
Adhesive manufacturing	3168	15.00	(Anderson et al., 2020)
Handtool manufacturing	3226	2.20	(Oregon BEST, 2017)
Machine shops	3239	3.00	(Khanal et al., 2024)
Packaging machinery manufacturing	3282	1.70	(Anderson et al., 2020)
Wholesale services - Machinery, equipment, and supplies	3378	2.90	(Oregon BEST, 2017)
Truck transportation	3399	1.50	(Oregon BEST, 2017)
Management of companies and enterprises	3451	6.70	(Oregon BEST, 2017)

In addition, we assessed the economic impacts of operating a prospective mass timber manufacturing facility in Wisconsin across different sizes of manufacturing capacities. We reviewed relevant literatures and referred to the capacity and number of employees employed in the seven existing and operational mass timber manufacturers across the North America. The production capacities of the operational mass timber manufacturers ranged from 5,000 to 140,000 cubic meters of mass timber production annually. We also referred to the literature in which two major mass timber manufacturers – SMARTLAM employing 72 employees in the firm with an annual production capacity of 52,103 m^3 of mass timber (SMARTLAM, 2021) and Timberlab creating 100 manufacturing jobs in the facility with an annual mass timber production capacity of 100,000 m^3 (Timberlab, 2024). Based on this information, we classified different sizes of mass timber manufacturing facilities following a geometric progression (Table 3).

Table 3. Different sizes of production along with the number of employees and annual production capacity

S.N.	Scale of mass timber production	No. of employees	Annual production (cubic meters)
1	Small-scale	28	20,000
2	Base - current	48	34,492
3	Medium-scale	86	62,000
4	Large-scale	180	130,000

3. Results

3.1 Procurement zones and competition hotspot for softwood milling facilities in Wisconsin

Based on the delivered wood price data for softwood species (pine and spruce) in Wisconsin, we estimated procurement zone for 85 softwood milling facilities based on a hauling time of 120 minutes to procure softwood logs at the delivered softwood log price of $300/MBF (Figure 3). The competition hotspot for these softwood milling facilities is also shown in the Figure 3, where the map's color scheme ranging from green to red indicates low to high competition for the softwood sawlogs.

The softwood sawmills are spatially distributed across all five regions in Wisconsin, with larger and higher numbers of mills in the Central, Northwest, and Northeast regions. The competition for softwood lumber is higher in Central Wisconsin, with some competition in the Northwest and Northeast regions closer to Minnesota and the Upper Peninsula of Michigan and low competition in the Southwest and Southeast regions of Wisconsin. The competition hotspot in the procurement zone at the delivered wood price provides the prospective manufacturers and supply chain actors a better understanding of how far they can travel to procure feedstock, ensure a sustainable supply of feedstock at sustained prices, and degree of competition such that higher competition is likely to ensure stable markets with better prices and quality products.

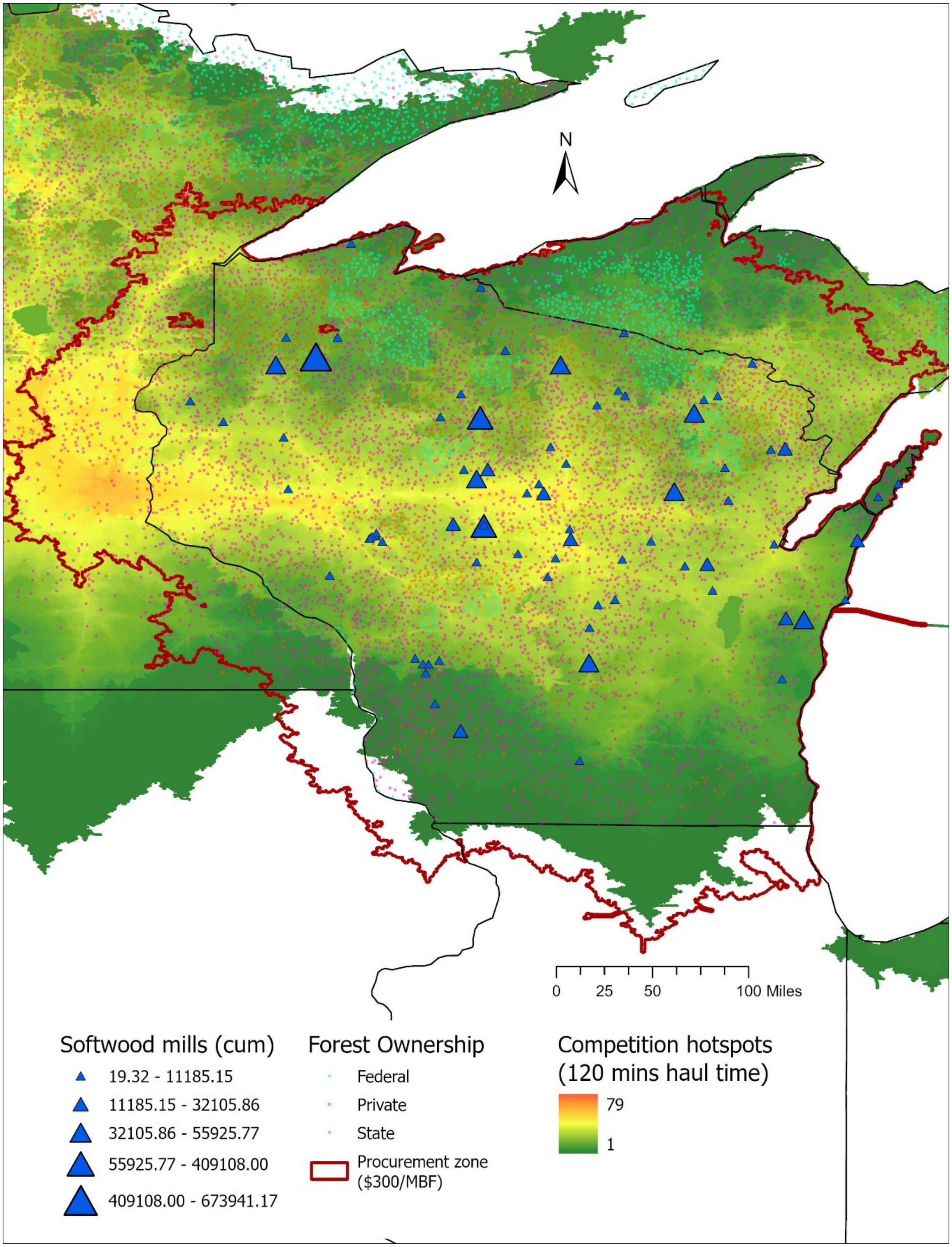

Figure 3. Procurement zone for softwood sawmills in Wisconsin for the current market average delivered softwood log price of $300/MBF and competition hotspots for softwood log procurement.

3.2 Transportation cost-based optimization

To identify the optimal potential mass timber location, we optimized the transportation cost for procuring feedstock from forest to softwood sawmills, from softwood sawmills to potential mass timber locations, and from the potential mass timber locations to cities, for both models - balancing supply and demand and supply only. We used $2.10/mile (VanderSchaaf et al., 2023) for the cost of transporting logs from forest to softwood sawmills, $3.50/mile as the cost of transporting lumber from softwood sawmills to potential mass timber locations (Kienzle, 2020), and $7.89/mile as the cost of transporting mass timber panels from potential mass timber facility to cities (personal communications with Gayle in Element5[1]). We also used $91.27/hour as the cost of operating a truck (Leslie & Murray, 2024). In addition, we ran the optimization model based on transport distance and time as a metric to identify the optimal location for potential mass timber locations (Appendix I).

3.2.1 Balanced Cost Model

The transportation cost-based optimization model identified Stevens Point (44°29'9.9312" N; 89°30'2.9448" E) in Portage County as the optimal location for a new mass timber manufacturing facility, when both demand and supply locations were incorporated in the model (Figure 4). This location was selected based on the optimization of transportation costs based on the distance travelled to procure logs from forests to softwood sawmills, lumber from sawmills to potential mass timber facilities, and mass timber panels from potential mass timber facilities to cities (demand centers).

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[1] Personal communication with Gayle Gordon, Logistics Coordinator at Element5 on October 30, 2023

A total of 106 forest plots will supply the feedstock (softwood logs) to nine softwood sawmills, which will then process logs into lumber for producing mass timber panels in the potential mass timber facility in Portage County (Figure 4). Majority of the feedstock for this potential location will come from Wisconsin woods, with a small amount also coming from the Upper Peninsula of Michigan. As this economic model takes into account both the supply of resources and the demand from cities, the procurement zone runs longitudinally from north to south reflecting the higher density of feedstock in the north and the higher city density in the south. The competition hotspot indicates higher competition in the Central region and within the procurement zone, as indicated by the higher concentration of softwood sawmills.

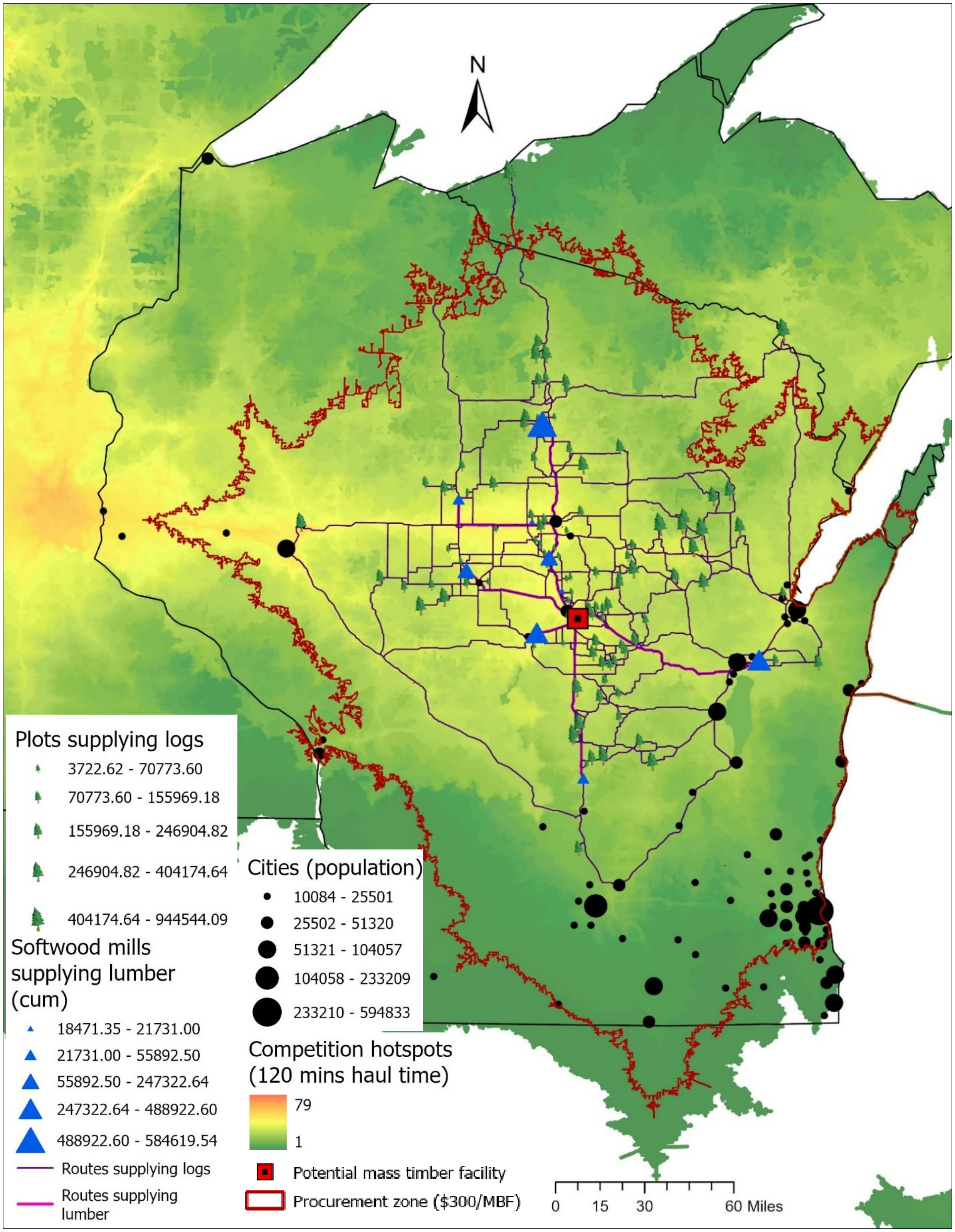

Figure 4. Map showing procurement zone (average delivered softwood log price of $300/MBF) and competition hotspots for optimal mass timber facility in Stevens Point in Portage County, Wisconsin based on optimized travel cost balancing demand and supply.

