

Understanding the Economic Contributions of the Arboriculture & Commercial Urban Forestry Sector in New England¹

Daniel A. Lass² and Richard W. Harper^{3*}

Abstract

This study details the results of a survey of firms that was conducted to establish a baseline for a further understanding of the value of the arboriculture/commercial urban forestry (ACUF) sector to the New England Economy, during February and March of 2022. The greatest percentage of responses came from Massachusetts firms (45 percent) followed by Connecticut (about 15 percent) and Maine (about 9 percent). Respondents from New Hampshire, Rhode Island and Vermont represented 6-7 percent of the sample and firms from other states (and international firms) comprised 11 percent of the sample. The distribution of firms' business income earned in each state were consistent with the firm location distribution. Large firms dominated the distribution of 2021 gross income for ACUF firms in this sample with about 48 percent of the respondents reporting gross incomes greater than \$500,000. There was also a relatively large number of small firms (about 10 percent) earning less than \$25,000. The 2021 total gross income of the 119 firms in this sample was estimated to be over \$252 million. Large firms earning over \$1 million in gross income represent 91 percent of the total gross income for this sample. Just over 70 percent of firms' gross income was from private individuals, with about 18 percent from commercial sources. Only about 7 percent was from state and local government. Tree pruning and removal was the predominant activity (over 55 percent), followed by tree fertilization and tree health at about 17 percent. Other tree care activities represented less than 10 percent of gross income.

Index words: firm, income, expenditure, arboriculture, urban forestry, commercial.

Significance to the Horticulture Industry

This research investigated the economic contributions of the arboriculture/commercial urban forestry (ACUF) industry through a survey that was administered to practitioners – arborists and commercial urban foresters – throughout the New England states (Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire, Maine). Economic contribution analysis of this segment of the broader “green industry” enables stakeholders and interested parties to educate legislators, regulatory decision-makers, and others about the importance of the arboriculture/commercial urban forestry sector. Organizations that include land-grant universities and professional associations may use findings from this research to validate and inform training and research opportunities.

Introduction

As interest in community development and beautification continues its ascent, urban centers – and the populations therein – find themselves increasingly con-

ducting local urban greening and tree planting initiatives (Doroski et al. 2020, Eisenman et al. 2021). This is of great importance to potentially large numbers of individuals as current estimates indicate that over 80% of the United States (U.S.) population is currently located in an urban setting, and global predictions indicate that by 2050 over two-thirds (68%) of the world's populace will be urbanized (United Nations 2018). The urban trees that comprise a segment of these urban landscapes are often installed for their affiliated social and ecological benefits that are derived by local residents (Hall and Knuth 2019, Mei et al. 2021, Elton et al. 2022). Community-wide, urban forests have the potential to provide important cost-savings benefits in relation to factors that include utility-related expenditures, and reductions in power plant utilization and emissions (McPherson et al. 1994, McPherson 2007).

Economic values associated with urban trees, however, may not be strictly limited to cost-savings. Assessments of homes may be augmented when located in neighborhoods with mature urban canopy cover, as owners may obtain both higher rental incomes and a higher home sale price in association with the presence of nearby trees (Donovan and Butry 2011, Donovan et al. 2019, Donovan et al. 2021). The presence of urban trees may promote extended periods of consumer shopping, and consumers themselves may be willing to spend more money when shopping in the vicinity of shaded areas (Wolf 2005).

Recent findings indicate that 55% of U.S. households engage in outdoor activities, including beautification through gardening and landscaping, with adults spending \$48 billion USD on lawn and gardening equipment and supplies, annually (Whitinger and Cohen 2021). Though numerous attempts to understand the value of the landscape enhancement, beautification, and urban greening have been undertaken, misunderstandings related to how the “green

Received for publication November 21, 2022; in revised form March 15, 2023.

¹Acknowledgements: We would like to thank the following individuals and organizations: Heather Leff (New England Chapter of the International Society of Arboriculture); Dr. Many Bayer and Candace Powning (University of Massachusetts Amherst); Victoria Wallace (University of Connecticut); Virginia Wood, Carrie Martin (Massachusetts Arborists Association); the New England State Urban & Community Forestry coordinators & staff; the arborists & commercial urban foresters who took the time to participate in this survey.

²Department of Resource Economics, University of Massachusetts, Amherst, MA 01003.

³Department of Environmental Conservation, University of Massachusetts, 160 Holdsworth Way, Amherst, MA 01003.

*Corresponding author. E-mail: rharper@eco.umass.edu.

industry” is specifically defined persist, sometimes resulting in confusion (Parajuli et al. 2022). Urban forestry itself, for example, is comprised of a network of stakeholders limited not just to private residents that plant trees, but that also includes decision-makers, technical professionals (i.e., urban foresters and arborists) and private business principals (Harper et al. 2017, Campbell et al. 2022). Arboriculture is generally regarded as a specialized domain within the broader discipline of urban forestry and is typically defined as the individualized care of a single tree (Miller et al. 2015), or a small number of trees. Hence, while an urban forester (also known as a city arborist or tree warden) is responsible for the management of the totality of the urban trees in a community (Harper et al. 2016), an arborist is more typically associated with the care of fewer numbers of trees on properties with more localized boundaries (O’Herrin et al. 2020).

Contribution analysis frameworks have long been in place to facilitate the understanding of important industries and economic contributors (i.e., the traditional forest industry), yet limited efforts have been undertaken to specifically identify the scope and scale of economic contributions generated by the tree care segment [arboriculture/commercial urban forestry (ACUF)] of the green industry. Though public expenditures related to tree care may be substantial, and often occur with broad support among community residents (Treiman and Gartner 2004, Treiman and Gartner 2005), it has been estimated that the private sector may represent the overwhelming majority (i.e., 92%) of direct jobs and outputs from the green industry (Parajuli et al. 2022).

