



NORTHEAST-MIDWEST
**STATE FORESTERS
ALLIANCE**

URBAN FORE\$TRY

ECONOMIC ANALYSIS

REGIONAL REPORT





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FOREWORD

Trees in our cities and suburbs contribute to local and regional economies by supporting jobs and other economic activities. For decades, we have known urban trees provide critical ecosystem services, environmental benefits and can improve human health. The following regional report is the first of its kind to pull urban-forestry-specific economic numbers out of broader green industry data. This regional report is an effort of states participating in the Northeast-Midwest State Forest Alliance (NMSFA), Urban and Community Forestry Committee (UCFC) to compile meaningful information about the urban forestry resource in the Northeast-Midwest region.

This report is the result of a multi-state Landscape Scale Restoration grant from the USDA Forest Service. The grant facilitated regional and state-by-state analysis of economic data using the IMPLAN model and quantified financial impacts of the urban forest resource using i-Tree Landscape. The Wisconsin Department of Natural Resources, Division of Forestry (on behalf of the UCFC) coordinated work on the grant project, including contracting with North Carolina State University (methodology development, IMPLAN data analysis, and preparation/review of region- and state-level reports) and the University of Wisconsin Survey Center (development, implementation and delivery of survey and data.) Participating states and other project partners helped define the scope and review drafts. All states in the region assisted with survey list development. The information provided in this report demonstrates the value of urban forestry to our regional economy and empowers decision makers to support the sustainable management of our urban forests. On behalf of the UCFC, I am proud to present the Urban Forestry Economic Analysis in the Northeast-Midwest Region.

Julie Coop, Chair | 2021-2022

Northeast-Midwest State Foresters Alliance, Urban & Community Forestry Committee
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I. EXECUTIVE SUMMARY

Urban forestry is a crucial section of the green industry and continues to grow as a popular solution to ecological issues in rapidly evolving urban landscapes. Along with providing aesthetic benefits and other critical ecosystem services, urban forestry contributes to local and regional economies by supporting jobs and economic activities through various businesses and industries. This report features a comprehensive analysis of the economic contribution of urban and community forestry to the regional economy of Washington, D.C. and 20 states in the Northeast-Midwest region. Economic contribution analyses, such as the one detailed in this report, are significant tools for communicating the greater monetary benefits of the urban forestry sector to policy makers and legislators.

THE SPECIFIC OBJECTIVES OF THE PROJECT

- 1 develop an input-output model to quantify the economic impact of the urban forest industry that can be applied consistently among states and regions
- 2 conduct economic impact analyses for the Northeast-Midwest region and for each state
- 3 quantify financial impacts of the urban forest resource for the Northeast-Midwest region and each sponsoring state using i-Tree Landscape derived environmental services and associated valuation estimates
- 4 develop and implement a framework and methodology to incorporate Urban Forest Inventory and Analysis data into i-Tree Landscape, piloting this work in Wisconsin

- 5 produce a report documenting methodology of analysis for future replication, and reports and factsheets for the Northeast-Midwest region and each sponsoring state detailing the financial contributions of the urban forest industry and resource
- 6 disseminate information developed for stakeholders and the public on the importance of the urban forest industry and resource.

Following rigorous discussion among project partners, the extensive scope of urban forestry was developed which includes six different groups: private businesses, public (county and municipal governments), state agencies, higher education institutions, investor-owned utilities working in tree-line maintenance, and non-profit organizations. The project partners then created an electronic survey which was distributed to individual contacts associated with the six groups. The survey instrument for the private sector was primarily designed to separate urban forestry from broader green industries in the region, while the survey questions for the public sector focused on capturing the involvement of local and municipal governments and other public agencies in urban forestry related activities. Next, we developed a complete profile of employment statistics associated with urban forestry businesses and activities for each group using the data obtained from primary surveys. The IMPLAN software, an input-output regional economic modeling system, was employed to estimate economy-wide ripple effects in the regional economy stemming from direct economic activities in urban forestry related industries.

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SURVEY RESULT HIGHLIGHTS

- Sample size: 30,336 emails across 24,880 businesses and agencies
- Response rates range from 3% (private businesses) to 59.5% (public state agencies)
- Businesses in the nursery and tree production sector reported the highest number of employees, while businesses in the nursery and florist's supplies merchant wholesalers reported the lowest employment numbers
- Private landscaping and tree care providers employ the largest percentage of workers in urban forestry
- Farm and garden equipment wholesaler businesses reported the highest average annual sales in total (\$2.5-\$5 million) and in urban forestry-related sales (\$440,000-\$879,000)
- Respondents from landscape or tree care services; nursery, greenhouse, and tree production; and nursery and garden supplies stores rated difficulty in recruiting workforce as between 'some' and 'quite a bit' of an issue impacting urban forestry activities
- Survey respondents associated with government, non-profit organizations, higher education institutions, and investor-owned utilities rated the future outlook of urban forestry in the study region between 'neutral' and 'somewhat good,' on average

The individualized web-based survey had a final sample size of 30,336 emails across 24,880 businesses and agencies. Response rates range from 3% (private businesses) to 59.5% (public state agencies), depending on the group surveyed. Of the groups in the private sector, businesses in the nursery and tree production sector reported the highest number of employees, while businesses in the nursery and florist's supplies merchant wholesalers reported the lowest employment numbers. However, private landscaping and tree care providers employ the largest percentage of workers in urban forestry. Approximately a quarter of nursery and florist merchant wholesalers and nursery and tree production employees perform work in urban forestry-related activities. Less than 20% of the employees in the following business types perform work in urban forestry: nursery and garden supply stores; farm and garden equipment wholesalers; and landscape architectural services. Farm and garden equipment wholesaler businesses reported the highest average annual sales in total (\$2.5-\$5 million) and in urban forestry-related sales (\$439,500-\$879,000). The surveyed nursery and garden supply stores follow closely behind with annual average total sales of \$1-\$2.5 million and annual UF-tree related sales averaging \$235,900-\$589,750.

In terms of respondents' opinions on issues influencing outlook by private business type, respondents from landscape or tree care services; nursery, greenhouse, and tree production; and nursery and garden supplies stores rated difficulty in recruiting workforce as between 'some' and 'quite a bit' of an issue impacting urban forestry activities. In addition, only survey respondents associated with landscape architectural and design services stated that difficulty in retaining employees was less than 'a little' of an issue impacting urban

forestry activities. Further, surveyed businesses characterized under nursery, greenhouse, and tree production and nursery and garden supplies stores rated inadequate supply chains as at least ‘some’ of an issue. Also, each business type agreed that inadequate research and development is between ‘not at all’ and ‘a little’ of an issue impacting their urban forestry activities. Finally, the majority of business types rated public perception and value of trees as between ‘a little’ and ‘some’ of an issue.

Survey respondents associated with government, non-profit organizations, higher education institutions, and investor-owned utilities rated the future outlook of urban forestry in the study region between ‘neutral’ and ‘somewhat good,’ on average. Out of the non-private groups, survey respondents associated with investor-owned utilities provided the highest average rating for difficulty in recruiting a workforce, between ‘some’ and ‘quite a bit’ and difficulty in retaining employees, between ‘a little’ and ‘some’ of an issue impacting their outlook of urban forestry activities. Each non-private group claimed that inadequate supply chains are between ‘not at all’ and ‘a little’ of an issue affecting the outlook of their activities in urban forestry. Higher education institutions rated inadequate research and development the highest, between ‘a little’ and ‘some’ of an issue. State agencies provided the highest rating for public perception and value of trees, between ‘some’ and ‘quite a bit’ of an issue.

ECONOMIC CONTRIBUTION ANALYSES

Results from the input-output modeling suggest that in 2018, urban forestry in the Northeast-Midwest states directly contributed \$17.6 billion in industry output and \$13.5 billion in value-added by supporting 258,550 full- and part-time jobs in various businesses and activities. Including direct, indirect, and

induced effects, urban forestry in the region had a total contribution of \$34.7 billion in industry output to the 21-state regional economy, employing more than 357,200 people with a payroll of about \$16.05 billion. The private sector, predominantly landscaping services, represents about 92% of the direct jobs and industry output in the study region. The public agencies (municipal, county, and state agencies) collectively contributed about \$1.2 billion in total industry output by supporting approximately 13,800 jobs to the regional economy. Similarly, higher education institutions and non-profit organizations had total job contributions of 1,430 and 2,270, respectively. We estimated that every dollar generated in urban forestry by the private sector contributed an additional \$1.00 to the 21-state regional economy. These numbers are crucial to highlight the economic significance of urban forestry businesses and agencies as well as to educate the public, economic development professionals, and legislators about the importance of urban and community forestry in the Northeast-Midwest states.

ECOSYSTEM SERVICES

Annual savings derived from urban forests were valued at over \$3.06 billion for communities across the 21-state region. This is a conservative estimate because it only incorporates three broad categories of ecosystem services: air pollution removal, avoided storm water runoff and carbon sequestration. This tree canopy, estimated to cover 27.9% of all incorporated and densely settled unincorporated communities, saved an estimated \$1.4 billion from the removal of air pollutants, \$600 million from the reduction of storm water and \$1.06 billion from the sequestration of carbon. These trees are critical pieces of community infrastructure that can be used to adapt to or mitigate environmental and social stressors.

II. GLOSSARY

Urban Forestry Defined In this study as the establishment, conservation, protection, and maintenance of trees in cities, suburbs, and other developed areas.

Carbon sequestration To capture and store atmospheric carbon dioxide.

Direct effects The expenditures or initial production changes associated with an industry or sector in the study area which are entered into the Input-Output analysis. These changes can be positive or negative and display how the study area's economy will respond.

Ecosystem services The benefits provided by ecosystems, such as wetlands filtering water or trees capturing air pollutants. Some of these services have financial implications.

Employee compensation Total payroll cost of an employee, inclusive of wages, salaries, payroll taxes, and benefits such as health insurance and retirement.

Employment The number of full-time, part-time, and seasonal jobs associated with a specific industry.

IMPLAN® Modeling software that performs Input-Output analysis. Its framework enables users to create regional economic models and multipliers for one or more counties or states in the USA. Version 3 of IMPLAN® accounts for commodity production and consumption for 536 industry sectors, 10 household income levels, taxes to local/state and federal governments, capital investment, imports/exports, transfer payments, and business inventories.

Indirect effects The economic impact of local industries purchasing goods and services from other industries along supply chains.

Induced effects The economic impact of household spending of labor income following deductions from taxes, savings, and income for commuting.

Industry Entities or businesses participating in similar types of economic activities.

Labor income The sum of employee compensation and proprietor income.

Multipliers The measure of an industry's connection to the economy of the study area

in terms of purchases, payments of wages and taxes, and other transactions.

Municipality The Census definition of an incorporated place, which is a type of governmental unit, incorporated under state law as a city, town (except in New England, New York, and Wisconsin), borough (except in Alaska and New York), or village, generally to provide governmental services for a concentration of people within legally prescribed boundaries (U.S. Census Bureau, 2018).

North American Industry Classification System (NAICS) An industrial classification scheme established and utilized by countries in North America for grouping entities by similar production processes.

Output The value in dollars of production within a study area. It equates to the total of sales and net inventory change.

Proprietor income Production income of sole proprietorships, partnerships, and tax-exempt cooperatives.

Region or Regional Economy The geographic area of interest (i.e., one or more

county or state) and its economic activity.

Sector The industries that make up the complete economy including businesses, households and institutions, and government. In the NAICS, sectors are one of the major areas of economic activity and are classified at the 2-digit level.

Social Accounting Matrix (SAM): SAMs capture all monetary market transaction, including what are called an economy's "ripple effects," during a study period by building upon Input-Out models to include transactions between industries and institutions, including those between institutions themselves.

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

Value-added (or Gross Regional Product [GRP]): The total of labor income, other property income, and production and import taxes. It is also the difference between an industry's total output and the cost of its intermediate inputs. GRP equals the sum of value-added for all economic sectors within the study region.

III. INTRODUCTION

The green industry consists of the businesses and activities involved in the creation, distribution, and services associated with landscape design, garden supplies and equipment, and ornamental plants in urban and semi-urban settings. While academic literature defines green industry as it relates to the production of urban greening products (Hall et al., 2005; New Hampshire Landscape Association, 2021), some governments and private organizations interpret green industry as it pertains to environmentally sustainable economic growth (United Nations Industrial Development Organization [UNIDO], 2021; World Green Economy Council, 2021). Urban forestry is one important contributing sector of the green industry (Mcpherson et al., 2005) that was first documented in the literature at the end of the 19th century. More recently, urban forestry has evolved to embody a socio-economic approach to growing trees in urban landscapes (Konijnendijk et al., 2006; Templeton & Goldman, 1996).