3.2.2 Supply-Weighted Cost Model

The transportation cost-based optimization model identified an optimal location near Gull Lake (46°0'0.6804" N; 91°47'23.2116" E) in Washburn County as the optimal location for a new mass timber manufacturing facility, when we accounted only for supply locations (Figure 5). This location was selected based on the optimization of transportation costs based on the distance travelled to procure logs from forests to softwood sawmills, as well as lumber from sawmills to potential mass timber facilities where mass timber panels will be produced but does not account the costs of transporting mass timber panels to cities or demand locations.

A total of 103 forest plots will supply the feedstock (softwood logs) to six softwood sawmills, which will then process logs into lumber for producing mass timber panels in the potential mass timber facility in Washburn County (Figure 5). Majority of the feedstock for this potential location will be supplied by forests from Wisconsin and one plot from Minnesota. As this economic model only prioritizes supply of resources, the procurement zone extends across the Northwest and Southeast regions. The softwood sawmills processing lumber are also sparsely distributed compared to the model balancing both supply and demand. The supply-only economic model will help prospective manufacturers understand and create cost-effective logistic and sustained supply line, while avoiding excessive competition, to ensure a balanced market environment which leads to better pricing and good quality products.

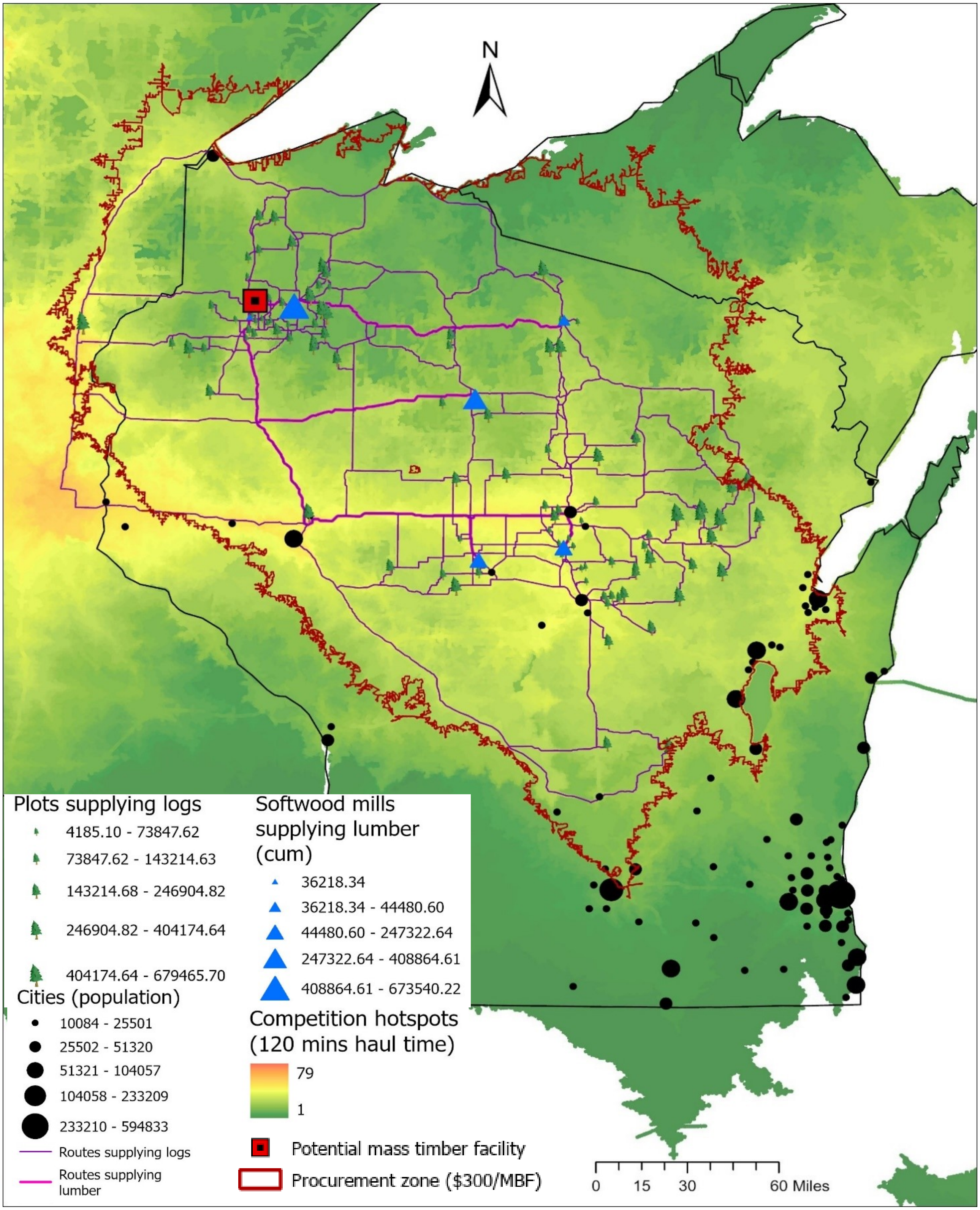

Figure 5. Map showing procurement zone (average delivered softwood price of $300/MBF) and competition hotspots for optimal mass timber facility in Washburn County, Wisconsin based on optimized travel cost accounting for supply only.

3.3 Softwood sawtimber availability for potential mass timber facility

We estimated the availability of softwood sawtimber for the identified optimal locations for mass timber facilities in Portage and Washburn counties across two economic scenarios using FIA data overlaid with the procurement zones.

For the transport cost-based optimization balancing supply and demand, analysis of FIA estimates showed that a total of 41.5 million MBF average annual softwood sawtimber is available within the procurement zone at the delivered softwood sawlog price of $300/MBF. About 98% of the available softwood sawtimber can be sourced from Wisconsin, 2.2% from Michigan, and less than 1% from Minnesota. About 75% of the softwood sawtimber is available in private forests, followed by 15% in state forests, and the remaining 10% from forests under federal ownership (Figure 6).

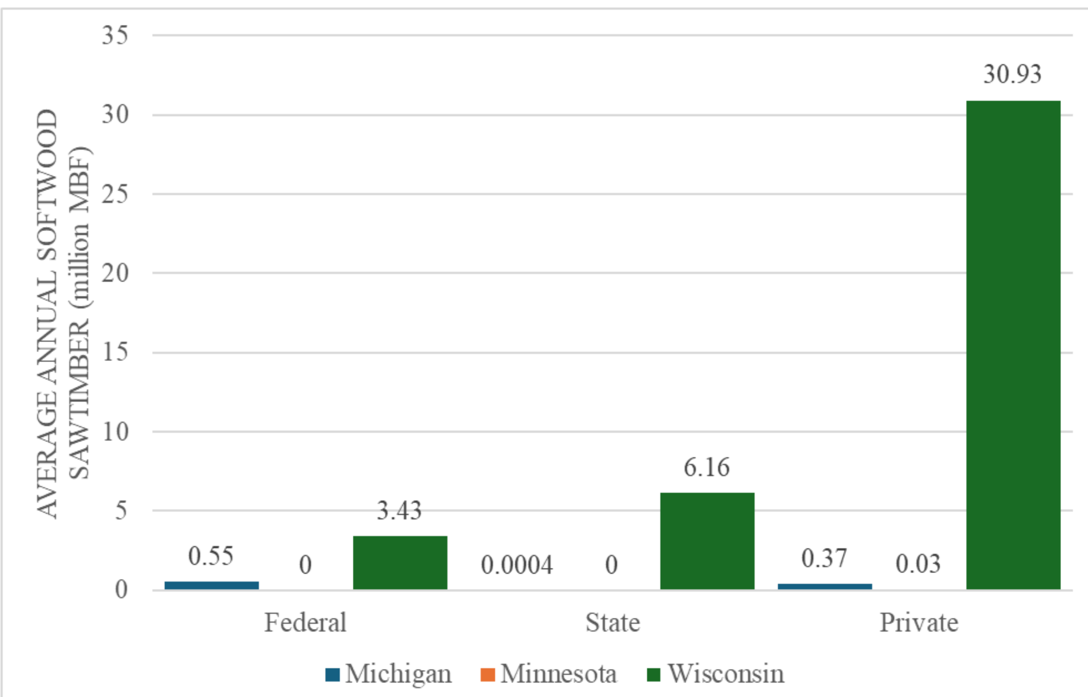

Figure 6. Total annual softwood sawtimber at the delivered softwood sawlog price of $300/MBF across ownerships and states for transport-cost based optimization balancing supply and demand.

For the transport cost-based optimization accounting for supply only, analysis of FIA estimates showed that a total of 53 million MBF average annual softwood sawtimber is available within the procurement zone at the delivered softwood sawlog price of $300/MBF. About 86% of the available softwood sawtimber can be sourced from Wisconsin, 10% from Michigan, and about 4% from Minnesota. About 65% of the softwood sawtimber is available in private forests, followed by 19% in state forests, and the remaining 16% from forests under federal ownership (Figure 7).

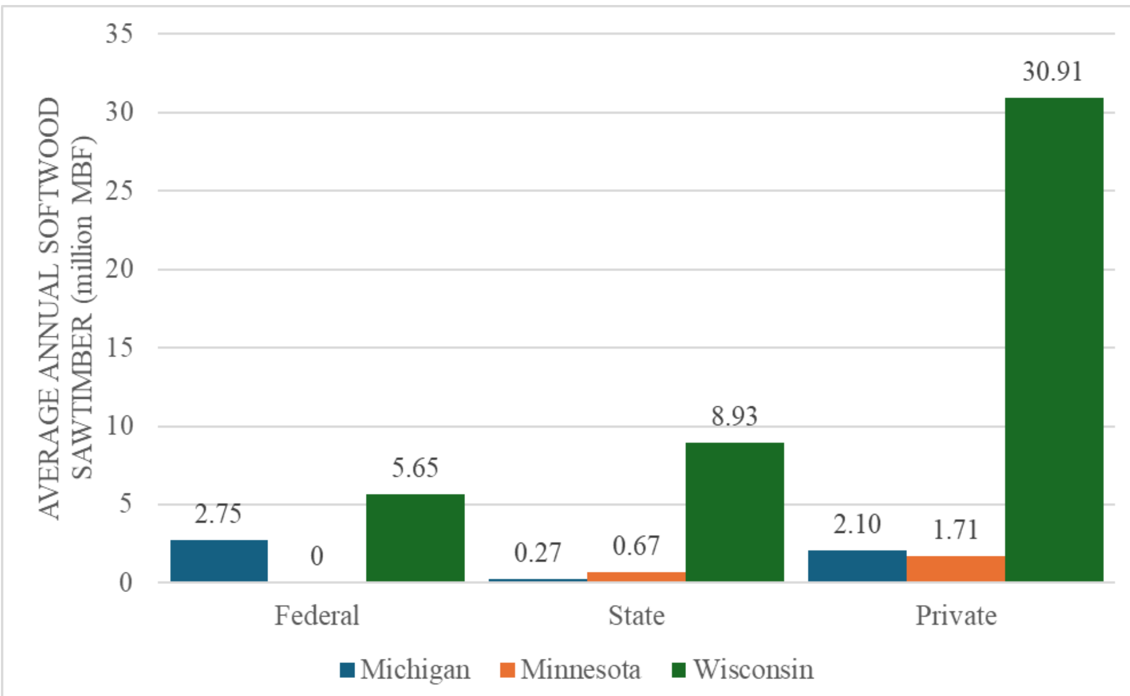

Figure 7. Total annual softwood sawtimber at the delivered softwood sawlog price of $300/MBF across ownerships and states for transport-cost based optimization accounting for supply only.