The purpose of this research, therefore, was to provide germinal descriptive statistics about the ACUF industry in New England to better understand the distribution of firms and annual economic contributions made by the ACUF sector at a rather granular level. For the purpose of this research, we defined arboriculture as the care of typically individual or fewer numbers of trees and shrubs located on residential and commercial properties by private business, and commercial urban forestry as the care of typically larger numbers of municipal trees (i.e., the “urban forest”) by private business.

Materials and Methods

Survey design. An electronic survey was composed and disseminated to arboriculture/commercial urban forestry (ACUF) firms throughout the states comprising the New England region of the United States using Qualtrics (Qualtrics, Provo, UT). The survey consisted of a series of 21 closed and open-ended questions designed following methods outlined by Dillman et al. (2014). Questions were formulated in relation to factors that included annual gross income, number of employees, annual payroll, business tax bill, and business-related impacts associated with the COVID-19 pandemic. In this study, we report descriptive statistics pertaining to these sample firms in 2021. Before formal distribution, the survey was piloted with subject-matter experts, including principals of ACUF firms.

Table 1. Survey of arboriculture/commercial urban forestry (ACUF) firms in New England - In which state is your principal place of business?

State	Survey Respondents		NEC ISA Members	
	Number of firms	Percent of firms	Number of firms	Percent of firms
Connecticut	17	14.8	56	16.8
Maine	10	8.7	18	5.4
Massachusetts	52	45.2	164	49.2
New Hampshire	8	7.0	42	12.6
Rhode Island	7	6.1	14	4.2
Vermont	8	7.0	23	6.9
Other (please specify):	13	11.3	16	4.8
	115	100.0	333	100.0

Survey distribution. In accordance with methods outlined by Dillman et al. (2014), the survey was initially disseminated on 15 February 2022 to principals of ACUF firms operating in the following states: Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire, Maine. A clearly defined population of ACUF firms does not exist; thus, to reach as many firms as possible the survey was formally disseminated through direct partnership with the New England Chapter of the International Society of Arboriculture (NEC ISA), who distributed the survey via their list-serve. The Massachusetts Arborist Association (MAA) and state agency urban forestry coordinators were also asked to help notify stakeholder groups about the survey through their respective state-wide networks. Follow-up emails were sent at one-week intervals and an email was sent on 15 March 2022 announcing that the survey deadline had been extended through 21 March 2022, with a final email being sent the day before the formal close of the survey.

Results and Discussion

Arboriculture/commercial urban forestry operations in New England. A total of 210 responses were received (Table 1). An initial question asked if the respondent was a business owner/representative of an ACUF firm that operated during 2021: 80 percent (168) of the respondents said “yes,” 19 percent (40) replied “no,” and two respondents did not answer the question. Those who replied “no” ended the survey. Respondents were then asked if at least 50 percent of their income was from ACUF related activities. There were 119 responses to this question and about 97 percent (115) replied “yes.” There was significant attrition at this point with 49 respondents choosing not to answer this initial question about firm income. Respondents were asked about the state that was the principal place of business for their firm (see Table 1 for a comparison of the distribution of firms across the six New England states for the survey respondents and for NEC ISA members). Those in the “other” category had principal places of business in states across the U.S.; there were international firms as well. As expected, the distribution for our sample shows that ACUF firms are more highly concentrated in the most populous states of Connecticut and Massachusetts, and conversational follow-

Table 2. Survey of arboriculture/commercial urban forestry (ACUF) firms in New England - Distribution of sample firms by 2021 business gross income (n=119).

Gross Income – 2021	Number of firms	Percent of firms	Cumulative percent
Less than \$25,000	12	10.1	10.1
\$25,000 - \$49,999	7	5.9	16.0
\$50,000 - \$74,999	4	3.4	19.3
\$75,000 - \$99,999	8	6.7	26.1
\$100,000 - \$149,999	4	3.4	29.4
\$150,000 - \$199,999	6	5.0	34.5
\$200,000 - \$299,999	9	7.6	42.0
\$300,000 - \$399,999	5	4.2	46.2
\$400,000 - \$499,999	7	5.9	52.1
\$500,000 - \$749,999	13	10.9	63.0
\$750,000 - \$999,999	5	4.2	67.2
\$1,000,000 - \$2,499,999	16	13.4	80.7
\$2,500,000 - \$4,999,999	9	7.6	88.2
\$5,000,000 - \$10,000,000	5	4.2	92.4
More than \$10,000,000	9	7.6	100.0
	119	100.0	

ups with industry representatives suggested these results were aligned with their expectations.

Gross income of ACUF firms and total contributions to the New England economy. Respondents were asked about the gross income of their firm in 2021 (see Table 2 for a summary of results). There were initially 168 respondents, but a number of the respondents declined to answer the income question. Income questions often cause apprehension among respondents and we chose to use a categorical question to help alleviate concerns about providing exact income values. However, there was still attrition in our sample either due to hesitation or perhaps timing of the survey (see Table 2 that identifies the income distribution for our sample, n = 119). The income distribution is fairly “top heavy”, with about 48% of the firms reporting gross income of over \$500,000. There are also a relatively large number of very small firms (about 10%) earning <\$25,000. The median gross income category for this sample was \$400,000 - \$499,999. While the median indicates the middle of the income distribution, it is not especially useful

for a distribution that is bimodal with a large number of small firms (nearly 30% earned less than \$150,000) and a large number of large firms (over 30% earned over \$1,000,000).

We used midpoints for the categories to estimate the distribution of total gross income across firm sizes for this sample (see Table 3 for estimates of the percentage of 2021 total sample gross income for each income category). To estimate 2021 total sample gross income, the midpoints of the gross income categories were multiplied by the number of firms in that category. For example, there were 12 firms in our sample that earned less than \$25,000. The estimated gross income for that category was determined to be \$150,000 (12 x \$12,500). A conservative value of \$15 million was used for the final category of “more than \$10 million” because there was no midpoint. The estimated 2021 total gross income for all firms in our sample using this method was more than \$252 million. The smallest firms (earning less than \$25,000) captured less than one percent of our sample’s estimated total gross income, while the largest firms (more than \$10 million) represented over 50 percent of the estimated total sample gross income. Firms earning over \$1 million in gross income represented about one-third of all firms (39 of 119 firms), and those firms represented over 91% of the 2021 total sample gross income. Thus, our sample suggests the substantial economic contribution of the ACUF industry is dominated by the largest firms in the ACUF sector and those firms represented an estimated \$229,750,000 – over 91% of the 2021 total sample gross income.