As such, urban forests provide essential ecosystem services to perpetually growing urban populations in the United States, making them an integral component of cities, municipalities, and communities. Urban forestry encompasses various tree management and maintenance activities on over 141 million acres of urban landscape in the United States (USDA Forest Service, 2021). In addition to private businesses that perform urban forestry activities, governments, non-profit organizations, and utility sectors are also crucial providers of urban forestry related activities and contribute substantially to local and state economies. With support from several public policies and legislations, there has been increased interest in maintaining and improving trees and forest resources in urban and surrounding areas in recent years. More recently, urban forestry has developed into a complex field composed of diverse stakeholders, businesses, public-private partnerships, and communities.

Nonetheless, the lack of a standard definition and accounting methodology for estimating the economic and social benefits of urban forestry activities have restricted the successful planning and further expansion of the Urban and Community Forestry Program (National Urban and Community Forestry Advisory Council, 2015). Major barriers in managing urban forestry programs partially result from the lack of consistent definitions and terms. This deficient framework fosters challenges to estimating the extent, contributions, and impact of the urban forestry sector. For the purposes of this report, we define the urban forestry sector as all sectors that participate in urban tree management activities that contribute to urban forestry such as landscape management and architecture, nurseries and tree distributors, and equipment dealers.

Economic contribution analysis of the urban forestry sector aids to communicate the industry's monetary benefits in terms of dollar values and jobs to lawmakers. However, economic contributions analyses, similar to urban forestry terminology and related frameworks, have tended to vary in scope, data used, input-output methodology, and measures reported. In addition, while state-level and regional economic contribution analyses covering forest products industries have been common in the literature (Henderson et al., 2017; Joshi et al., 2017; Parajuli et al., 2018; Pelkki and Sherman, 2020), limited studies have focused on the urban forestry sector. This gap is due in part to the complexity of the urban forestry sector, but also by the historical, economic, and cultural significance of the forest product industry.

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The main purpose of this report is to estimate the economic contribution of the urban forestry sector in the Northeast-Midwest states of the United States. First, we developed a standard definition of urban forestry that characterized the scope of the sectors in the 21 states. We included all private, public, and non-profit businesses and organizations associated with urban forestry in the region of interest. Following, we compiled the employment profile of all the related industries and agencies through online surveys and public sources. We used the Impact Analysis for Planning (IMPLAN) software, an input-output modeling program created by the U.S. government, to estimate the economic contribution of urban forestry to the regional economy in terms of several economic and business metrics including jobs, labor income, value-added, and tax collections (IMPLAN, 2021). We developed an extensive scope of urban forestry building on the methodological approach of Hodges and Court (2019) by incorporating the involvements of private, public, higher education institutions, private utility companies, and non-profit organizations.

IV. LITERATURE REVIEW

A large body of literature has estimated economic contributions of the green industry to various regional economies across the United States. Meanwhile, fewer studies have explored economic contributions from urban forestry by separating the urban forestry portion from broader green industry sectors (T1).

The majority of the green industry in the private sector is well defined by IMPLAN and the North American Industry Classification System (NAICS). As a result, conducting economic contribution analyses of the overall green industry in the United States is relatively straightforward.

T1 PREVIOUS STUDIES ON ECONOMIC IMPACT AND CONTRIBUTION ANALYSIS OF UF IN VARIOUS U.S. STATES (THIS IS NOT AN EXHAUSTIVE LIST)

REGION	YEAR(S)	TITLE	AUTHOR(S)	RESULTS (TOTAL EFFECTS)
California	1990s	<i>Estimating Economic Activity and Impacts of Urban Forestry in California with Multiple Data Sources from the Early 1990s</i>	Templeton and Goldman (1996)	57,200 jobs \$3.38 billion in output \$1.87 billion in labor income
California	2009	<i>Impacts of Urban Forestry on California's Economy in 2009</i>	Templeton et al. (2011)	58,769 jobs \$3.53 billion in output \$3.26 billion in labor income
Florida	2017	<i>Economic Contributions of Urban Forestry in Florida in 2017</i>	Hodges and Court (2019)	80,808 total jobs \$8.4 billion in output \$3.4 billion in labor income
Texas	2017	<i>Economic Impact of Urban Forests in Texas</i>	Tian and Stottlemeyer (2019)	57,645 jobs \$4.7 billion in output \$2.1 billion in labor income
Georgia	2019	<i>2019 Economic Benefits of the Forest Industry in Georgia</i>	Georgia Tech (2021)	48,244 jobs \$4.8 billion in output \$2.03 billion in labor income

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Templeton and Goldman (1996) were the first to estimate economic impacts of urban forestry activities in California. The researchers later updated the analysis with a different approach and newer dataset (Templeton et al., 2011). The most recent study concluded that in 2009, urban forestry in California contributed over \$3.5 billion in economic output, supporting approximately 58,770 full- and part-time jobs, based on the extensive data collected from primary and secondary sources to account for involvements of households, commercial businesses, and utilities (Templeton et al., 2011). Likewise, other studies that estimated economic contributions of urban forestry to state economies include Hodges and Court (2019) in Florida, Tian and Stottlemeyer (2019) in Texas, and the Georgia Forestry Commission (Georgia Tech, 2021) in Georgia (T1). Notably, the aforementioned studies varied widely in terms of the scope of urban forestry, data sources, and the approach employed in the input-output analysis. Further, the studies are non-peer reviewed reports, apart from Templeton and Goldman (1996).

At the national-level, Hall et al. (2006) estimated the economic impacts of the green industry using 2002 IMPLAN data. The researchers repeated their analyses periodically following their initial study in 2006 (Hall et al., 2011; Hodges et al., 2015; Hall et al., 2020). Most recently, Hall et al. (2020) estimated that in 2018, the green industry in the United States had a total economic contribution of \$348 billion in industry output, which supported over 2.3 million jobs within the broader national economy. In addition, Palma and Hall (2015) and Gale (2021) calculated the estimated economic contributions of the green industry to the state economies of Texas and Utah, respectively.

The limited and inconsistent efforts in economic contribution analysis of urban forestry are due primarily to two reasons: (a) there are currently no established IMPLAN or NAICS sectors that correspond specifically to urban forestry and

(b) there is no standard framework to separate the urban forestry sector from broader green industries. The economic activity of urban forestry can be represented by the portion of multiple industries within the broader green industry sectors. IMPLAN integrates urban forestry related private businesses into the broader green industries. However, public sector involvement is not well distinguished in the industry classification system. Hence, the previous studies in urban forestry economic analysis either overlooked the public sector involvement (e.g., Georgia Tech, 2021) or relied on dated secondary information to estimate private sectors' contributions (Tian and Stottlemeyer, 2019). While Templeton et al. (2011) did incorporate both the private and public sectors in their analysis, their methodological framework is not easily replicated in other states as they utilized data sources only found in California.

In contrast, Hodges and Court (2019)'s methodological approach in identifying the scope of urban forestry in Florida and the input-output analysis are replicable, relatively inclusive, and current. More specifically, Hodges and Court (2019) separated the urban forestry portion from the green industry through surveying the related private businesses and utilizing a national survey of municipal tree care and management (Hauer and Peterson, 2016) to estimate the public sector involvement in urban forestry in Florida. Nonetheless, their methodology still omitted various segments of urban and community forestry including self-employed jobs in urban forestry, specifically in landscaping and tree care services, other public agencies except municipal governments, non-profit organizations, and higher education institutions. Further, their IMPLAN analysis approach also lacks clarity as to whether they accounted for margin analysis for wholesalers and retailers as well as the public sector's economic contribution using the analysis-by-parts method (Hodges and Court, 2019).

V. OBJECTIVES

This project involved conducting an economic contribution analysis of the urban forest industries along with estimating ecosystem service benefits of urban forestry in the Northeast-Midwest region (a 20-state region + Washington D.C.), and in 16 participating states (**F1**).

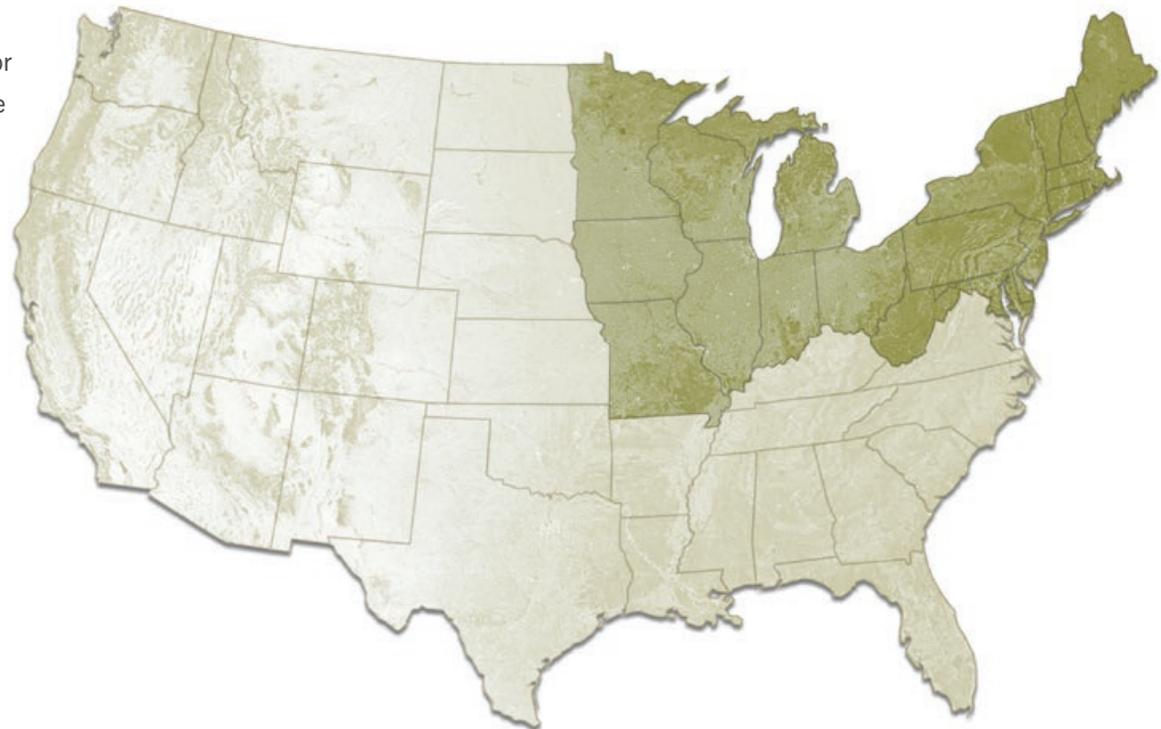
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- 1 Develop an input-output model to quantify the economic impact of the urban forest industry that can be applied consistently among states and regions.
- 2 Conduct economic impact analyses for the Northeast-Midwest region and for each state.
- 3 Quantify financial impacts of the urban forest resource for the Northeast- Midwest region and each sponsoring state using i-Tree Landscape derived environmental services and associated valuation estimates.

- 4 Develop and implement a framework and methodology to incorporate Urban Forest Inventory and Analysis data into i-Tree Landscape, piloting this work in Wisconsin.
- 5 Produce a report documenting methodology of analysis for future replication, and reports and fact sheets for the Northeast-Midwest region and each sponsoring state detailing the financial contributions of the urban forest industry and resource.
- 6 Disseminate information developed for stakeholders and the public on the importance of the urban forest industry and resources.

F1 THE 21 STATES INVOLVED IN THE SURVEY

Connecticut	Massachusetts	Ohio
Delaware	Michigan	Pennsylvania
Illinois	Minnesota	Rhode Island
Indiana	Missouri	Vermont
Iowa	New Hampshire	Washington, D.C.
Maine	New Jersey	West Virginia
Maryland	New York	Wisconsin



VI. SCOPE OF URBAN FORESTRY

We have explained all the methodological procedures in the separate methodology report in detail. Since there are no well-defined industries specific to urban forestry and IMPLAN integrates urban forestry into broader green sectors, we delineated the scope of urban forest industries in the study region. First, a list of private industries as well as public agencies and non-profit organizations involved in urban forestry was developed based on an extensive review of available literature. The developed scope of urban forestry industries and activities was rigorously discussed with the representatives from each participating state, and other project partners from universities and agencies. Then, all the project team participants were surveyed to develop consensus on the following final list of urban forestry related industries and activities in both private and public sectors (**T2**).