The availability of softwood sawtimber is higher in the procurement zone for the optimal location in Washburn County compared to Portage County, highlighting the forest-rich areas in the northern region. Forestry remains a core industry for rural areas in Wisconsin but is also facing challenges such as mill closures and associated job losses. The promotion of new industries such as the mass timber industry present promising opportunities for economic development and the revitalization of rural communities.

3.4 Economic Impact Analysis

3.3.1 Economic impacts at the state level

Table 4. Annual economic impacts of operating a new mass timber manufacturing facility in Wisconsin across different scales of production.

Production scale	Impact Type	Employment No.	Labor Income	Value Added	Output
			---------------million US $ (2023) ----------- -		
Small-scale	*Direct*	28	$2.14	$4.96	$35.31
	Indirect	58	$4.62	$6.94	$16.50
	Induced	29	$1.7	$3.17	$5.18
	Total	115	$8.46	$15.07	$56.99
	SAM Multiplier	4.09	3.95	3.04	1.61
Base-current	*Direct*	48	$3.67	$8.53	$60.90
	Indirect	99	$7.98	$11.97	$28.47
	Induced	50	$2.91	$5.47	$8.92
	Total	197	$14.56	$25.96	$98.30
	SAM Multiplier	4.10	3.97	3.04	1.61
Medium-scale	*Direct*	86	$6.57	$15.32	$109.48
	Indirect	178	$14.34	$21.51	$51.18
	Induced	90	$5.23	$9.82	$16.03
	Total	354	$26.14	$46.65	$176.69
	SAM Multiplier	4.12	3.98	3.05	1.61
Large-scale	*Direct*	180	$13.76	$32.10	$229.55
	Indirect	374	$30.07	$45.11	$107.33
	Induced	189	$10.95	$20.57	$33.59
	Total	743	$54.78	$97.78	$370.46
	SAM Multiplier	4.13	3.98	3.05	1.61

Table 4 presents the annual economic impacts of operating a new mass timber manufacturing facility in Wisconsin across different scales of production capacity. The operation of a new mass timber manufacturing facility for the base case scenario is estimated to create 48 direct jobs at the facility, generating $3.67 million of direct labor income, $60.90 million of direct output, and $8.53 million of direct value added. This direct impact extends to indirect and induced economic impacts through inter-industry purchases and labor spending generating indirect and induced impacts. Accounting for direct, indirect and induced effect, a new mass timber facility will create 197 full-and-part time jobs with associated $98.3 million of output and $25.96 million of value added.

The operation of a new mass timber production facility for small to large production scales is estimated to create 28 to 180 direct jobs at the facility, generating $2.14 to $13.76 million in direct labor income, $35.31 to $229.55 million of direct output, and $4.96 to $32.10 million in direct value-added. The total SAM multiplier for the base case scenario is 4.10 for employment and 1.61 for total output, which indicates that for each direct job at the facility, there are 3.10 additional jobs created and for each dollar invested in mass timber production facility, an additional $0.61 is circulated in the economy through indirect and induced effects.

Table 5. Impacts on average annual taxes by the operation of a new mass timber manufacturing facility in Wisconsin across different scales of production.

Production scale	Impact type	County	State	Federal	Total
		----------------100 thousand US $ (2023) ----------------			
Small-scale	*Direct*	$0.82	$1.75	$5.66	$8.23
	Indirect	$1.79	$3.10	$10.32	$15.20
	Induced	$1.32	$1.81	$4.08	$7.21
	Total	$3.93	$6.66	$20.06	$30.65
Base-current	*Direct*	$1.24	$4.74	$26.03	$32.01
	Indirect	$0.03	$0.05	$0.16	$0.23
	Induced	$2.28	$3.12	$7.05	$12.46
	Total	$3.55	$7.91	$33.24	$44.70
Medium-scale	*Direct*	$2.55	$5.42	$17.42	$25.38
	Indirect	$5.55	$9.61	$32.00	$47.16
	Induced	$4.08	$5.59	$12.63	$22.30
	Total	$12.18	$20.62	$62.04	$94.84
Large-scale	*Direct*	$5.34	$11.36	$36.47	$53.17
	Indirect	$11.65	$20.14	$67.10	$98.89
	Induced	$8.55	$11.72	$26.47	$46.74
	Total	$25.54	$43.22	$130.03	$198.79

Table 5 shows the total impacts on average annual taxes at the county, state, and federal level with the operation of a new mass timber manufacturing facility in Wisconsin. In the base case scenario, the total tax impact is $4.4 million, comprising $1.15 million in state and local taxes and $3.32 million in federal taxes. Depending on the scale of production, tax contributions range from $3.10 million for small-scale operations to $19.9 million for large scale production.

3.3.2 Economic impacts at the county level

We assessed the economic impacts for the two counties identified in this study as the optimal locations for potential mass timber manufacturing facility in Wisconsin (Tables 6 – 9)

Portage County

Table 6. Economic impacts of operating a new mass timber manufacturing facility in Portage County's economy across different scales of production

Production scale	Impact type	Employment No.	Labor Income	Value Added	Output
			--------------million US $ (2023) -----------		
Small-scale	*Direct*	28	$3.74	$6.99	$35.31
	Indirect	28	$2.16	$3.61	$8.85
	Induced	18	$0.86	$1.79	$2.95
	Total	75	$6.76	$12.39	$47.11
	SAM Multiplier	2.66	1.81	1.77	1.33
Base-current	*Direct*	48	$6.40	$12.03	$60.90
	Indirect	23	$1.82	$3.10	$6.80
	Induced	23	$1.05	$2.23	$3.70
	Total	94	$9.27	$17.36	$71.40
	SAM Multiplier	1.96	1.44	1.44	1.17
Medium-scale	*Direct*	86	$11.47	$21.58	$109.48
	Indirect	88	$6.73	$11.23	$27.48
	Induced	57	$2.67	$5.52	$9.11
	Total	230	$20.87	$38.33	$146.07
	SAM Multiplier	2.68	1.82	1.78	1.33
Large-scale	*Direct*	180	$24.02	$45.20	$229.55
	Indirect	184	$14.11	$23.56	$57.67
	Induced	119	$5.59	$11.57	$19.08
	Total	482	$43.71	$80.33	$306.29
	SAM Multiplier	2.68	1.82	1.78	1.33

Table 6 presents the economic impacts of operating a mass timber manufacturing in Portage County, Wisconsin. For the base case scenario, it is estimated to create 48 direct jobs at the facility, generating $6.40 of direct labor income, $60.90 million of direct output, and $12.03 million of direct value added. Accounting for indirect and induced impacts stemming from the direct impacts, the operation of a new mass timber manufacturing facility will create 94 total jobs, generate $9.27 million in total labor income, $71.40 million in total output, and $17.36 million in total value added.

Similarly, the total impacts of operating a mass timber manufacturing facility in Portage County from small to large scale of production creates 75 to 482 total jobs, $6.76 to $43.71 million in labor income, $47.11 to $302.29 million in output, and $12.39 to $80.33 million in value added. The total SAM multiplier for the base case scenario is 1.96 for employment and 1.17 for total output, suggesting that for each direct job created at the facility, there is additional 0.96 jobs created and for each dollar invested, an additional $0.17 is circulated in the economy through indirect and induced effects.

Table 7. Impacts on average annual taxes by the operation of a new mass timber manufacturing facility in Portage County across different scales of production

Production scale	**Impact type**	**County**	**State**	**Federal**	**Total**
		------------hundred thousand US $(2023) ----------------			
Small-scale	*Direct*	$0.86	$2.35	$8.14	$11.35
	Indirect	$1.18	$1.83	$4.82	$7.82
	Induced	$0.87	$1.20	$2.06	$4.13
	Total	$2.90	$5.38	$15.02	$23.29
Base-current	*Direct*	$1.48	$4.05	$13.97	$19.49
	Indirect	$2.04	$3.15	$8.32	$13.51
	Induced	$1.49	$2.06	$3.55	$7.10
	Total	$5.01	$9.26	$25.83	$40.10
Medium-scale	*Direct*	$2.66	$7.27	$25.04	$34.97
	Indirect	$3.67	$5.67	$14.97	$24.30
	Induced	$2.68	$3.70	$6.36	$12.74
	Total	$9.00	$16.64	$46.37	$72.01
Large-scale	*Direct*	$5.57	$15.24	$52.43	$73.24
	Indirect	$7.69	$11.90	$31.40	$50.99
	Induced	$5.61	$7.75	$13.34	$26.70
	Total	$18.87	$34.89	$97.17	$150.93

Table 7 shows contribution in annual taxes by the operation of a new mass timber facility in Portage County. The total annual tax contribution to the county with the operation of a new mass timber facility for the base case scenario is $4.01 million. The total tax contribution from small to large scale of production ranges from $2.33 million to 15.10 million.

Washburn County

Table 8. Economic impacts of operating a new mass timber manufacturing facility in Washburn County's economy across different scales of production.

Production scale	**Impact type**	**Employment no.**	**Labor Income**	**Value Added**	**Output**
			--------------million US $ (2023) -----------		
Small-scale	*Direct*	28	$3.74	$6.99	$35.31
	Indirect	45	$2.38	$3.53	$10.79
	Induced	15	$0.64	$1.37	$2.31
	Total	88	$6.75	$11.90	$48.42
	SAM Multiplier	3.15	1.81	1.70	1.37
Base-current	*Direct*	48	$6.40	$12.03	$60.90
	Indirect	78	$4.10	$6.10	$18.63
	Induced	26	$1.10	$2.35	$3.97
	Total	152	$11.61	$20.48	$83.51
	SAM Multiplier	3.17	1.81	1.70	1.37
Medium-scale	*Direct*	86	$11.47	$21.59	$109.48
	Indirect	140	$7.38	$10.98	$33.50
	Induced	47	$1.97	$4.22	$7.13
	Total	273	$20.83	$36.78	$150.11
	SAM Multiplier	3.17	1.82	1.70	1.37
Large-scale	*Direct*	180	$24.02	$45.22	$229.55
	Indirect	293	$15.48	$23.02	$70.27
	Induced	99	$4.13	$8.84	$14.94
	Total	572	$43.63	$77.08	$314.76
	SAM Multiplier	3.18	1.82	1.70	1.37

Table 8 shows the economic impacts of operating a mass timber manufacturing facility in Washburn County, Wisconsin. The direct impacts the same as in Portage County; however, indirect and induced impacts are higher in Washburn County. SAM multipliers are also higher for Washburn County than Portage County. The total SAM multiplier for the base case scenario for the Washburn County is 3.17 got employment and 1.37 for total output, which indicates for each direct employment at the facility in Washburn County, there are 2.17 additional jobs created and for each dollar invested, an additional $0.37 is circulated in the economy through indirect and induced impacts.