The aforementioned method estimated contributions only for the 119 ACUF firms in our sample that provided information regarding gross income. NEC ISA membership data suggest 333 ACUF firms in operation in New England. We estimated total gross income for all NEC ISA members by assuming the same income distribution of firms and increasing the number of firms from 119 to 333. For example, the 12 firms earning less than \$25,000 increased to 34 firms, and the total gross income for this category increased to \$425,000. The total gross income for all 333 NEC ISA members was estimated to be \$703,037,500 following this method. This may over or

Table 3. Survey of arboriculture/commercial urban forestry (ACUF) firms in New England - Estimated 2021 total sample gross income and percentage of 2021 total sample gross income by category of firms (n=119).

Gross income – 2021	Number of firms	Midpoint	Estimated total income	Percent of total 2021 income
Less than \$25,000	12	\$ 12,500	\$ 150,000	0.06%
\$25,000 - \$49,999	7	\$ 37,500	\$ 262,500	0.10%
\$50,000 - \$74,999	4	\$ 62,500	\$ 250,000	0.10%
\$75,000 - \$99,999	8	\$ 87,500	\$ 700,000	0.28%
\$100,000 - \$149,999	4	\$ 125,000	\$ 500,000	0.20%
\$150,000 - \$199,999	6	\$ 175,000	\$ 1,050,000	0.42%
\$200,000 - \$299,999	9	\$ 250,000	\$ 2,250,000	0.89%
\$300,000 - \$399,999	5	\$ 350,000	\$ 1,750,000	0.69%
\$400,000 - \$499,999	7	\$ 450,000	\$ 3,150,000	1.25%
\$500,000 - \$749,999	13	\$ 625,000	\$ 8,125,000	3.22%
\$750,000 - \$999,999	5	\$ 875,000	\$ 4,375,000	1.73%
\$1,000,000 - \$2,499,999	16	\$ 1,750,000	\$ 28,000,000	11.10%
\$2,500,000 - \$4,999,999	9	\$ 3,250,000	\$ 29,250,000	11.59%
\$5,000,000 - \$10,000,000	5	\$ 7,500,000	\$ 37,500,000	14.86%
More than \$10,000,000	9	\$ 15,000,000	\$ 135,000,000	53.51%
	119		\$ 252,312,500	

Table 4. Survey of arboriculture/commercial urban forestry (ACUF) firms in New England - Mean percentage of 2021 gross income earned in New England states (n=115).

Percent of gross income by state	Number of firms	Mean percent	No income in this state	All income earned in this state
Connecticut	115	15.4	76.5	9.6
Maine	115	8.7	86.1	5.2
Massachusetts	115	44.4	43.5	35.7
New Hampshire	115	7.8	84.3	6.1
Rhode Island	115	5.9	87.8	0.9
Vermont	115	7.2	87.8	5.2
Other states:	115	10.6	82.6	5.2
Total		100.0		

underestimate total gross income for the ACUF industry depending upon how well our sample represents the gross income distribution of firms. For example, it may overestimate the contributions of very large firms if they were over-represented in the study sample.

Gross income by state and sources of income. Respondents were asked what percentage of their 2021 gross income was earned across the New England states (Table 4). Firms' average percentages of gross income by state are consistent with the principal place of business. For example, Massachusetts was the principal place of business for 45.2 percent of the firms, and 44.4 percent of all firms' gross income was earned in Massachusetts. The final two columns in Table 4 show the percentages of firms that did not earn any gross income in each state, and the percentages of firms that earned all their gross income in that state. Massachusetts had the highest percentage of firms earning all gross income in that state at 35.7 percent (41 firms) and Rhode Island had the lowest at just 0.9 percent (just 1 firm). This shows that a majority of the firms earned all of their gross income in the state of their principal place of business, with the exception of Rhode Island firms. For example, 41 of the 52 Massachusetts firms (78.8 percent) earned all income in Massachusetts. The percentages for the remaining New England firms were: Connecticut 64.7 percent; Maine 60 percent; New Hampshire 87.5 percent; Rhode Island 14.3 percent; and Vermont 75 percent.

The sources of firms' incomes and the activities that generated income for this sample are shown in Tables 5 and 6. There was an increase in the number of firms (n=120) willing to answer these questions. The greatest percentage of ACUF firms' gross income for our sample came from *private individuals* (Table 5). Over 70 percent of their gross income was from *private individuals*,

dwarfing the gross income percentages from *commercial* sources (17.9 percent), *local governments* (5.3 percent), and *state governments* (1.8 percent). Perhaps surprisingly, the largest firms, those with gross incomes of \$500,000 and over, reported an even greater percentage of income from *private individuals* (74.2 percent). They reported slightly lower percentages of gross income from *commercial* and *local governments*, but a slightly higher percentage (2.3 percent) from *state governments*. We focused on providing a snapshot of the ACUF industry by presenting descriptive statistics, but there were a number of exceptions to the averages presented and the large standard deviations illustrated great variation in the percentages reported by these firms. Firms with the greatest gross income (over \$10 million) did earn more of their income (21 percent) from commercial sources and there were firms that earned a majority of their gross income from specific commercial activities (i.e., pruning, fertilizing, planting, etc.).