The scope of urban forestry was discussed in all three webinars, with specific emphasis on sectors to be included in the second webinar. All team members who attended the webinar had ample opportunity to discuss their opinions on which sectors related to urban forestry should be included in the analysis. The consensus on the final list of urban forest industries in both private and public sectors was established by surveying all the project partners from participating states, institutions, and organizations.

T2 SCOPE OF URBAN FORESTRY IN NORTHEAST-MIDWEST REGION

PRIVATE INDUSTRIES

- Landscaping services (NAICS 561730)
- Nursery and tree production (NAICS 111421)
- Nursery, garden, and farm supply stores (NAICS 444220)
- Farm and garden machinery and equipment merchant wholesalers (NAICS 423820)
- Nursery stock and florists' supplies merchant wholesalers (NAICS 424930)
- Landscape architectural services (NAICS 541320)
- Private (investor-owned) utility companies

PUBLIC SECTORS

- Municipalities
- Counties
- State agencies involved in urban forestry

HIGHER EDUCATION INSTITUTIONS

NON-PROFIT ORGANIZATIONS



The project 'Team' includes principal and co-principal investigators from several universities, WDNR staff, representatives from each participating state, project partners from the University of Wisconsin Stevens Point, Mid-State Technical College and the Tree Care Industry Association, and a USDA Forest Service representative. Other partners providing match for this project include: The Davey Institute, Indiana Arborist Association, Massachusetts State Urban Forestry Advisory Board, Michigan State University, Vermont Urban & Community Forestry Council, Ohio Chapter International Society of Arboriculture, and Connecticut Non-Profits. For this project, the region or study area incorporates the Northeast-Midwest states of: Connecticut, Delaware, Illinois, Indiana, Iowa, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, Washington D.C, West Virginia, and Wisconsin. However, the participating states from the Northeast-Midwest region are Connecticut, Illinois, Indiana, Iowa, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, New Jersey, New York, Ohio, Pennsylvania, Vermont, and Wisconsin.

VII. METHODS

Six different groups across the 21-state region were surveyed: private businesses, public (county and municipal governments), public (state agencies), higher education institutions, investor-owned utilities working in tree-line maintenance, and non-profit organizations. The University of Wisconsin Survey Center (UWSC) sent the surveys out on September 29, 2020, and stopped accepting survey responses on November 4, 2020, after three reminder emails. The survey instrument for the private sector was primarily designed to separate urban forestry from broader green industries as well as to evaluate the current issues and opportunities related to urban forest businesses in the region. On the other hand, the survey questions for the public sector focused on capturing the involvement of local and municipal governments and other public agencies in urban forestry.

We then compiled a complete profile of sales and expenditures of economic activities related to establishment, care, and maintenance of urban forests utilizing publicly available sources in addition to the primary surveys to separate urban forestry activities from broader green industries. Also utilizing data from the primary surveys and publicly available sources, we developed a complete profile of employment statistics including job number and percentage of jobs in urban forestry associated with each group and sector, a key input in the IMPLAN modeling. For the private industries, the 2018 employment numbers in each North American Industry Classification System (NAICS) category were obtained from the Census of Employment and Wages (CEW) from the US Bureau of Labor Statistics (US BLS, 2021). Since CEW does not incorporate self-employed jobs and businesses with their own social insurance programs (IMPLAN Data Team,

2021), the 2017 IMPLAN data was utilized to compute self-employed jobs specifically in landscaping services (NAICS 561730) and Nursery and tree production businesses (NAICS 111421).

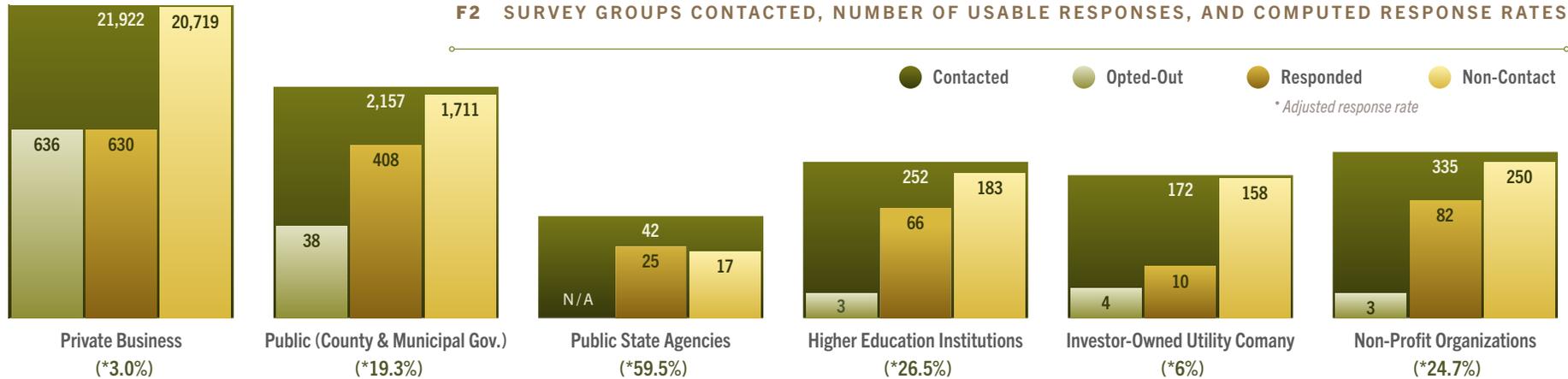
Subsequently, we aggregated state-level IMPLAN data from 21 states to develop a regional input-output model with a trade flows specification and social accounts for households. In terms of an economic contribution method, we employed the method 1 for multisector contribution analysis explained in Parajuli et al. (2018). Then, we used the analysis-by-part (ABP) method for the labor income spending pattern to estimate indirect and induced effects of local and state governments, higher education institutions, and non-profit organizations in the study area utilizing the developed employment profile.

We specify the steps in our approach to the surveys and subsequent economic contribution analysis in more detail in the Urban Forestry Economic Analysis in the Northeast and Midwest Methodology Report. Also described in the Methodology Report, we quantified the estimated benefits from ecosystem services provided by urban trees using tools within i-Tree, a suite of software developed by the U.S. Forest Service that enables forestry analyses and benefit assessments (i-Tree, 2021). More specifically, this project used i-Tree Landscape to assess urban forest-derived ecosystem services across three broad categories: air quality, carbon storage and sequestration, and hydrology.

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VIII. SURVEY RESULTS

F2 SURVEY GROUPS CONTACTED, NUMBER OF USABLE RESPONSES, AND COMPUTED RESPONSE RATES

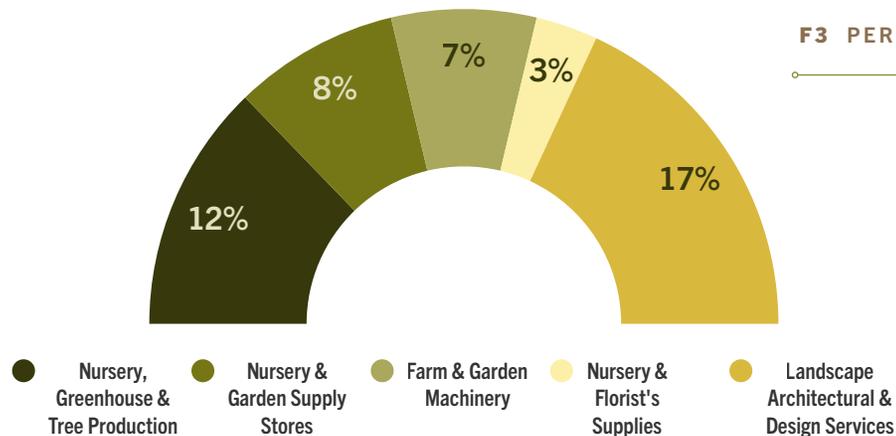


RESPONSE RATES

Response rates range from 3% (private businesses) to 59.5% (public state agencies), depending on the group surveyed (F2). The higher education institutions and non-profit organizations surveyed are both associated with adjusted response rates of

approximately 25%, whereas almost 20% of the county and municipal governments surveyed provided usable responses. Lastly, 6% of investor-owned utilities contacted in the study region responded to the survey.

F3 PERCENTAGE OF SURVEY RESPONSES BROKEN OUT BY THE BUSINESS SECTOR

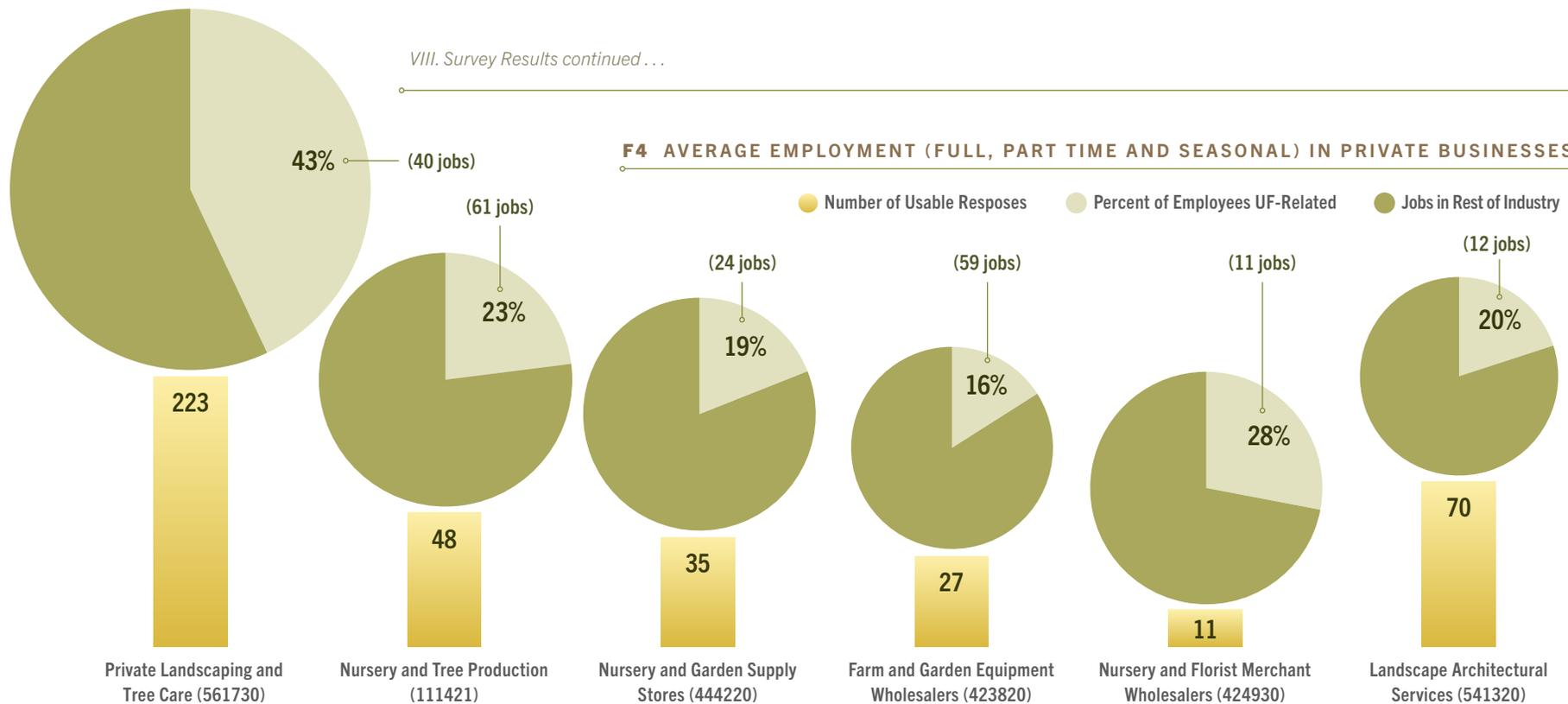


PRIVATE INDUSTRY

The number of responses from the private industry group vary depending on business type (F3). Those businesses involved in the landscape or tree care services (NAICS 561730) constituted the majority of the completed surveys with 54% of the responses. Landscape and architectural design services represented 17% of the responses followed by 12% from those in nursery and tree production. Nursery supply stores and wholesalers had the least amount of representation in the survey with 8% and 3% of the responses, respectively.