Table 9. Impacts on county's average annual taxes by the operation of a new mass timber manufacturing facility in Washburn County across different scales of production.

Production scale	**Impact type**	**County**	**State**	**Federal**	**Total**
		--------------hundred thousand US $ (2023) --------------			
Small-scale	*Direct*	$1.13	$1.95	$8.82	$11.91
	Indirect	$1.39	$1.54	$5.46	$8.39
	Induced	$0.81	$0.74	$1.63	$3.18
	Total	$3.34	$4.23	$15.91	$23.47
Base-current	*Direct*	$1.95	$3.36	$15.14	$20.45
	Indirect	$2.41	$2.65	$9.42	$14.48
	Induced	$1.40	$1.27	$2.80	$5.47
	Total	$5.76	$7.28	$27.36	$40.40
Medium-scale	*Direct*	$3.51	$6.03	$27.13	$36.67
	Indirect	$4.33	$4.77	$16.94	$26.04
	Induced	$2.51	$2.28	$5.03	$9.81
	Total	$10.35	$13.08	$49.10	$72.53
Large-scale	*Direct*	$7.37	$12.63	$56.80	$76.80
	Indirect	$9.08	$10.01	$35.54	$54.63
	Induced	$5.26	$4.77	$10.53	$20.56
	Total	$21.70	$27.41	$102.87	$151.99

Operating a new mass timber manufacturing facility with the base case scenario in Washburn County produces a total annual tax contribution of $4.04 million (Table 9). The total tax contribution from small to large scale of production ranges from $2.35 million to 15.20 million.

3.3.3 Economic impacts of operating a new mass timber facility to the neighboring counties

Any industry's production creates demand for other industries, some of which "leaks" outside the area of interest. For example, it is common for people to work in a different county than they live in or industries to source raw materials from neighboring counties. Therefore to address this leakage, we examined the economic impacts at the inter-county level based on commuting flows between home (place of residence) to work (primary place of work). We referred to American Commuter Survey data from 2016 to 2020 and identified the top five counties of residence for individuals who commute to Portage County and Washburn County as the primary place of work.

For Portage County as the primary place of work, the top five counties of residence were Portage County, Wood County, Marathon County, Waupaca County, and Waushara County. Similarly, for Washburn County as the primary place of work, the top five counties of residence were Washburn County, Barron County, Burnett County, Sawyer County, and Douglas County.

We performed a county level MRIO analysis for top five commuter counties linked to Portage and Washburn, across various production scales (Figures 8 -11). Key economic indicators are in Tables 1 and 2 of Appendix II.

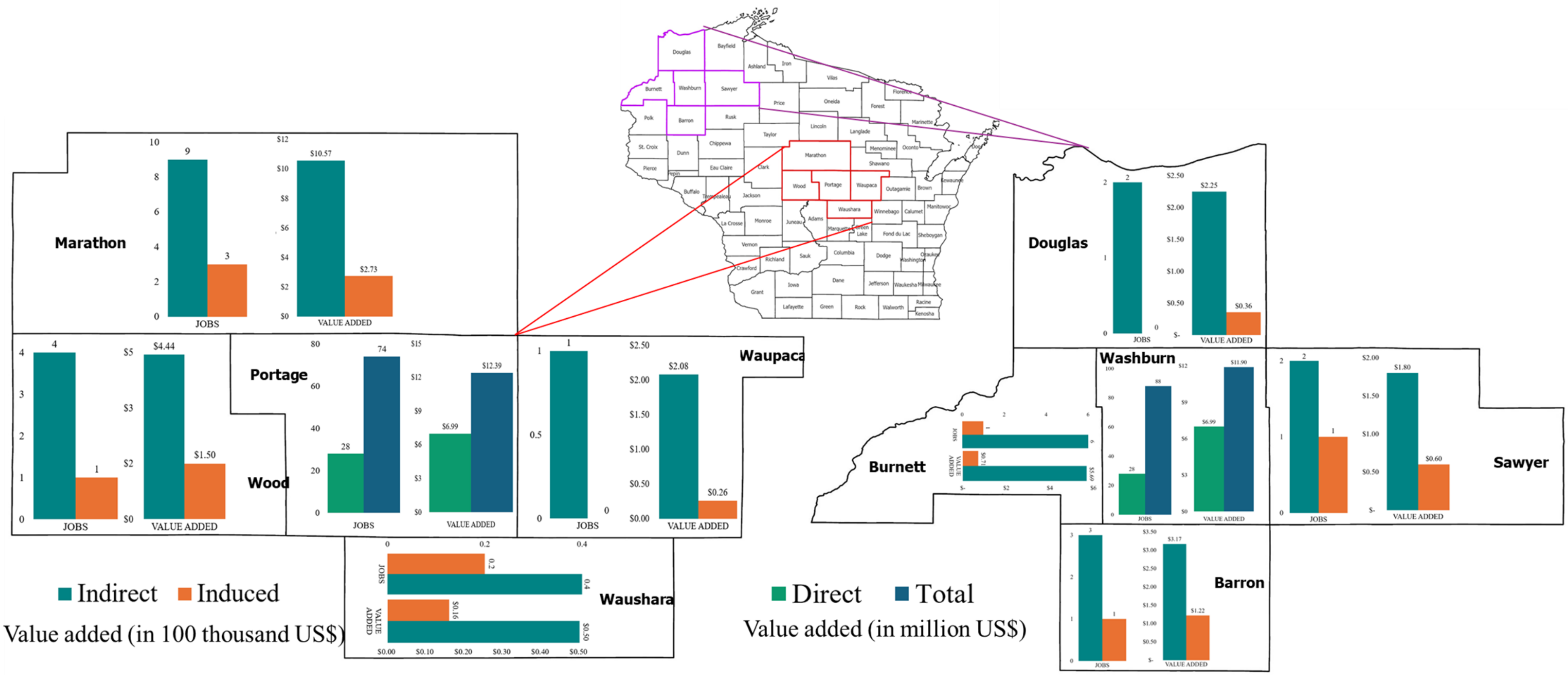

Figure 8. Annual economic impacts of operating a new mass timber facility with small scale of production in Portage County and Washburn County and across the neighboring counties.

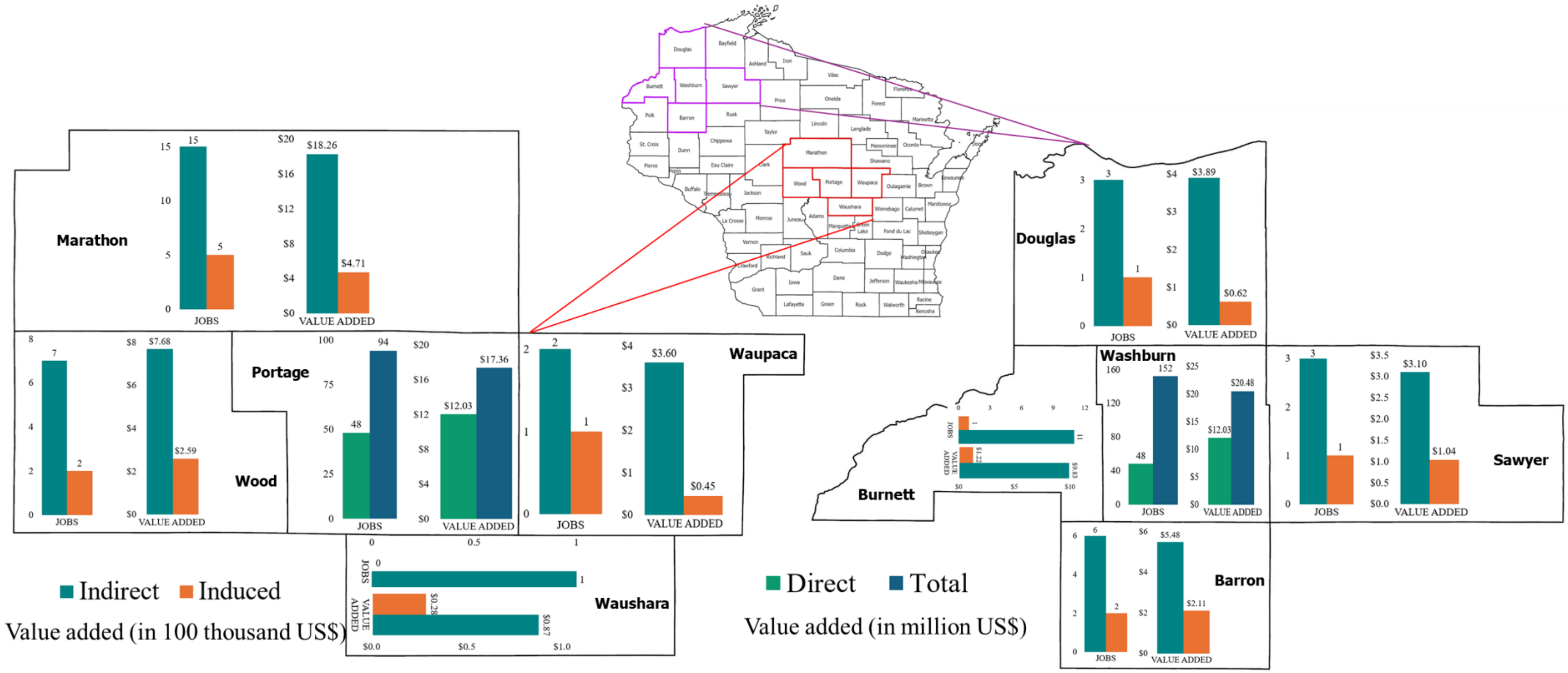

Figure 9. Annual economic impacts of operating a new mass timber facility with base(current)-scale of production in Portage County and Washburn County and across the neighboring counties.

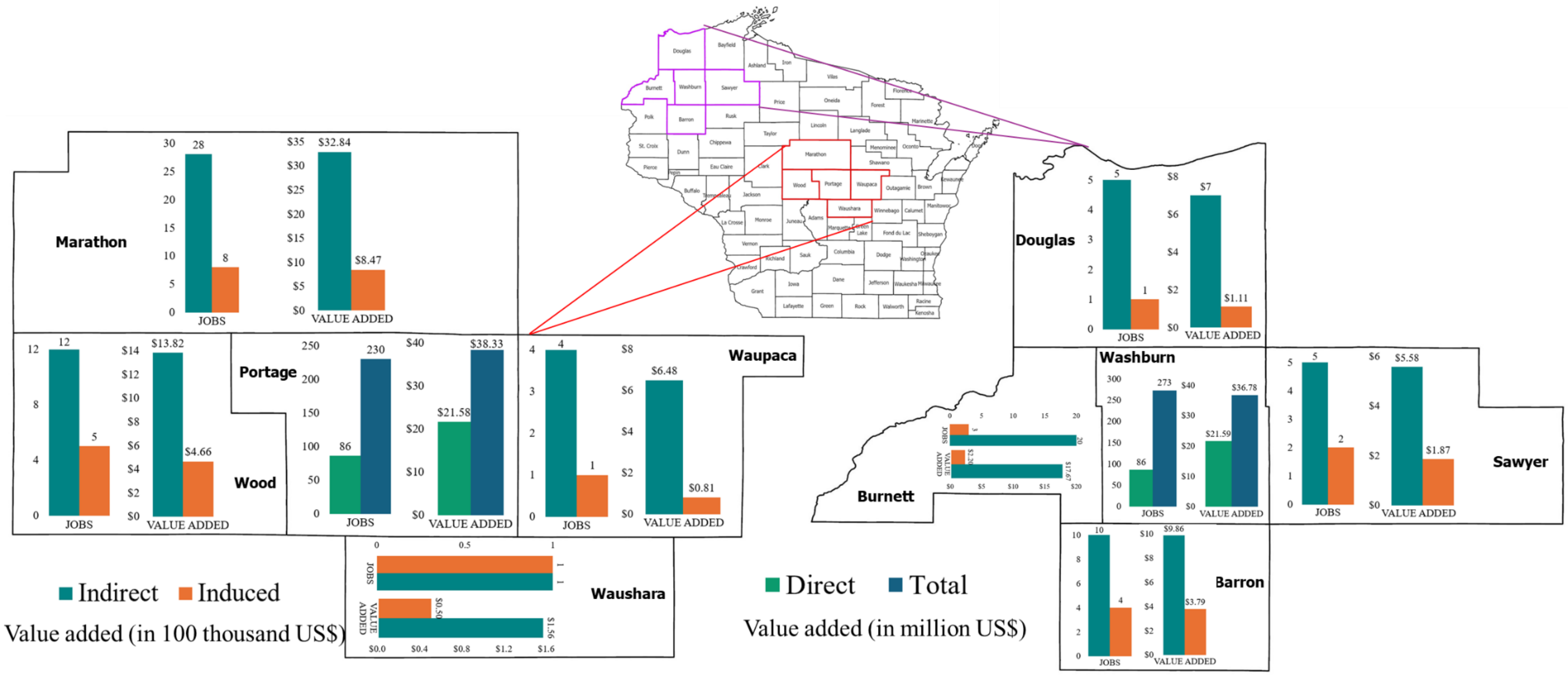

Figure 10. Annual economic impacts of operating a new mass timber facility with medium scale of production in Portage County and Washburn County and across the neighboring counties.