Tree pruning & tree removal was the most important activity for these ACUF firms, representing 55.3 percent of their gross income on average (Table 6). *Tree fertilizing & tree health care* was next, averaging 16.8 percent of their gross income. Other activities represented less than 10 percent of gross income and *non-arboriculture/commercial urban forestry activities* averaged just 1.1 percent of gross income. Once again, the large standard deviations indicate a great amount of variation in percentages reported. For the largest firms, those with gross incomes of \$500,000 and over, the two top income activities were *tree pruning & tree removal* and *tree fertilizing & tree health*; percentages for the largest firms were greater than the means at 61.9 percent and 19.7 percent, respectively. There were many firms across the size distribution that focused on single activities. For example, some firms earned 100 percent of their gross income from *tree pruning and tree removal*. The maximum reported percentages were 100 percent for all ACUF activities except *tree planting*.

Labor – number of workers employed by ACUF firms. Respondents were asked about the number of full-time, part-time, and seasonal workers they employed during 2021 (Table 7). Full-time workers were defined as those working 30 hours or more per week for at least nine months during the year (Perry and Stack 2009). Part-time workers were defined as those employees working less than 30 hours per week and fewer than nine months during the past year. The final category, seasonal workers, may have worked any number of hours, but fewer than nine months during the past year. Respondents were also reminded to include themselves in their count of workers. The number of respondents reporting employment declined to 109 and

Table 5. Survey of arboriculture/commercial urban forestry (ACUF) firms in New England - Mean percent of 2021 gross income by source (n=120).

Income category	Number of firms	Mean percent	Standard deviation
Commercial (e.g., business campus/grounds)	120	17.9	23.7
Local government (e.g., town/municipal/county grounds, parks, roadways)	120	5.3	9.9
State government (e.g., grounds, parks, roadways):	120	1.8	5.8
Private individuals (e.g., homeowners)	120	70.1	32.8
Other (please specify)	120	4.9	18.0
		100.0	

Table 6. Survey of arboriculture/commercial urban forestry (ACUF) firms in New England - Mean percent of 2021 gross income by arboriculture category (n=120).

Income generating activities	Number of firms	Mean percent	Standard deviation
Tree pruning and tree removal	120	55.3	34.1
Tree fertilizing, pesticide/tree health care applications	120	16.8	21.2
Tree planting	120	4.6	7.3
Consultations (e.g., conducting tree risk assessment, tree appraisal, or an urban forest inventory)	120	8.8	21.7
Landscape services	120	7.4	19.5
Other arboriculture/commercial urban forestry (please specify)	120	6.2	20.5
Non-arboriculture/commercial urban forestry	120	1.1	4.4
		100.0	

one firm did not report part-time and seasonal employment. Decreased response may have been due to survey fatigue or the limited availability of detailed labor information.

Descriptive statistics for the number of 2021 workers are shown in Table 7. The average number of full-time workers was 53.9 workers in 2021. The very large standard deviation and comparing the mean (53.9 full-time workers) to the median (4.0 full-time workers) provided evidence of tremendous variation in employment across firms in this sample. The median indicates that 50 percent of the firms had four or fewer full-time workers in 2021. The third quartile (column labelled Q3 in Table 7) indicates that 75 percent of the firms employed 10 or fewer full-time workers. The number of workers employed by large firms has a very large positive impact on the mean; the median is more representative of full-time employment for firms in the ACUF industry. The mean numbers of part-time and seasonal workers were 2.6 and 4.5 workers, respectively. Again, the median suggests a very different employment profile with at least 50 percent of the firms in this sample hiring no part-time or seasonal workers. The third quartile shows that at least 75 percent of the firms in this sample hired one or fewer part-time and seasonal workers.

The large difference between the median and mean, and the low third quartile, indicate that the distribution for number of full-time workers is skewed to the right. Most firms are small, but the great number of employees (a maximum in the thousands) of the largest firms has a large effect on the mean or average number of full-time workers. The distribution for full-time workers is shown in Figure 1 and clearly illustrates that a majority of the firms in the industry were small, hiring fewer than 10 employees. There are also large firms with many full-time employees that have a profound effect on the average or mean for 2021. Given the shape of the distribution, the quartiles and median are better measures for describing the distribution of full-time employees.

Chronic employee shortages are renowned in the ACUF sector, as evidenced by a recent (2021) green industry

members' survey that indicated that the major issue for tree care businesses during the pandemic (63 percent) related to obtaining qualified employees (Tree Care Industry Association 2021). Respondents of our survey were asked if they found it difficult to hire qualified workers in 2021. More than two-thirds of the respondents (73 respondents or 68.8 percent) answered "Yes." Those that found it difficult were asked how many additional workers they would have hired that year (see Table 8 for descriptive statistics in relation to the number of additional workers that respondents would have hired). On average, these firms would have hired 7.4 full-time workers. The distribution is again skewed-right, with at least 25 percent of the firms only hiring one additional worker. The median shows that at least 50 percent of the firms would have hired no more than two additional workers; 25 percent of the respondents would have hired 3 or more workers (quartile 3). The effect of large firms that would have hired many additional workers causes the mean to be larger than the median. While most of the additional workers hired would have been full-time, the third quartiles indicate at least 25 percent of the firms would have hired one or more part-time or seasonal workers.

NEC ISA membership data suggest a total of 333 firms in the New England region. This may underestimate the number of firms as not all ACUF firms may be members; it may overestimate the number of firms if some firms exited the industry, but neglected to cancel their membership. Assuming that 333 ACUF firms operated in the New England region during 2021, we would increase employment estimates by a factor of 3.05 (number of respondents/NEC ISA membership). Thus, 2021 full-time employment would be 17,945 workers. Similarly, part-time, and seasonal employment numbers would increase to 874 and 1,500, respectively. Our projection of total employment would be 20,319 workers. We do not have information on the distribution of NEC ISA firms by size. If we had a greater proportion of large firms responding to our survey, then these projections would overestimate 2021 employ-

Table 7. Survey of arboriculture/commercial urban forestry (ACUF) firms in New England - Mean number of employees by labor category in 2021 (n=108).