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F4 AVERAGE EMPLOYMENT (FULL, PART TIME AND SEASONAL) IN PRIVATE BUSINESSES



Of the businesses surveyed, those in the nursery and tree production, and farm and garden machinery sectors reported the highest number of employees on average, including full-time, part-time, and seasonal employees (F4). Landscape or tree care services reportedly employed approximately 40 total employees, 25 of which are full time, 2 part time, and 13 seasonal employees. Nursery stores averaged approximately 24 employees, 9 of which are full time, 5 being part time, and 9 seasonal. Landscape and architectural design companies have about 12 total employees on average, 9 being full time, 1 part time employee, and 2 seasonal employees. Nursery and florist’s supplies merchant wholesalers have the lowest employment numbers with approximately 6 full time employees, 3 seasonal employees, and 1 part time employee.

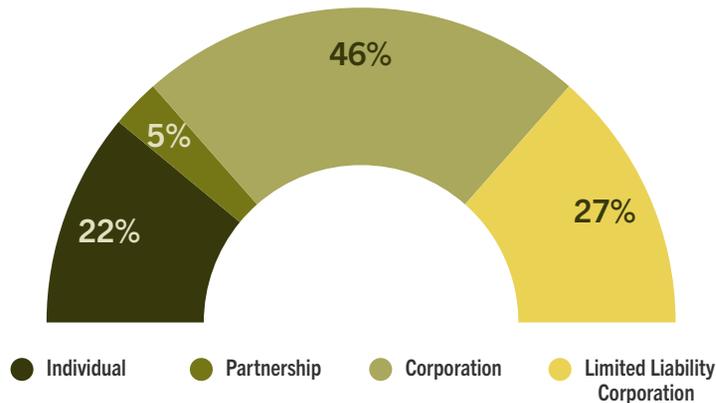
Figure 4 also presents the average percentages of employees in each business type particularly involved in urban forestry related activities. Private landscaping and tree care providers employ the largest percentage of workers in urban forestry (43%). Approximately a quarter of nursery and florist merchant wholesalers and nursery and tree production employees perform work in urban forestry-related activities. Less than 20% of the employees in the following business types perform work in urban forestry: nursery and garden supply stores; farm and garden equipment wholesalers; and landscape architectural services.

F5 AVERAGE YEARS IN BUSINESS BY BUSINESS TYPES WITHIN THE GREEN INDUSTRY



The average number of years each business type has been in operation ranges from 28 to 46 years (F5). On average, farm and garden machinery companies in the study region have been in business for over 50 years. Nursery stores have on average 46 years in the business followed by nursery and tree production

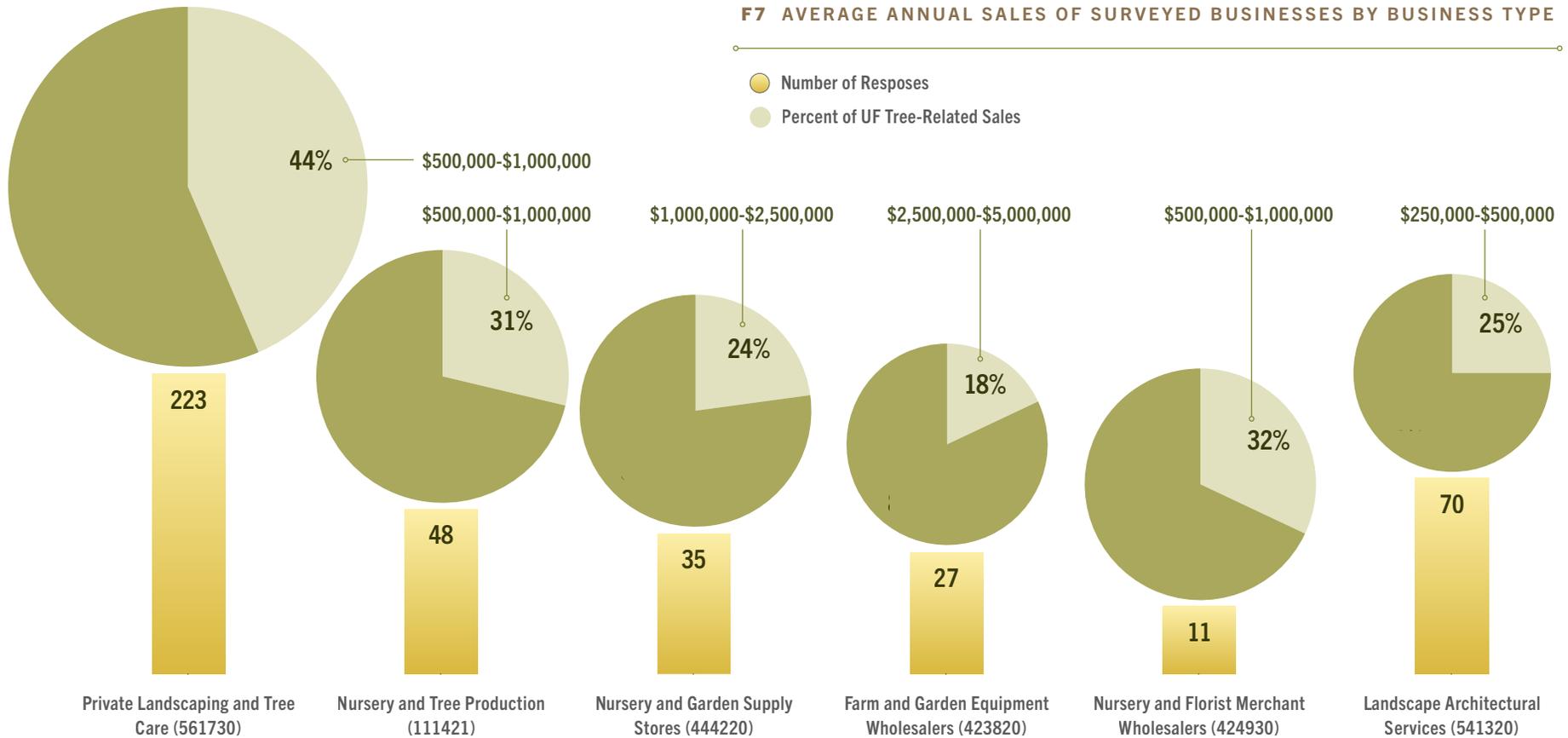
businesses averaging 45 years in business. Nursery supply wholesalers follow closely with 40 years on average of active business. Landscape or tree care services were in the business, on average, 30 years, with landscape design being in the business the least amount of time, averaging 28 years.



F6 ORGANIZATIONAL STRUCTURE OF GREEN INDUSTRY BUSINESSES SURVEYED

Figure 6 represents the organizational structure of the private businesses related to the green industry in the study states. Roughly 46% of the surveyed businesses are corporations, followed by 27% structured as an LLC, 22% being under individual ownership, and only 5% structured as a partnership.

F7 AVERAGE ANNUAL SALES OF SURVEYED BUSINESSES BY BUSINESS TYPE



Average annual sales and UF tree-related sales also range by business type (F7). Farm and garden equipment wholesaler businesses reported the highest average annual sales in total (\$2.5-\$5 million) and in urban forestry-related sales (\$439,500-\$879,000). The surveyed nursery and garden supply stores follow closely behind with annual average total sales of \$1-\$2.5 million and

annual UF-tree related sales averaging \$235,900-\$589,750. Nonetheless, sales for urban forestry activities from the two business types contribute the lowest percentage of total sales out of the private industry groups surveyed. The four remaining business types each state that over 25% of annual total sales on average is associated with urban forestry-related activities.

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F8 FUTURE OUTLOOK OF URBAN FORESTRY ACTIVITIES BY INDUSTRY TYPES

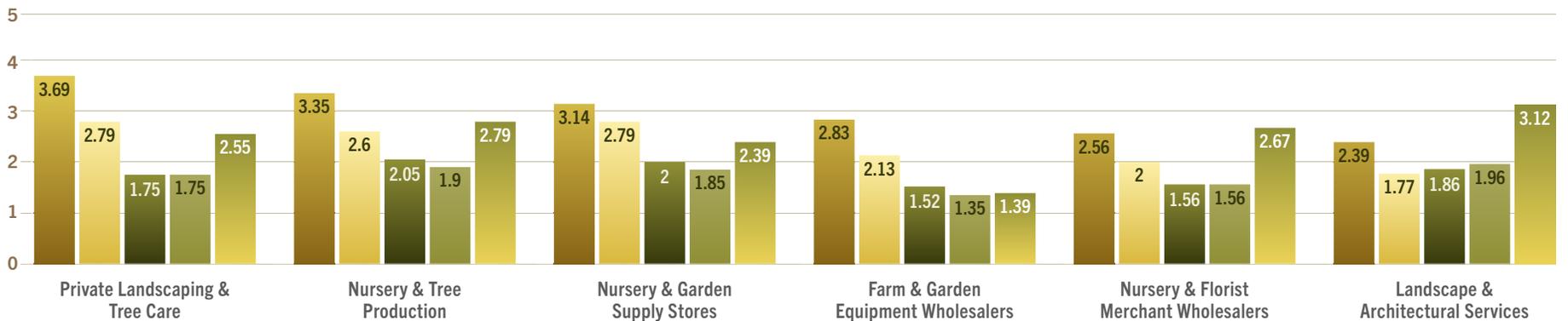


Respondents' outlook on the future of urban forestry activities in their business varies depending on business type (**F8**). Outlook is based on a 5-point ordinal scale: 1- extremely bad, 2- somewhat bad, 3- neutral, 4- somewhat good, 5-extremely good. Landscape or tree care services (3.87) and landscape design (3.44) had an average outlook between 'neutral' and 'somewhat good.' Both nursery and tree production (3.50) and nursery stores (3.50) also had an average outlook between 'neutral' and 'somewhat good,' but slightly lower than those of the landscape or tree care services and landscape and design. Nursery supply wholesalers (2.75) had the least positive outlook in their urban forestry activities with an average between 'somewhat bad' and 'neutral.'

F9 AVERAGE SEVERITY OF ISSUES IMPACTING URBAN FORESTRY ACTIVITIES BY BUSINESS TYPE

ON A SCALE FROM 1 TO 5 — 1- NOT AT ALL | 2- A LITTLE | 3- SOME | 4- QUITE A BIT | 5- A GREAT DEAL

● Difficulty in Recruiting Workforce ● Difficulty in Retaining Employees ● Inadequate Supply Chains ● Inadequate R&D ● Public Perception and Value of Trees



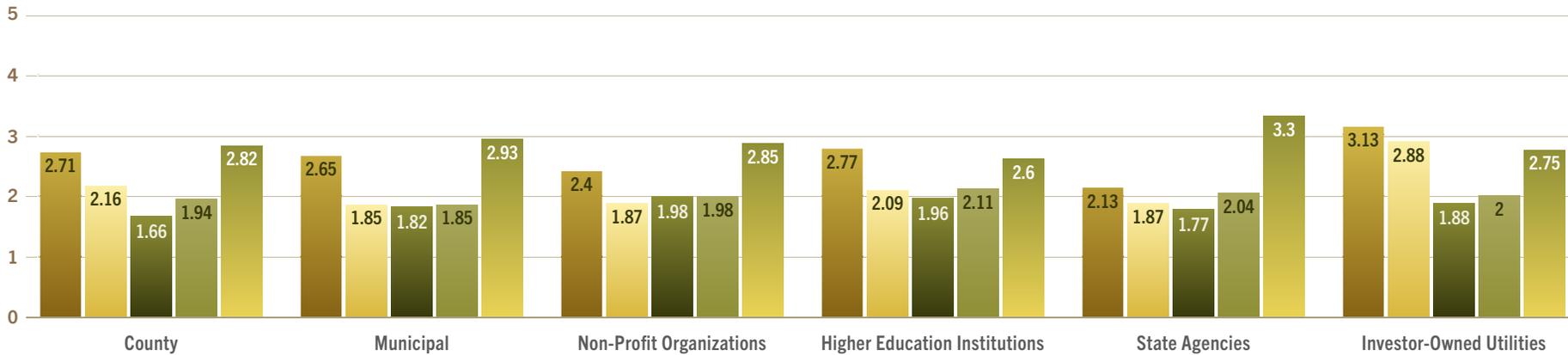
The survey asked respondents their perception on the severity of five issues presented on a 5-point ordinal scale. In terms of the business type, respondents from landscape or tree care services (3.69); nursery, greenhouse, and tree production (3.35); and nursery and garden supplies stores (3.14) rated difficulty in recruiting workforce as between ‘some’ and ‘quite a bit’ of an issue impacting urban forestry activities (F9). Meanwhile, the other three business types rated the severity of the issue as more than ‘a little’ but less than ‘some’ (farm and garden machinery: 2.83; nursery and florist’s supplies merchant wholesalers: 2.56; landscape architectural and design services: 2.39). In addition, only survey respondents associated with landscape architectural and design services stated that difficulty in retaining employees was less than ‘a little’ (1.77) of an issue impacting urban forestry activities. The remaining five business types rated difficulty in retaining employees between ‘a little’ and ‘some’ of an issue (F9).