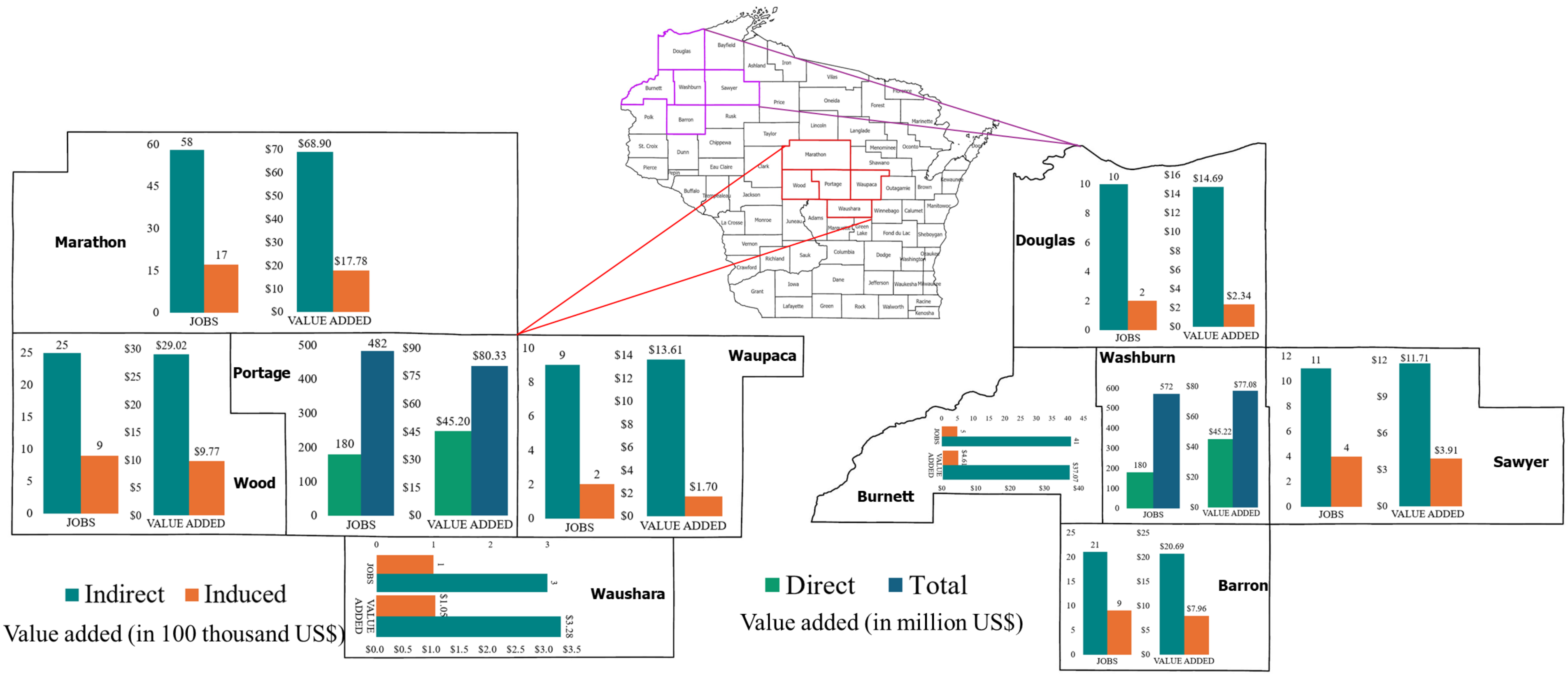

Figure 11. Annual economic impacts of operating a new mass timber facility with large scale of production in Portage County and Washburn County and across the neighboring counties.

4. Conclusions

With the construction of the tallest mass timber structure in the world, Wisconsin has a unique opportunity to expand mass timber momentum in the Midwest by establishing a mass timber manufacturing facility in the state. This study identified two optimal locations—Stevens Point in Portage County and a site near Gull Lake in Washburn County—based on the optimization of travel cost, distance, and time, using two economic models, one that balanced both demand and supply, and one focused exclusively on supply. We also identified procurement zones and competition hotspots for softwood sawmills sourcing softwood logs from forests, including the annual average availability of softwood sawtimber across the Lake States under different ownerships, to support the potential mass timber manufacturing facility. Economic impact analyses at the county, state, and regional levels were conducted to assess the impacts of operating a new mass timber manufacturing facility.

The average annual softwood sawtimber availability ranges from 41.46 to 53.0 million MBF across the Lake States when paid at the current market delivered softwood log price ($300/MBF) in Wisconsin. Most of the available softwood sawtimber, ranging from 86% to 95% will be procured from Wisconsin, with the remainder sourced from neighboring states of Michigan and Minnesota. Forests under private ownership will dominate the supply (over 65%), followed by state and federal forests. The high availability of feedstock in Wisconsin, particularly from private forests, presents a valuable opportunity for domestic utilization of forest resources and the creation of better market opportunities through the engagement of private forest landowners in active forest management. Information on resource availability within procurement zones and potential competition for feedstock will assist forest managers and prospective mass timber manufacturers in building a cost-effective, efficient, and sustained supply chain.

Economic impact analyses indicate significant benefits to the county, state, and regional economies from operating a new mass timber facility in Wisconsin at different production scales (small, base, medium, and large). Direct output is estimated to range from $35.3 million to $229.5 million at the facility from small- to large-scale and a total output ranging from $56.99 million to $370.46 million in the state's economy. For Portage County, total output is estimated to range from $47.11 million to $306.29 million, and for Washburn County, total output ranges from $48.42 million to $314.76 million across various production scales. The facility is also expected to contribute significant annual tax revenues at the county, state, and federal levels. SAM multipliers were similar across different scales of production but differed between the two counties—higher in Washburn County compared to Portage County, indicating stronger economic impacts in rural areas.

The operation of a mass timber manufacturing facility in Wisconsin would create new market opportunities for forest landowners, particularly in rural areas, and support rural economic prosperity. It would also support to generate revenue that can be reinvested in forest management and the continued health of the forest products industry. While this study identified two optimal locations based on two economic models and minimizing procurement transportation costs between supply and demand points, additional social-economic factors not captured in our model may influence investment decisions.

With abundant softwood sawtimber resources available in Wisconsin and the surrounding region, the state is well-positioned to support mass timber manufacturing facilities in any location in the state, depending on the specific socio-economic or related operational preferences of prospective investors. Such development would help diversify Wisconsin’s forest products industry through value-added products like mass timbe and create jobs across the wood supply chain and in related sectors such as sawmills and commercial logging, thereby supporting broader economic development.

Furthermore, ongoing efforts into the use of hardwood species in mass timber construction will expand the opportunity for Wisconsin and the Lake States region to become a regional hotspot for the growing mass timber industry in the United States.

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Appendix I: Distance and Time-based optimization

Identification of optimal location for new mass timber manufacturing facility balancing demand and supply

The distance-and time-based optimization model identified an optimal location for a new mass timber manufacturing facility in Portage County, Wisconsin, when both demand and supply locations were incorporated in the model (Figures 1 and 2). This location was selected based on the optimization of transportation distances and time for procuring logs from forests to softwood sawmills, lumber from sawmills to potential mass timber facilities, and CLT panels from potential mass timber facilities to cities (demand centers).

For the distance-based optimization, a total of 137 forest plots will supply the feedstock (softwood logs) to nine softwood sawmills, which will then process logs into lumber for producing mass timber panels in Portage County (Figure 1). Most of the feedstock will be supplied by forests in central Wisconsin, as indicated by the procurement zone of current market delivered softwood log prices in Wisconsin, while a small portion of logs will also be procured from the Upper Peninsula of Michigan.

For the time-based optimization, a total of 114 forest plots will supply softwood logs to 13 softwood sawmills which will supply lumber to the mass timber manufacturing facility in Portage County (Figure 2). Majority of feedstock in this model will be supplied from central and northern Wisconsin and again a small portion from the Upper Peninsula of Michigan.