Type of labor	Number of firms	Number of workers	Mean	Standard deviation	Q1	Median	Q3
Full-time (worked 30 hours or more per week, and 9 months or more during the year)	109	5,874	53.9	279.5	1.0	4.0	10.0
Part-time (worked less than 30 hours per week and 9 months or more during the year)	108	286	2.6	17.3	0.0	0.0	1.0
Seasonal (worked any number of hours per week, but less than 9 months of the year)	108	491	4.5	23.6	0.0	0.0	1.0

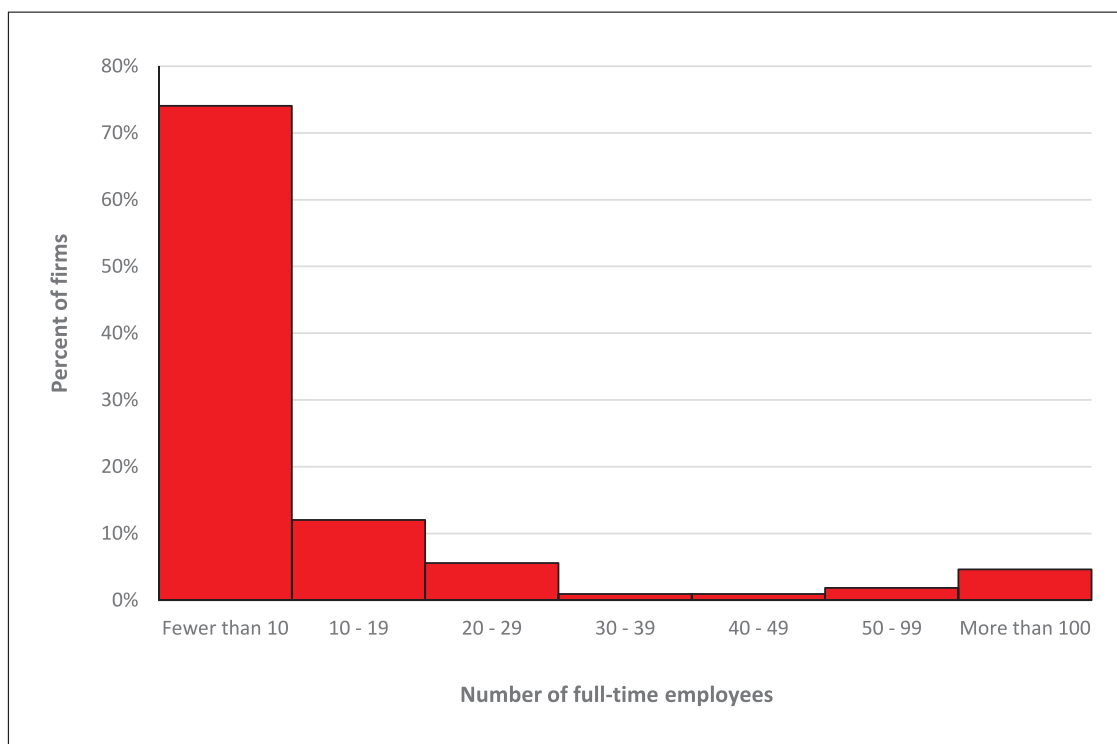


Fig. 1. Survey of arboriculture/commercial urban forestry (ACUF) firms in New England - Distribution for number of 2021 full-time employees of ACUF sample firms.

ment. Given the lack of information about the true population of ACUF firms in New England, we cannot provide confidence interval estimates. Total 2021 employment by firms responding our survey (6,651 workers) clearly underestimates total employment, and our projection of over 20,000 workers may overestimate total 2021 employment.

Total payroll for ACUF firms. Total employment in 2021 was over 6,600 full-time, part-time and seasonal workers (see Table 9 for the distribution of ACUF firms' total payroll for these employees). The distribution for payroll categories is also characterized as a right skewed distribution. The median category, the center of the distribution, for total payroll was \$150,000 - \$199,999. More than 18 percent of the firms in this sample paid less than \$25,000 in total payroll and just over 28 percent paid less than \$50,000 in total payroll. The third quartile, the upper 25 percent of the distribution, is the \$500,000 - \$749,999 category. Thus, at least 25 percent of the firms paid more than \$500,000 in total payroll for 2021.

Gross income for the ACUF industry was dominated by large firms in 2021 (see Table 4). The same is true for total payroll. We estimated the total payroll for the ACUF firms

responding to this survey (see Table 10 for results). Mid-points of each payroll category are multiplied by the number of firms in each category to estimate total payroll for those firms. Note that there is no mid-point for the final category. We used a conservative value of \$15 million, which may lead to an underestimate of the total payroll by these firms. We estimate that the 103 firms responding to the payroll question paid a total of \$128,037,500 in wages, salary, employee taxes and benefits in 2021. Importantly, these are estimates only for the respondents of this survey. At the point in the survey that firms answered the employment questions, participation in our survey declined to 109 respondents. There was a further decline to 103 respondents for the payroll questions. Survey fatigue and reluctance to share income and payroll information were likely factors.

The first two categories of the payroll distribution account for 28.2 percent of the firms; these firms represent just 0.48 percent of the total estimated payroll for the survey respondents (Table 10). The center of the distribution is the \$150,000 - \$199,999 payroll category. We estimate that the lower half of the distribution represents nearly \$4 million in total payroll, but only three percent of the total payroll for all firms responding. Nearly

Table 8. Survey of arboriculture/commercial urban forestry (ACUF) firms in New England - Number of additional employees firms would you have ideally hired in each category if qualified workers were available (n=73).

Type of labor	Number of firms	Mean	Standard deviation	Q1	Median	Q3
Full-time (worked 30 hours or more per week, and 9 months or more during the year)	73	7.4	22.1	1.0	2.0	3.0
Part-time (worked less than 30 hours per week and 9 months or more during the year)	73	1.3	6.0	0.0	0.0	1.0
Seasonal (worked any number of hours per week, but less than 9 months of the year)	73	2.3	8.4	0.0	0.0	1.0

Table 9. Survey of arboriculture/commercial urban forestry (ACUF) firms in New England - Number and percent of firms by total amount of business' payroll in 2021 (n=103).