Further, surveyed businesses characterized under the nursery, greenhouse, and tree production (2.05) and nursery and garden supplies stores (2.00) rated inadequate supply chains as at least ‘some’ of an issue. Each business type agreed that inadequate R&D is between ‘not at all’ and ‘a little’ of an issue impacting their urban forestry activities (F9). Finally, the majority of business types rated public perception and value of trees as between ‘a little’ and ‘some’ of an issue (F9). The outliers – farm and garden machinery (1.39) and landscape architectural and design services (3.12) – reported public perception and value of trees as less than ‘a little’ and more than ‘some’ of an issue impacting urban forestry activities, respectively.

F10 PUBLIC, HIGHER EDUCATION, AND NON-PROFIT SECTORS' OPINIONS ON ISSUES IMPACTING THE FUTURE OUTLOOK OF UF ACTIVITIES

ON A SCALE FROM 1 TO 5 — 1- NOT AT ALL | 2- A LITTLE | 3- SOME | 4- QUITE A BIT | 5- A GREAT DEAL

● Difficulty in Recruiting Workforce ● Difficulty in Retaining Employees ● Inadequate Supply Chains ● Inadequate R&D ● Public Perception and Value of Trees



OTHER SECTORS

Figure 11 features the average response value from respondents associated with the public sector, higher education institutions, non-profit organizations, and investor-owned utilities regarding their opinions on issues impacting the future outlook of urban forestry activities, rated from 1 for not at all to 5 for a great deal. Each group of respondents from the public sectors surveyed – county, municipal, and state – rated difficulty in recruiting a workforce as between ‘a little’ and ‘some’ of an issue impacting future urban forestry activities (F10). Similarly, each group claimed that inadequate supply chains are between ‘not at all’ and ‘a little’ of an issue impacting the outlook of their activities in urban forestry. Meanwhile, county-government respondents differed from the other two groups regarding the perceived impact of retaining a workforce on urban forestry

activities. Conversely, state agencies rated inadequate R&D as ‘a little’ of an issue, a slight increase from the average rating provided by county and municipal government related respondents. State agencies also rated public perception and value of trees with a higher severity, compared to the other two public sector groups.



HIGHER EDUCATION INSTITUTIONS

Respondents from higher education institutions rated each of the following as between ‘a little’ and ‘some’ of an issue influencing their future activities related to urban forestry, in order from highest to lowest severity: difficulty in recruiting a workforce, public perception and value of trees, inadequate R&D, and difficulty in retaining employees (**F10**). The group on average identified inadequate supply chains as between ‘not at all’ and ‘a little’ of an issue impacting their outlook on urban forestry activities.

NON-PROFIT ORGANIZATIONS

Respondents associated with non-profit organizations also characterized difficulty in recruiting a workforce and the public perception and value of trees as at least ‘a little’ of an issue (**F10**). The respondents rated the other statements slightly less than “a little” of an issue influencing their future activities in urban forestry.

INVESTOR-OWNED UTILITIES

Survey respondents associated with investor-owned utilities provided the highest average rating for difficulty in recruiting a workforce, between ‘some’ and ‘quite a bit’ of an issue impacting their outlook of urban forestry activities (**F10**). The group on average rated the following as at least ‘a little’ of an issue, listed from highest to lowest severity: difficulty in retaining employees, public perception and value of trees, and inadequate R&D. Similar to the public sectors, higher education institutions, and non-profit organizations surveyed, investor-owned utilities characterized inadequate supply chains as between ‘not at all’ and ‘a little’ of an issue influencing their projected activities in urban forestry.

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F11 FUTURE OUTLOOK OF URBAN FORESTRY ACTIVITIES BY BUSINESS TYPE



Figure 11 shows the average perceived outlook of urban forestry among survey respondents associated with government, non-profit organizations, higher education institutions, and investor-owned utilities. Each respondent group/sector rated the future outlook of urban forestry in the study region between ‘neutral’ and ‘somewhat good,’ on average. More specifically, only the average outlook of respondents associated with county governments (3.45) was less than 3.5. Above that threshold, the perceived outlook of urban forestry among sectors other than private industries is in the following order, from lowest to highest average outlook: investor-owned utilities, municipal governments, state agencies, higher education institutions, and non-profit organizations (**F11**).

IX. REGIONAL ECONOMIC CONTRIBUTION ANALYSIS

F12A DIRECT EFFECT ECONOMIC CONTRIBUTION OF URBAN FORESTRY IN NORTHEAST-MIDWEST STATES, 2018

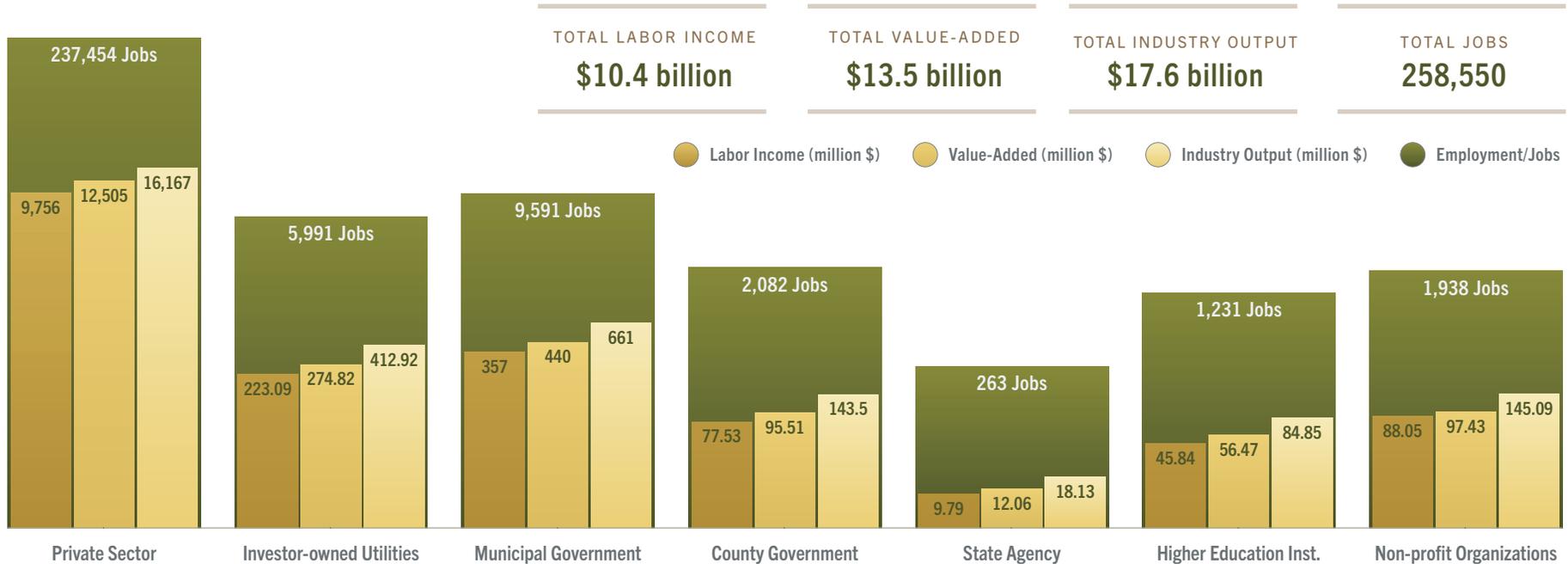
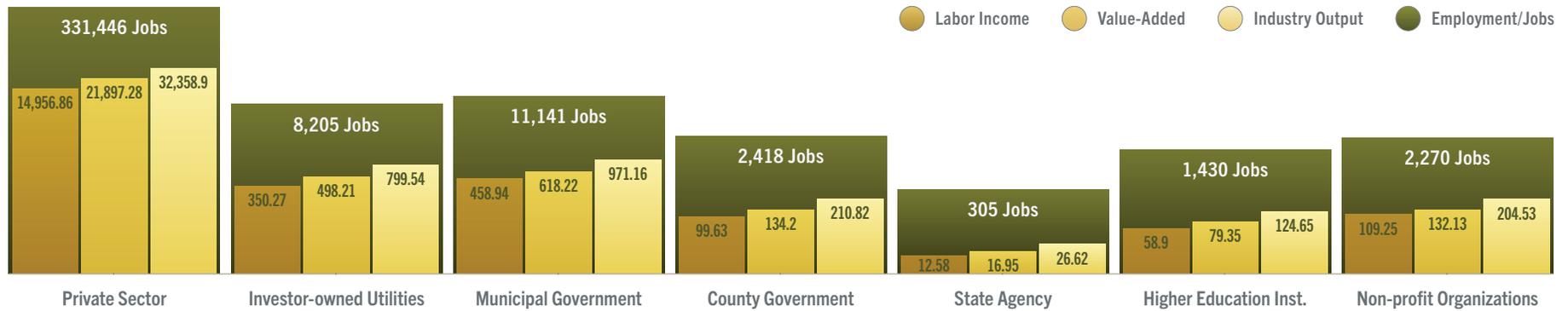


Figure 12A presents the summary economic contribution results obtained from individual IMPLAN scenarios representing each sector of urban forestry in the 21 states. Based on the input-output modeling, we estimated that in 2018, urban forestry in the Northeast-Midwest states directly supported 258,550 full- and part-time jobs in various businesses and activities. The total job contribution of urban forestry including direct, indirect, and induced employment was 357,215. In terms of labor income, urban forestry in this region collectively contributed about \$10.4 billion directly, and over \$16 billion including the multiplier effects throughout the regional economy.

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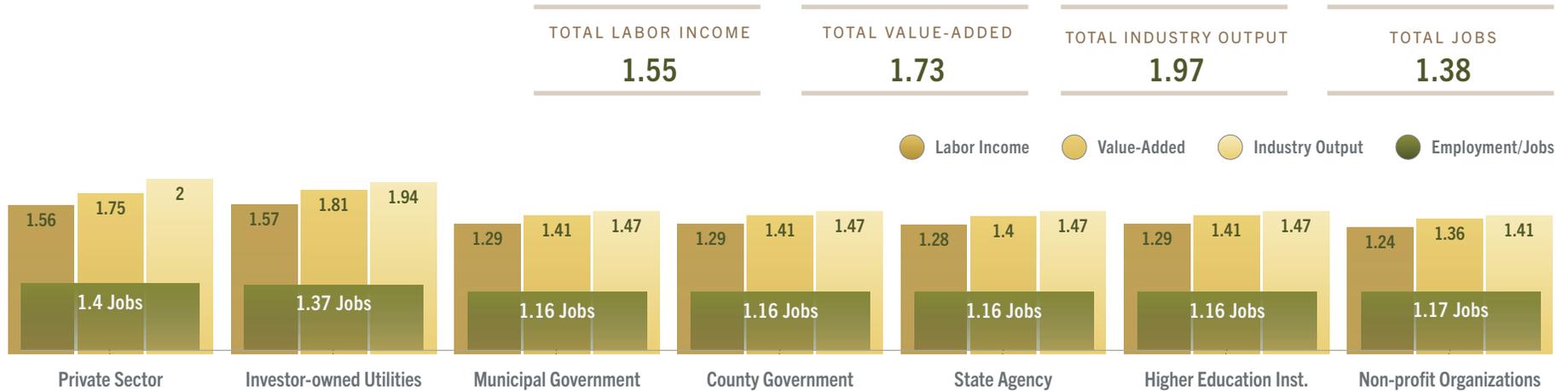
12B TOTAL EFFECT ECONOMIC CONTRIBUTION OF URBAN FORESTRY IN NORTHEAST-MIDWEST STATES, 2018

TOTAL LABOR INCOME	TOTAL VALUE-ADDED	TOTAL INDUSTRY OUTPUT	TOTAL JOBS
\$16 billion	\$23.4 billion	\$34.7 billion	357,215



Similarly, in terms of value-added, which is equivalent to gross domestic product, urban forestry in the 21 states contributed approximately \$13.5 billion to the regional economy directly, and if we account for the indirect and induced effects, the total value-added contribution in 2018 was about \$23.4 billion (**F12B**). In terms of industry output representing all economic activities, the direct and total contributions of the regional urban forestry were about \$17.6 billion and \$34.7 billion, respectively. The overall SAM multiplier associated with employment was estimated to be 1.38, indicating that every job in urban forestry in these states resulted in another 0.38 jobs in other sectors of the economy. Similarly, every dollar generated in urban forestry contributed an additional 97 cents in industry output to the rest of the regional economy.