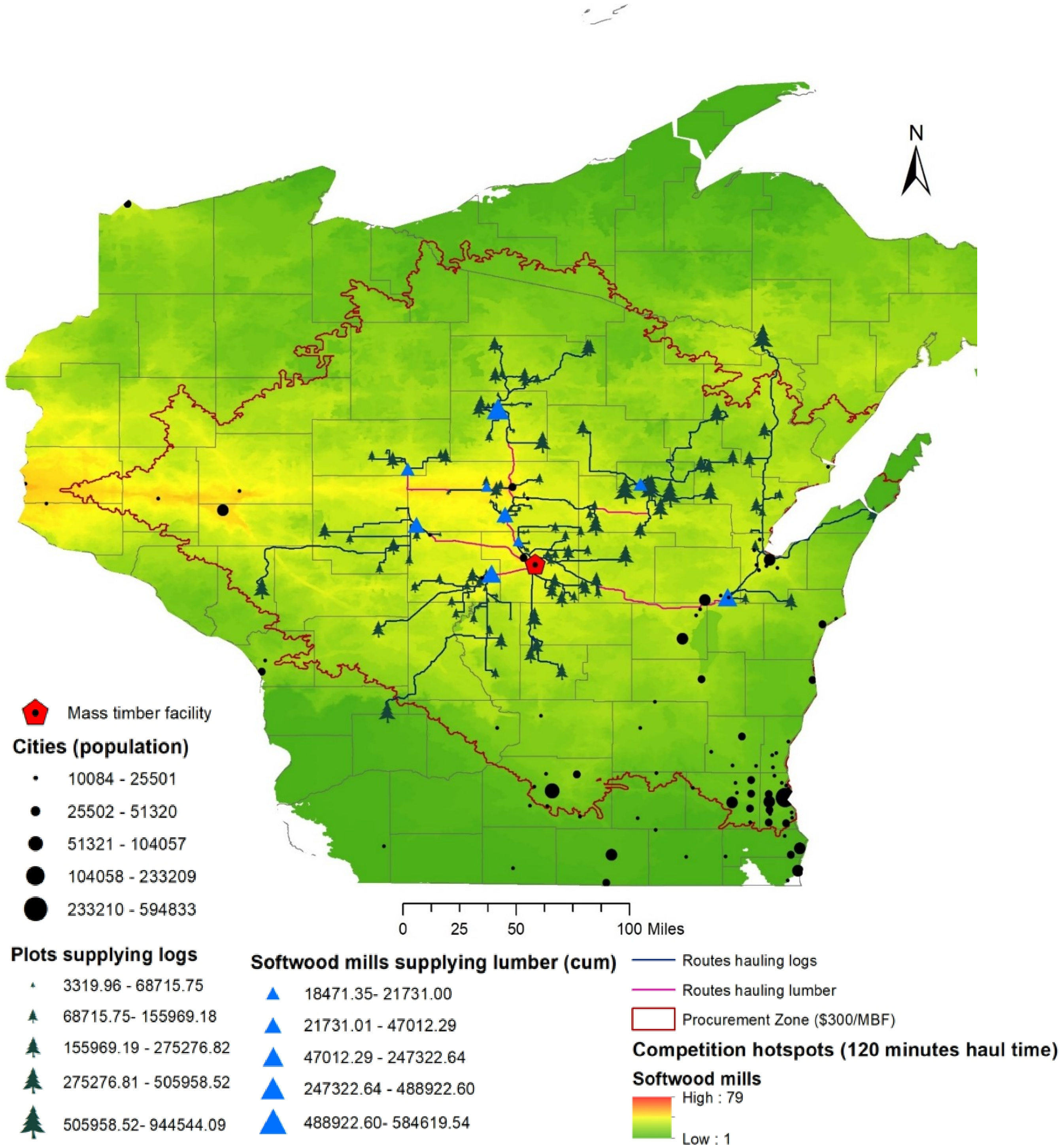

Figure 1. Map showing procurement zone (based on average delivered softwood price of $300/MBF) and competition hotspots of potential mass timber facility in Portage County, Wisconsin based on optimized travel distances and balancing both demand and supply.

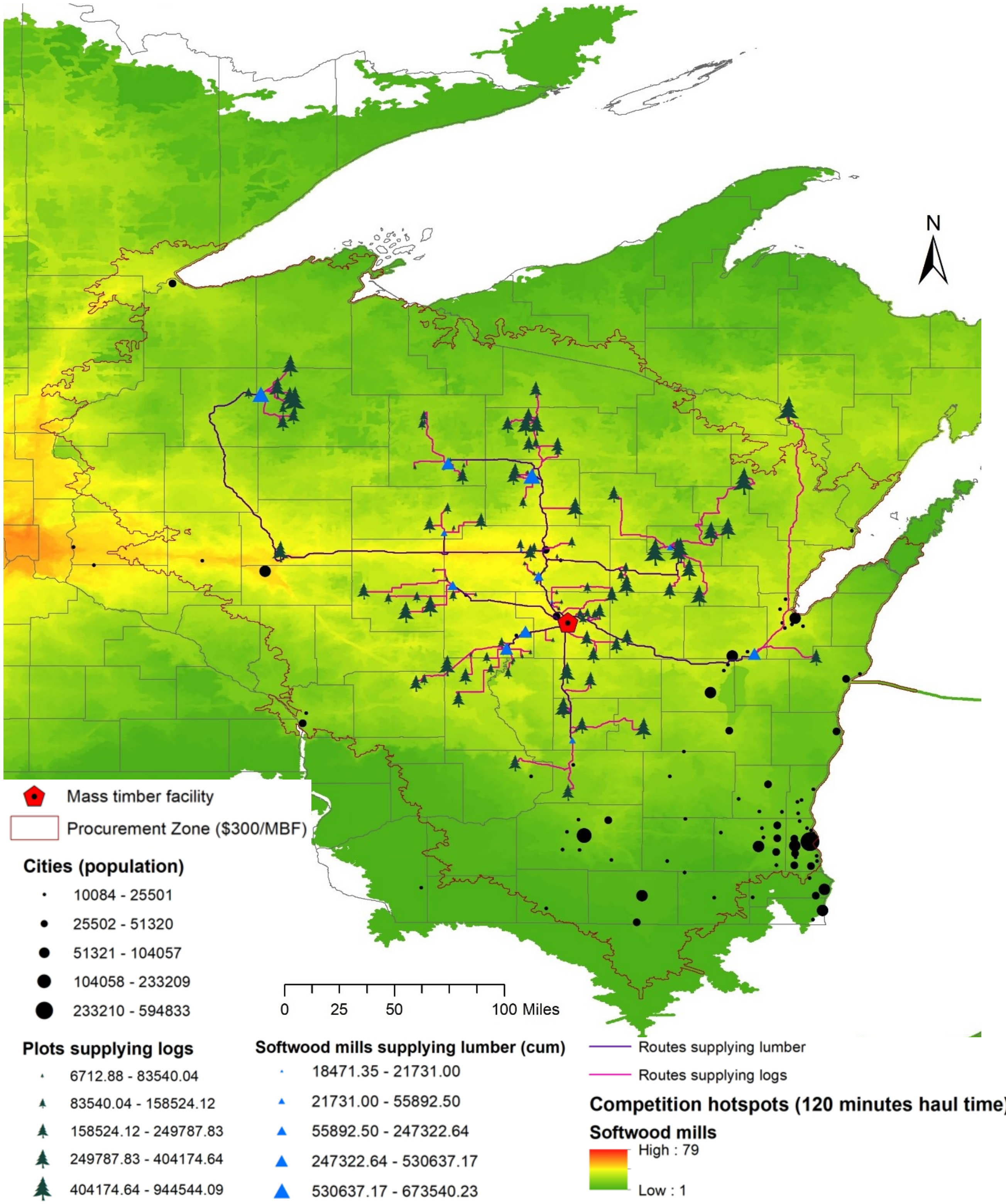

Figure 2. Map showing procurement zone (based on average delivered softwood price of $300/MBF) and competition hotspots of potential mass timber facility in Portage County, Wisconsin based on optimized travel time and balancing both demand and supply.

Identification of optimal location for new mass timber manufacturing facility accounting for supply only

In the scenario where only supply was accounted for, both the distance-and time-based optimization identified an optimal location for a mass timber manufacturing facility in Washburn County (Figures 3 and 4). This location was selected based on the optimization of transportation distances and time for procuring logs from forests to softwood sawmills, lumber from sawmills to potential mass timber facilities, but not from potential mass timber facilities to cities (demand centers).

For the distance-based optimization, a total of 111 forest plots will supply softwood logs to five softwood mills which will then supply lumber to potential mass timber facility in Washburn County (Figure 3). The procurement zone for this facility extends from northwestern Wisconsin to southeastern Wisconsin, and even into Minnesota and the Upper Peninsula of Michigan.

For the time-based optimization, a total of 105 plots will supply logs to eight softwood mills for manufacturing mass timber at the potential facility in Washburn County (Figure 4). Without accounting for demand centers, the procurement zone extends further north, including some parts of Minnesota, with most forests located in the central and northern Wisconsin.

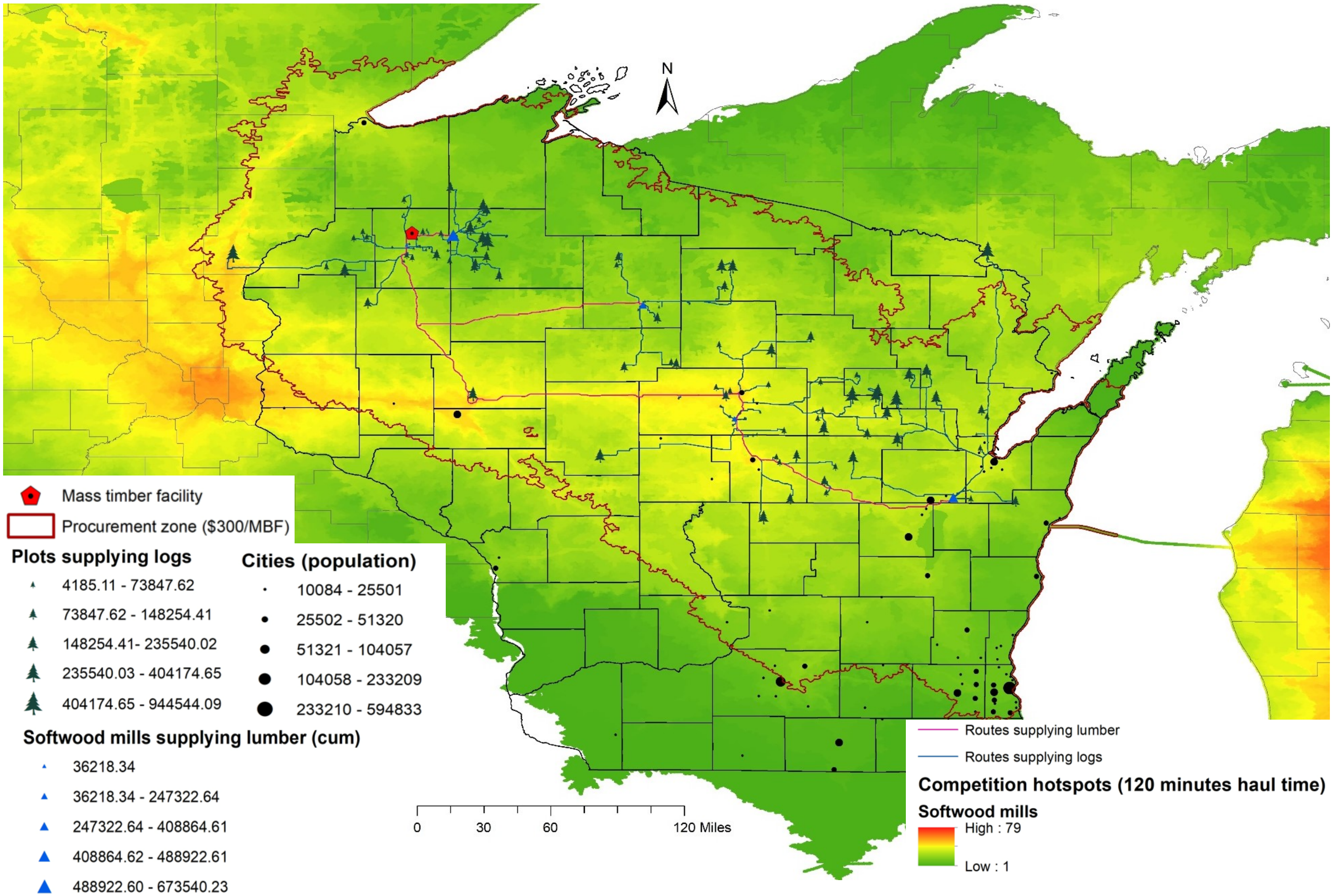

Figure 3. Map showing procurement zone (based on average delivered softwood price of $300/MBF) and competition hotspots of potential mass timber facility in Washburn County, Wisconsin based on optimized travel distance accounting for supply only.