Total payroll – 2021	Number of firms	Percent of firms	Cumulative percent of firms
Less than \$25,000	19	18.4	18.4
\$25,000 - \$49,999	10	9.7	28.2
\$50,000 - \$74,999	6	5.8	34.0
\$75,000 - \$99,999	6	5.8	39.8
\$100,000 - \$149,999	6	5.8	45.6
\$150,000 - \$199,999	9	8.7	54.4
\$200,000 - \$299,999	7	6.8	61.2
\$300,000 - \$399,999	9	8.7	69.9
\$400,000 - \$499,999	4	3.9	73.8
\$500,000 - \$749,999	7	6.8	80.6
\$750,000 - \$999,999	3	2.9	83.5
\$1,000,000 - \$2,499,999	8	7.8	91.3
\$2,500,000 - \$4,999,999	2	1.9	93.2
\$5,000,000 - \$10,000,000	2	1.9	95.1
More than \$10,000,000	5	4.9	100.0
	103	100.0	

84 percent of firms we surveyed paid less than \$1 million in payroll for 2021. They account for nearly \$15 million in payroll for the ACUF industry, and this is only about 25 percent of the total for all firms responding to our survey. We estimate the largest 16.5 percent of the firms responding represented \$110.5 million in payroll or over 86 percent of payroll for the firms responding to this survey.

Total 2021 payroll for respondents to this survey was estimated at \$128,037,500 using midpoints of the payroll categories and numbers of firms in each payroll category (Table 10). We assume the distribution of the 333 NEC ISA firms follows that of our sample and inflate the number of firms in each category. For example, 18.4 percent of the firms in this sample paid less than \$25,000 in total payroll. We estimate that 61 firms (18.4 percent of 333 NEC ISA members) paid less than \$25,000 in total payroll for a total of \$762,500 for that payroll category. Following this approach for all payroll categories, we estimate the total payroll for the NEC ISA members (333 firms) to be \$417,887,500. This may be an overestimate if our survey

had a greater response rate for large firms. It may underestimate the total industry payroll due to our use of a conservative value for the final category for which a midpoint does not exist. Again, our estimated payroll for the survey respondents of \$128 million is clearly low, and the projection to the NEC ISA firms of nearly \$418 million may overestimate the total payroll for the New England ACUF industry.

Business tax contributions by ACUF firms. Firms also contribute to the economy through local, state, and federal taxes paid. Firms were asked to report their total taxes paid including property, excise, sales and use, and income taxes for 2021 (see Table 11 for total tax categories and number of respondents in each category). As seen in income and payroll distributions (Tables 3 and 10), the distribution is dominated by small firms, but there are a number of large firms paying more than \$500,000 in taxes. The center of this right-skewed distribution is best measured by the median category of \$30,000 - \$39,999 in total taxes paid. Sixty-two percent of the firms had tax bills lower than \$40,000, while 9.9 percent had tax bills that exceeded \$500,000.

Total taxes paid for the sample firms were estimated using numbers of firms in each category, midpoints for the lower categories, and a value of \$750,000 for the top category. For example, the 27 firms that paid less than \$10,000 in taxes were estimated to contribute a total of \$135,000 in local, state and federal taxes (Table 11). Following this approach, we estimated total taxes paid by these 101 ACUF firms to be nearly \$12 million (\$11,870,000) in 2021. The 62 smaller firms with tax bills under \$40,000 (63 percent of the respondents) were estimated to have paid a total of \$980,000 in 2021. The total for these firms represents just over eight percent of the total taxes paid by all sample respondents. By contrast, the very largest firms in the sample (9.9 percent of the respondents) paying more than \$500,000 each in taxes represented an estimated \$7.5 million in taxes in 2021. These firms account for more than 63 percent of the total taxes paid by the 101 survey respondents. The total taxes

Table 10. Survey of arboriculture/commercial urban forestry (ACUF) firms in New England - Estimated 2021 total payroll and percentage of 2021 total sample payroll for each category of firms (n=103).

Total payroll – 2021	Number of firms	Midpoint	Estimated total payroll	Percent of total 2021 payroll
Less than \$25,000	19	\$ 12,500	\$ 237,500	0.19
\$25,000 - \$49,999	10	\$ 37,500	\$ 375,000	0.29
\$50,000 - \$74,999	6	\$ 62,500	\$ 375,000	0.29
\$75,000 - \$99,999	6	\$ 87,500	\$ 525,000	0.41
\$100,000 - \$149,999	6	\$ 125,000	\$ 750,000	0.59
\$150,000 - \$199,999	9	\$ 175,000	\$ 1,575,000	1.23
\$200,000 - \$299,999	7	\$ 250,000	\$ 1,750,000	1.37
\$300,000 - \$399,999	9	\$ 350,000	\$ 3,150,000	2.46
\$400,000 - \$499,999	4	\$ 450,000	\$ 1,800,000	1.41
\$500,000 - \$749,999	1	\$ 625,000	\$ 4,375,000	3.42
\$750,000 - \$999,999	3	\$ 875,000	\$ 2,625,000	2.05
\$1,000,000 - \$2,499,999	8	\$ 1,750,000	\$ 14,000,000	10.93
\$2,500,000 - \$4,999,999	2	\$ 3,250,000	\$ 6,500,000	5.08
\$5,000,000 - \$10,000,000	2	\$ 7,500,000	\$ 15,000,000	11.72
More than \$10,000,000	5	\$ 15,000,000	\$ 75,000,000	58.58
	103		\$ 128,037,500	

Table 11. Survey of arboriculture/commercial urban forestry (ACUF) firms in New England - Distribution of firm total 2021 tax payments and estimated total taxes for each category of firms (n=101).