F12C SAM MULTIPLIER ECONOMIC CONTRIBUTION OF URBAN FORESTRY IN NORTHEAST-MIDWEST STATES, 2018



The economic contribution of urban forestry varies widely among the sectors. The private sector, predominantly landscaping services, represents about 92% of the direct jobs and industry output in the study region. The public agencies (municipal, county, and state agencies) collectively contributed about \$1.2 billion in total industry output by supporting approximately 13,800 jobs to the regional economy (F12C). Similarly, higher education institutions and non-profit organizations had total job contributions of 1,430 and 2,270, respectively. We estimated that the private sector had the largest SAM multiplier values in most of the metrics. The SAM value of 2.00 associated with the industry output of the private sector indicates that every dollar generated in urban forestry by the private sector contributed an additional \$1.00 to the 21-state regional economy.

F13 DIRECT TAX CONTRIBUTION OF URBAN FORESTRY IN NORTHEAST-MIDWEST STATES, 2018

Urban forestry in the 21 states also had substantial contributions to the local or state and federal taxes (F13). In 2018, urban forestry businesses and employees in the study region paid over \$988.68 million in state and local taxes and about \$2.1 billion in federal taxes. Most of the state and local taxes were collected on production and imports of goods, followed by household taxes. Employee compensation and households were the major categories contributing to about 90% of federal taxes collected directly from urban forestry businesses and employees in the region.



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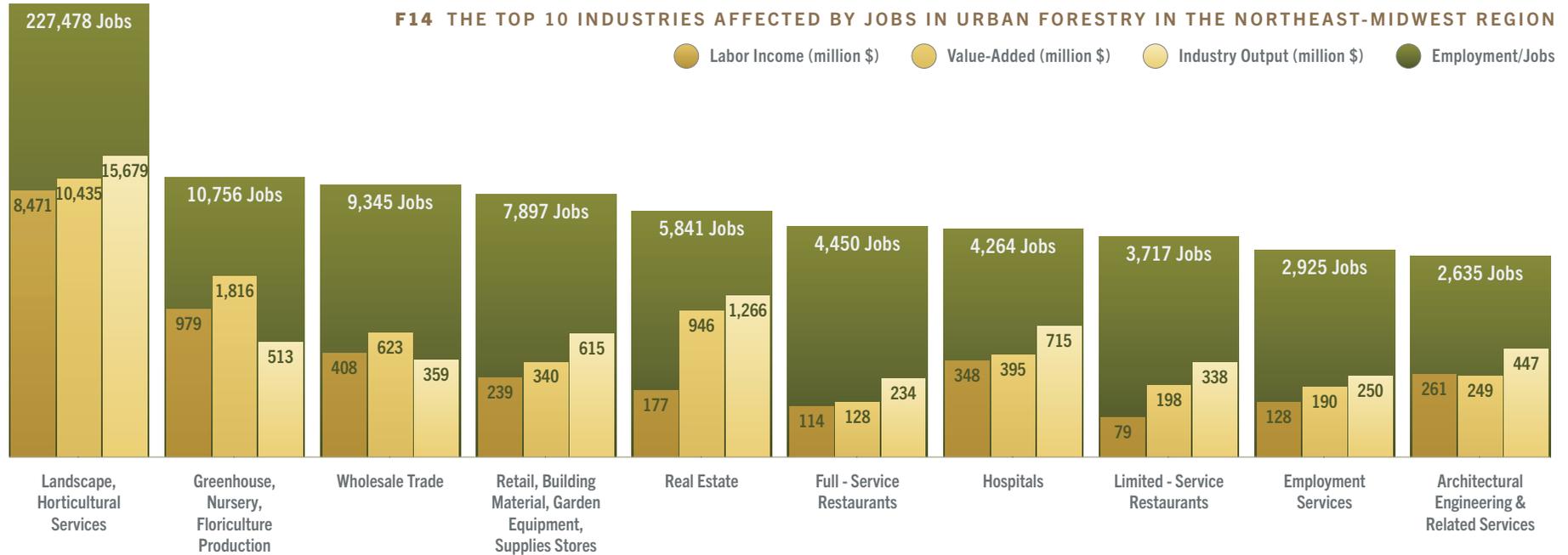


Table 14 presents the top 10 industries in the region that have the highest employment contributions from urban forestry. A total of 227,478 jobs with an industrial output of about \$15.7 billion in landscape and horticultural services were contributed by the urban forestry in the study region. Urban forestry supported 10,756 jobs in greenhouse, nursery, and floriculture production, 9,345 jobs in the wholesale trade industry, and about 7,900 jobs in the retail sector in the study region (F14). Through the multiplier effects, employees in urban forestry in the study region supported a number of jobs in real estate, full-service and limited-service restaurants, and hospitals, playing a vital role in the overall regional economy.

F15 ECONOMIC CONTRIBUTIONS OF PRIVATE URBAN FORESTRY INDUSTRIES IN THE REGION



Because the private sector represents over 92% of the urban forestry industries in the region, we also explored the economic contribution of each industry within the private sector. Figure F15 presents economic contributions of the private urban forestry industries in the study region. Among the six major business types, landscaping and tree care services (NAICS 561730) represent about 85% of the total contribution from the private sector in terms of all business metrics. Over 207,000 direct full- and part-time jobs were supported by private landscaping and tree care services in various aspects of urban trees management, plantation, and arboriculture services. Retailers and wholesalers involved in equipment and

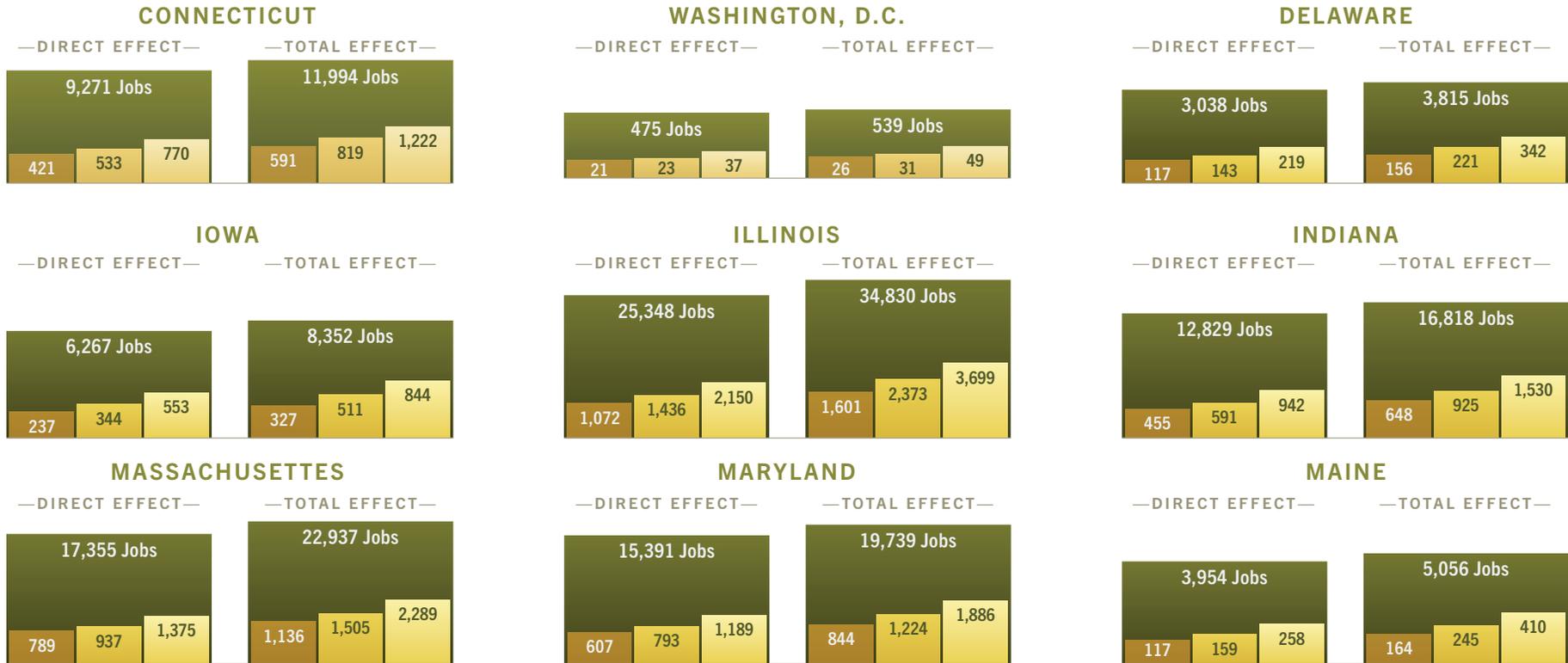
supplies needed in urban forestry also contributed over \$872 million in industry output directly by supporting over 20,000 direct jobs in the region. The numbers were even higher when we accounted for indirect and induced effects in the regional economy stemming from direct employment and value-added services in urban forestry. In aggregate (direct, indirect, and induced effects), the private industries involved in urban forestry contributed over \$32 billion in industry output and about \$22 billion in value-added by employing over 331,400 people in the 21-state NE MW region.

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F16 SUMMARY OF URBAN FORESTRY ECONOMIC CONTRIBUTIONS BY STATES IN 2018

● Labor Income (million \$) ● Value-Added (million \$) ● Industry Output (million \$) ● Employment/Jobs

*Total effects from the individual state-level numbers do not sum to the total regional results because of the leakage effects



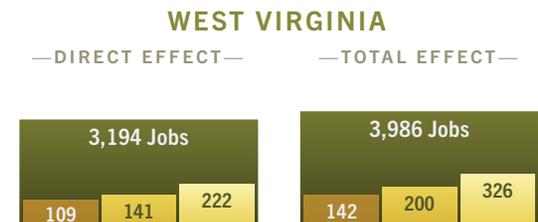
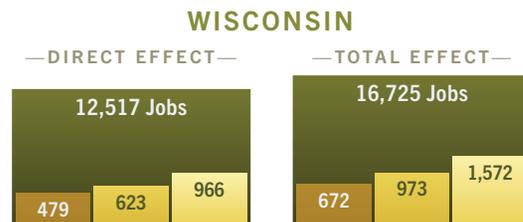
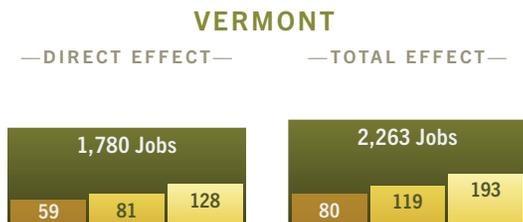
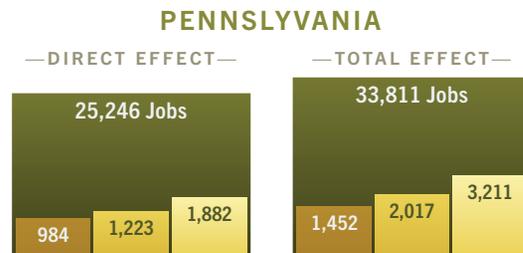
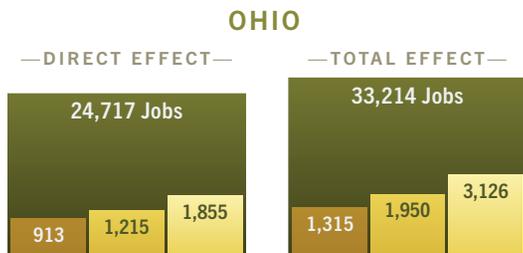
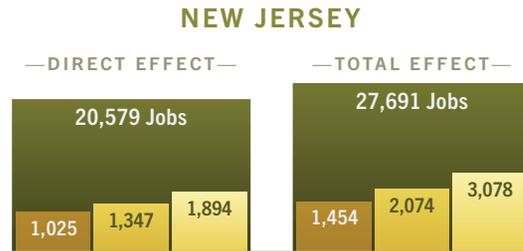
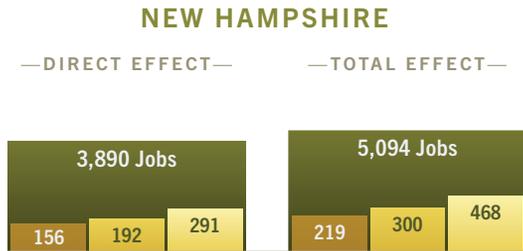
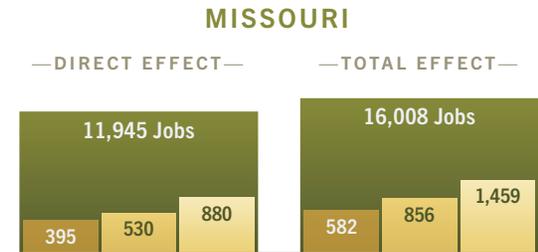
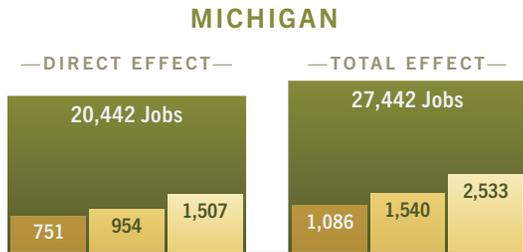
In order to explore the state-specific economic contribution analysis of urban forestry, we also estimated the state-level IMPLAN models for all 21 states separately. Figure 17 reports the economic contribution analysis of urban forestry by state. Among the 21 states included in the regional analysis, the top five states in terms of the total jobs are Illinois, New York, Pennsylvania, Ohio, and New Jersey, all of which had over 27,600 jobs supported by urban forestry

in their respective state economies. Other notable states with employment contributions exceeding over 22,000 jobs include Michigan and Massachusetts. States with over 15,000 total jobs supported by urban forestry in 2018 are Maryland, Indiana, Wisconsin, Missouri, and Minnesota. Other state-specific business metrics in both direct and total contributions are presented in (F17).