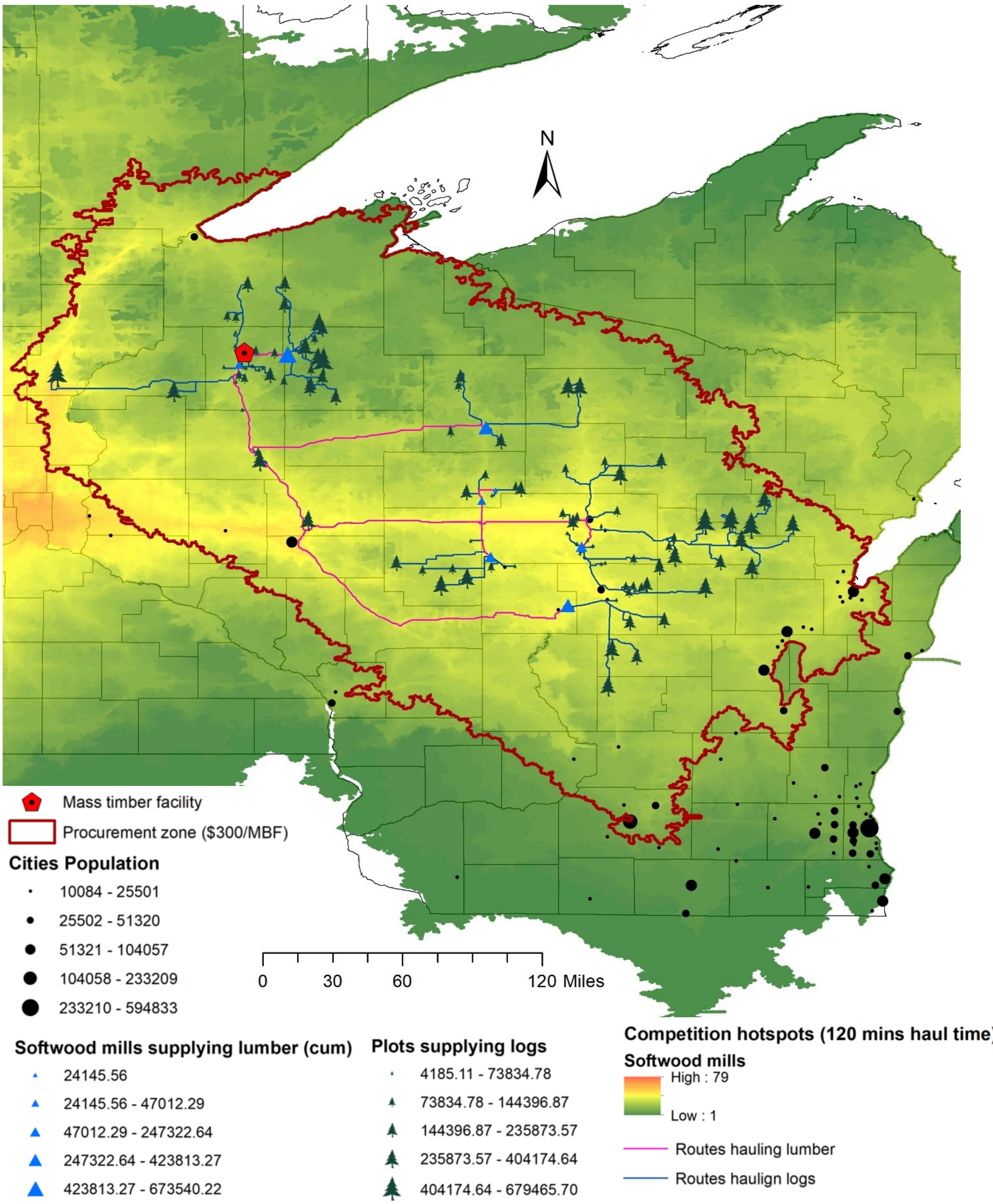

Figure 4. Map showing procurement zone (based on average delivered softwood price of $300/MBF) and competition hotspots of potential mass timber facility in Washburn County, Wisconsin based on optimized travel time accounting for supply only.

For the transport cost-based optimization balancing supply and demand, analysis of FIA estimates showed that a total of 16.43 million MBF average annual softwood sawtimber is available within the procurement zone at the delivered softwood sawlog price of $300/MBF. In addition, over 95% of the softwood sawtimber can be sourced from Wisconsin. About 66% of the softwood sawtimber is available in private forests, followed by 21% in state forests, and the remaining 13% from federal ownership (Figure 5).

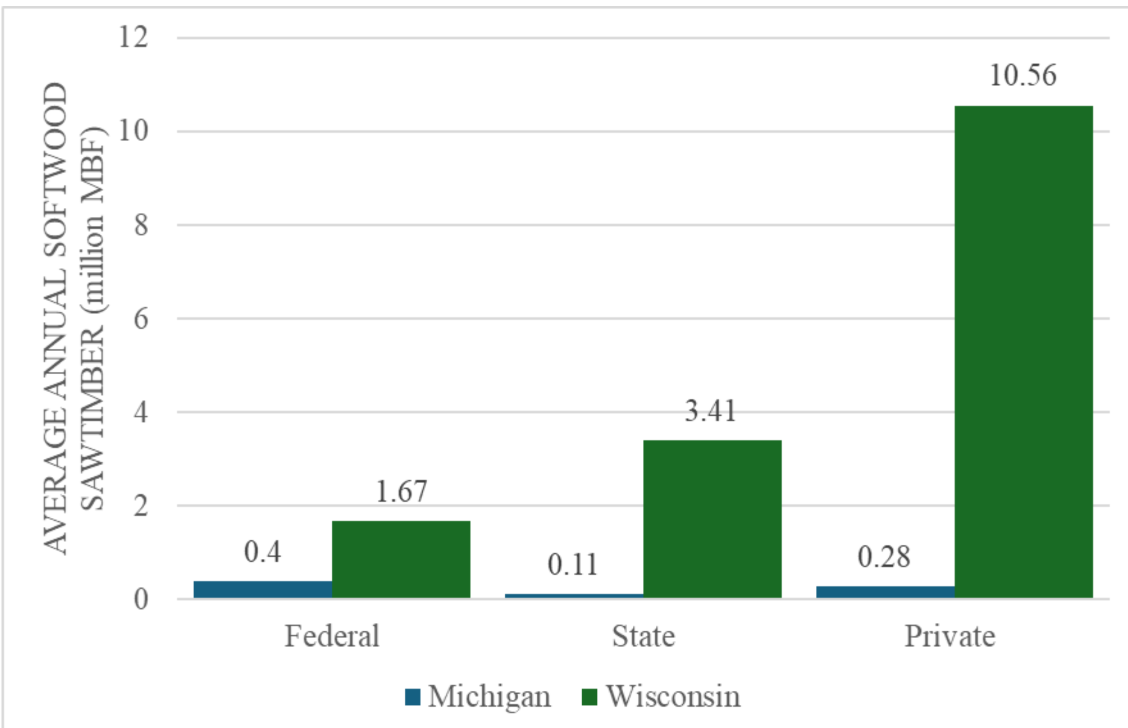

Figure 5. Total annual softwood sawtimber at the delivered softwood sawlog price of $300/MBF across ownerships and states for transport-distance based optimization balancing supply and demand.

For the travel time-based optimization balancing supply and demand, a total of 21.93 million MBF average annual softwood sawtimber is available within the procurement zone at the delivered softwood sawlog price of $300/MBF in Wisconsin. In addition, about 95% of the softwood sawtimber can be sourced from

Wisconsin, followed by 4% from Michigan, and remaining (1%) from Minnesota. Approximately 62% of the softwood sawtimber is available in private forests, followed by 23% in state forests, and the remaining 15% from federal ownership (Figure 6).

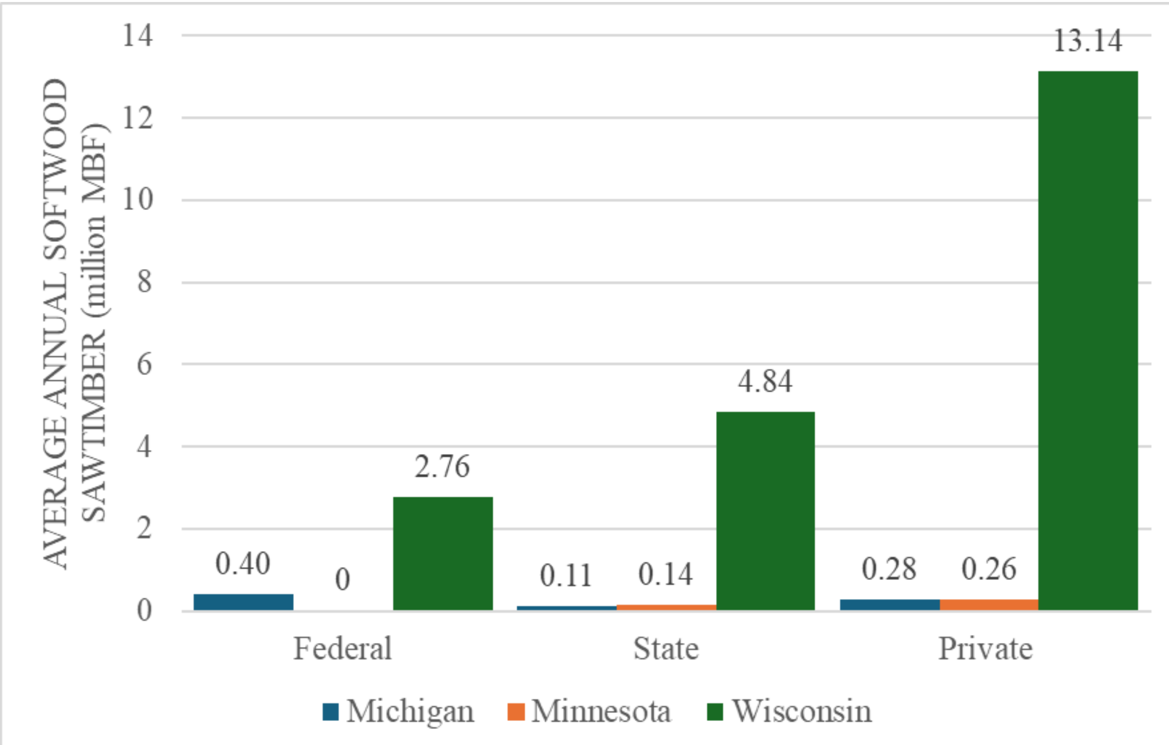

Figure 6. Total annual softwood sawtimber at the delivered softwood sawlog price of $300/MBF across ownerships and states for transport time-based optimization balancing supply and demand.

For the scenario with travel distance-based optimization and accounting for supply only, we estimated availability of a total of 19.65 million MBF average annual softwood sawtimber within the procurement zone at the delivered softwood sawlog price of $300/MBF in Wisconsin. In addition, about 92% of the softwood sawtimber can be sourced from Wisconsin, followed by 6% from Minnesota, and remaining (2%) from Michigan. About 65% of the softwood sawtimber is available in private forests, followed by 25% in state forests, and the remaining 10% from federal ownership (Figure 7).

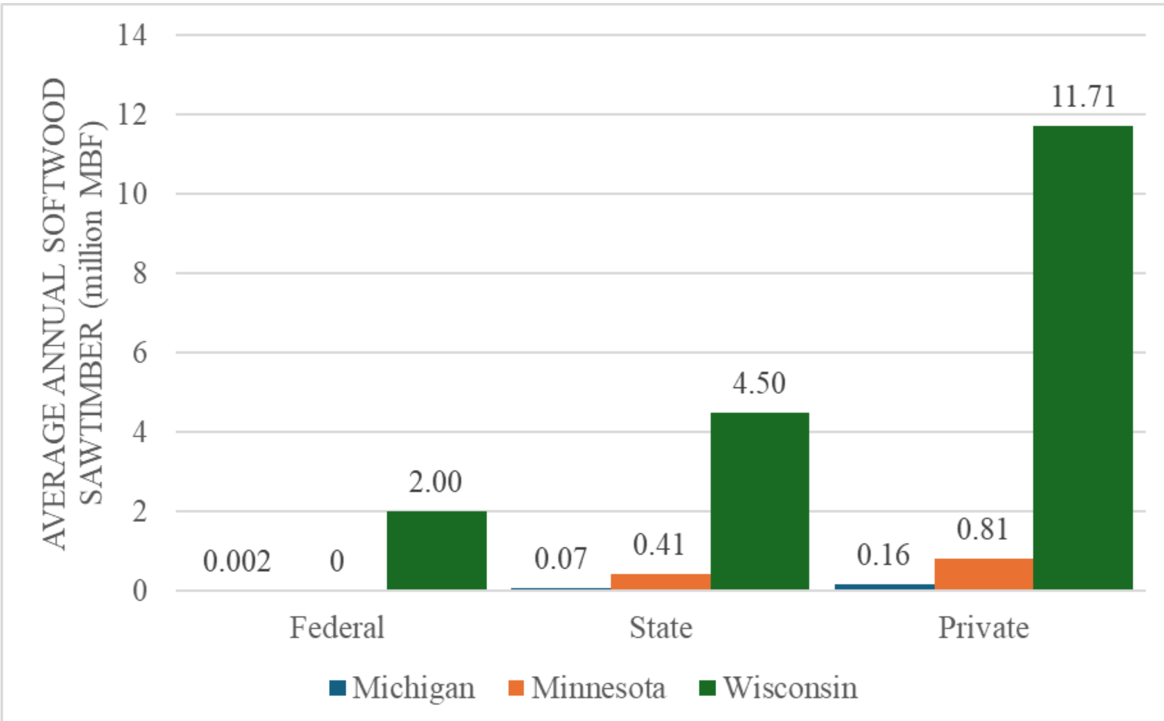

Figure 7. Total annual softwood sawtimber at the delivered softwood sawlog price of $300/MBF across ownerships and states for transport-distance based optimization accounting for supply only.