Total Taxes - 2021	Number of firms	Percent of firms	Mid-point	Estimated total taxes for firms in this category
Less than \$10,000	27	26.7%	\$ 5,000	\$ 135,000
\$10,000 - \$19,999	13	12.9%	\$ 15,000	\$ 195,000
\$20,000 - \$29,999	12	11.9%	\$ 25,000	\$ 300,000
\$30,000 - \$39,999	10	9.9%	\$ 35,000	\$ 350,000
\$40,000 - \$49,999	2	2.0%	\$ 45,000	\$ 90,000
\$50,000 - \$74,999	9	8.9%	\$ 62,500	\$ 562,500
\$75,000 - \$99,999	7	6.9%	\$ 87,500	\$ 612,500
\$100,000 - \$149,999	4	4.0%	\$ 125,000	\$ 500,000
\$150,000 - \$199,999	4	4.0%	\$ 175,000	\$ 700,000
\$200,000 - \$249,999	1	1.0%	\$ 225,000	\$ 225,000
\$250,000 - \$299,999	0	0.0%	\$ 275,000	\$ -
\$300,000 - \$399,999	2	2.0%	\$ 350,000	\$ 700,000
\$400,000 - \$499,999	0	0.0%	\$ 450,000	\$ -
More than \$500,000	10	9.9%	\$ 750,000	\$ 7,500,000
	101	100.0%		\$ 11,870,000

paid is again dominated by large firms consistent with our findings for gross income and payroll.

NEC ISA membership totalled 333 firms and as done for income and payroll we projected tax contributions for the NEC ISA membership using the distribution for our sample and midpoints. We do not have information on firm size distribution for the NEC ISA data and this simple projection may well overestimate the impact of large firms if our survey over-represents that size class. We estimate that the population of NEC ISA firms would contribute \$39,135,743 in local, state and federal taxes. The survey respondents paid a total of nearly \$12 million, which underestimates tax contributions by the ACUF industry. Projecting total industry taxes using the distribution of survey respondents and NEC ISA membership numbers results in an estimate of over \$39 million, which may overestimate the impact.

Important issues for the ACUF industry. Respondents were asked what issues they felt had the greatest impact on their businesses. Survey participants were presented with seven issues that were assembled by industry representatives and New England Extension professionals (Table 12). Respondents were asked to rank the issues as well as include an issue they felt was missing from our list in an open-ended “other” option. A ranking of “1” indicated the issue with the greatest impact on their business and a ranking of “8” indicated the issue with the least impact (see Table 12 for the categories presented to the respondents,

the percent of respondents choosing each ranking, and the average ranking for each issue). A low average ranking indicates an issue with the greatest impact on firms’ businesses.

Labor availability and other labor issues was clearly identified as having the greatest impact on these ACUF firms (n=100) (Table 12). Fifty-one percent of the respondents cited labor as the issue with the greatest impact and an additional six firms added specific labor issues in the open-ended “other” category. Labor had the lowest average ranking at 2.72 (recall that a ranking of “1” indicates the issue with the greatest impact on a firm and a low average ranking indicates the issue with the greatest impact, on average). Labor issues were ranked as one of the top two issues by 62 percent of the firms and as one of the top three issues by 71 percent. Issues including “regulation and regulatory oversight,” “worker safety,” and “health care costs” had similar average rankings of 3.74, 3.97 and 3.74, respectively. These issues were ranked in the top two by about one-third of the firms and in the top three for over 45 percent. The remaining issues had greater average rankings and were ranked in the top two issues by 26 percent or fewer of the firms in our sample.

The open-ended options gave us some interesting observations by respondents. In addition to the number of firms providing specific labor issues, seven firms listed equipment issues including costs, availability, restrictions, and the scale of equipment. Also included in “other” were issues related to business operation and competition,

Table 12. Survey of arboriculture/commercial urban forestry (ACUF) firms in New England - Distributions of respondents’ rankings of issues affecting the ACUF industry.

Issues	Percent of respondents								Number of firms	Average rank
	1	2	3	4	5	6	7	8		
Regulation and regulatory oversight	22.0	14.0	13.0	14.0	10.0	15.0	7.0	5.0	100	3.74
Labor availability and other labor issues	51.0	11.0	9.0	7.0	7.0	2.0	7.0	6.0	100	2.72
Worker safety	14.0	18.0	14.0	8.0	20.0	14.0	7.0	5.0	100	3.97
Health care costs	15.0	19.0	14.0	18.0	13.0	11.0	4.0	6.0	100	3.74
Energy costs	13.0	11.0	17.0	15.0	15.0	7.0	13.0	9.0	100	4.26
Pesticide use	7.1	4.0	5.1	8.1	13.1	18.2	28.3	16.2	100	5.59
Liability	10.0	16.0	15.0	18.0	14.0	11.0	12.0	4.0	100	4.11
Other (please specify)	14.6	4.5	0.0	6.7	0.0	1.1	3.4	69.7	98	5.80

insurance costs and problems with underinsured firms, environmental problems such as climate change and invasive species problems. Education was listed in “other” by several firms including educating homeowners about possible perils related to tree care.

We considered the possibility that firm rankings among these issues may be related to firm size. Correlation analysis was used to investigate associations among measures of firm size including gross income, numbers of full-time employees, and numbers of part-time employees. There were no statistically important associations between the seven issues listed and the three measures of firm size (data not shown). There were important associations among several of the issues. Firms that ranked “labor availability and other labor issues” as having important impacts also ranked “regulation and regulatory oversight” as having important impacts. The same was found to be true for “labor availability and other labor issues” and both “worker safety” and “health care costs.” The lack of important associations with firm size indicates these are important issues across the ACUF industry.

In conclusion, the greatest percentage of survey responses from ACUF firms in the New England region came from Massachusetts (45 percent) followed by Connecticut (about 15 percent) and Maine (about 9 percent). Respondents from New Hampshire, Rhode Island and Vermont represented 6-7 percent of the sample and firms from other states (and international firms) comprised about 11 percent of our sample. The percentages of firms’ business income earned in each state were consistent with firm location.