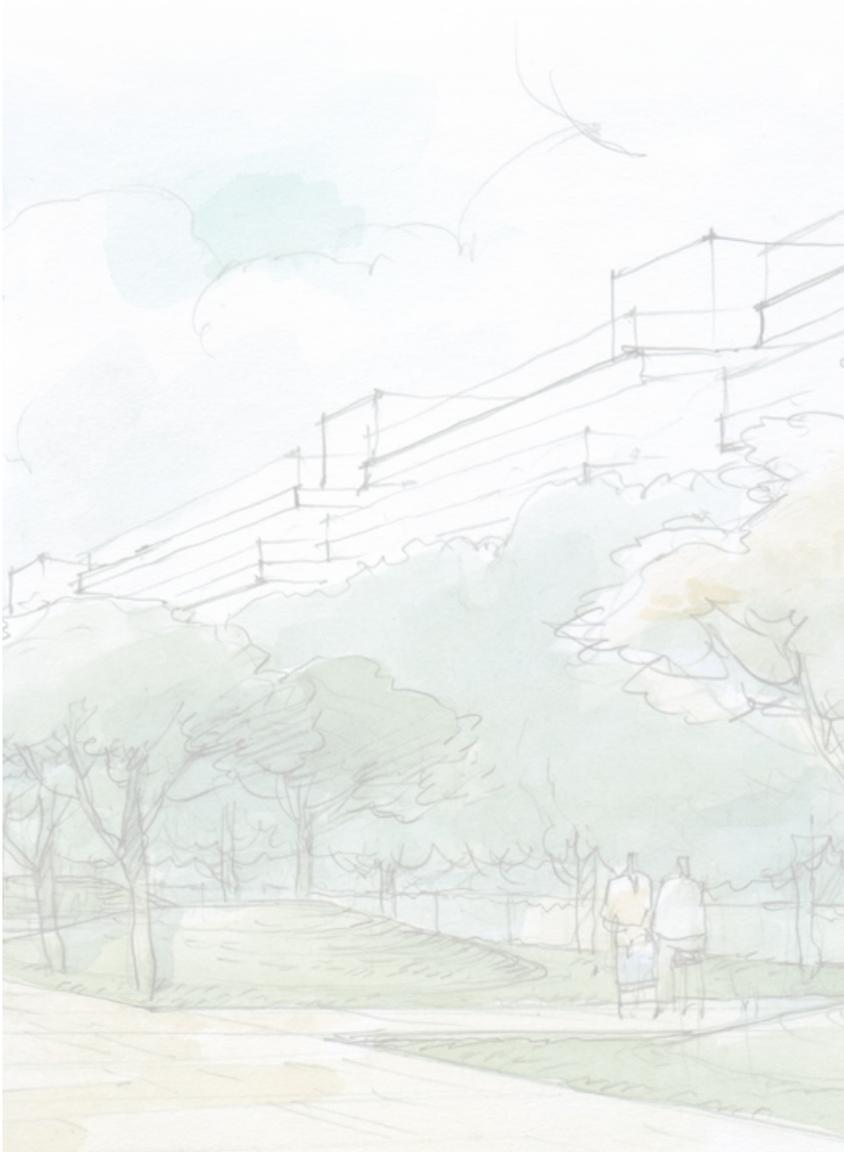
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F17 SUMMARY OF URBAN FORESTRY ECONOMIC CONTRIBUTIONS BY STATES IN 2018

● Labor Income (million \$)
 ● Value-Added (million \$)
 ● Industry Output (million \$)
 ● Employment/Jobs



X. ECOSYSTEM SERVICES



As a proxy for urban and community forests, this analysis uses the boundaries of Census places, a category encompassing both incorporated, as well as densely-settled unincorporated, communities (U.S. Census Bureau, 2018). This is a broader geographic classification than only the incorporated places outlined in discussions of public urban forestry employment above. Over 88 million people live in these places out of a total 127 million that live across the 21-state region, meaning these urban forests provide nearby nature for 69% of the region's population.

Urban forests offer myriad ecosystem services to these places, from building community culture, to improving mental and emotional health, to offering food and habitat for wildlife. However, only some of these ecosystem services are quantifiable in economic terms on a large scale across the region. These include the removal of air pollutants, the reduction of stormwater, and the storage and sequestration of carbon. The pilot incorporation of Urban Forest Inventory and Analysis (UFIA) data enabled the estimation of additional ecosystem services for Wisconsin only. The UFIA-informed results were not integrated into the regional numbers, so that the region was approached consistently. i-Tree Landscape was used to tabulate these services for all 12,924 places within the 21 states. It should be noted that the reliance on coarse canopy data for many communities in i-Tree Landscape leads to underestimates of canopy cover resulting in conservative estimates of ecosystem services. Where possible, higher resolution canopy data was used.

Nonetheless, it is estimated that trees cover 27.9% of the combined lands of these communities, saving them \$3.06 billion a year across just those three broad categories of ecosystem services. This includes \$1.36 billion from the removal of air pollutants, \$635 million from the reduction of stormwater and \$1.06 billion from the sequestration of carbon.

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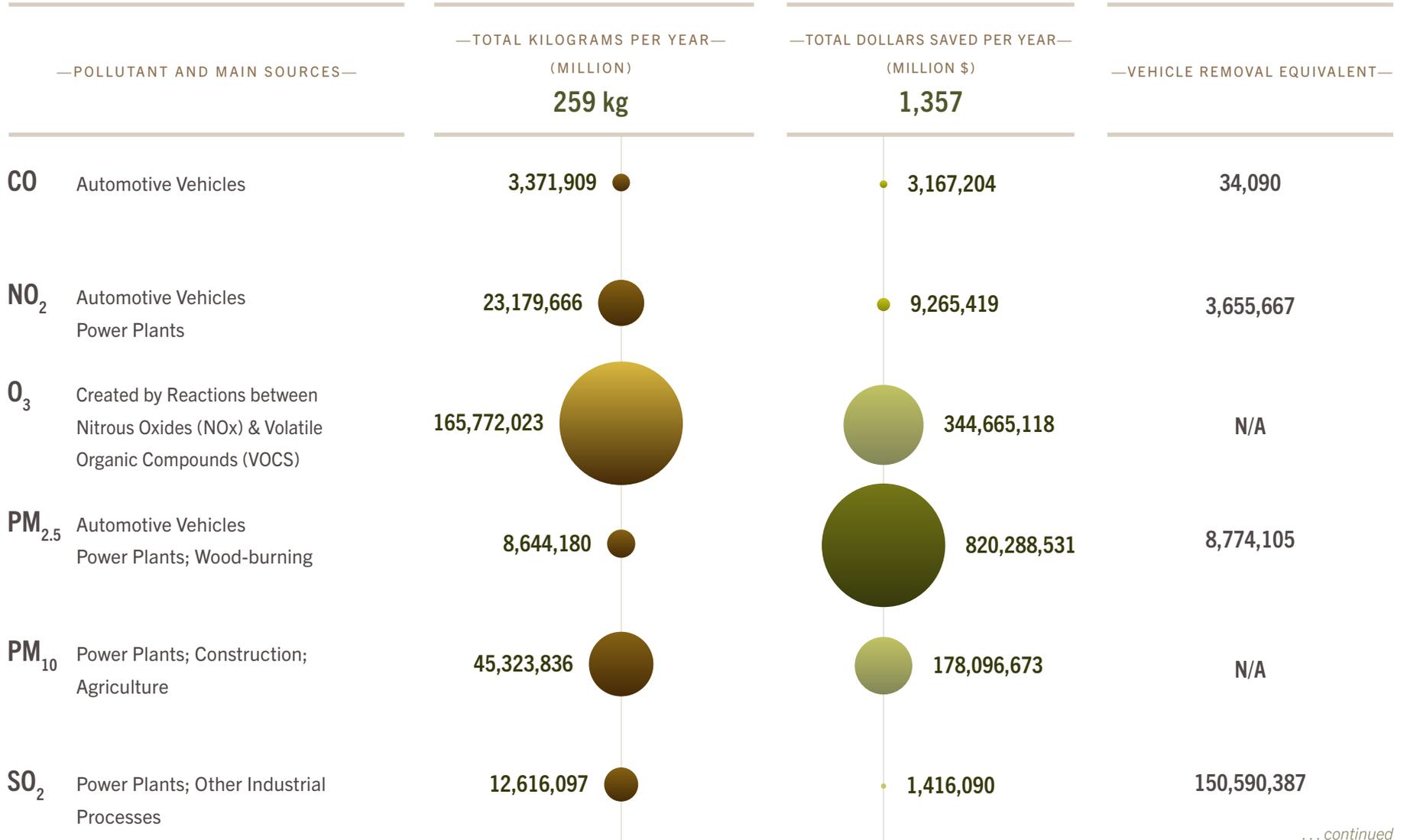
Six different air pollutants were analyzed within i-Tree Landscape: carbon monoxide (CO), nitrogen dioxide (NO₂), ozone (O₃), fine particulate matter (PM_{2.5}), particulate matter (PM₁₀) and sulfur dioxide (SO₂). Table 13 identifies the weight removed, money saved and main emission sources for each of these pollutants. The table also expresses urban forests' pollutant reduction capacity by the equivalent number of vehicles removed from roads.

Trees also have an important role in intercepting and slowing rainwater, as well as preventing some of it from being funneled to grey stormwater infrastructure. In the 21-state region, trees are estimated to intercept 2.392 billion m³ of rainwater a year, ultimately preventing 269 million m³ of it from reaching stormwater systems. To use a colloquial comparison, that is the equivalent of 71,740 Olympic size swimming pools (each 50m x 25m x 3m). The value of that avoided runoff is \$635 million - calculated by the amount of water no longer needed to be managed by wastewater facilities. Of note, additional hydrologic benefits of trees, such as erosion control or evapotranspiration helping to cool communities, are beyond this study.

Finally, urban forests are critical infrastructure for climate change mitigation. Across the region, these community trees store 290 million metric tons of carbon, the equivalent of about 1.06 billion metric tons of CO₂. This carbon storage is valued at \$54.50 billion. Each year, these forests sequester 6 million metric tons of carbon, or the equivalent of 21 million metric tons of CO₂. The annual sequestration of carbon in regional community forests is valued at \$1.06 billion. These monetary values are calculated using the current social costs of carbon within i-Tree Landscape.



F17 OVERVIEW OF AIR POLLUTION REMOVAL BY TREES IN CENSUS PLACES IN THE NORTHEAST-MIDWEST REGION



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The entire region’s trees and forests, including rural areas, store about 5.5 billion metric tons of carbon, at a sequestration rate of 84 million metric tons a year. Thus, using i-Tree Landscape figures, urban and community forests store about five percent of the region’s total forest carbon and sequester about seven percent of the carbon a year. Some urban trees can also cool their surroundings or prevent sunlight or wind from penetrating a building. These processes could reduce emissions by avoiding emissions in the first place. However, estimates of avoided energy usage are not part of this study, except for Wisconsin.