For the scenario with travel time-based optimization and accounting for supply only, we estimated availability of a total of 18.66 million MBF average annual softwood sawtimber within the procurement zone at the delivered softwood sawlog price of $300/MBF in Wisconsin. In addition, about 93% of the softwood sawtimber can be sourced from Wisconsin, followed by 6% from Minnesota, and remaining (<1%) from Michigan. About 64% of the softwood sawtimber is available in private forests, followed by 25% in state forests, and the remaining 11% from federal ownership (Figure 8).

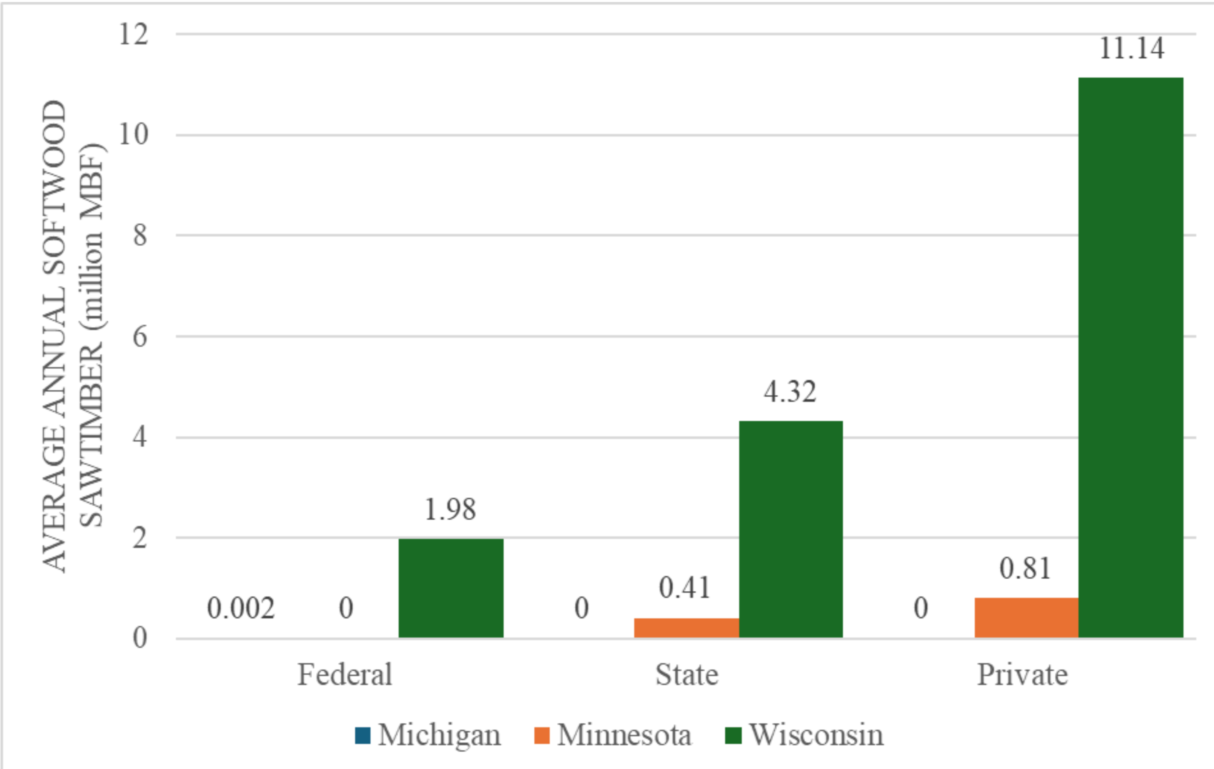

Figure 8. Total annual softwood sawtimber at the delivered softwood sawlog price of $300/MBF across ownerships and states for transport-time based optimization accounting for supply only.

Appendix II: Annual economic impacts at the inter-county level

Table 1: Annual economic impacts at the multi-county level across four neighboring counties as place of residence with Portage County as the optimal location of operating a new mass timber facility of different scales of production.

Residence County	Production scale	Impact type	Employment No.	Labor Income	Value Added	Output
				----hundred thousand US $(2023) --		
Wood	Small-scale	*Indirect*	4	$2.84	$4.44	$12.17
		Induced	1	$0.79	$1.50	$2.44
		Total	5	$3.63	$5.94	$14.61
	Base-current	*Indirect*	7	$4.92	$7.68	$21.03
		Induced	2	$1.36	$2.59	$4.21
		Total	9	$6.28	$10.26	$25.24
	Medium-scale	*Indirect*	12	$8.85	$13.82	$37.86
		Induced	5	$2.45	$4.66	$7.58
		Total	17	$11.30	$18.48	$45.44
	Large-scale	*Indirect*	25	$18.58	$29.02	$79.48
		Induced	9	$5.15	$9.77	$15.90
		Total	34	$23.73	$38.80	$95.38
Marathon	Small-scale	*Indirect*	9	$6.59	$10.57	$28.28
		Induced	3	$1.42	$2.73	$4.39
		Total	12	$8.00	$13.30	$32.67
	Base-current	*Indirect*	15	$11.38	$18.26	$48.84
		Induced	5	$2.45	$4.71	$7.58
		Total	20	$13.82	$22.97	$56.42
	Medium-scale	*Indirect*	28	$20.46	$32.84	$87.86
		Induced	8	$4.40	$8.47	$13.64
		Total	36	$24.87	$41.31	$101.49
	Large-scale	*Indirect*	58	$42.93	$68.90	$184.31
		Induced	17	$9.24	$17.78	$28.61
		Total	75	$52.17	$86.67	$212.92
Waupaca	Small-scale	*Indirect*	1	$0.89	$2.08	$6.47
		Induced	0	$0.11	$0.26	$0.43
		Total	1	$1.00	$2.34	$6.90
	Base-current	*Indirect*	2	$1.54	$3.60	$11.18
		Induced	1	$0.19	$0.45	$0.74
		Total	3	$1.73	$4.05	$11.92
		Indirect	4	$2.77	$6.48	$20.13

	Medium-scale	*Induced*	1	$0.34	$0.81	$1.33
		Total	5	$3.11	$7.29	$21.46
	Large-scale	*Indirect*	9	$5.81	$13.61	$42.24
		Induced	2	$0.72	$1.70	$2.80
		Total	11	$6.54	$15.30	$45.04
Waushara	Small-scale	*Indirect*	0.4	$0.44	$0.50	$1.09
		Induced	0.2	$0.06	$0.16	$0.28
		Total	0.6	$0.50	$0.66	$1.37
	Base-current	*Indirect*	1	$0.76	$0.87	$1.89
		Induced	0	$0.11	$0.28	$0.48
		Total	1	$0.87	$1.14	$2.37
	Medium-scale	*Indirect*	1	$1.36	$1.56	$3.41
		Induced	1	$0.20	$0.50	$0.86
		Total	2	$1.56	$2.06	$4.28
	Large-scale	*Indirect*	3	$2.86	$3.28	$7.18
		Induced	1	$0.42	$1.05	$1.81
		Total	4	$3.28	$4.33	$8.99

Table 2: Annual economic impacts at the multi-county level across four neighboring counties as place of residence with Washburn County as the optimal location of operating a new mass timber facility of different scales of production.

Residence County	Production scale	Impact type	Employment No.	Labor Income	Value Added	Output
				---hundred thousand US $(2023) --		
Barron	Small-scale	*Indirect*	3	$2.57	$3.17	$6.77
		Induced	1	$0.59	$1.22	$2.06
		Total	4	$3.16	$4.39	$8.83
	Base-current	*Indirect*	6	$4.44	$5.48	$11.71
		Induced	2	$1.02	$2.11	$3.55
		Total	8	$5.46	$7.59	$15.26
	Medium-scale	*Indirect*	10	$7.99	$9.86	$21.06
		Induced	4	$1.84	$3.79	$6.39
		Total	14	$9.83	$13.65	$27.45
	Large-scale	*Indirect*	21	$16.77	$20.69	$44.21
		Induced	9	$3.86	$7.96	$13.40
		Total	30	$20.63	$28.65	$57.61
Burnett	Small-scale	*Indirect*	6	$2.66	$5.69	$12.17
		Induced	1	$0.28	$0.71	$1.24
		Total	7	$2.95	$6.40	$13.41
		Indirect	11	$4.60	$9.83	$21.01

	Base-current	*Induced*	1	$0.49	$1.22	$2.14
		Total	12	$5.09	$11.05	$23.16
	Medium-scale	*Indirect*	20	$8.27	$17.67	$37.79
		Induced	3	$0.88	$2.20	$3.86
		Total	23	$9.15	$19.87	$41.65
	Large-scale	*Indirect*	41	$17.34	$37.07	$79.27
		Induced	5	$1.85	$4.61	$8.09
		Total	46	$19.20	$41.69	$87.36
Sawyer	Small-scale	*Indirect*	2	$1.20	$1.80	$5.55
		Induced	1	$0.29	$0.60	$1.00
		Total	3	$1.48	$2.40	$6.55
	Base-current	*Indirect*	3	$2.06	$3.10	$9.58
		Induced	1	$0.50	$1.04	$1.72
		Total	4	$2.56	$4.14	$11.30
	Medium-scale	*Indirect*	5	$3.71	$5.58	$17.24
		Induced	2	$0.89	$1.87	$3.10
		Total	7	$4.61	$7.45	$20.34
	Large-scale	*Indirect*	11	$7.79	$11.71	$36.17
		Induced	4	$1.87	$3.91	$6.50
		Total	15	$9.66	$15.62	$42.68
Douglas	Small-scale	*Indirect*	2	$1.14	$2.25	$5.05
		Induced	0	$0.15	$0.36	$0.59
		Total	2	$1.29	$2.61	$5.64
	Base-current	*Indirect*	3	$1.97	$3.89	$8.72
		Induced	1	$0.26	$0.62	$1.03
		Total	4	$2.23	$4.51	$9.75
	Medium-scale	*Indirect*	5	$3.55	$7.00	$15.69
		Induced	1	$0.47	$1.11	$1.85
		Total	6	$4.02	$8.11	$17.54
	Large-scale	*Indirect*	10	$7.46	$14.69	$32.94
		Induced	2	$0.98	$2.34	$3.88
		Total	12	$8.44	$17.03	$36.82

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DEPT. OF NATURAL RESOURCES

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