Large firms dominated the distribution of 2021 gross income for ACUF firms in this sample with about 48 percent of the respondents reporting gross incomes greater than \$500,000. There was also a relatively large number of small firms (about 10 percent) earning less than \$25,000. The 2021 total gross income of the 119 firms in this sample was estimated to be over \$252 million. Large firms earning over \$1 million in gross income represent 91 percent of the total gross income for this sample. Just over 70 percent of firms’ gross income was from private individuals, with about 18 percent from commercial sources. Only about 7 percent was from state and local government. Tree pruning and removal was the predominant activity (over 55 percent) followed by tree fertilization and tree health at about 17 percent. Other activities all represented less than 10 percent of gross income.

On average, firms hired 54 full-time workers in 2021. The number of workers employed by the largest firms dominates the mean – the median number of workers per firm was just four. The average number of part-time workers was 2.6 in 2021 and the average number of seasonal workers was 4.5. Total full-time employment for our sample was 5,874 workers in 2021. Total part-time and seasonal employment for our sample added 286 part-time and 491 seasonal workers in 2021. Total employment for firms in this sample was over 6,600 full-time, part-time, and seasonal employees in 2021; and firms wanted to hire more workers with over two-thirds indicating that it was

difficult to hire qualified workers. On average, firms would have hired an additional 7.4 workers in 2021.

A majority of firms (over 54 percent) in this sample had total payroll amounts of less than \$200,000 and less than 10 percent of the firms had total payrolls over \$1 million. The 2021 total payroll for firms (n=103) in our sample was estimated to be over \$128 million. The largest firms in our sample (16.5 percent of the firms) represented over 86 percent of the total payroll of all firms in our sample. As with gross income, the large firms dominate total employment and total payroll.

In addition to the gross income, employment, and total payroll contributions of the ACUF industry, firms also pay federal, state, and local taxes that support the economy. Responses for taxes paid indicated most firms (63 percent) had total 2021 tax bills under \$40,000. These smaller firms contributed an estimated \$980,000 to federal, state, and local coffers in 2021. The largest firms, about 10 percent of this sample, paid taxes of \$500,000 or more and represented an estimated \$7.5 million in 2021 tax payments. Using mid-points of tax payment categories, we estimated the firms in this sample paid nearly \$12 million in federal, state, and local taxes in 2021.

NEC ISA membership data suggest 333 firms operated in the New England ACUF industry during 2021. Total 2021 gross income for 333 firms was estimated by inflating our estimate for the firms in this sample. We estimate the total 2021 gross income for the NEC ISA membership to be over \$703 million. Employment and payroll numbers for this sample were used to estimate 2021 values for the 333 NEC ISA firms. We estimate just over 20,000 workers and a total payroll of more than \$417 million for the industry. Tax payments by firms in this sample were estimated to be nearly \$12 million and taxes paid by the 333 NEC ICA members was estimated at over \$39 million. These values may over-estimate the economic contributions of the ACUF industry if large firms are over-represented in our sample relative to the true population of ACUF firms.

A majority of the firms in this sample (51 percent) indicated that labor issues had the greatest impacts on their businesses. Labor issues were ranked in the top three for 71 percent of the firms. Several other issues including “regulation and regulatory oversight,” “worker safety,” and “health care costs” were ranked in the top three by over 45 percent of the firms.

What are the economic contributions to the New England region? We found that the sample firms earned 89.4 percent of gross income in the six New England states, on average (Table 4). Thus, we should reduce the estimated total gross income for NEC ISA firms to estimate gross income earned in New England. Using firms’ reported percentages earned in New England and gross income category midpoints, we calculated that the firms in this sample earned \$188,115,375 in the New England states, about 75 percent of the sample firms’ 2021 total gross income. The reduction is greater than expected due to larger firms earning greater percentages of gross income outside the six New England states. Applying this adjustment to the predicted total 2021 gross income for the NEC ISA firms gives an estimate of \$527,278,125 for

gross income earned in the six New England states. This may over or underestimate total gross income for the ACUF industry depending upon how well our sample represents the gross income distribution of firms. This method may well overestimate the contributions of very large firms if they are over-represented in the sample of this study. We also note that the NEC ISA data suggested a greater percentage of firms with a principal place of business in the six New England states than was found in this study. The percentage earned in New England states may be greater than 75 percent. The true impact of ACUF firms' New England gross income is likely between \$500 million and \$700 million.

The same adjustments were made to the NEC ISA estimates for labor (number of workers), total payroll, and total taxes. We estimate that about 15,240 workers (full-time, part-time and seasonal) were employed to generate the gross income earned in the six New England states, with a total payroll of \$313,415,625. Taxes paid by the NEC ISA firms would be \$29,351,807.

Systematic efforts to determine economic contributions made by the ACUF sector of the green industry in New England have been limited, perhaps due in part to the fact that a well-defined population of firms does not exist. This limitation prevents developing a truly random sample and performing inferential statistics, and precludes the generation of confidence interval estimates. The non-probabilistic nature of our convenience sample, however, facilitated responses from an available pool of willing survey participants (Coleman et al. 2023, Etikan 2016, Day 1994) that yielded beneficial statistical data about our sample of firms. These data may inform future research on the ACUF industry, policy and regulation, and training and research initiatives conducted by professional associations, the Cooperative Extension system and other organizations.

Though reliance on industry contacts made it difficult to determine the actual number of firms surveyed, this effort was an example of a strong collaboration among active local stakeholders (Kandel et al. 2010, Keenan et al. 2007), and a successful participatory initiative with industry professionals (Harper et al. 2017, Yin et al. 2017). Conclusive statements cannot be made regarding either response rates or the representativeness of this data in relation to the ACUF industry in New England writ-large, but it was evident that the number of firms across states were consistent with NEC ISA membership numbers. The firms in our sample clearly contribute substantial gross income, employment, payroll and taxes to local, state and federal economies.

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