As described in the Executive Summary, one of the objectives of this study was to incorporate Urban Forest Inventory and Analysis (UFIA) data into i-Tree Landscape, to enable improved estimates of air pollution removal, carbon storage and sequestration, and avoided runoff. Furthermore, UFIA data also permits the estimation of electricity and fuel avoidance, the amount of energy carbon avoided, the amount of volatile organic compounds produced by trees, and the compensatory value of trees. Summarized results from the pilot incorporation of Wisconsin UFIA data into i-Tree Landscape are in (T3). Note the UFIA-informed results use urban areas as their boundaries, but the default Landscape results use Census places (U.S. Census Bureau, 2011). Given the significantly smaller area occupied by urban areas than the default places, it seems that localized data incorporated from UFIA produced greater ecosystem services compared to the default i-Tree results. More information is available in the Wisconsin report.

T3 COMPARISON OF SELECTED ECOSYSTEM SERVICES DERIVED FROM UFIA-INFORMED I-TREE LANDSCAPE AND DEFAULT I-TREE LANDSCAPE IN WI

	UFIA-INFORMED I-TREE RESULTS	DEFAULT I-TREE RESULTS
Total area(km²)	4,903	9,280
Carbon storage (metric tons)	11 million	15.1 million
Carbon sequestration (metric tons / year)	453 thousand	303 thousand
Total air pollution removal (kg/year)	13.1 million	16.1 million
Total avoided runoff (m³/year)	23.3 million	12.4 million
Electricity avoided (kwh / year)	499.7 million	NA
Fuel avoided (Btu / year)	8.0 trillion	NA
Carbon emissions avoided (metric tons / year)	265,534	NA
VOC emissions (metric tons / year)	6,090	NA
Compensatory value of trees (\$)	\$32.2 billion	NA

X. CONCLUSIONS

Urban forestry has received considerable attention in recent years, not only for trees' intrinsic and infrastructure values in urban and suburban landscapes but also for the economic significance of various businesses and industries relying on urban forestry. However, estimating the economic contribution of urban forestry is somewhat challenging as it is quite difficult to separate the sector from broader green industries. As a result, estimation of the sector's economic contributions through input-output modeling requires additional effort to characterize industry portions specific to urban forestry. In this report, we outlined our approach to developing a standard methodology and model set-ups to capture urban forestry related businesses and activities exclusively. We then applied our approach to estimate the economic contributions of urban forestry in the 21 Northeast-Midwest states. To this end, our study makes an important methodological contribution and sets a milestone in urban forestry economic contribution analysis. We complemented this analysis with a conservative assessment of ecosystem services, allowing for a more holistic perspective on the economic impact of urban forests.

Results from our regional IMPLAN model suggest that the majority of the urban forestry-related employment opportunities are in the private sector, which collectively represents industries related to urban tree cares and services, nursery and tree production, machinery supplies, and landscape architecture, among others. The results also indicate that landscaping and tree care services were the most dominant private sectors, contributing to more than 237,400 direct jobs in the study region. Interestingly, the magnitude of SAM multipliers in the private sector industries were higher than those associated with the public sectors, which reflects the diversified market channels of private industries and

the subsequent magnified ripple effects in the rest of the economy (Henderson et al., 2017). While employment from urban forestry in the public sectors in the study region is minimal, our results suggest a meaningful contribution of this sector in large metro areas. Public sector investments in urban forestry have paid off through employment opportunities, ripple effects in other sectors of the economy, and ecosystem service-related benefits such as shade and health (Hardy et al., 2000; Donovan, 2017).

The framework and findings documented in this report also have important management and policy implications:

- Using stakeholder input and rigorous discussion as a foundation, we established an exhaustive scope of urban forestry, incorporating the involvements of private, public, non-profit, and higher education institutions in urban forestry.
- Our approach developed an input-output analysis framework for urban forestry with the use of a relatively novel application of the analysis-by-parts method and margins analysis for wholesalers and retailers. This approach is easily generalizable and can be used to estimate comparable results regardless of the study region.
- Our results could provide justification for enhancement of current programs or creation of new measures to support urban forest management.
- The comprehensive nature of this study leads to a complete picture of urban forestry contributions, including areas that require attention.

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- Results from this study could be used to develop targeted technical and financial assistance to jurisdictions that require capacity building.
- Private sector urban forestry industries could also use the results to highlight their importance while communicating with the public and policymakers.
- The consideration of ecosystem services shows that urban forests save communities and society at-large substantial amounts of money, in addition to generating economic activity.

Response rates to the various survey groups that varied widely among the target groups represent a potential caveat of this study. While response rates from the public sector, higher education institutions, and non-profit organizations were relatively higher compared to other studies based on web-based surveys (e.g., Sinclair et al., 2012), the response rate from private businesses (about 3%) was less than expected. The COVID-19 pandemic is one possible reason explaining lower survey responses from private businesses. Nonetheless, the lower response rates are consistent with the finding that web-based surveys may be more effective for the groups with smaller population sizes (Sinclair et al., 2012). To this end, we suggest that future studies adopt a mixed-mode approach utilizing both paper-based and web-based platforms.



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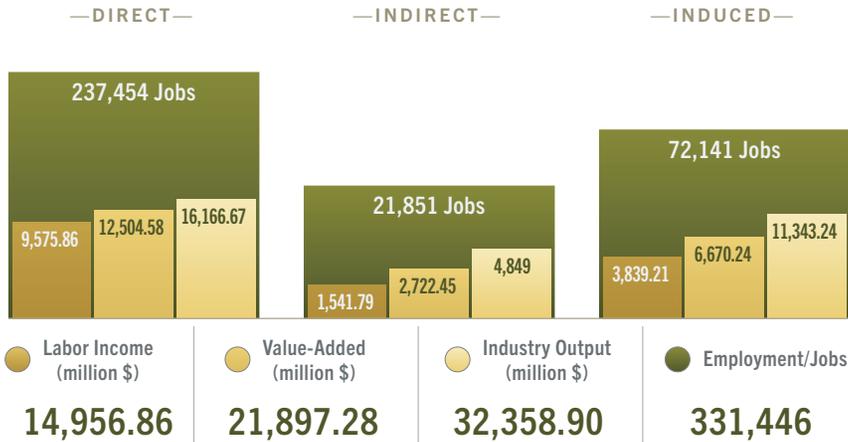
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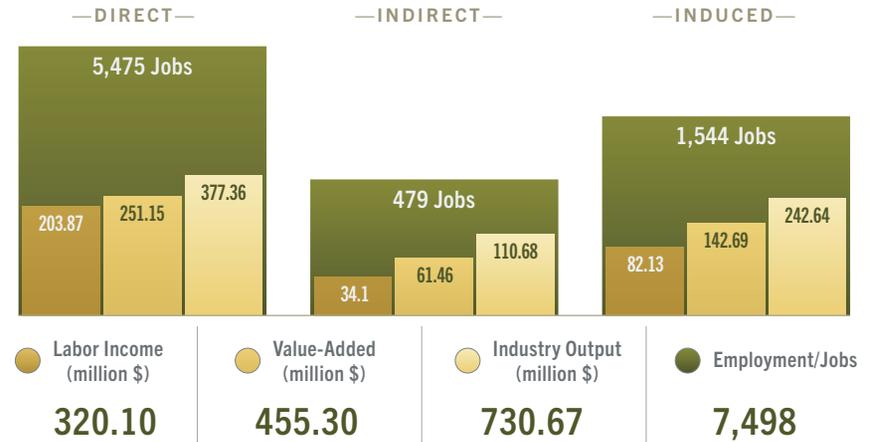
APPENDIX A

ECONOMIC CONTRIBUTIONS (DIRECT, INDIRECT, INDUCED, AND TOTAL) OF ALL SECTORS FEATURED IN THE STUDY

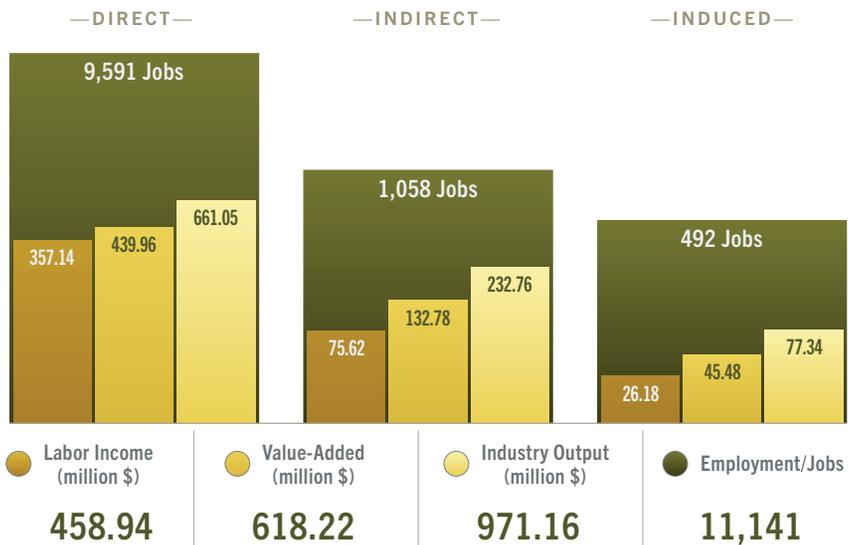
— PRIVATE —



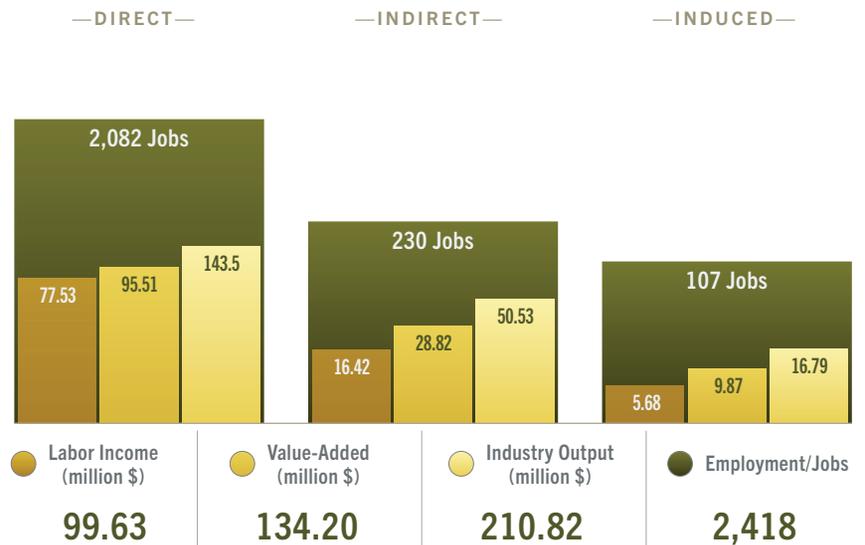
— INVESTOR-OWNED UTILITIES —



— MUNICIPAL GOVERNMENT —



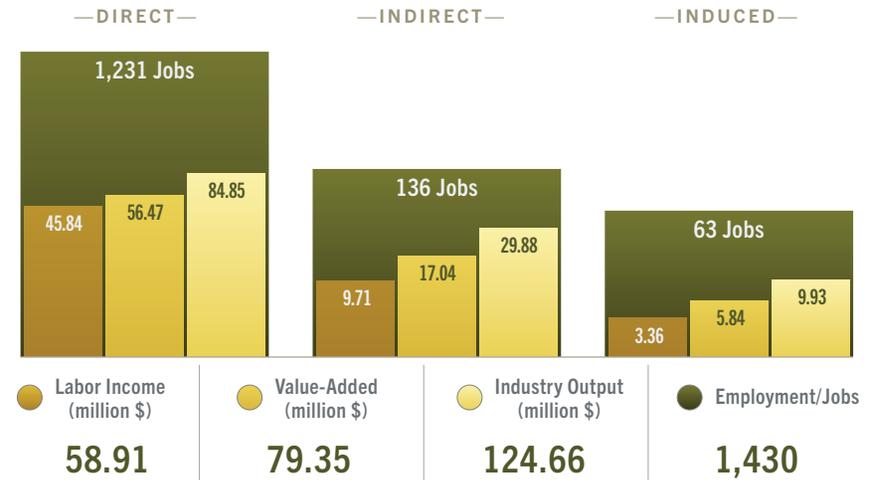
— COUNTY GOVERNMENT —



— STATE AGENCIES —



— HIGHER EDUCATION —



— NON-PROFIT —





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